BACHELORS' DEGREE PROGRAMME

B.Tech

Detailed Syllabi for students admitted to KIIT University

KIIT UNIVERSITY

Declared U/S 3 of U G C A c t, 1956
B h u b a n e s w a r, O r i s s a, I n d i a

ACADEMIC CURRICULA

2014 - 15

BACHELORS' DEGREE PROGRAMME

B.Tech

Course Structures and Detailed Syllabi for students admitted during session 2013-14 & 2014-15

COURSE STRUCTURE FOR FIRST YEAR B.TECH.PROGRAMME AT KIIT UNIVERSITY, BHUBANESWAR (FOR STUDENTS ADMITTED IN THE SESSION 2014-2015)

(Syllabus common to All Branches of B. Tech. Programme)

FIRST SEMESTER (SCHEME-I)

	Theory						
Sl. No	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1.	MA-1001	Mathematics – I	3	1	0	4	4
2.	PH-1001	Physics – I	3	0	0	3	3
3.	CH-1001	Chemistry	3	1	0	4	4
4.	ME-1001	Engg. Mechanics	3	1	0	4	4
5.	EE-1001	Electrical Science	3	0	0	3	3
	Total of Theory					**18**	**18**
	Practical						
1.	PH-1091	Physics Lab – I	0	0	3	3	2
2.	CH-1091	Chemistry Lab	0	0	3	3	2
3.	EE-1091	Electrical Science Lab	0	0	3	3	2
	Total of Practical					**9**	**6**
	Sessionals						
1.	CE-1081	Engg. Graphics	0	0	3	3	2
	Total of Sessional					**3**	**2**
	Grand Total					**30**	**26**

SECOND SEMESTER (SCHEME-I)

	Theory						
Sl. No	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1.	MA-1002	Mathematics – II	3	1	0	4	4
2.	PH-1002	Physics – II	3	0	0	3	3
3.	CS-1001	Programming in C	3	0	0	3	3
4.	EC-1001	Basic Electronics	3	0	0	3	3
5.	HS-1001	Professional Communication	3	0	0	3	3
	Total of Theory					**16**	**16**
	Practical						
1.	PH-1092	Physics Lab – II	0	0	3	3	2
2.	EC-1091	Basic Electronics Lab	0	0	3	3	2
3.	CS-1091	Computer Programming Lab	0	0	3	3	2
	Total of Practical					**9**	**6**
	Sessionals						
1.	ME-1081	Basic Manufacturing Systems	0	0	3	3	2
2.	HS-1081	Professional Communication Lab	0	0	2	2	1
	Total of Sessional					**5**	**3**
	Grand Total					**30**	**25**
3.	EAA – 1	Extra Academic Activity					P/NP

FIRST SEMESTER
(SCHEME-II)

	Theory						
Sl. No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1.	MA-1001	Mathematics – I	3	1	0	4	4
2.	PH-1001	Physics – I	3	0	0	3	3
3.	CS-1001	Programming in C	3	0	0	3	3
4.	EC-1001	Basic Electronics	3	0	0	3	3
5.	HS-1001	Professional Communication	3	0	0	3	3
	Total of Theory					**16**	**16**
	Practical						
1.	PH-1091	Physics Lab – I	0	0	3	3	2
2.	EC-1091	Basic Electronics Lab	0	0	3	3	2
3.	CS-1091	Computer Programming Lab	0	0	3	3	2
	Total of Practical					**9**	**6**
	Sessionals						
1.	ME-1081	Basic Manufacturing Systems	0	0	3	3	2
2.	HS-1081	Professional Communication Lab	0	0	2	2	1
	Total of Sessionals					**5**	**3**
	Grand Total					**30**	**25**

SECOND SEMESTER
(SCHEME-II)

	Theory						
Sl. No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1.	MA-1002	Mathematics – II	3	1	0	4	4
2.	PH-1002	Physics – II	3	0	0	3	3
3.	CH-1001	Chemistry	3	1	0	4	4
4.	ME-1001	Engg. Mechanics	3	1	0	4	4
5.	EE-1001	Electrical Science	3	0	0	3	3
	Total of Theory					**18**	**18**
	Practical						
1.	PH-1092	Physics Lab – II	0	0	3	3	2
2.	CH-1091	Chemistry Lab	0	0	3	3	2
3.	EE-1091	Electrical Science Lab	0	0	3	3	2
	Total of Practical					**9**	**6**
	Sessionals						
1.	CE-1081	Engg. Graphics	0	0	3	3	2
	Total of Sessional					**3**	**2**
	Grand Total					**30**	**26**
2.	EAA – 1	Extra Academic Activity					P/NP

COURSE STRUCTURE FOR B.TECH IN CIVIL ENGINEERING

SEMESTER-III

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	MA2001	Mathematics-III	3	1	0	4	4
2	CE2001	Fluid Mechanics-I	3	1	0	4	4
3	CE2003	Solid Mechanics	3	1	0	4	4
4	CE2005	Surveying	3	0	0	3	3
5	CE2007	Civil Engineering Materials & Construction	3	0	0	3	3
6	CE2009	Environmental Engineering-I	3	0	0	3	3
Total of Theory						**21**	**21**
Practical							
1	CE2091	Environmental Engg. Lab	0	0	3	3	2
2	CE2093	Material Testing Lab	0	0	3	3	2
3	CE2095	Surveying Field Work-I	0	0	3	3	2
Sessional							
1	CE2081	Building Drawings	0	0	3	3	2
Total Practical & Sessional						**12**	**8**
Semester Total						**33**	**29**

SEMESTER-IV

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	MA2004	Numerical Methods	3	1	0	4	4
2	CE2002	Fluid Mechanics-II	3	1	0	4	4
3	CE2004	Structural Analysis-I	3	1	0	4	4
4	CE2006	Transportation Engineering-I	3	0	0	3	3
5	CE2008	Advanced Surveying	3	0	0	3	3
6	CE2012	Design of Concrete Structure-I	3	1	0	4	4
Total of Theory						**22**	**22**
Practical							
1	CE2092	Fluid Mechanics Lab	0	0	3	3	2
2	CE2094	Transportation Engg. Lab.	0	0	3	3	2
3	CE2096	Surveying Field Work-II	0	0	3	3	2
Sessional							
1	HS 2081	Language Lab	0	0	2	2	1
Total Practical & Sessional						**11**	**7**
Semester Total						**33**	**29**

SEMESTER-V

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	CE3001	Structural Analysis-II	3	1	0	4	4
2	CE3003	Water Resources Engineering-I	3	1	0	4	4
3	CE3005	Geotechnical Engineering-I	3	1	0	4	4
4	CE3007	Design of Steel Structure	3	1	0	4	4
5	HS2002	Engineering Economics	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
1	CE3091	Geotechnical Engineering Lab.	0	0	3	3	2
Sessional							
1	CE3081	Hydrology & Irrigation Design	0	0	3	3	2
2	CE3083	Structural Design (Steel)	0	0	3	3	2
3	TP3081	CAT-I	0	0	**2**	**2**	**1**
Total Practical & Sessional						**11**	**7**
Semester Total						**30**	**26**

SEMESTER-VI

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	CE3002	Water Resources Engineering-II	3	1	0	4	4
2	CE3004	Geotechnical Engineering-II	3	1	0	4	4
3	CE3006	Design of Concrete Structures-II	3	1	0	4	4
4	CE3008	Environmental Engineering-II	3	0	0	3	3
5	CE3012	Construction Planning & Management	3	0	0	3	3
Total of Theory					**18**		**18**
Practical							
Sessional							
1	CE3082	Water Resources Design	0	0	3	3	2
2	CE3084	Structural Design (RCC)	0	0	3	3	2
3	CE3086	Geotechnical Engineering Design	0	0	3	3	2
4	CE3088	Estimating & Costing	0	0	2	2	1
5	TP3082	CAT-II	0	0	**2**	**2**	**1**
Total Practical / Sessional					**13**		**8**
Semester Total					**31**		**26**

SEMESTER-VII

Sl. No.	Course Code	Subjects	L	T	P	Total	Credit
1	CE4001	Transportation Engineering-II	3	0	0	3	3
2		Department Elective-I	3	0	0	3	3
3		Department Elective-II/Open Elective	3	0	0	3	3
4		Department Elective-III/Open Elective	3	0	0	3	3
5		Institute Elective	3	0	0	3	3
Total of Theory						**15**	**15**
Practical							
1	CE4091	Concrete & Structure Lab	-	-	3	3	2
Sessional							
1	CE4081	Project Preparation	0	0	6	6	3
2	CE4083	Practical Training	-	-	-	-	2
3	CE4085	Transportation Design	0	0	3	3	2
4	CE4087	Environmental Design	0	0	3	3	2
Total Sessional						**15**	**11**
Semester Total						**30**	**26**

SEMESTER-VIII

Sl. No.	Course Code	Subjects	L	T	P	Total	Credit
1		Department Elective-IV	3	0	0	3	3
2		Department Elective-V/ Open Elective	3	0	0	3	3
3		Department Elective-VI/ Open Elective	3	0	0	3	3
Total of Theory						**9**	**9**
Sessional							
1	CE4082	Project	0	0	9	9	5
2	CE4084	Seminar	0	0	3	3	2
3	CE4086	Comprehensive Viva-Voce	-	-	-	-	2
Total of Sessional						**12**	**9**
Semester Total						**21**	**18**

LIST OF INSTITUTE ELECTIVES

Institute Elective - I

Sl. No.	Subject Code	Subject Name	Credit
1.	HS-3004	Human Resource Management	3
2.	HS-3006	Entrepreneurship	3
3.	HS-3008	Management Concepts & Practices	3

LIST OF DEPARTMENT ELECTIVES

Dept. Elective - I, II & III

1.	CE4031	Concrete Technology	3
2.	CE6231	Finite Element Methods	3
3.	CE6239	Composite Structures	3
4.	CE4033	Structural Dynamics	3
5.	CE4035	Advanced Solid Mechanics	3
6.	CE4037	Reinforced Concrete Repairs and Maintenance	3
7.	CE4039	Pavement Materials	3
8.	CE4041	Engineering Geology	3
9.	CE4043	Machine Foundation Engineering	3
10.	CE6235	Advanced Foundation Engineering	3
11.	CE4045	Open Channel Hydraulics	3
12.	CE4047	Groundwater Hydrology and Management	3
13.	CE4049	Remote Sensing & GIS	3
14.	CE4051	Flood and Drought Estimation and Management	3
15.	CE4053	Solid and Hazardous Waste Management	3
16.	CE4055	Construction Finance Management	3

Dept. Elective - IV, V & VI

1.	CE4032	Structural Analysis-III	3
2.	CE6232	Design of bridges	3
3.	CE4034	Earthquake Engineering	3
4.	CE4036	Advanced Steel Design	3
5.	CE6234	Pre-stressed Concrete	3
6.	CE6242	Soil-Structure Interaction	3
7.	CE6138	Advanced Repairs and Rehabilitation of Structures	3
8.	CE4038	Tunnel Engineering	3
9.	CE4042	Earth and Earth Retaining Structures	3
10.	CE4044	Ground Improvement Engineering	3
11.	CE4046	Traffic Engineering & Transportation Planning	3
12.	CE4048	Pavement Design	3
13.	CE4052	Disaster Management	3
14.	CE6136	Building Services Planning	3
15.	CE4054	Construction Methods & Equipments	3
16.	CE6106	Construction Engineering Practices	3
17.	CE4056	Cost Effective Housing	3
18.	CE6134	Project quality and Safety Management	3
19.	CE4058	Water Power Engineering	3
20.	CE4062	Water Resources Systems	3
21.	CE4064	Environmental Impact Assessment & Auditing	3
22.	CE6244	Optimization Techniques	3

List of Open Electives offered by School of Civil Engineering

Sl. No.	**Semester**	**Course code**	Subjects	Credit	Pre-requisite
1	III	CE2001	Fluid Mechanics-I	4	Nil
2	III	CE2003	Solid Mechanics	4	Engineering Mechanics
3	III	CE2007	Civil Engineering Materials & Construction	3	Nil
4	IV	CE2002	Fluid Mechanics-II	4	Fluid Mechanics-I
5	IV	CE2006	Transportation Engg.-I	3	Nil
6	V	CE3005	Geotechnical Engineering-I	4	Nil
7	V	CE3003	Water Resources Engineering-I	4	Nil
8	VI	CE3004	Geotechnical Engineering-II	4	Geotechnical Engg-I
9	VI	CE3002	Water Resources Engineering-II	4	Water Resources Engg.-I
10	VII	CE4001	Transportation Engg.-II	3	Transportation Engg.-I
11	VIII	CE4064	Environmental Impact Assessment & Auditing	3	Nil
12	VIII	CE4052	Disaster Management	3	Nil

COURSE STRUCTURE FOR B.TECH IN COMPUTER SCIENCE & ENGINEERING

SEMESTER-III

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	MA-2003	Discrete Mathematics	3	1	0	4	4
2	CS-2001	Data Structures & Algorithms	3	1	0	4	4
3	IT-2001	Object Oriented Programming	3	0	0	3	3
4	MA-2001	Mathematics III	3	1	0	4	4
5	EC-2009	Digital Electronic Circuits	3	1	0	4	4
6	CH-2001	Environmental Sciences	2	0	0	2	2
Total of Theory						**21**	**21**
Practical							
1	CS-2091	Data Structures Lab	0	0	3	3	2
2	IT-2091	Object Oriented Programming Lab	0	0	3	3	2
3	EC-2093	Digital Electronic Circuits Lab	0	0	3	3	2
Total Practical						**9**	**6**
Semester Total						**30**	**27**

SEMESTER-IV

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	CS-2004	Database Management Systems	3	1	0	4	4
2	CS-2002	Operating Systems	3	1	0	4	4
3	IT-2002	Programming Tools and Techniques	3	1	0	4	4
4	EC-2004	Introduction to Digital Communication	3	1	0	4	4
5	MA-2002	Mathematics – IV	3	1	0	4	4
Total of Theory						**20**	**20**
Practical							
1	CS-2094	DBMS Lab	0	0	3	3	2
2	CS-2092	Operating System Lab	0	0	3	3	2
3	IT-2092	Programming Tools and Techniques Lab	0	0	3	3	2
Sessional							
1	HS-2081	Language Lab	0	0	2	2	1
Total Practical & Sessional						**11**	**7**
Semester Total						**31**	**27**

SEMESTER-V

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	CS-3001	Design & Analysis of Algorithms	3	1	0	4	4
2	IT-3003	Software Engineering	3	1	0	4	4
3	IT-3001	Computer Networks	3	1	0	4	4
4	CS-3003	Formal Languages and Automata Theory	3	1	0	4	4
5	CS-3005	Computer Organization and Architecture	3	1	0	4	4
Total of Theory						**20**	**20**
Practical							
1	CS-3091	Design & Analysis of Algorithms Lab	0	0	3	3	2
2	IT-3091	Computer Networks Lab	0	0	3	3	2
Sessional							
1	TP-3081	CAT –I	0	0	2	2	1
Total Practical & Sessional						**8**	**5**
Semester Total						**28**	**25**

SEMESTER-VI

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	CS-3002	Compiler Design	3	1	0	4	4
2	IT-3004	Object Oriented System Design	3	1	0	4	4
3	CS-3006	High Performance Computer Architecture	3	1	0	4	4
4	CS-3004	Computer Graphics	3	0	0	3	3
5		Institute Elective I	3	0	0	3	3
Total of Theory						**18**	**18**
Practical							
1	CS-3092	Compiler Design Lab	0	0	3	3	2
2	IT-3098	Software Engineering Lab	0	0	3	3	2
3	CS-3094	Computer Graphics Lab	0	0	3	3	2
Sessional							
1	TP-3082	CAT-II			1	1	1
Total Practical & Sessional						**10**	**7**
Semester Total						**28**	**25**

SEMESTER-VII

Sl. No.	Course Code	Subjects	L	T	P	Total	Credit
1	CS-4001	Artificial Intelligence	3	1	0	4	*4*
2	IT-3002	Data Analytics	3	1	0	4	*4*
3		Departmental Elective I / Open Elective	3	0	0	3	*3*
4		Departmental Elective I I / Open Elective	3	0	0	3	*3*
5		Departmental Elective III /Open Elective	3	0	0	3	*3*
6		Institute Elective II	3	0	0	3	*3*
Total of Theory						**20**	**20**
Practical							
1	IT-3092	Data Analytics Lab	0	0	3	3	2
Sessional							
1	CS-4081	Project Preparation	0	0	6	6	3
2	CS-4083	Practical Training	-	-	-	-	2
Total Practical & Sessional						**9**	**7**
Semester Total						**29**	**27**

SEMESTER-VIII

Sl. No.	Course Code	Subjects	L	T	P	Total	Credit
1		Departmental Elective IV / Open Elective	3	0	0	3	3
2		Departmental Elective V	3	0	0	3	3
3		Departmental Elective VI	3	0	0	3	3
Total of Theory						**9**	**9**
Sessional							
1	CS-4082	Project	0	0	9	9	5
2	CS-4084	Seminar	0	0	3	3	2
3	CS-4086	General Viva Voce	-	-	-	-	2
Total of Sessional						**12**	**9**
Semester Total						**21**	**18**

LIST OF INSTITUTE ELECTIVES

Institute Elective - I

Sl. No.	Subject Code	Subject Name	Credit
1	HS-2002	Engineering Economics	3
2.	HS-2004	Public Finance	3
3.	HS-2006	International Economics	3

Institute Elective - II

1.	HS-3002	Organizational Behaviour	3
2	HS-3004	Human Resource Management	3
3.	HS-3006	Entrepreneurship	3
4.	HS-3008	Management Concepts & Practices	3

LIST OF DEPARTMENT ELECTIVES

Dept. Elective - I

1.	CS-4021	Parallel and Distributed Computing	3
2.	CS-4023	Real-time Systems	3
3.	IT-4021	Computer Security	3
4.	IT-3006	Mobile Computing	3

Dept. Elective – II

1	CS-4041	Pattern Recognition	3
2	CS-4043	Image Processing	3
3.	CS-4045	Optimization Techniques	3
4.	IT-4045	Server Side Computing	3
5.	IT-4041	Information Retrieval	3

Dept. Elective – III

1	CS-4061	Distributed Database Systems	3
2	CS-4063	Simulation and Modeling	3
3.	CS-4065	Distributed Operating System	3
4.	IT-4065	Introduction to DataMining and Warehousing	3
5.	IT-4063	Soft Computing	3

Dept. Elective – IV

1	CS-4022	Software Testing	3
2	CS-4024	Service Oriented Architecture	3
3.	CS-4026	Robotics and Control	3
4.	IT-4026	Natural Language Processing	3
5.	IT-4022	Management Information System	3

Dept. Elective – V

1	CS-4042	Embedded System	3
2	IT-4042	M-Commerce	3
3	IT-4024	Software Project Management	3
4	IT-4025	Cloud Computing	3

Dept. Elective – VI

1	CS-4044	Microprocessor	3
2	CS-4062	Human Computer Interaction	3
3.	CS-4064	Computer Vision	3
4.	IT-4044	Internet of Things	3
5.	IT-4062	CyberLaw and Intellectual Property Rights	3

COURSE STRUCTURE FOR B.TECH IN INFORMATION TECHNOLOGY

SEMESTER-III

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	MA-2003	Discrete Mathematics	3	1	0	4	4
2	CS-2001	Data Structures & Algorithms	3	1	0	4	4
3	IT-2001	Object Oriented Programming	3	0	0	3	3
4	MA-2001	Mathematics III	3	1	0	4	4
5	EC-2004	Digital Electronic Circuits	3	1	0	4	4
6	CH-2001	Environmental Sciences	2	0	0	2	2
Total of Theory						**21**	**21**
Practical							
1	CS-2091	Data Structures Lab	0	0	3	3	2
2	IT-2091	Object Oriented Programming Lab	0	0	3	3	2
3	EC-2092	Digital Electronic Circuits Lab	0	0	3	3	2
Total Practical						**9**	**6**
Semester Total						**30**	**27**

SEMESTER-IV

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	CS-2004	Database Management Systems	3	1	0	4	4
2	CS-2002	Operating Systems	3	1	0	4	4
3	IT-2002	Programming Tools and Techniques	3	1	0	4	4
4	IT-2004	Statistical Techniques	3	1	0	4	4
5	MA-2002	Mathematics – IV	3	1	0	4	4
Total of Theory						**20**	**20**
Practical							
1	CS-2094	DBMS Lab	0	0	3	3	2
2	CS-2092	Operating System Lab	0	0	3	3	2
3	IT-2092	Programming Tools and Techniques Lab	0	0	3	3	2
Sessional							
4	HS-2081	Language Lab	0	0	2	2	1
Total Practical & Sessional						**11**	**7**
Semester Total						**31**	**27**

SEMESTER-V

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	CS-3001	Design & Analysis of Algorithms	3	1	0	4	4
2	IT-3003	Software Engineering	3	1	0	4	4
3	IT-3001	Computer Networks	3	1	0	4	4
4	CS-3003	Formal Languages and Automata Theory	3	1	0	4	4
5	CS-3005	Computer Organization and Architecture	3	1	0	4	4
Total of Theory						**20**	**20**
Practical							
1	CS-3091	Design & Analysis of Algorithms Lab	0	0	3	3	2
2	IT-3091	Computer Networks Lab	0	0	3	3	2
Sessional							
1	TP-3081	CAT–I	0	0	2	2	1
Total Practical & Sessional						**8**	**5**
Semester Total						**28**	**25**

SEMESTER-VI

Theory							
Sl. No.	**Course Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1	CS-3002	Compiler Design	3	1	0	4	4
2	IT-3004	Object Oriented System Design	3	1	0	4	4
3	IT-3002	Data Analytics	3	1	0	4	4
4	IT-3006	Mobile Computing	3	0	0	3	3
5		Institute Elective I	3	0	0	3	3
Total of Theory						**18**	**18**
Practical							
1	CS-3092	Compiler Design Lab	0	0	3	3	2
2	IT-3098	Software Engineering Lab	0	0	3	3	2
3	IT-3092	Data Analytics Lab	0	0	3	3	2
Sessional							
1	TP-3082	CAT–II	0	0	2	2	1
Total Practical and Sessional						**11**	**7**
Semester Total						**29**	**25**

SEMESTER-VII

Sl. No.	Course Code	Subjects	L	T	P	Total	Credit
1	IT-4003	Data Mining	3	1	0	4	4
2	IT-4001	Enterprise Resource Planning	3	1	0	4	4
3		Department Elective I / Open Elective	3	0	0	3	3
4		Department Elective I I / Open Elective	3	0	0	3	3
5		Department Elective III /Open Elective	3	0	0	3	3
6		Institute Elective II	3	0	0	3	3
Total of Theory						**20**	**20**
Practical							
1	IT-4091	Enterprise Resource Planning Lab	0	0	3	3	2
Sessional							
1	IT-4081	Project Preparation	0	0	6	6	3
2	IT-4083	Practical Training	-	-	-	-	2
Total Practical and Sessional						**9**	**7**
Semester Total						**29**	**27**

SEMESTER-VIII

Sl. No.	Course Code	Subjects	L	T	P	Total	Credit
1		Department Elective IV / Open Elective	3	0	0	3	3
2		Department Elective V	3	0	0	3	3
3		Department Elective VI	3	0	0	3	3
Total of Theory						**9**	**9**
Sessional							
1	IT-4082	Project	0	0	9	9	5
2	IT-4084	Seminar	0	0	3	3	2
3	IT-4086	General Viva Voce	-	-	-	-	2
Total of Sessional						**12**	**9**
Semester Total						**21**	**18**

LIST OF INSTITUTE ELECTIVES

Institute Elective –I

Sl. No.	Subject Code	Subject Name	Credit
1.	HS-2002	Engineering Economics	3
2.	HS-2004	Public Finance	3
3.	HS-2006	International Economics	3

Institute Elective –II

1.	HS-3002	Organizational Behaviour	3
2.	HS-3004	Human Resource Management	3
3.	HS-3006	Entrepreneurship	3
4	HS-3008	Management Concept & Practices	3

LIST OF DEPARTMENT ELECTIVES

Department Elective-I

1.	CS-4021	Parallel and Distributed Computing	3
2.	CS-4023	Real-Time Systems	3
3.	IT-4025	Cloud Computing	3
4.	IT-4023	Bioinformatics	3

Department Elective-II

1.	CS-4041	Pattern Recognition	3
2.	CS-4043	Image Processing	3
3.	IT-4045	Server Side Computing	3
4.	IT-4041	Information Retrieval	3
5.	IT-4043	Information Security	3
6.	IT-4065	Introduction To Data Mining & Ware Housing	3

Department Elective-III

1.	CS-4061	Distributed Database Systems	3
2.	CS-4001	Artificial Intelligence	3
3.	IT-4063	Soft Computing	3
4.	IT-4061	Information Coding Techniques	3

Department Elective-IV

1.	CS-4022	Software Testing	3
2.	CS-4024	Service Oriented Architecture	3
3.	IT-4022	Management Information System	3
4.	IT-4024	Software Project Management	3

Department Elective-V

1.	IT-4042	M-Commerce	3
2.	CS-4042	Embedded System	3
3.	CS-4044	Microprocessors	3
4.	CS-4026	Robotics and Control	3
5.	IT-4026	Natural Language Processing	3
6	IT-4044	Internet of Things	3

Department Elective-VI

1.	CS-4062	Human Computer Interaction	3
2.	IT-4062	Cyber Law & Intellectual Property Rights	3
3.	CS-4066	Ethics in Computing	3
4.	CS-3006	High Performance Computer Architecture	3
5.	IT-4064	Multimedia Applications	3
6	CS-4064	Computer Vision	3

List of Open Electives offered by School of Computer Engineering

Sl. No.	Semester	Course code	Subjects	Credit	Pre-requisite
1	VII	CS-4021	Parallel Distributed Computing	3	---
2.	VII	CS-4023	Real Time System	3	---
3.	VII	CS-4041	Pattern Recognition	3	---
4	VII	CS-4061	Distributed Database Systems	3	DBMS
5.	VII	CS-4001	Artificial Intelligence	3	---
6.	VII	IT-4063	Soft Computing	3	---
7.	VIII	CS-4024	Service Oriented Architecture	3	---
8.	VIII	IT-4022	Management Information System	3	---
9.	VIII	IT-4024	Software Project Management	3	---

COURSE STRUCTURE FOR B.TECH IN ELECTRICAL ENGINEERING

SEMESTER-III

Theory							
Sl. No.	**Subject Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1.	MA 2001	Mathematics –III	3	1	0	4	4
2.	EE 2001	Electrical Machines-I	3	1	0	4	4
3.	EE 2003	Network Analysis	3	1	0	4	4
4.	EC 2007	Analog Electronics	3	1	0	4	4
5.	CS 2003	Data Structure and Java Programming	3	1	0	4	4
6.	CH 2001	Environmental Science	2	0	0	2	2
Total Theory						**22**	**22**
Practical							
1.	CS 2093	Data Structure and Java Programming Lab	0	0	3	3	2
2.	EE 2091	Networks & Electronics Circuit Lab	0	0	3	3	2
Sessional							
1.	HS 2081	Language Lab	0	0	2	2	1
Total Practical & Sessional						**8**	**5**
Total of Semester						**30**	**27**

SEMESTER-IV

Theory							
Sl. No.	**Subject Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1.	MA 2002	Mathematics-IV	3	1	0	4	4
2.	EE 2002	Electrical Machines –II	3	1	0	4	4
3.	EC 2009	Digital Electronic Circuits	3	1	0	4	4
4.	EE 2004	Electrical Measurements and Instrumentation	3	1	0	4	4
5.	ME 2016	Thermal Engineering Applications	3	1	0	4	4
Total Theory						**20**	**20**
Practical							
1.	EE 2092	Electrical Measurements and Instrumentation Lab	0	0	3	3	2
2.	EE 2094	Digital & Linear IC Lab	0	0	3	3	2
3.	EE 2096	Electrical Machines Lab	0	0	3	3	2
Total Practical & Sessional						**9**	**6**
Total of Semester						**29**	**26**

SEMESTER-V

Theory							
Sl. No.	**Subject Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1.	EE 3001	Electric Power Transmission & Distribution	3	1	0	4	4
2.		Institute Elective I	3	1	0	4	4
3.	EE 3003	Linear Control Theory	3	1	0	4	4
4.	EE 3005	Power Electronics	3	1	0	4	4
5.	EC 3003	Microprocessors & Microcontrollers	3	1	0	4	4
Total Theory						**20**	**20**
	Practical:						
1.	EE 3091	Power Electronics Lab	0	0	3	3	2
2.	EE 3093	Microprocessors Lab	0	0	3	3	2
3.	EE 3095	Control System Lab	0	0	3	3	2
Sessional							
1.	TP 3081	CAT-I	0	0	2	2	1
Total Practical & Sessional						**11**	**7**
Total of Semester						**31**	**27**

SEMESTER-VI

Theory							
Sl. No.	**Subject Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1.	EE 3002	Power Systems Operation & Control	3	1	0	4	4
2.	EE 3004	Electromagnetic Field	3	0	0	3	3
3.	EC 3009	Communication Engineering	3	1	0	4	4
4.	EC 3008	Introduction to Digital Signal Processing	3	1	0	4	4
5.		Institute Elective-II	3	0	0	3	3
6.		Department Elective-I / Open Elective	3	0	0	3	3
Total Theory						**21**	**21**
Practical							
1.	EE 3092	Power Systems Lab	0	0	3	3	2
Sessional:							
1.	EE 3082	Electrical Machine Design	0	0	3	3	2
2.	TP 3082	CAT-II	0	0	2	2	1
Total Practical & Sessional						**8**	**5**
Total of Semester						**29**	**26**

SEMESTER-VII

Theory							
Sl. No.	**Subject Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1.	EE 4001	Electric Drives	3	1	0	4	4
2.	EE 4003	Switch Gear and Protection	3	0	0	3	3
3.	EE 4005	Renewable Energy Systems	3	0	0	3	3
4.		Department Elective-II / Open Elective	3	0	0	3	3
5.		Department Elective-III / Open Elective	3	0	0	3	3
Total Theory						**16**	**16**
Practical:							
1.	EE 4091	Electric Drives Lab	0	0	3	3	2
Sessional:							
1.	EE 4081	Project Preparation	0	0	6	6	3
2.	EE 4083	Practical Training	-	-	-	-	2
3.	EE 4085	Power System Design	0	0	3	3	2
Total Practical & Sessional						**12**	**9**
Total of Semester						**28**	**25**

SEMESTER-VIII

Theory							
Sl. No.	**Subject Code**	**Subjects**	**L**	**T**	**P**	**Total**	**Credit**
1.	EL 4001	Industrial Automation & Control	3	0	0	3	3
2.		Department Elective- IV/Open Elective	3	0	0	3	3
3.		Department Elective-V	3	0	0	3	3
4.		Department Elective-VI	3	0	0	3	3
Total Theory						**12**	**12**
Sessional:							
1.	EE 4082	Project	0	0	9	9	5
2.	EE 4084	Seminar	0	0	3	3	2
3.	EE 4086	Comprehensive Viva	-	-	-	-	2
Total Practical & Sessional						**12**	**9**
Total of Semester						**24**	**21**

LIST OF INSTITUTE ELECTIVES

Institute Elective-I

Sl. No.	Subject Code	Subject Name	Credit
1.	HS 2002	Engineering Economics	3
2.	HS 2004	Public Finance	3
3.	HS 2006	International Economics	3

Institute Elective-II

1.	HS 3002	Organizational Behaviour	3
2.	HS 3004	Human Resource Management	3
3.	HS 3006	Entrepreneurship	3
4.	HS 3008	Management Concepts & Practices	3

LIST OF DEPARTMENT ELECTIVES

Elective- 1

1.	CS 3052	RDBMS	3
2.	EE 3022	Power Apparatus Design	3
3.	EE 3024	Principles of Industrial Instrumentation	3
4.	EE 3026	Electrical Engineering Materials	3

Elective- II

1.	EE 4021	Power Station Engineering	3
2.	EE 4023	Installation, Commissioning and Maintenance of Electrical Equipments	3
3.	EE 4027	Instrumentation for Power Industries	3
4.	EE 6138	Energy Management and Audit	3

Elective- III

1.	EE 6121	Computer Application in Power System	3
2.	EE 4033	Modern Control Theory	3
3.	EE 4035	Utilization of Electric Power	3
4.	EE 6134	Bio Power Engineering	3

Elective- IV

1.	EE 6123	Power Market Reforms	3
2.	EE 4032	Power Quality	3
3.	EI 4022	Virtual Instrumentation	3
4.	EE 6136	Wind Power Engineering	3

Elective- V

1.	EE 4036	High voltage Engineering	3
2.	EE 4034	Advanced Power Electronics	3
3.	EI 4032	Biomedical Instrumentation	3
4.	EE 6132	Solar Power Engineering	3

Elective- VI

1.	EE 4038	High Voltage AC & DC Transmission	3
2.	EE 4040	Electric Traction and Drive	3
3.	EE 6122	Computational Intelligent controllers	3
4.	EE 6139	Illumination Engineering	3

List of Open Electives offered by School of Electrical Engineering

Sl. No.	Semester	Subject Code	Subjects	Credit	Pre-requisite
1.	IV	EE2006	Introduction to Electrical Machines and Power Electronics	03	Electrical Science, Basic Electronics
2.	VII	EE4005	Renewable Energy Systems	03	Electrical Science, Chemistry
3.	VII	EE6138	Energy Management and Audit	03	Electrical Science, Chemistry
4.	VIII	EE6139	Illumination Engineering	03	Electrical Science, Physics
5.	VIII	EE6134	Bio Power Engineering	03	Chemistry
6.	VIII	EE6132	Solar Power Engineering	03	Physics

COURSE STRUCTURE FOR B.TECH IN ELECTRONICS & TELECOMMUNICATION ENGINEERING

SEMESTER-III

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credits**
1.	MA2001	Mathematics – III	3	1	0	4	4
2.	EC2001	Analog Electronic Circuits – I	3	1	0	4	4
3.	EC2003	Signals & Systems	3	0	0	3	3
4.	EE2003	Network Analysis	3	1	0	4	4
5.	EC2005	Semiconductor Devices	3	0	0	3	3
6.	CS2003	Data Structure & Java Programming	3	1	0	4	4
Total of Theory						**22**	**22**
Practical							
7.	EC2091	Electronic Circuit and Networks Lab	0	0	3	3	2
8.	CS2093	Data Structure & Programming Lab	0	0	3	3	2
Sessional							
9.	HS2081	Language Lab	0	0	2	2	1
Total of Practical & Sessional						**8**	**5**
Semester Total						**30**	**27**

SEMESTER-IV - ELECTRONICS & TELECOMMUNICATION ENGINEERING

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credits**
1.	MA2002	Mathematics – IV	3	1	0	4	4
2.	EC2002	Analog Electronic Circuits – II	3	1	0	4	4
3.	EC2006	Analog Communication Techniques	3	1	0	4	4
4.	EC2008	Measurements & Instrumentation	3	1	0	4	4
5.	EC2009	Digital Electronic Circuits	3	1	0	4	4
6.	CH2001	Environmental Science	2	0	0	2	2
Total of Theory						**22**	**22**
Practical							
7.	EC2092	Analog Integrated Circuits Lab	0	0	3	3	2
8.	EC2093	Digital Electronic Circuits Lab	0	0	3	3	2
Total of Practical						**6**	**4**
Semester Total						**28**	**26**

SEMESTER-V - ELECTRONICS & TELECOMMUNICATION ENGINEERING

Theory							
Sl.No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credits**
1.	EC3001	Electromagnetic Theory	3	1	0	4	4
2.	EC3003	Microprocessors & Microcontrollers	3	1	0	4	4
3.	EL3001	Control Systems	3	1	0	4	4
4.	EC3005	Digital Communication Techniques	3	1	0	4	4
5.		Institute Elective – I	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
6.	EC3091	Communication Engineering Lab	0	0	3	3	2
7.	EC3093	Microprocessor & Microcontroller Lab	0	0	3	3	2
8.	EI3093	Control & Instrumentation Lab	0	0	3	3	2
Sessional							
9.	TP3081	C A T – I	2	0	0	2	1
Total of Practical & Sessional						**11**	**7**
Semester Total						**30**	**26**

SEMESTER-VI - ELECTRONICS & TELECOMMUNICATION ENGINEERING

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credits**
1.	EC3002	Antenna & Wave Propagation	3	1	0	4	4
2.	EC3004	VLSI Design	3	0	0	3	3
3.	EC3007	Digital Signal Processing	3	1	0	4	4
4.		Dept. Elective – I/Open Elective	3	0	0	3	3
5.	EC3006	Data Communication & Networking	3	1	0	4	4
Total of Theory						**18**	**18**
Practical							
6.	EC3094	VLSI Lab	0	0	3	3	2
7.	EC3095	DSP Lab	0	0	3	3	2
8.	EC3096	Electronic System Design & Simulation Lab	0	0	3	3	2
Sessional							
9.	TP3082	C A T – II	2	0	0	2	1
Total of Practical & Sessional						**11**	**7**
Semester Total						**29**	**25**

SEMESTER-VII - ELECTRONICS & TELECOMMUNICATION ENGINEERING

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credits**
1.	EC4001	RF & Microwave Engineering	3	1	0	4	4
2.		Institute Elective – II	3	0	0	3	3
3.	EC4003	Wireless & Mobile Communication Engineering	3	1	0	4	4
4.		Dept. Elective – II	3	0	0	3	3
5.	CS4003	Computer Organization and Operating Systems	3	1	0	4	4
Total of Theory						**18**	**18**
Practical							
6.	EC4091	Microwave & Antenna Lab	0	0	3	3	2
7.	EC4093	Wireless Communication & Networking Lab	0	0	3	3	2
Sessional							
8.	EC4081	Project Preparation	0	0	6	6	3
9.	EC4083	Practical Training	-	-	-	-	2
Total of Practical & Sessional						**12**	**9**
Semester Total						**30**	**27**

SEMESTER-VIII - ELECTRONICS & TELECOMMUNICATION ENGINEERING

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credits**
1.		Dept. Elective – III	3	0	0	3	3
2.		Dept. Elective – IV/Open Elective	3	0	0	3	3
3.		Dept. Elective – V /Open Elective	3	0	0	3	3
4.		Dept. Elective – VI /Open Elective	3	0	0	3	3
Total of Theory						**12**	**12**
Sessional							
5.	EC4082	Project	0	0	9	9	5
6.	EC4084	Seminar	0	0	3	3	2
7.	EC4086	General Viva-Voce	-	-	-	-	2
Total of Sessional						**12**	**9**
Semester Total						**24**	**21**

LIST OF INSTITUTE ELECTIVES

Institute Elective – I

Sl. No	Subject Code	Subject Name	Credit
1.	HS2002	Engineering Economics	3
2.	HS2006	International Economics	3
3.	HS2004	Public Finance	3

Institute Elective – II

1.	HS3006	Entrepreneurship	3
2.	HS3008	Management Concepts & Practices	3
3.	HS3002	Organizational Behavior	3
4.	HS3004	Human Resource Management	3

LIST OF DEPARTMENT ELECTIVES

Dept. Elective-I

1.	EC3022	Advanced Microprocessors	3
2.	EC3024	Embedded Systems	3
3.	EC3026	Computational Intelligence	3
4.	EE3028	Power Electronic Circuits	3

Dept. Elective-II

1.	EL4001	Industrial Automation & Control	3
2.	EC4021	Radar & Television Engineering	3
3.	EC4023	Adaptive Systems & Signal Processing	3
4.	EI4025	Principle of Analytical Instrumentation	3

Dept. Elective-III

1.	EC4025	Optical & Satellite Communication	3
2.	CS3032	RDBMS	3
3.	EC6102	Telecommunication Switching Networks & Protocols	3
4.	EC6224	Low Power VLSI Design	3

Dept. Elective-IV, V & VI

1.	EC6108	Digital Image Processing	3
2.	EC4044	Information Theory & Coding	3
3.	EC4046	Modern Digital Communication Techniques	3
4.	EC6316	Microwave Integrated Circuits	3
5.	EC6112	Communication & Network Security	3
6.	EC6128	Wireless Sensor Network	3
7.	EI4032	Bio-medical Instrumentation	3
8.	EC4028	Smart Antennas	3
9.	EC6236	MEMS & Applications	3
10	EC6313	Optimization Techniques in Engineering	3
11	EC4022	Arm Processor & Applications	3

COURSE STRUCTURE FOR B.TECH IN ELECTRONICS & ELECTRICAL ENGINEERING

SEMESTER-III

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credits**
1.	MA2001	Mathematics-III	3	1	0	4	4
2.	EC2007	Analog Electronics	3	1	0	4	4
3.	EE2003	Network Analysis	3	1	0	4	4
4.	EC2003	Signals & Systems	3	0	0	3	3
5.	EE2001	Electrical Machines – I	3	1	0	4	4
6.	CS2003	Data Structure & Java Programming	3	1	0	4	4
Total of Theory						**23**	**23**
Practical							
7.	EC2091	Electronic Circuits & Networks Lab				3	2
8.	CS2093	Data Structure & Programming Lab				3	2
Sessional							
9.	HS2081	Language Lab				2	1
Total of Practical & Sessional						**8**	**5**
Semester Total						**31**	**28**

SEMESTER-IV - ELECTRONICS & ELECTRICAL ENGINEERING

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credits**
1.	MA2002	Mathematics – IV	3	1	0	4	4
2.	EE2002	Electrical Machines – II	3	1	0	4	4
3.	EC2008	Measurements & Instrumentation	3	1	0	4	4
4.	EC2009	Digital Electronic Circuits	3	1	0	4	4
5.		Inst. Elective – I	3	0	0	3	3
6.	CH2001	Environmental Science	2	0	0	2	2
Total of Theory						**21**	**21**
Practical							
7.	EC2096	Digital & Linear IC Lab	0	0	3	3	2
8.	EC2098	Measurements & Instrumentation Lab	0	0	3	3	2
9.	EE2096	Electrical Machines Lab	0	0	3	3	2
Total of Practical						**9**	**6**
Semester Total						**30**	**27**

SEMESTER- V - ELECTRONICS & ELECTRICAL ENGINEERING

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credits**
1.	EC3001	Electromagnetic Theory	3	1	0	4	4
2.	EE3001	Electric Power Transmission & Distribution	3	1	0	4	4
3.	EC3003	Microprocessors & Microcontrollers	3	1	0	4	4
4.	EL3001	Control Systems	3	1	0	4	4
5.	EC3007	Digital Signal Processing	3	1	0	4	4
Total of Theory						**20**	**20**
Practical							
6.	EL3091	Control Systems Lab	0	0	3	3	2
7.	EC3093	Microprocessor & Microcontroller Lab	0	0	3	3	2
8.	EC3095	DSP Lab	0	0	3	3	2
Sessional							
9.	TP3081	C A T – I	2	0	0	2	1
Total of Practical & Sessional						**11**	**7**
Semester Total						**31**	**27**

SEMESTER- VI - ELECTRONICS & ELECTRICAL ENGINEERING

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credits**
1.	EC3009	Communication Engg	3	1	0	4	4
2.	EE3005	Power Electronics	3	1	0	4	4
3.	EE3002	Power System Operation and Control	3	1	0	4	4
4.		Dept. Elective – I	3	0	0	3	3
5.		Inst. Elective – II	3	0	0	3	3
Total of Theory						**18**	**18**
Practical							
6.	EC3091	Communication Engg. Lab	0	0	3	3	2
7.	EE3091	Power Electronics Lab	0	0	3	3	2
8.	EE3092	Power Systems Lab	0	0	3	3	2
Sessional							
9.	TP3082	C A T – II	**0**	**0**	**2**	**2**	**1**
Total of Practical & Sessional						**11**	**7**
Semester Total						**29**	**25**

SEMESTER-VII - ELECTRONICS & ELECTRICAL ENGINEERING

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credits**
1.	EE4001	Electric Drives	3	1	0	4	4
2.	EE4003	Switch Gear and Protection	3	0	0	3	3
3.	EL4001	Industrial Automation & Control	3	0	0	3	3
4.	EC3006	Data Communication & Networking	3	1	0	4	4
5.		Dept. Elective – II / Open Elective	3	0	0	3	3
Total of Theory						**17**	**17**
Practical							
6.	EE4091	Electric Drives Lab	0	0	3	3	2
Sessional							
7.	EL4081	Project Preparation	0	0	6	6	3
8.	EL4083	Practical Training	-	-	-	-	2
9.	EE4085	Power System Design	0	0	3	3	2
Total of Practical & Sessional						**12**	**9**
Semester Total						**29**	**26**

SEMESTER- VIII - ELECTRONICS & ELECTRICAL ENGINEERING

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credits**
1.		Dept. Elective – III	3	0	0	3	3
2.		Dept. Elective – IV / Open Elective	3	0	0	3	3
3.		Dept. Elective – V / Open Elective	3	0	0	3	3
4.		Dept. Elective – VI / Open Elective	3	0	0	3	3
Total of Theory						**12**	**12**
Sessional							
5.	EL4082	Project	0	0	9	9	5
6.	EL4084	Seminar	0	0	3	3	2
7.	EL4086	General Viva Voce	-	-	-	-	2
Total of Sessional						**12**	**9**
Semester Total						**24**	**21**

LIST OF INSTITUTE ELECTIVES

Institute Elective – I

Sl. No	Subject Code	Subject Name	Credit
1.	HS2002	Engineering Economics	3
2.	HS2006	International Economics	3
3.	HS2004	Public Finance	3

Institute Elective – II

1.	HS3006	Entrepreneurship	3
2.	HS3008	Management Concepts & Practices	3
3.	HS3002	Organizational Behaviour	3
4.	HS3004	Human Resource Management	3

LIST OF DEPARTMENT ELECTIVES

Dept. Elective-I

1.	EL3022	Advanced Control Systems	3
2.	EC3004	VLSI Design	3
3.	EC3024	Embedded Systems	3
4.	CS3054	Computer Architecture	3

Dept. Elective-II

1.	EC4025	Optical & Satellite Communication	3
2.	CS3032	RDBMS	3
3.	EC3026	Computational Intelligence	3
4.	EI4021	Industrial Instrumentation	3

Dept. Elective-III

1.	EE4021	Power Station Engineering	3
2.	EC4023	Adaptive Systems & Signal Processing	3
3.	EE4034	Advanced Power Electronics	3
4.	EE6113	Computer Application in Power Systems	3

Dept. Elective-IV, V & VI

1.	EE4036	High Voltage Engineering	3
2.	EE4005	Renewable Energy Systems	3
3.	EE4038	High Voltage AC & DC Transmission	3
4.	EE6138	Energy Management & Audit	3
5.	EE4040	Electric Traction & Drive	3
6.	EC6108	Digital Image Processing	3
7.	EC6313	Optimization Techniques in Engineering	3
8.	EI4032	Bio-medical Instrumentation	3
9	EC4048	Mobile Communication Engineering	3

COURSE STRUCTURE FOR B.TECH IN ELECTRONICS & INSTRUMENTATION ENGINEERING

SEMESTER-III

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credits**
1.	MA2001	Mathematics – III	3	1	0	4	4
2.	EC2003	Signals & Systems	3	0	0	3	3
3.	EC2007	Analog Electronics	3	1	0	4	4
4.	EE2003	Network Analysis	3	1	0	4	4
5.	EC2005	Semiconductor Devices	3	0	0	3	3
6.	CS2003	Data Structure & Java Programming	3	1	0	4	4
Total of Theory						**22**	**22**
Practical							
7.	EC2091	Electronic Circuits & Networks Lab	0	0	3	3	2
8.	CS2093	Data Structure & Programming Lab	0	0	3	3	2
Sessional							
9.	HS2081	Language Lab	0	0	2	2	1
Total of Practical & Sessional						**8**	**5**
Semester Total						**30**	**27**

SEMESTER- IV - ELECTRONICS & INSTRUMENTATION ENGINEERING

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credits**
1.	MA2002	Math-IV	3	1	0	4	4
2.	EI2002	Material Science	3	0	0	3	3
3.	EC2009	Digital Electronic Circuits	3	1	0	4	4
4.	EI2004	Electrical & Electronic Measurements	3	1	0	4	4
5.	EE2008	Electrical Machines	3	1	0	4	4
6.	CH2001	Environmental Science	2	0	0	2	2
Total of Theory						**21**	**21**
Practical							
7.	EC2096	Digital & Linear IC Lab	0	0	3	3	2
8.	EI2092	Electrical & Electronic Measurements Lab	0	0	3	3	2
9.	EE2096	Electrical Machines Lab	0	0	3	3	2
Total of Practical						**9**	**6**
Semester Total						**30**	**27**

SEMESTER-V - ELECTRONICS & INSTRUMENTATION ENGINEERING

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credits**
1.	EC3003	Microprocessors & Microcontrollers	3	1	0	4	4
2.	EI3001	Instrumentation – I	3	1	0	4	4
3.	EC3009	Communication Engg	3	1	0	4	4
4.	EL3001	Control Systems	3	1	0	4	4
5.	ME3013	Thermodynamics & Fluid Mechanics	3	1	0	4	4
Total of Theory						**20**	**20**
Practical							
6.	EL3091	Control Systems Lab	0	0	3	3	2
7.	EC3091	Communication Engg Lab	0	0	3	3	2
8.	EC3093	Microprocessor & Microcontroller Lab	0	0	3	3	2
Sessional							
9.	TP3081	C A T – I	0	0	2	2	1
Total of Practical & Sessional						**11**	**7**
Semester Total						**31**	**27**

SEMESTER-VI - ELECTRONICS & INSTRUMENTATION ENGINEERING

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credits**
1.	EC3007	Digital Signal Processing	3	1	0	4	4
2.	EI3004	Process Control – I	3	1	0	4	4
3.	EI3002	Instrumentation – II	3	1	0	4	4
4.	EE3005	Power Electronics	3	1	0	4	4
5.		Inst. Elective – I	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
6.	EI3092	Instrumentation Lab	1	0	3	3	2
7.	EI3094	Instrumentation System Design & Simulation Lab	0	0	3	3	2
8.	EC3095	DSP Lab	0	0	3	3	2
Sessional							
9.	TP3082	C A T – II	0	0	2	2	1
Total of Practical & Sessional						**11**	**7**
Semester Total						**30**	**26**

SEMESTER-VII - ELECTRONICS & INSTRUMENTATION ENGINEERING

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credits**
1.	EC3004	VLSI Design	3	0	0	3	3
2.	EI4001	Analytical Instrumentation	3	1	0	4	4
3.	EI4003	Process Control – II	3	0	0	3	3
4.		Dept. Elective – I	3	0	0	3	3
5.		Inst. Elective – II	3	0	0	3	3
Total of Theory						**16**	**16**
Practical							
6.	EC4095	VLSI Lab	0	0	3	3	2
7.	EI4091	Process Control Lab	0	0	3	3	2
Sessional							
8.	EI4081	Project Preparation	0	0	6	6	3
9.	EI4083	Practical Training	-	-	-	-	2
Total of Practical & Sessional						**12**	**9**
Semester Total						**28**	**25**

SEMESTER-VIII - ELECTRONICS & INSTRUMENTATION ENGINEERING

Theory							
Sl. No	**Subject Code**	**Course Title**	**L**	**T**	**P**	**Total**	**Credits**
1.		Dept. Elective – II/Open Elective	3	0	0	3	3
2.		Dept. Elective – III/Open Elective	3	0	0	3	3
3.		Dept. Elective – IV/Open Elective	3	0	0	3	3
4.		Dept. Elective – V/Open Elective	3	0	0	3	3
Total of Theory						**12**	**12**
Sessional							
5.	EI4082	Project	0	0	9	9	5
6.	EI4084	Seminar	0	0	3	3	2
7.	EI4086	General Viva Voce	-	-	-	-	2
Total of Sessional						**12**	**9**
Semester Total						**24**	**21**

LIST OF INSTITUTE ELECTIVES

Institute Elective – I

Sl. No	Subject Code	Subject Name	Credit
1.	HS2002	Engineering Economics	3
2.	HS2006	International Economics	3
3.	HS2004	Public Finance	3

Institute Elective – II

1.	HS3006	Entrepreneurship	3
2.	HS3008	Management Concepts & Practices	3
3.	HS3002	Organizational Behaviour	3
4.	HS3004	Human Resource Management	3

LIST OF DEPARTMENT ELECTIVES

Dept. Elective – I

1.	EC4029	Industrial Data Networks	3
2.	EI4023	Fiber Optic Instrumentation	3
3.	CS3054	Computer Architecture	3
4.	EC3024	Embedded Systems	3

Dept. Elective-II

1.	EI4024	Neural Networks & Fuzzy Logic Control	3
2.	EC4034	Telemetry & Remote Control	3
3.	EC4023	Adaptive Systems & Signal Processing	3
4.	EI4022	Virtual Instrumentation	3

Dept. Elective-III, IV & V

1.	EI4032	Bio-medical Instrumentation	3
2.	EI4034	Nonlinear Control Theory	3
3.	EI4036	Power Plant Instrumentation	3
4.	EI4038	Instrumentation for oil & gas industries	3
5.	EI4040	Sensor Technology	3
6.	EC4048	Mobile Communication Engg.	3
7.	EC6108	Digital Image Processing	3
8.	EC6128	Wireless Sensor Networks	3
9.	EC6313	Optimization Techniques in Engineering	3

List of Open Electives offered by School of Electronics Engineering

Sl. No.	Semester	Code	Subject	Credit	Pre-requisite
1	III	EC2003	Signals and Systems	3	Math – I & II
2	IV	EC2009	Digital Electronic Circuits	4	Basic Electronics
3	IV	EC2008	Measurements & Instrumentation	4	Basic Electronics
4	V	EC3003	Microprocessors & Microcontrollers	4	Digital Electronic Circuits
5	V	EC3009	Communication Engg	4	Basic Electronics
6	V	EL3009	Control Systems	4	Electrical Science
7	VI	EC3004	VLSI Design	3	Digital Electronic Circuits
8	VII	EL4001	Industrial Automation & Control	3	Measurements & Instrumentation, Control Systems
9	VII	EI4001	Analytical Instrumentation	4	Measurements & Instrumentation
10	VIII	EI4032	Biomedical Instrumentation	3	Measurements & Instrumentation
11	VIII	EC4048	Mobile Communication Engineering	3	Communication Engineering
12	VIII	EI4036	Power Plant Instrumentation	3	Measurements & Instrumentation

COURSE STRUCTURE FOR B.TECH IN MECHANICAL ENGINEERING

SEMESTER-III

Theory							
Sl No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	ME2001	Engineering Thermodynamics	3	1	0	4	4
2	ME2003	Fluid Mechanics	3	0	0	3	3
3	ME2005	Mechanics of Solids	3	1	0	4	4
4	ME2007	Material Science and Engineering	3	0	0	3	3
5	ME2009	Kinematic & Kinetics of Machines	3	0	0	3	3
6	MA2001	Mathematics-III	3	1	0	4	4
Total of Theory						**21**	**21**
Practical							
1	ME2091	Fluid Mechanics Lab	0	0	3	3	2
2	ME2093	Material Testing Lab	0	0	3	3	2
3	ME2095	Kinematics Lab	0	0	3	3	2
Sessional							
1	ME2081	Machine Drawing	0	0	3	3	2
Total of Practical & Sessional						**12**	**8**
Semester Total						**33**	**29**

SEMESTER-IV

Theory							
Sl No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	ME2002	Machine Dynamics	3	0	0	3	3
2	ME2004	Heat Transfer	3	1	0	4	4
3	ME2006	Basic Manufacturing Processes	3	0	0	3	3
4	EE2006	Introduction to Electrical Machines and Power Electronics	3	0	0	3	3
5	MA2004	Numerical Methods	3	1	0	4	4
6	CH2001	Environmental Science	2	0	0	2	2
Total of Theory						**19**	**19**
Practical							
1	ME2092	Machine Dynamics Lab	0	0	3	3	2
2	ME2094	Heat Trasfer Lab	0	0	3	3	2
3	EE2098	Electrical Machines and Power Electronics Lab	0	0	3	3	2
Sessional							
1	ME2082	Manufacturing Practice	0	0	3	3	2
2	HS2081	Language Lab	0	0	2	2	1
Total of Practical & Sessional						**14**	**9**
Semester Total						**33**	**28**

SEMESTER-V

Theory							
Sl No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	ME3001	Fluid Dynamics & Hydraulic Machines	3	1	0	4	4
2	ME3003	Internal Combustion Engines & Gas Turbines	3	0	0	3	3
3	ME3005	Mechanical Measurements and Control	3	0	0	3	3
4	ME3007	Manufacturing Processes & Design	3	0	0	3	3
5	ME3009	Fundamentals of Machine Design	3	0	0	3	3
6		Institute Elective-I	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
1	ME3091	Hydraulic Machines Lab	0	0	3	3	2
2	ME3093	Measurements and Instrumentation Lab	0	0	3	3	2
Sessional							
1	ME3081	Machine Design	0	0	3	3	2
2	ME3083	CAD Lab	0	0	3	3	2
3	TP3081	CAT-I	0	0	2	2	1
Total of Practical & Sessional						**14**	**9**
Semester Total						**33**	**28**

SEMESTER-VI

Theory							
Sl No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	ME3002	Refrigeration & Air Conditioning	3	0	0	3	3
2	ME3004	Metal Cutting & Cutting Tool Design	3	1	0	4	4
3	ME3006	Metrology, Quality Control and Reliability	3	0	0	3	3
4	ME3008	Industrial Engineering & Management	3	0	0	3	3
5	ME3012	Design of Machine Elements	3	0	0	3	3
6		Institute Elective-II	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
1	ME3092	IC Engines & RAC Lab	0	0	3	3	2
2	ME3094	Computational Technique Practice lab	0	0	3	3	2
Sessional							
1	ME3082	Metal Cutting & Cutting Tool Design	0	0	3	3	2
2	ME3084	Computer Aided Design and Analysis	0	0	3	3	2
3	TP3082	CAT-II	0	0	2	2	1
Total of Practical & Sessional						**14**	**9**
Semester Total						**33**	**28**

SEMESTER-VII

Theory							
Sl No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	ME4001	Advanced Manufacturing Processes	3	0	0	3	3
2	ME4003	Power Plant Engineering	3	0	0	3	3
3		Dept. Elective-I	3	0	0	3	3
4		Dept. Elective -II/Open Elective	3	0	0	3	3
5		Dept. Elective -III/ Open Elective	3	0	0	3	3
Total of Theory						**15**	**15**
Practical							
1	ME4091	Advanced Manufacturing Processes Lab	0	0	3	3	2
Sessional							
1	ME4081	Project Preparation	0	0	6	6	3
2	ME4083	Practical Training	-	-	-	-	2
Total of Practical & Sessional						**9**	**7**
Semester Total						**24**	**22**

SEMESTER-VIII

Theory							
Sl No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	ME4002	Industrial Automation	3	0	0	3	3
2		Dept. Elective -IV /Open Elective	3	0	0	3	3
3		Dept. Elective -V /Open Elective	3	0	0	3	3
Total of Theory						**9**	**9**
Practical							
Sessional							
1	ME4082	Project	0	0	9	9	5
2	ME4084	Seminar	0	0	3	3	2
3	ME4086	Comprehensive Viva	-	-	-	-	2
Total of Practical & Sessional						**12**	**9**
Semester Total						**21**	**18**

LIST OF INSTITUTE ELECTIVES

Institute Elective – I

Sl. No	Subject Code	Subject Name	Credit
1.	HS2002	Engineering Economics	3
2.	HS2004	Public Finance	3
3.	HS2006	International Economics	3

Institute Elective – II

1.	HS3002	Organizational Behavior	3
2.	HS3004	Human Resource Management	3
3.	HS3006	Entrepreneurship	3
4.	HS3008	Management Concept & Practices	3

LIST OF DEPARTMENT ELECTIVES

Department Elective-I

1.	ME4021	Automobile Engineering	3
2.	ME4023	Gas Dynamics & Jet Propulsion	3
3.	ME4025	Computational Fluid Dynamics	3
4.	ME4027	Micro and Nano Fluidics	3
5.	ME4029	Alternative Fuels and Renewable Energy	3

Department Elective-II

1.	ME4041	Mechanical Vibration and Noise Engineering	3
2.	ME4043	Introduction to Composite Materials	3
3.	ME4045	Introduction to Finite Element Method	3
4.	ME4047	Tribology	3
5.	ME4049	Advanced Mechanics of Solids	3

Department Elective-III

1.	ME4061	Operations Research	3
2.	ME4063	Metal Forming Processes	3
3.	ME4065	Modeling and Simulation	3
4.	ME4067	Machine Tool Technology	3
5.	ME4069	Computer Integrated Manufacturing	3

Department Elective-IV

1.	ME4022	Supply Chain Management	3
2.	ME4024	Innovation and New Product Development	3
3.	ME4026	Total Quality Management	3
4.	ME4028	Industrial Safety	3
5.	ME4032	Flexible and Sustainable Manufacturing	3

Department Elective-V

1.	ME4042	Machine Maintenance & Condition Monitoring	3
2.	ME4044	Rapid Prototyping	3
3.	ME4046	Artificial Inteligence Techniques	3
4.	ME4048	Intellectual Property Rights	3
5.	ME4052	Nano Technology	3

COURSE STRUCTURE FOR B.TECH IN MECHANICAL (AUTOMOBILE) ENGINEERING

SEMESTER-III

Theory							
Sl No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	ME2001	Engineering Thermodynamics	3	1	0	4	4
2	ME2003	Fluid Mechanics	3	0	0	3	3
3	ME2005	Mechanics of Solids	3	1	0	4	4
4	ME2007	Material Science and Engineering	3	0	0	3	3
5	ME2009	Kinematic & Kinetics of Machines	3	0	0	3	3
6	MA2001	Mathematics-III	3	1	0	4	4
Total of Theory						**21**	**21**
Practical							
1	ME2091	Fluid Mechanics Lab	0	0	3	3	2
2	ME2093	Material Testing Lab	0	0	3	3	2
3	ME2095	Kinematics Lab	0	0	3	3	2
Sessional							
1	ME2081	Machine Drawing	0	0	3	3	2
Total of Practical & Sessional						**12**	**8**
Semester Total						**33**	**29**

SEMESTER-IV

Theory							
Sl No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	ME2002	Machine Dynamics	3	0	0	3	3
2	ME2004	Heat Transfer	3	1	0	4	4
3	ME2006	Basic Manufacturing Processes	3	0	0	3	3
4	EE2006	Introduction to Electrical Machines and Power Electronics	3	0	0	3	3
5	MA2004	Numerical Methods	3	1	0	4	4
6	CH2001	Environmental Science	2	0	0	2	2
Total of Theory						**19**	**19**
Practical							
1	ME2092	Machine Dynamics Lab	0	0	3	3	2
2	ME2094	Heat Trasfer Lab	0	0	3	3	2
3	EE2098	Electrical Machines and Power Electronics Lab	0	0	3	3	2
Sessional							
1	ME2082	Manufacturing Practice	0	0	3	3	2
2	HS2081	Language Lab	0	0	2	2	1
Total of Practical & Sessional						**14**	**9**
Semester Total						**33**	**28**

SEMESTER-V

Theory							
Sl No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	ME3001	Fluid Dynamics & Hydraulic Machines	3	1	0	4	4
2	ME3003	Internal Combustion Engines & Gas Turbines	3	0	0	3	3
3	ME3005	Mechanical Measurements and Control	3	0	0	3	3
4	ME3007	Manufacturing Processes & Design	3	0	0	3	3
5	ME3009	Fundamentals of Machine Design	3	0	0	3	3
6		Institute Elective-I	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
1	ME3091	Hydraulic Machines Lab	0	0	3	3	2
2	ME3093	Measurements and Instrumentation Lab	0	0	3	3	2
Sessional							
1	ME3081	Machine Design	0	0	3	3	2
2	ME3083	CAD Lab	0	0	3	3	2
3	TP3081	CAT-I	0	0	2	2	1
Total of Practical & Sessional						**14**	**9**
Semester Total						**33**	**28**

SEMESTER-VI

Theory							
Sl No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	ME3002	Refrigeration & Air Conditioning	3	0	0	3	3
2	ME3004	Metal Cutting & Cutting Tool Design	3	1	0	4	4
3	ME3006	Metrology, Quality Control and Reliability	3	0	0	3	3
4	ME3008	Industrial Engineering & Management	3	0	0	3	3
5	ME3012	Design of Machine Elements	3	0	0	3	3
6		Institute Elective-II	3	0	0	3	3
Total of Theory						**19**	**19**
Practical							
1	ME3092	IC Engines & RAC Lab	0	0	3	3	2
2	ME3094	Computational Technique Practice lab	0	0	3	3	2
Sessional							
1	ME3082	Metal Cutting & Cutting Tool Design	0	0	3	3	2
2	ME3084	Computer Aided Design and Analysis	0	0	3	3	2
3	TP3082	CAT-II	0	0	2	2	1
Total of Practical & Sessional						**14**	**9**
Semester Total						**33**	**28**

SEMESTER-VII

Theory							
Sl No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	ME4001	Advanced Manufacturing Processes	3	0	0	3	3
2	ME4003	Power Plant Engineering	3	0	0	3	3
3		DE-I	3	0	0	3	3
4		DE-II/Open Elective	3	0	0	3	3
5		DE-III/ Open Elective	3	0	0	3	3
Total of Theory						**15**	**15**
Practical							
1	ME4091	Advanced Manufacturing Processes Lab	0	0	3	3	2
Sessional							
1	ME4081	Project Preparation	0	0	6	6	3
2	ME4083	Practical Training	0	0	0	0	2
Total of Practical & Sessional						**9**	**7**
Semester Total						**24**	**22**

SEMESTER-VIII

Theory							
Sl No.	**Course Code**	**Subject**	**L**	**T**	**P**	**Total**	**Credit**
1	ME4002	Industrial Automation	3	0	0	3	3
2		DE-IV /Open Elective	3	0	0	3	3
3		DE-V /Open Elective	3	0	0	3	3
Total of Theory						**9**	**9**
Practical							
Sessional							
1	ME4082	Project	0	0	9	9	5
2	ME4084	Seminar	0	0	3	3	2
3	ME4086	Comprehensive Viva	0	0	0	0	2
Total of Practical & Sessional						**12**	**9**
Semester Total						**21**	**18**

LIST OF INSTITUTE ELECTIVES

Institute Elective – I

Sl. No	Subject Code	Subject Name	Credit
1.	HS2002	Engineering Economics	3
2.	HS2004	Public Finance	3
3.	HS2006	International Economics	3

Institute Elective – II

1.	HS3002	Organizational Behavior	3
2.	HS3004	Human Resource Management	3
3.	HS3006	Entrepreneurship	3
4.	HS3008	Management Concept & Practices	3

LIST OF DEPARTMENT ELECTIVES

Department Elective-I

1.	ME4031	Noise, Vibration and Harshness	3
2.	ME4033	Automotive Safety and Lighting	3
3	ME4035	Automotive Chassis, Suspension and Transmission System	3
4.	ME4037	Automotive Materials and Processes	3

Department Elective-II

1.	ME4051	Assembly Line Automation	3
2.	ME4053	Design of Experiments and Optimization Techniques	3
3.	ME4055	Automotive Electrical Systems and Electronics	3
4.	ME4057	Theory and Design of Jigs and Fixture	3

Department Elective-III

1.	ME4071	Fuels and Emissions	3
2.	ME4073	Total Quality Management	3
3.	ME4075	Engine Tribology	3
4.	ME4077	Off-Road Vehicles	3

Department Elective-IV

1.	ME4024	Innovations and New Product Development	3
2.	ME4034	Vehicle Dynamics	3
3.	ME4036	Marketing Management	3
4.	ME4038	Total Life Cycle Management	

Department Elective-V

1.	ME4054	Tractor and Farm Equipments	3
2.	ME4056	Combustion Engineering	3
3.	ME4058	Two and Three Wheelers	3
4.	ME4062	Vehicle Maintenance	3

List of Open Electives offered by School of Mechanical Engineering

Semester	Course code	Subjects	Credit	Pre-requisite
6th	ME3006	Metrology, Quality Control and Reliability	3	-
6th	ME3008	Industrial Engineering & Management	3	-
7th	ME4003	Power Plant Engineering	3	-
7th	ME4045	Introduction to Finite Element Method	3	Mechanics of Solids
7th	ME4061	Operations Research	3	-
8th	ME4002	Industrial Automation	3	-
8th	ME4046	Artificial Inteligence Techniques	3	-
8th	ME4052	Nano Technology	3	-

PHYSICS COURSES

PH-1001 **PHYSICS - I** **Cr-3**

PART-1 (Optics)

(i). Interference : **(6 Hrs)**

Condition of Interference, Analytical methods, Energy distribution, wedge shaped thin film, colors in thin film, Newton's ring (determination of λ and μ).

(ii) Diffraction : **(5 Hrs)**

Types of diffraction, Fraunhoffer diffraction at single slit, plane transmission grating, determination of wavelength of light. Missing order spectra

(iii) Polarization : **(5 Hrs)**

Polarization, circularly and elliptically polarized light, Malus law, Brewster's law, Double refraction, Nicol prism as polarizer and analyzer, optical activity (qualitative), Half shaded Plate.

(iv) Laser : **(3 Hrs)**

Absorption, Spontaneous and stimulated emission, Einstein's coefficient in Laser, population inversion, pumping, Ruby and gas laser, Application.

(v) Fiber optics : **(3 Hrs)**

Principle, types of fiber, acceptance angle, numerical aperture, signal propagation in optical fiber, attenuation, signal loss and dispersion.

PART- II (Electromagnetic theory) : (14 Hrs)

(i) Vector calculus: Elementary idea of gradient, divergence and curl of a vector field, Gauss's divergence theorem and Stokes' theorem (Statements only).

(ii) Coulomb's law in Electrostatics, Gauss's law in Electrostatics, Biot-savart's law, Ampere's circuital law, Faraday's law in electromagnetic induction, displacement current.

(iii) Maxwell's electromagnetic equations in differential and integral form,

(iv) Electromagnetic wave equations, Solution of wave equation in free space, Transverse nature of e. m. wave, Scalar and vector potential, Pointing vector.

Text Books :

1. Engineering Physics, B. K. Pandey & S. Chaturbedi, Pub.Cengage, New Delhi, 2013.
2. Concepts of Modern physics, A. Beiser, Pub. TMH, 1963
3. Elements of Electromagnetic, S.P. Seth, Pub. Dhanpat Rai, 2001

Reference Books:

1. *Engineering Physics*, *Gaur* and S.C. *Gupta*, *Dhanpat Rai Publications, New Delhi*, 2003.
2. Fundamentals of Optics. A.F.*Jenkins* & E.H.*White , Pub,McGraw-Hill , 1953*
3. Introduction to Electrodynamics, David J. Griffiths, Wily, 3rd Edition, 2003.
4. *Optics, A. K. Ghatak, TMH, 2nd Edition, New Delhi, 2008.*
5. *Elements of Electromagnetics, M.N.O. Sadiku*, *Oxford University Press*, 3rd edition New Delhi,2009.
6. M*odern* Engineering Physics, *A.S. Vasudeva*, Pub. *S. Chand* , New Delhi, 2013

PH-1002 **PHYSICS -II** **Cr-3**

PART-1: Quantum Mechanics: (18 Hrs)

(i) **Particle nature of radiation**, Black body radiation, Photo-electric effect, Compton scattering,
(ii) **Dual nature of matter**, de- Broglie hypothesis, matter wave, Group velocity and Phase velocity, uncertainty relation,
(iii) **Schrodinger's wave equation** (time dependent and time independent). Wave function and its physical interpretation,
(iv) **One dimensional problems** involving particle in a box of infinite potential height, potential step, potential barrier and tunneling.

PART-2 Solid – State Physics (18 Hrs)

(i) **Crystallography:**
Lattice, basis and crystal structure, unit cell, crystal systems, no of atoms per unit cell, coordination number, packing fraction for cubic and hcp lattice, Lattice plane, Miller indices, relation between interplaner distance and miller indices, Bragg's law, X-ray diffraction.

(ii) **Semiconductor Physics :**
Energy Band in Solids, Classification of Solids: Conductor, Semiconductor and Insulator, Intrinsic and extrinsic semiconductors: Fermi level, carrier concentration, conductivity, mobility and resistivity.

(iii) **Superconductivity:**
Transition temperature, critical magnetic field, Meissner's effect, Type-I & Type-II superconductors

Text Books :

1. Engineering Physics, B. K. Pandey & S. Chaturbedi, Pub.Cengage, New Delhi, 2013.
2. Concepts of Modern physics, A. Beiser, Pub. TMH, 1963

Reference Books:

1. Engineering Physics, *Gaur* and S.C. *Gupta*, *Dhanpat Rai Publications, New Delhi*, 2003.
2. Quantum Physics, S. Gasiorowicz, , John Wiley & Sons, 2nd Edition New York NY, 1996
3. M*odern* Engineering Physics, *A.S. Vasudeva*, Pub. *S. Chand* , New Delhi, 2013
4. Introduction to Solid State Physics , *Charles Kittel,,* Pub. *Wiley*; 8th edition, 2004.

CHEMISTRY COURSE

CH-1001 **CHEMISTRY** **Cr-4**

1. **Structure & Bonding**: Failure of classical mechanics, Dual character of matter (with verification), Heisenberg uncertainty principle, Scrodinger equation (derivation not required), idea of quantization in boundary system, Significance and interpretation of wave function, Concept of orbitals, origin of radial and angular wave function and corresponding plots, LCAO-MO theory, energy level diagrams for homo and hetero nuclear diatomic molecules, Metallic bonding (Band theory), Bonding in complexes (VBT and CFT), application in explaining magnetic moment and color in complexes**.**

(11Hrs)

2. **Electrochemistry and Corrosion**: Brief introduction to equilibrium thermodynamics, Conductance, dilution effect**,** Electrochemical cell, types of electrodes, electrode and cell potential and their measurement, Nernst equation and applications (EMF, pH, K_{SP} and K_{eq}), Thermodynamics of Cell, Primary and Secondary cell, Different types of fuel cells, Corrosion (types and mechanism) and prevention.

(9 Hrs)

3. **Kinetics and Catalysis**: Rate laws, rate laws for multi step reactions using steady state approximation (excluding chain reactions), theories of reaction rate: Collision theory (rate expression), Lindeman modification, Absolute

reaction rate theory (rate expression), Catalysis: types, theories, kinetics of enzyme catalysis**,** introduction to Green Chemistry with reference to catalysis.

(8 Hrs)

4. **Spectroscopy**: Interaction and relation with matter, types of spectroscopy. UV-Vis spectroscopy: different electronic transitions, basic concept of selection rule, factors affecting λ_{max}, calculation of λ_{max} for ene- and enone- system, IR spectroscopy: different vibrational modes, fundamental band and overtones, calculation of stretching frequencies, application to functional group transformation and distinction of functional isomers. **(8 Hrs)**
5. **Organic Reaction Mechanism**: Electronic effects and reaction intermediates, Nucleophilic substitution reactions, electrophilic aromatic substitution, electrophilic and free radical addition reactions, Nucleophilic addition to carbonyl groups, Organo-metallic compounds, study of selected organic reactions. **(9 Hrs)**
6. **Nano Materials**: Introduction to confined electronic system, nano-materials, Graphite, Fullerenes, Carbon nano-tubes, nano-wires, nano-cones,Application of nano-materials. **(3 Hrs)**

Text Books

1. A Text Book Of Engineering Chemistry, Shashi Chawala, 2013, Dhanpat Rai & Co.
2. Elementary Organic Spectroscopy ; Principles And Chemical Applications, Y.R. Sharma, 5th Edition, S. Chand & Company Ltd.

Reference Books

1. Advanced Inorganic chemistry- *Satya Prakash, G.D Tuli, R.D. Madan;* 2012, S. Chand Group
2. Principles Of Physical Chemistry- B.R. Puri, L.R. Sharma, M.S. Pathania; 42nd Edition, 2007, Vishal Publishing Co.
3. Elements of Physical Chemistry- *Samuel Glasstone;* 2nd Edition, Macmillan
4. Organic Chemistry, *R.T. Morrison and R.N. Boyd;* 6th Edition, Prentice Hall International
5. Reaction mechanism in Organic Chemistry- *S.M. Mukharjee and S.P. Singh;* 3rd Edition, 2000, Macmillan
6. Spectrometric identification of Organic compounds, 7th Edition- Robert M. ***Silverstein,*** *Francis X. Webster, David J. Kiemle;* John Wiley & Sons, INC.
7. Nano-Materials- *A.K. Bandopadhya;* 2008, New Age International
8. Green Chemistry: Environment Friendly Alternatives, *R. Sanghi, M.M. Srivastava* ; 2003, Alpha Science **International Limited**
9. Engineering Chemistry-I- *B.B. Patra, B. Samantray,* 2011**,** Pearson
10. Engineering Chemistry- *P. Rath*, 3rd Edition, Cengage Learning

CH-2001 ENVIRONMENTAL SCIENCE Cr-2

1. **Overview on environment**: Introduction, chemical composition and components of earth and atmosphere. **(4 Hrs)**

2. **Air pollution**: Natural and anthropogenic sources of atmospheric pollutants, significance of these pollutants and their reactions in atmosphere, controlling measures, some important atmospheric phenomena such as green house effect, ozone layer depletion and acid rain. (**5 Hrs)**

3. **Water pollution**: Types, sources and consequences of water pollution, chemical analysis of water quality parameters, sewage and waste water treatment, controlling measures. **(6 Hrs)**

4 **Waste management**: Sources and generation of solid wastes, their nature and chemical composition, characterization and classification of solid wastes, management of solid wastes. **(3Hrs)**

5. **Biochemical effect of some pollutants**: Biochemical pathways and toxic effects of some toxic metals

like Pb, Cd, Hg and As, radioactive and bio-medical wastes. **(4Hrs)**

6. **Environmental impact assessment**: Origin, development and its management. **(2Hrs)**

Text Books:

1. Environmental Chemistry, 7th Edition- A.K. De, *New Age International*

Reference Books:

1. Environmental Chemistry- P.S. Sandhu, *New Age International*
2. A text book of environmental studies: Environmental Sciences, 2004, Gurdeep R. Chatwal and Harish Sharma, *Himalaya*

MATHEMATICS COURSE

MA-1001 MATHEMATICS-I Cr-4

Ordinary Differential Equations : (12 hrs)
Basic concepts and definitions of 1st order differential equations; Formation of differential equations; solution of differential equations: variable separable, homogeneous, equations reducible to homogeneous form, exact differential equation, equations reducible to exact form, linear differential equation, equations reducible to linear form (Bernoulli's equation); orthogonal trajectories , applications of differential equations.

Linear Differential equations of 2nd and higher order (10 hrs)
Second order linear homogeneous equations with constant coefficients; differential operators; solution of homogeneous equations; Euler-Cauchy equation; linear dependence and independence; Wronskian; Solution of non-homogeneous equations: general solution, complementary function, particular integral; solution by variation of parameters; undetermined coefficients; higher order linear **homogeneous equations; applications.**

Differential Calculus(Two and Three variables): (5 hrs)
Taylor's Theorem, Maxima and Minima ,Lagrange's multipliers

Matrices, determinants, linear system of equations: (11 hrs)
Basic concepts of algebra of matrices; types of matrices; Vector Space, Sub-space, Basis and dimension, linear system of equations; consistency of linear systems; rank of matrix; Gauss elimination; inverse of a matrix by Gauss Jordan method; linear dependence and independence, linear transformation; inverse transformation ; applications of matrices; determinants; Cramer's rule;

Matrix-Eigen value problems: (10 hrs)
Eigen values, Eigen vectors, Cayley Hamilton theorem, basis, complex matrices; quadratic form; Hermitian, Skew-Hermitian forms; similar matrices; diagonalization of matrices; transformation of forms to principal axis (conic section).

Text Books:

1. Kreyszig E., Advanced Engineering Mathematics ,Wiley ,9th edition.
2. Shanti Narayan and P.K.Mittal, Differential Calculus, S. Chand, reprint 2009

References Books:

1.Grewal B.S., Higher Engineering Mathematics, Khanna Publishers,36th edition
2.Dass H.K., Introduction to engineering Mathematics, S.Chand & Co Ltd, 11th edition
3.Ramana B.V., Higher Engineering Mathematics, TMH, 1st edition
4. J.Sinha Roy and S Padhy , A course on ordinary and partial differential Equation , Kalyani Publication , 3rd edition

MA-1002 MATHEMATICS-II Cr-4

Laplace Transforms: (10 Hrs)
Laplace Transform, Inverse Laplace Transform, Linearity, transform of derivatives and Integrals, Unit Step function, Dirac delta function , Second Shifting theorem, Differentiation and Integration of Transforms, Convolution, Integral Equation, Application to solve differential and integral equations, Systems of differential equations.

Series Solution of Differential Equations: **(14 Hrs)**
Power series; radius of convergence, power series method, Frobenious method; Special functions: Gamma function, Beta function; Legendre's and Bessel's equations; Legendre's function, Bessel's function ,orthogonal functions; generating functions.

Fourier series, Integrals and Transforms: **(10 Hrs)**
Periodic functions, Even and Odd functions, Fourier series, Half Range Expansion, Fourier Integrals, Fourier sine and cosine transforms, Fourier Transform

Vector Differential Calculus: **(4 Hrs)**
Vector and Scalar functions and fields, Derivatives, Gradient of a scalar field, Directional derivative, Divergence of a vector field, Curl of a vector field.

Vector Integral Calculus: **(10 Hrs)**
Line integral, Double Integral, Green's theorem, Surface Integral, Triple Integral, Divergence Theorem for Gauss, Stoke's Theorem.

Text books

1. Kreyszig E., Advanced Engineering Mathematics , Wiley ,9th edition.

Reference books

1.Grewal B.S., Higher Engineering Mathematics, Khanna Publishers, 36th edition
2.Dass H.K., Introduction to engineering Mathematics, S.Chand & Co Ltd, 11th edition
3.Ramana B.V., Higher Engineering Mathematics, TMH, Ist edition
4. J.Sinha Roy and S Padhy, A course on ordinary and partial differential Equation, Kalyani Publication , 3rd edition

MA-2001 MATHEMATICS-III Cr-4

Partial Differential Equations: **(20 Hrs)**

Basic concepts, Solution of PDE by Variable Separable method, Mathematical Modeling of one dimensional Wave equation and its solution, Classification of PDE and transformation into its Normal form, D'Alembert's solution of Wave equation, Solution of one dimensional Heat equation, Steady state flow of heat in a rectangular bar, Solution of one dimensional heat equation by Fourier Integral, Solution of two dimensional wave equation, Laplace Equation in Polar, Cylindrical and Spherical coordinates and applications. Solution of PDE by use of Laplace Transform.

Complex Analysis:
Complex Numbers and Functions: **(10 Hrs)**
Basic concept ,Complex functions, Derivatives, Analyticity, Cauchy Riemman equations, Exponential, Trigonometric, hyperbolic, Logarithmic functions, general powers,
Complex integration: **(14 Hrs)**
Line integral, Line Integral of independent path, Cauchy's integral theorem, Cauchy's integral formula, Derivatives of analytic function. Taylor's series, Maclaurin's series, Laurent's series, Expansion of functions, singularities, Residues, Residue Integration method, Evaluation of Real Integrals;
Mapping: **(4 Hrs)**
Conformal mapping and linear fractional transformation(LFT).

Text Book: Advanced Engineering Mathematics by Erwin Kryeszig, Wiley , INC.

Reference Books: Higher Engineering Mathematics by B. V. Ramanna, TMH

MA-2002 MATHEMATICS-IV Cr-4

Approximations & Errors: (**2 Hrs)**
Approximation of numbers by truncation and rounding-off, Types of errors,
Numerical solution of Non linear equations: **(6 Hrs)**
Solutions by Bisection Method, Fixed Point Iteration Method , Newton-Raphson Method, Regula-Falsi and Secant Method, Rate of Convergence of Secant & Newton-Raphson Method .

Interpolation & Approximation: **(10 Hrs)**

Finite Differences, Operators and Relation between them. Interpolation: Newton's forward and backward difference interpolation, Newton's divided difference interpolation and Lagrange interpolation.

Approximation of functions by best fit straight line, quadratic and exponential curves using Least Square Method .

Numerical Differentiation & Integration: **(8 Hrs)**

Numerical differentiation of 1^{st} and 2^{nd} order using difference table. Trapezoidal rule, Simpson's $1/3^{rd}$ and $3/8^{th}$ rules , Gauss-Legendre's two points and three points formulae. Error in Numerical Integration.

Numerical Solution to ODE: **(6 Hrs)**

Taylor series Method, Euler's Method, Modified Euler's Method, Runge-Kutta Methods of order 2 and 4, reduction of 2^{nd} order ODE to 1st order ODE and its solution by R-K method of order four.

Solution of System of Linear Equations: **(6 Hrs)**

LU- factorization(Crout, Doolittle & Cholesky), solutions by Gauss-Seidel and Gauss-Jacobi methods.

Largest eigen value and corresponding eigen vector by Power Method.

Probability Theory: **(10 Hrs)**

Introduction to Probability, Random variables and Probability distributions, Mean and Variance of probability distributions, Mathematical expectation, Moments and moment generating function. Binomial and Poisson distributions, Normal distribution.

Text Book:

1. Advanced Engineering Mathematics by Erwin Kreszig, **Wiley**, INC.
2. Introductory Methods of Numerical Analysis by S. S. Sastry, PHI.

Reference Books:

1. Higher Engineering Mathematics by B. V. Ramanna , TMH.
2. Higher Engineering Mathematics by B. S. Grewal , Khanna Publisher.
3. Numerical Methods for Scientific and Engineering Computation by Jain , Iyenger and Jain, New age International (P) Ltd..
4. Numerical Methods by Arumugam, Thangapandi and Somasundaram, Scitech Publishers.

MA-2003 DISCRETE MATHEMATICAL STRUCTURE Cr-4

Logic: **(6 Hrs)**

Proposition, Truth values, Connectives, Logical equivalence of composite statement (using truth table & without truth table), Predicates and Quantifiers, Rules of Inference, Methods of Induction.

Set, Relation & Function: **(8 Hrs)**

Set, Operations on set, Principles of Inclusion and Exclusion, Relation, Types of relations, Properties on Binary Relation, Equivalence relation, partial ordering, relation, Hasse diagram, Lattice, Definition of function, Injection, Bijection, Surjection, Permutation function.

BooleanAlgebra: **(8 Hrs)**

Lattices and Algebraic system, principles of duality law, Basic properties, Boolean function and Boolean Expressions, DNF & CNF.

Recurrence Relation and their solutions: **(8 Hrs)**

Discrete numeric function and their manipulation, Generating Function,

Concept of Recurrence Relation with constant coefficients, Solution of Recurrence Relation.(Direct Method and by using generating function).

Graph Theory: **(10 Hrs)**

Basic Terminology, Types of Graphs, Group Code, Isomorphic Test, Adjacency & Incident Matrix, Paths, Circuit, shortest path Algorithms (Dijkstra),Tree, Rooted Tree, Binary Tree, spanning tree, cut set, MST Algorithms.(PRIM & KRUSKHAL), Planar Graph

Groups and Rings: **(8 Hrs)**

Concept of binary operations, Algebraic structures, Semigroup, monoid, Group, Abelian group with examples. Properties of groups, Cyclic groups and its generator, Sub group, Normal subgroup, cosets, Lagrange's Theorem, Homomorphism and Isomorphism, ring, field, Integral domain (Definition with examples)

Text Book: Discrete Mathematical Structure, PHI by Kolman, Busby & Ross.

Reference Book:

1. Elements of Discrete Mathematics.A Computer oriented approch by C.L Liu,D.P.Mohapatra(Tata Mc GrawHill 4th Edition-2013)
2. Discrete Mathematics and its Applications by Kenneth H Rosen (Tata Mc GrawHill 4th Edition)

MA-2004 NUMERICAL METHODS Cr-4

Approximations & Errors: **(2 Hrs)**
Approximation of numbers by truncation and rounding-off, Types of errors,
Numerical solution of Non linear equations: **(6 Hrs)**
Solutions by Bisection Method, Fixed Point Iteration Method , Newton-Raphson Method, Regula-Falsi and Secant Method, Rate of Convergence of Secant & Newton-Raphson Method .
Interpolation & Approximation: **(6 Hrs)**

Finite Differences, Operators and Relation between them. Interpolation: Newton's forward and backward difference interpolation, Newton's divided difference interpolation and Lagrange interpolation.
Numerical Differentiation & Integration: **(8 Hrs)**
Numerical differentiation of 1^{st} and 2^{nd} order using difference table. Trapezoidal rule, Simpson's $1/3^{rd}$ and $3/8^{th}$ rules , Gauss-Legendre's two points and three points formulae. Error in Numerical Integration.
Numerical Solution to ODE: **(6 Hrs)**
Taylor series Method, Euler's Method, Modified Euler's Method, Runge-Kutta Methods of order 2 and 4, reduction of 2^{nd} order ODE to 1st order ODE and its solution by R-K method of order four.
Solution of System of Linear Equations: **(4 Hrs)**
Solutions by Gauss-Seidel and Gauss-Jacobi methods.
Numerical Solution to PDE: **(8 Hrs)**
Types of Partial differential equations, Finite difference approximations of derivatives, Numerical solution of Laplace equation by five point formula, Numerical solution of Parabolic equations by Schmidt method and Crank-Nicolson method.
Probability Theory: **(8 Hrs)**
Introduction to Probability, Random variables and Probability distributions, Mean and Variance of probability distributions, Mathematical expectation, Moments and moment generating function. Binomial and Poisson distributions, Normal distribution.

Text Books:

1. Advanced Engineering Mathematics by Erwin Kreszig, **Wiley**,9th edition
2. Introductory Methods of Numerical Analysis by S. S. Sastry, PHI.

Reference Books:

1. Higher Engineering Mathematics by B. V. Ramanna , TMH.
2. Higher Engineering Mathematics by B. S. Grewal , Khanna Publisher.
3. Numerical Methods for Scientific and Engineering Computation by Jain , Iyenger and Jain, New age International (P) Ltd..
4. Numerical Methods by Arumugam, Thangapandi and Somasundaram, Scitech Publishers.

HUMANITIES COURSES

HS - 1001 PROFESSIONAL COMMUNICATION Cr-3

Unit -1 : Overview of Communication **(10 Hrs)**

Concept and Meaning, Process of Communication, Methods-Verbal/Non-Verbal, Spoken/Written, Channels, Barriers of Communication.

Unit-2 : Fundamentals of Grammar **(8 Hrs)**

Time, Tense & Aspect, Types of Verbs, Subject-Verb Agreement, Articles, Prepositions, Active-Passive Voice, Vocabulary, Verbal Analogy, Sentence completion, Reading Comprehension

Unit-3 : Written Communication & Analysis **(10 Hrs)**

Principles of Effective Writing, Plain English and Bias-free English, Writing Business Letters (Enquiries, Quotations, Orders, Complaint Letters),Writing short Technical Reports -Types, Formats, Importance, pre-writing, structure of report, revising a report, editing, proof reading of report and sample reports

Unit - 4 : Effective Oral Communication **(8 Hrs)**

Basic Sounds of English, Stress, Intonation, Group Discussion Strategies, Job Interviews.

Text Book:

1. *Technical Communication Principle & Practice.*Minakshi Raman & Sangeeta Sharma, OUP.

Reference Books:

1. *Effective Technical Communication.* M. Ashraf Rizvi, TMH Publication.
2. *Speaking and Writing for Effective Business Communication.* Francis Soundaryaraj. Macmilan: India.
3. *Communicative Grammar.* Geoffery Leech & Jan Svartvik, Longman: London.
4. *Business Communication.* S.M.Rai and Urmila Rai, Himalaya Publication: Mumbai.
5. *Placement Interviews,Skills for Success.* S. Anandamurugan.Tata McGraw Hill Education Private Limited:New Delhi
6. *BCOM,A South-Asian Perspective*.2e.Carol.M.Lehman.,Debbie D. Dufrene and Mala Sinha. Cengage Learning Pvt. Ltd.: New Delhi
7. How to prepare for Group Discussion and Interview. 2nd Edition. Hari Mohan Prasad and Rajnish Mohan,Tata McGraw Hill:New Delhi 2006
8. English Vocabulary in use (advance) by Michacl McCarthy, Felicity O Dell, Cambridge University Press,UK,1st edition, 2002
9. Practical English usage by Michel Swan, Oxford University Press,USA,3rd edition,2005
10. Oxford English Grammar by Sidney Greenbaum, Oxford University Press:USA,1st Edition,1996
11. Verbal Ability and Reading Comprehension for the CAT. Arun Sharma and Meenakshi Upadhyay,Tata Mcgraw-Hill:New Delhi.

HS - 2002 ENGINEERING ECONOMICS Cr-3

UNIT-I : **Introduction to Economics and Engineering Economics**- Basic concepts of Economics: Demand Analysis, Supply Analysis, Market Equilibrium. Revenue Analysis. Demand Forecasting- Quantitative Methods.

(9 Hrs)

UNIT-II Production and Cost Analysis: Short Run and Long Run Production Functions, Producer's Equilibrium condition.Cobb-Douglas Production Function. Cost Concepts: Short Run and Long Run Cost curves. Break-Even Analysis.Market: Perfect Competition, Monopoly, Discriminating monopolist. **(9 Hrs)**

UNIT-III Time Value of Money: Interest Formulas and their applications. Evaluation of Investment, Proposals-Present Worth method of comparison, Future worth method of comparison, Annual Equivalent Method of comparison,Economic Appraisal Technique-Net Present Value, Rate of Return, Cost Benefit analysis.Depreciation and Income Tax Consideration. Inventory control. (**9 Hrs)**

UNIT-IV- Money Banking: Functions of commercial banks.Inflation.Money market and Capital market. Business cycle and Business policies. National Income Accounting. (**9 Hrs)**

Text Books:

1. Engineering Economics .James L.Riggs,David D.Bedworth and Sabah U.Randhawa, McGraw Hill,India.
2. Engineering Economics. R.Panneerselvam,Pub: PHI Learning Private Limited:New Delhi

Reference Books:

1. . Mangerial Economics,Theory and Applications. D.M.Mithani, Himalaya Publication:New Delhi

2. Money Banking. S.B.Gupta,S.Chand and Company Limited:New Delhi

3. Keynesian and Post-Keynsian Economics. R.D. Gupta. Kalyani Publishers.

HS - 2004 PUBLIC FINANCE Cr-3

UNIT-I **Introduction-** Definition and scope of Public Finance. Difference between public finance and Private Finance, Public goods, Private goods and their characteristics. Market Failure, Merit goods, Mixed goods, Externalities and the role of Government. Tax subsidy Analysis, Principle of Maximum Social advantage.

(**9 Hrs)**

UNIT- II **Public Expenditure** –Meaning, Classification and canons of public expenditure.Causes of Growth of public Expenditure, Effects of public Expenditure on production, distribution and economic stability.Wagner's law of Increasing State activities, Peacock-Wiseman hypothesis.Trends of Public Expenditure in India.

(**9 Hrs)**

UNIT-III **Public Revenue**.Sources of Public Revenue, Effects of tax on production,Distribution and economic activities.Principles of Taxation- Benefit theory, Ability-to Pay Theory, Subjective and Objective Approaches, Direct and Indirect taxes, Neutrality in taxation.Allocative and Equity aspects of Income tax and commodity taxes. Theory of optimal taxation, Excess Burden of taxes,Tradeoff between Equity and Efficiency. The problem of double taxation.Shifting and Incidence of taxation : Forward and Backward shifting, Tax Capitalization, Incidence of commodity taxes and income tax, VAT, Features of the Indian Tax system.

(**9 Hrs)**

UNIT-IV **Public Debt**.Sources of Public borrowing, Effects of Public Debts, Importance of Public borrowings.Tax vs public debt, Burden of Public Debt, Shifting of Debt burden, Methods of debt redemption.Budget-Concept of Budget-Balanced and Unbalanced budget. Concept of deficit-Revenue,Budgetary,Fiscal and Primary deficit, Budget as an instrument of economic policy.Deficit Financing and its Limitations. Fiscal Policy- Its related problems. Fiscal sector reforms in India. (**9 Hrs)**

Text Books:
1. Public Finance. B.P.Tyagi,Jai Prakash Nath Publication :Meerat.UP.
2. Public Finance. D.N.Mithani,Himalaya Publishing House:New Delhi.

Reference Books:
*3. Public Finance and Policy.*Musgrave and Musgrave,Tata McGraw Hill :New Delhi.
*4. Modern Public Finance.B.*P.Herber.Richard D. Iruin,Homehood.
*5. Government Finance.*Due and Frendler.Pearson Publication:New Delhi.

HS - 2006 INTERNATIONAL ECONOMICS Cr-3

UNIT-I International Trade--The importance of International Trade (with emphasis on its significance in the present era of Globalization, measurement of Gains from Trade and their distribution. Theories of International Trade- Absolute and Comparative cost advantage theories, application of opportunity costs, Heckscher – Ohlin Theorem: its empirical Relevance, Leontif Paradox. (**9 Hrs)**

UNIT-II Balance of Trade and Balance of Payment-- Concept of Balance of Trade and Balance of Payments, Causes of Disequilibrium, Measures to correct .Disequilibrium (both monetary and non-monetary methods) and their relative merits and demerits.Free Trade vs Protection. (**9 Hrs)**

UNIT-III Foreign Exchange- Demand for and Supply of Foreign exchange, Fixed vs Flexible exchange rate, Rise and Fall of Gold Standard, Theories of exchange rate determination- Mint Parity Theory, Purchasing Power Parity Theory, Balance of Payments Theory.
The Brettonwoods system/IMF. **(9 Hrs)**

UNIT-IV **Concept of Terms of Trade**- Theories of Terms of Trade, Prebisch and Singer Theory, Economic effects of Tariff on National Income, Terms of Trade and Income Distribution, Effects of Quotas, Effective rate of Protection.Forms of economic co-operation- Theory of Custom Union. Changing structure of India's foreign trade since Independence, composition and Direction of India's Foreign Trade, Trends in India's Balance of Payments, Export Promotion and Import Substitution Strategy.GATT/WTO,TRIPS and TRIMS,FERA and FEMA.

(**9 Hrs)**

Text Books:

1.International Economics. Bo Sodersten, Mc Millan,1991.
2. International Economics. C.P.Kindleberger: Richard.D.Irwin : *Mac Millan Publication,1973*

Reference Books:

1. International Economics. D Salvatore: 8th Edition, Wiley India:New Delhi.
2. Indian Economy: Ruddar Datt and K.P.M. Sundaram,Publication: S.Chand and Company Limited:New Delhi
3. International Trade – Selected Reading, J Bhagawati (Ed.),Cambridge University Press:India.

HS- 3002 ORGANIZATIONAL BEHAVIOUR Cr-3

UNIT-1- Introduction to Organization and Organizational Behaviour- Meaning and definition of organization, features and principles of organization, Organizational structures and nature of organizational behavior.

(**9 Hrs)**

UNIT-2-Personality-Meaning of Personality, Personality Development, Determinants of personality, Application of personality in the organizational level. Motivation-concept of motivation, motivation and behavior, Theories of motivation, Need theory, Hygiene theory, Theory X and Theory Y,Elements of sound motivational system, Motivation in Indian organization.

(**9 Hrs)**

UNIT-3-Leadership---Meaning,Theory of leadership, Trait theory,Behavioural theory, Leadership styles, Leadership in Indian Organisation. Group Dynamics-Concept of Group Dynamic, Types of Group, Group Behaviour, Group Decisions, Techniques to improve group decision, merits and de-merits of group decision.

(**9 Hrs)**

UNIT-4- Organizational Change---Meaning and Nature of organizational chage,Factors of organizational change, Resistance to change, Factors in resistance, Overcoming resistance to change, Organizational Development-Concept, Objectives and process of organization development.

(**9 Hrs)**

Text Books:

1.ORGB, An innovative Approach to Learning and Teaching ,Organizational Behaviour, Nelson, Quick, Khandelwal, Cengage Learning.

Reference Books :

1. Organizational Behaviour Dr S.S.KHANKA, S.CHAND.

2.Organisational Behaviour. Arun Kumar and N.Meenaskshi .Vikas Publishing House.

3. *Managing Organisational Behaviour*,Moorhead & Griffin. CENGAGE Learning.

4.*Human Behaviour at Work*. Keith Davies

HS3004 HUMAN RESOURCE MANAGEMENT Cr-3

UNIT-1-Human Resource Management- Meaning & Definition, Functions, Scope & Objectives, Qualities of a HR Manager **(9 Hrs)**

UNIT-2-Human Resource Planning- Meaning & Definition, Importance of HRP,HRP Process. Barriers of HRP, Factors of sound HRP.

Recruitment – Meaning & Definition, Sources of Recruitment, Recruitment Process, Effective Recruitment. Training & Performance Appraisal- Definition & Objective ,Areas of Training, Meaning & Definition of Performance Appraisa, process, Effective principles of performance Appraisal.

(9 Hrs)

UNIT-3- Industrial Relations- Concept & Meaning, Objective & Importance, Reasons of poor Industrial Relation. Industrial Disputes- Meaning & Definition, Causes of Industrial Dispute, Prevention of Industrial Dispute, Conditions for good Industrial Relation. **(9 Hrs)**

UNIT-4- Workers Participation in Management- Meaning & Need, Forms of Participation, Scheme of participation ,Merits & Demerits. Collective Bargain- Meaning & Definition, Objective & Importance, Process of Collective Bargain, Effective Condition.

Employee Discipline-Guidelines for action, Penalties & Punishment, Rewards of Discipline**. (9 Hrs)**

Text Books:

1.Human Resource Management. P. Subba Rao, Himalaya Publishing House.
2.Human Resource Management. K.Aswathappa. Mc GRAW HILL Education.
Reference Books:

1.Human Resource Development Management . A. M.Seikh S.Chand
2.Industrial relation, trade union & labour legislation. Sinha Sekha.Pearson Publication.
3. Human Resource Management . S.S.Khanka, S. Chand.

HS - 3006 ENTREPRENEURSHIP Cr-3

UNIT-I-New Industrial Policy of 1991,Meaning and Definition of Entrepreneurship, Incentives and benefits available to SSI Units and New Entrepreneurs. Dearth of entrepreneurial talent in India, Growth of SSI in India. Procedures to start SSIs. **(9 Hrs)**

UNIT-II- Market survey and research pricing and techniques, Distribution Channel, Sales promotion activities. Raising Finance and enterprise launching. **(9 Hrs)**

UNIT-III-Financial Management, Working Capital Management, Costing,Book Keeping, Break-Even-Analysis. Taxation: Income Tax, Excise duty, Sales tax and VAT. (**9 Hrs)**

UNIT-IV- Decision making – Types, Forecasting-Qualitative and Quantitative methods, Personal Management, Motivation and theories of motivation. Preliminary Project Report (PPR),Detailed Project Report (DPR) writing.

(**9 Hrs)**

Text Books:

1. *Entrepreneurial Development and Management.* Vasant Desai.Himalaya Publication.
2. Entrepreneur*ial Development.* S.S.Khanka. S.Chand .

Reference Books:

1. *Industrial Organisation and Engg.Economics.* Sharma & Banga.Khanna Publication.
2. Entrepreneurship New Venture Creation. David H.Holt.Prentice Hall .PHI

HS-3008 MANAGEMENT CONCEPTS AND PRACTICES Cr-3

UNIT-1- Introduction to Management, Meaning and Nature, Functions of management, Theories of management, Classical theory,modern theory, Principles of management**.** **(9 Hrs)**

UNIT-II-Marketing: Identifying Market segments ,Market mix, product ,price, Distribution and promotion, Advertisement and market research. pricing strategies. (**9 Hrs)**

UNIT-III-Finance- Introduction, Scope & Functions ,financial statements, working capital management, Capital budgeting decision. (**9 Hrs)**

UNIT-IV-Production: Production planning and control, systems and procedure of inventory management, ,strategy Management : Firm and its environment, process of strategic planning.

(**9 Hrs)**

Text Books:

1.Organization And Management. R.D.AGARWAL.TATA Mc GRAW HILL Pvt. Ltd
2. Modern Business Organization And Management. Sherlekar & Sherlekar, Himalaya Publishing House.

Reference Books:

1. Principles & Practices of Management. L.M.Prasad
2. A Framework for Marketing, Management-Philip Kotler
3. Finanical Management. I.M.Panday.
4. Production and Operations Management. Everett E.Adam Jr. Ronald J.Ebert.

CIVIL ENGINEERING COURSES

CE2001 FLUID MECHANICS-I Cr-4

Introduction: Properties of Fluids, Concept of Shear Stress in Fluids, Newtonian, Non Newtonian & Ideal Fluids. **(4 Hrs)**

Fluid-Statics: Pressure at a Point, Pascal's Law, Pressure Head and Piezometric Head, Measurement or Pressure (Manometers), Pressure on Plane & Curved Surfaces, Buoyancy & Floating Bodies, Stability of Floating Bodies, Metacentre. **(12 Hrs)**

Fluid Kinematics: Fluid Motion, Fluid Acceleration, Types of Flows, Stream Lines, Path Lines, Streak Lines and Stream Tubes, Concept of Control Volume, Continuity Equation, Rotational & Irrotational Motion, Stream Function & Velocity Potential Function, Potential Flow & Laplace Equation, Flow Net Analysis and its Utility. **(8 Hrs)**

Fluid Dynamics: Euler's Equation, Bernoulli's Energy Equation, Application Of Bernoulli's Energy Equation, Pitot Tube, Venturimeter, Orifice Meter, Flow Through Orifices And Mouth Pieces, Momentum Principles, Application Of Momentum Equation, Force On Pipe Bend. **(14 Hrs)**

Laminar Flow: Navier Stoke's Equation, Laminar Flow Through Circular Pipes, Flow Between Parallel Plates, Stoke's Law, Measurement Of Viscosity. **(4 Hrs)**

Dimensional Analysis & Model Analysis: Dimensions, Physical Quantities In Fluid Flow, Dimensionally Homogeneous Equations, Buckingham's Π Theorem And Model Studies. **(6 Hrs)**

Text Book:

1. *A text book of Fluid Mechanics by R.K.Rajput, S.Chand and company Ltd. 2012,*
2. *"Engineering Fluid Mechanics", by Prof K. L. Kumar, 8th Revised Edition, S. Chand & Co Ltd.*

Reference Books:

1. *"Engineering Fluid Mechanics" by R.J. Garde & A. G. Mirajgaonker, Scitech Publications (India) Private Limited.*
2. *"Fluid Mechanics & Hydraulic Machines" by R.K. Bansal, 9th Edition, Laxmi Publications.*
3. *"Fluid Mechanics" by V.L. Streeter, E.B. Wylie & K.M. Bedford, 9th Edition, Tata McGraw-hill Publication.*
4. *"Fluid mechanics" by Frank M. White, 7th Edition, Tata McGraw-hill Publication*
5. *"Hydraulics & Fluid Mechanics" by P.N Modi & S.M.Seth, 19th Edition, Rajsons Publication Private Limited.*

CE2002 FLUID MECHANICS-II Cr-4

Pumps & Turbines: Jet striking in a plane & curved surfaces, Classification of turbines, Pelton turbine components, work done and efficiencies, Kaplan turbine, Francis Turbine, Classification of pumps. Classification of pumps, Reciprocating pumps, Centrifugal pump - Components, classification and velocity diagram. **(8 Hrs)**

Boundary Layer Theory: Laminar & Turbulent boundary layer, momentum equation for Boundary layer, hydrodynamically smooth & rough surfaces. **(6 Hrs)**

Pipe flow: Darcy-Weisbach formula, Laminar flow in pipes, velocity distribution & resistance to flow, resistance to flow in turbulent flow, Moody's diagram. **(8 Hrs)**

Pipe flow problem: energy losses in transition, pipe fittings & valves, problems on siphons, pipes in series and parallel, branching of pipes, pipe networks. **(10 Hrs)**

Drag & Lift: Drag due to ideal & real fluids, types, drag in a flat plate, sphere, circular disc, cylinders and aerofoil. Lift due to ideal & real fluids, lift on a sphere, cylinder and aerofoil, induced drag. **(4 Hrs)**

Flow in open channels: Uniform flow- Chezy's & Manning's formulae, Uniform flow problems, hydraulically efficient section, Energy & momentum equations, specific energy, flow in transitions. Gradually varied flow - Differential equation of GVF, Flow profiles, GVF computation. Rapidly varied flow, Hydraulic jump, Water Hammer, Surge tank. **(12 Hrs)**

Text Book:

1. *"Fluid Mechanics through problems" by R.J.Garde, 3rd Edition, Newage International Publishers, New Delhi*
2. *"Flow in Open Channels" by K. Subramanya, 3rd Edition, TMH Education Pvt. Ltd, New Delhi*

Reference Books:

1. *"Hydraulics & Fluid Mechanics" by P. N. Modi & S. M. Seth, 19th Edition, Rajsons Publication Private Limited.*
2. *"Fluid Mechanics & Hydraulic Machines" by R.K. Bansal, 9th Edition, Laxmi Publications, New Delhi.*
3. *"Fluid Mechanics" by V.L. Streeter, E.B. Wylie & K.M. Bedford, 9th Edition, Tata McGraw-hill Publication, New Delhi.*
4. *"Fluid mechanics" by Frank M. White, 7th Edition, Tata McGraw-hill Publication, New Delhi.*

CE2003 SOLID MECHANICS Cr-4

Simple Stresses and Strains: Concept of Stress, Stress and Strain in Materials Under Tension, Compression and Shear, Elastic Constants, Relation Between Elastic Constants, Thermal Stress and Strain, Stress & Strain of Composite Bars. **(10Hrs)**

Compound Stresses and Strains: Two Dimensional Stress System, Principal Planes, Principal Stresses, Mohr's Stress Circle, Principal Strains, Mohr's Strain Circle, Principal Stresses Computed From Principal Strains. **(10Hrs)**

Bending Stresses & Shear Stresses in Beams: Bending Moment and Shear Force Diagram of Determinate Beams, Theory of Simple Bending of Initially Straight Beams, Distribution of Normal & Shear Stresses, Unsymmetrical Bending, Shear Center, Position of Shear Centre, Shear Flow, Shear Center for Symmetrical & Unsymmetrical Section. **(10 Hrs)**

Torsion: Torsion in Solid & Hollow Circular Shafts, Torque and Power Transmitted by Solid and Hollow Shafts, Strength of Shafts, Combined Bending & Torque, Closed Coiled Helical Springs. **(6 Hrs)**

Columns & Struts: Elastic Instability, Euler Theory-Column with One end Free & Other end Fixed, Column with Both ends Hinged, Column with both ends fixed, Column with one end fixed and the other end Hinged, Eccentrically Loaded Column, Column with Initial Curvature. **(6 Hrs)**

Cylinders & Shells: Stresses & Strains in Thin Cylinders and Thin Spherical Shell Under Internal Pressure, Thick Cylinders Subjected to Internal & External Pressures Compound Cylinders. **(4 Hrs)**

Theories Of Failure: Stress Concentration, Principal Stress Theory, Maximum Shear Stress Theory, Principal Strain Theory, Total Strain Energy Theory, Distortion Energy Theory. **(2 Hrs)**

Text Book:

1. *"Strength of Material" by S. S. Ratan, Second Edition, TMH Education Pvt Ltd, New Delhi*
2. *"Strength of Material",by R.K.Rajput, Fifth Edition, S.Chand and Co. Ltd.*

Reference Books:

1. *"Strength of Materials" by G. H. Ryder, Third Edition, Macmillan Publisher India Ltd*
2. *"Elements of strength of Materials" by S. Temoshenko & D. H. Yong, Fifth Edition, EWP an east-west edition*
3. *"Engineering Mechanics of Solids" by E. P. Popov , Second Edition, PHI Publisher Ltd*

CE2004 STRUCTURAL ANALYSIS-I Cr-4

S.F.D. & B.M.D.: Definition, type of supports, shears force and bending moment diagram of all determinate beams, frames etc. S.F.D and B.M.D for the structures with internal hinge, Inter-relation between S.F.D and B.M.D. Obtain B.M diagram from S.F diagram. **(9 Hrs)**

Slope And Deflection of Beams: Double Integration method, Maculay's method, Moment Area method, Conjugate beam method, virtual work (Unit load) method, strain energy method. Castiglione's theorems of strain energy. Maxwell's reciprocal theorem, Betti's theorem, Rayleigh-Ritz method. **(15 Hrs)**

Plane Trusses and Space Trusses: Analysis of forces in members of a simple truss, Deflection of truss joints-Analytical and graphical methods, Williot-Mohr diagram. Forces in members of simple space truss. **(5 Hrs)**

Arches & Cables: Analysis of three hinged parabolic and circular arches for bending moment, normal thrust and redial shear, Analysis of cables and three hinged suspension bridges. **(7 Hrs)**

Influence lines and Rolling loads: Rolling loads and influence lines for simple supported beams. Influence lines for forces in members of Pratt and Warren trusses with parallel top and bottom cords, Influence lines for three hinged arch i.e. for horizontal thrust, bending moment, normal thrust and radial shear. **(12 Hrs)**

Text Book:

1. *"Structural Analysis Vol I", by S.S. Bhavikatti,4th Edition, Vikas Publishing House Pvt Ltd, New Delhi.*
2. *"Structural Analysis", R C Hibbeler, 8th Edition, Pearson Education India.*

Reference Books:

1. *"Fundamentals of structural analysis", S K Roy and S Chakrabarthy, 2nd edition, S Chand.*
2. *"Theory of Structures", S Ramammrutham and R Narayan, Dhanpat Rai, 1993.*

CE2005 SURVEYING Cr-3

Introduction to Surveying: Objectives of Surveying, Primary divisions of Surveying, Classification of Surveying, Principles of Surveying, Units of measurements, Plans and Maps, Introduction to types of scales used in Surveying maps, Introduction to Vernier and Types of Vernier, Error due to Wrong Scales, Types of Mistakes and Errors in Surveying (in brief). **(4 Hrs)**

Chaining: Introduction to chaining, Principle of chain surveying, Methods of measuring distance, Types of Chains and Tapes used in Surveying, Other accessories used in chain surveying, Ranging of a Survey line (Direct & Indirect), Process of measuring distances with chains and tapes, Errors caused by wrong chain length (In length, Area and Volume), Types of errors in chaining ant taping, Correction of errors in chaining and taping (Problems), Chain Surveying (Process in Field, Important line terminologies used in chain surveying, Offsets and Types of Offsets, Instruments for measuring right angles, Obstacles in Chaining and Problems on Obstacles, Precautions during Chain surveying.

(5 Hrs)

Compass Surveying: Introduction to Compass Surveying, Principle of Compass Surveying, Designation of Bearings used in Compass Surveying, Types of Bearing Systems, Declination of the Magnetic Bearing w.r.t. True Bearing, Types of Compasses used in Compass Surveying, Fore Bearing and Back Bearing with examples, Calculation of included angles from Bearings, Computation of Bearing from Internal Angles, Local attraction, Correction of Bearing for Local attraction, Traversing with Chain and Compass, Types of errors in Compass surveying, Plotting the compass traversing survey, Adjustments for closing error in closed traverse surveys, Precautions in Compass surveying. **(5 Hrs)**

Plane Table Surveying: Introduction to Plane Table Surveying, Principle of Plane Table Surveying, Plane table accessories, Setting up of plane table in field, Orientation in plane table, Plane table methods (Radiation, Intersection, Traversing and Resection), Comparison of the methods, Two-Point Problem, Three-Point Problem (Tracing Paper method, Graphical method, Trial and error method, Lehmann's rule, Adjustments of the Plane table, Errors in Plane tabling, Advantages and Disadvantages in Plane tabling. **(4 Hrs)**

Measurement of Elevations-Levelling: Introduction to Levelling, Terminology of terms used in Levelling, Methods of finding elevation, Direct methods for finding levels, Types of Levelling instruments, Levelling staff, Temporary adjustments in levelling instruments, Basic levelling operation in field and terminology, Reduction of levels (Height of Collimation Method, Rise and Fall Method), Problems on reduction of levels, Other methods in levelling (Fly levelling, Check levelling, Profile levelling, Cross section levelling, Reciprocal levelling), Curvature and Refraction (Correction for Curvature, Correction for Refraction, Distance to the Visible horizon, Dip of the Horizon, Balancing back sight and fore sight, Reciprocal levelling, Errors in levelling, Advantages of leveling. (**5 Hrs)**

Contours: Introduction to Contours, Terminology used in Contour Operations, Characteristics of Contours, Use of Contour maps (Elaborate practical applications in Drawing of Sections, Determination of Intervisibility between two points, Tracing contour gradient and location of route, Measurement of drainage areas, Calculation of Reservoir Capacity using Trapezoidal formula and Prismoidal formula, Intersection of Surfaces and Measurement of Earth work).

(4 Hrs)

Measurement of Angles in Vertical Plane-Theodolite Survey: Introduction to Theodolite Surveying, Principle of Theodolite Surveying, Essentials of Transit Theodolite, Definitions and Terms used in Theodolite Surveying, Temporary adjustments in Theodolite, Measurement of Horizontal angles (Method of Repetition, Method of Reiteration), Field procedure for Theodolite Surveying, Sources of errors in Theodolite Work, Advantages and Disadvantages of Theodolite Survey, Problems in Theodolite Surveying, Problems on Omitted Measurements.

(5 Hrs)

Curves: Types of Horizontal and Vertical Curves, Simple Circular Curve, Elements of a Simple Circular Curve, Designation of Curve, Fundamentals of Geometry of Circular Curve, Introduction to layout of Simple Circular Curve, Tape and Theodolite Method, Laying out a curve by Deflection angle (Rankine's Method), Laying out a curve by Two Theodolite Method, Transition Curve, Combined Curve, Requirements of Vertical Curve, Length of Vertical Curve, Vertical Curves by equation of parabola, Different applications of Curve setting. **(4 Hrs)**

Text Book:

1. *"Surveying and Levelling" by R. Subramanian; 2nd Edition, Oxford publications, New Delhi.*
2. *"Surveying Vol. I" by S. K. Duggal; McGraw Hill Education (India) Private Limited.*

Reference Books:

1. *"Surveying Vol. I" by Dr. B. C. Punmia, Ashok K. Jain & Arun K. Jain; Laxmi Publications (P) Ltd.*
2. *"A Text book of Surveying and Levelling" by R. Agor; Khanna Publishers.*
3. *"Surveying and Levelling (Part 1)" by T. P. Kanetkar & S. V. Kulkarni; Pune Vidyarthi Griha Prakashan.*
4. *"Surveying and Levelling" by N. N. Basak; Tata McGraw-Hill Private Limited.*
5. *"Surveying and Levelling" by S. C. Rangwal, K. S. Rangwala & P. S. Rangwala; Charotar Publishing House Pvt. Ltd.*

CE2006 TRANSPORTATION ENGINEERING-I Cr-3

Introduction: Definition of Transportation Engineering, Role of transportation, different modes of transportation and their merits and demerits, scope of highway engineering. **(1 Hrs)**

Highway development and planning: Historical development of road construction, roman road, Tresaguet construction, Metcalf construction, Telford construction and Macadam construction. **(1 Hrs)**

Highway development in India: Jayakar Committee, Central Road Fund ,Indian Roads Congress, Central Road Research Institute ,Motor vehicle act ,First twenty year road plan, Second twenty year road plan, Highway Research board, Third twenty year road plan. **(1 Hrs)**

Classification of roads: Classification of roads by Nagpur road plan, classification of urban roads.**Road pattern.** **(1 Hrs)**

Highway alignment and survey: Requirements, factors controlling the highway alignment. **(1 Hrs)**

Engineering survey and highway location: Map study, reconnaissance survey, preliminary survey, final location and detail surveys. Drawing & reports, new highway projects. **(1 Hrs)**

Highway Geometric Design: Importance of geometric design, design control and criteria, Highway cross section element, Typical cross section of road, Sight distance, SSD, OSD, ISD, Design of horizontal alignment, Superelevation, Attainment of super elevation, Widening of pavement on horizontal curve, Horizontal transition curve, Set-back distance on horizontal curves, Curve resistance, Design of vertical alignment, Grade compensation, Summit curve and Valley curve. **(8 Hrs)**

Highway Materials: Significance of subgrade soil, CBR test, desirable properties of road aggregate, Test for road aggregate, Bituminous materials, Bitumen, Tar, Emulsion, types of bitumen, Test on bitumen, Marshall Method of Bituminous Mix Design, Bankelman Beam, Bump Integrator, Stabilization of soil, Specification for construction of Earth, Moorum, Water bound macadam(WBM), Wet mix macadam(WMM), Bituminous and Concrete roads.

(4 Hrs)

Traffic Engineering: Scope of traffic engineering, Traffic characteristics, Traffic studies, Traffic volume study, Speed studies, Origin and Destination(O&D) study, Traffic flow characteristics, Traffic capacity study, Parking study, Accident

studies, Level of Service, Passenger Car Unit(PCU), Relationship between Speed, Travel Time, Volume, Density and Capacity, Regulatory sign, Informatory signs, Traffic Signals, Rotary intersection, Mini Roundabout.

(6 Hrs)

Pavement Design: Difference between Flexible and Rigid pavement, Design of Flexible pavement as per IRC: 37-2001 and Design of Rigid pavement as per IRC: 58-2002. **(5 Hrs)**

Road making machinery and equipments: Bull dozer and Scraper, Power shovel, Dragline, Clamshell, Hoe, Compacting Equipment. **(1 Hrs)**

Road Drainage: Significance of highway drainage, Requirements of highway drainage, Surface drainage, Cross drainage, Sub-Surface drainage, Road construction in water-logged area. **(1 Hrs)**

Highway maintenance: Introduction, causes of pavement failures, failure in flexible pavement and rigid pavement, maintenance of flexible and rigid pavement. **(1 Hrs)**

Tunnel Engineering: Necessity of tunnel, tunneling versus open cut, different cross section of tunnel, transfer of surface alignment, heading and enlargement, drilling and blasting and shuttering, shield tunneling, tunneling under water drainage, ventilation of tunnels, tunnel lining. **(2 Hrs)**

Bridge engineering: Introduction, site selection, types of bridges, terminology related to bridge engineering, superstructure, bridge foundation, types of foundations. **(2 Hrs)**

Text Book:

1. *"Highway Engineering" by S. K. Khanna & C. E. G. Justo, 9th Edition, Khanna Publishers, New Delhi.*

Reference Books:

1. *"Bridge Engineering" by Rangwala, Charotar Publishing House Pvt. Ltd.*
2. *"Roads, Railways, Bridges, Tunnels and Harbour dock Engineering" by B. L. Gupta & Amit Gupta, Standard Publication*

CE2007 CIVIL ENGINEERING MATERIALS & CONSTRUCTION Cr-3

Stones: Classification, composition, characteristics, uses, method of quarrying and dressing. **(4 Hrs)**

Bricks: Brick earth, method of Brick manufacture, testing of bricks, classification. **(4 Hrs)**

Cement: Portland cement:-Classification, Chemical composition, hydration, tests for cement fineness test, normal consistency, setting time, soundness, tensile and compressive strength. **(4 Hrs)**

Concrete: Composition of concrete, W/C ratio, Workability, Compressive and tensile strength, Nominal Mix design, pozzolanic concrete, Light weight and high density concrete, Elasticity, Shrinkage and creep of concrete.

(6 Hrs)

Timber: Characteristics and suitability for different purposes, Defects and decay seasoning preservation of timber.

(4 Hrs)

Foundation: Shallow foundation, Deep foundation, Description and types of spread foundation, Description and types of pile foundations, Methods of pile driving, Pile driving formulae (isolated and group of piles),Excavation and timbering of trenches, Well foundations, Caissons, Cofferdams. **(5 Hrs)**

Masonry: Definition of terms; classification of masonry; stone masonry; classification, dressing, joints, maintenance; Brick masonry; Types of bonds, brick laying, structures in brickwork; Partition walls. **(3 Hrs)**

Door & Windows: Criterion of size; types of doors and windows ventilators and fanlights sash and casement windows, skylights and lanterns; fixture and fastenings for doors and windows. **(3 Hrs)**

Floors: Ground flooring, upper flooring, types, preparation, advantages and disadvantages. **(3 Hrs)**

Text Book:

1. *"A Text Book of Building Construction" by Dr. S.K.Sharma, Revised Edition, S.Chand Publication, 1987.*
2. *"Engineering Materials" by S.C.Rangwala, Charotar Publishing House, 2011.*

Reference Books:

1. *"Building Material" by M. L. Gambhir, 1st Edition, TMH Education, New Delhi.*
2. *"Building Construction" by B. C. Punmia, Jain & Jain, 10th Edition, Laxmi Publication, New Delhi.*
3. *"Building Material" by P. C. Verghese, PHI Learning (P) Ltd., New Delhi, 2005*
4. *"Building Material" by S.S.Bhavikatti, 1st Edition, Vikas Publication.*
5. *Materials for civil and construction engineers by Michael S. Mamlouk and John P. Zaniewski, 3rd edition, Pearson Education Inc., 2011*

CE2008 ADVANCED SURVEYING Cr-3

Total Station and Electronic Distance Measurement: Introduction to Total Station, Advantages and Disadvantages of Total Station, Measuring Angles, Types of Total Station, Advancement in Total Station Technology, Automatic Target Recognition (ATR), Introduction to EDM, Measurement Principle of EDM instrument, EDM instrument characteristics, Classification of EDM, Errors in Electronic Distance Measurement, Error correction in EDM, Zero Correction, Prisms used in EDM, Accuracy in EDM, Field procedure in EDM, Geometry of EDM, EDM without reflecting prisms, Focusing and sighting. **(4 Hrs)**

Tacheometry: Introduction to Tacheometry, Principle of Tacheometric Surveying, Methods in the Tacheometric Surveying, Uses of Tacheometry, Types of instruments used in Tacheometric Surveying, Systems of Tacheometric Measurements (Stadia Method and Non-Stadia Method), Stadia Method or Fixed-hair Method, Principle of Stadia Method, Determination of Tacheometric Constants, Anallactic Lens, Inclined Stadia Measurements, Uses of Stadia Method, Errors in Stadia Measurement, Tangential Method. Both Angles are above horizontal line of sight, Both Angles are below horizontal line of sight, One of the Vertical Angles is above and the other below the horizontal line of sight, Subtense Bar Method, Subtense bar Instrument, Effect of Angular Error.

(6 Hrs)

Triangulation : Introduction, Triangulation, Principle of Triangulation, Purpose of Triangulation Surveys, Classification Triangulation, Layout of Triangulation, Ideal figures for triangulation, Size of triangulation, Well conditioned triangle of a triangulation system, Strength of triangulation figures, Accuracy of triangulation, Routine of triangulation survey, Field work of triangulation, Signals and towers, Classification of signals, Base line measurement, Equipments for base line measurement, Normal tension, Extension of base, Number of Zeros, Types of triangulation stations, Triangulation computations, Height adjustment of triangulation net, Base net.

(6 Hrs)

Theory of Errors and Adjustments: Introduction, Definitions, Weight of the observations, Laws of weights, Assignment of weightage to the field observations, Adjustment of accidental errors, Method of least squares, Probable values of directly observed quantities, Probable values of indirectly observed quantities, Conditioned quantities, Calculation of constants of line equations by method of least squares, Probable error, Triangulation adjustment, Adjustment of a chain of triangles, Adjustment of a quadrilateral, Methods of adjustment of braced quadrilaterals, Adjustment of a centered polygon, Adjustment of level work. **(5 Hrs)**

Remote Sensing: Introductions to remote sensing; Applications and importance of remote sensing, Introduction to GPS: Available GPS net works, Limitations and applications of GPS; GPS receivers. Basic concepts and fundamentals of remote sensing- elements involved in remote sensing, electromagnetic spectrum, remote sensing terminology and units, over view of Indian Remote sensing satellites and sensors, Energy resources, energy interactions with earth surface features and atmosphere, resolution, visual interpretation techniques, basic elements, converging evidence, interpretation for terrain evaluation, spectral properties of water bodies, introduction to digital data analysis.

(6 Hrs)

Map Projections: Introduction; Scale Factor; Geometry of the sphere and cone; Areas; Surface areas of solids; Types of Map Projections; Map projection to a plane; Gnomonic Projection; Stereographic Projection; Orthographic Projection; Conical Projection; Albers Equal-area Projection; Polyconic Projection; Conformal Projection; Lambert Projection; Mercator Projection; Transverse Mercator Projection; Universal Transverse Mercator Projection; The choice of projection. **(3 Hrs)**

Geographic Information System (GIS): Introduction, GIS definition and terminology, GIS categories, components of GIS, fundamental operations of GIS, A theoretical framework for GIS, Data collection and input overview, data input and output. Keyboard entry and coordinate geometry procedure, manual digitizing and scanning, Raster GIS, Vector GIS - Advantages and disadvantages. File management, Spatial data – Layer based GIS, Feature based GIS mapping, Computational Analysis Methods (CAM), Visual Analysis Methods (VAM), Data storage-vector data storage, attribute data storage, overview of the data manipulation and analysis. Integrated analysis of the spatial and attribute data. **(6 Hrs)**

Text Books:

1. *"Global Positioning System" by Satheesh Gopi, Revised Edition, TMH Education Pvt. Ltd, New Delhi.*
2. *"Surveying" Vol-2 by S.K.Duggal, 4th Edition, TMH Education Pvt. Ltd, New Delhi*
3. *"Advanced Surveying, Total station, GIS & Remote sensing" by Satheesh Gopi, R.Sathi Kumar and N.Madhu, Pearson Education, New Delhi*

Reference Books

1. *"A Text Book of Advanced Surveying" by R. Agor; Khanna Publishers.*
2. *"Remote Sensing and GIS" by Basudeb Bhatta, Oxford University Press.*
3. *"Surveying" Vol. I, II and III by Dr. B. C. Punmia, Ashok K. Jain and Arun K. Jain; Laxmi Publications (P) Limited.*
4. *"Remote Sensing and Geographical Information System" by A. M. Chandra and S. K. Ghosh; Narosa Publishing House.*
5. *"Textbook of Remote Sensing and Geographical Information System" by M. Anji Reddy,BS Publications.*
6. *"Textbook of Remote Sensing and Geographical Information System" by Kali Charan Sahu, Atlantic Publications*

CE2009 ENVIRONMENTAL ENGINEERING-I Cr-3

Water Supply Engineering: General requirement for water supply, sources of water supply, Estimation of water demand. Intake structures, pumping and transportation of water. Physical, chemical and biological characteristics of water and their significance, Water quality criteria, Water borne diseases. **(13 Hrs)**

Engineered systems for water treatment: Aeration, sedimentation, softening, coagulation, filtration, ion exchange, and disinfection. General description of water distribution system. **(15 Hrs)**

Plumbing systems: House-connections, overhead tanks, design of internal distribution system, ventilation and lighting of buildings. **(2 Hrs)**

Air Pollution: Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits. **(3 Hrs)**

Noise Pollution: Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution. **(3 Hrs)**

Text Book:

1. *"Water Supply Engineering & Environmental Engineering (Vol. I)" by S.K. Garg., Twentieth Revised Edition, Khanna Publishers, 2013.*
2. *"Environmental Engineering", H.S. Peavy, D.R. Rowe, & G. Tchobanoglous, Seventh Edition, McGraw Hill, 1985.*

Reference Books:

1. *"Water and Wastewater Technology", M.J. Hammer, Seventh Edition, Prentice Hall, 2011.*
2. *"Water Supply and Sewerage", Terence J. McGhee, Sixth Edition, Tata McGraw Hill, 2014*
3. *"Water and Wastewater Engineering", Davis & Mackenzie, First Edition, McGraw Hill, 2010.*
4. *"Introduction to Environmental Engineering", M.L. Davis & D.A. Cornwell, Fourth Edition, Tata McGraw Hill, 2010.*
5. *"Unit Operations and Processes in Environmental Engineering", T.D. Reynolds & P.A. Richards, Second Edition, PWS Publishing Company, CENGAGE Learning, 2009.*
6. *"Manual on water supply and Treatment", CPHEEO, Ministry of Urban Development, GoI, New Delhi, 2009.*

CE2012 DESIGN OF CONCRETE STRUCTURES - I Cr-4

Materials, Basic properties of concrete and reinforcement. **(2 Hrs)**

Basic working stress and limit state design concepts. **(4 Hrs)**

Design of singly-doubly reinforced sections, flanged sections. **(6 Hrs)**

Design of simply supported and continuous beam subjected to flexure, shear and torsion by limit state methods. **(10 Hrs)**

Design of one-way and two-way slab (simply supported and continuous) by limit state methods. **(8 Hrs)**

Design of staircases. **(4 Hrs)**

Design of short and long columns with axial and eccentric loading. **(8 Hrs)**

Design of isolated column footing. **(6 Hrs)**

Text Book:

1. *"Design of Concrete Structures", U.Pillai & D.Menon, TataMcgraw Hill publishing company ltd. New Delhi 2003*
2. *"Reinforced Concrete limit state design", by A. K. Jain, Nem Chand & Bros, 2002*

Reference Books:

1. *"Prestressed Concrete", by N. Krishna Raju, Tata McGraw Hill publishing company ltd, New Delhi*
2. *"Limit state design of reinforced concrete", by P C Varghese, Prentice Hall of India pvt ltd. New Delhi 2002*

CE3001 STRUCTURAL ANALYSIS II Cr-4

Degree of static and kinematic indeterminacy. **(5 Hrs)**

Analysis of fixed beam by moment area method. **(5 Hrs)**

Analysis of beams by consistent deformation method and theorem of three moments. **(6 Hrs)**

Analysis of beams and frames by, Slope deflection method, Moment distribution method, Kani's method**,** Strain energy method. **(24 Hrs)**

Analysis of two hinged arches and fixed arches. **(4 Hrs)**

Two hinged suspension bridges. **(4 Hrs)**

Text Book:

1. *"Structural Analysis Vol II" by S.S. Bhavikatti, 4th Edition, Vikas Publication*
2. *"Indeterminate structural analysis" by C. K. Wang, 1st Edition, TMH Edu. Pvt Ltd., New Delhi.*

Reference Books:

1. *"Theory of Structures" by S. Ramammrutham, Dhanpat Rai Publication, New Delhi.*
2. *"Theory of Structures (I & II)" by Pandit & Gupta, McGraw-Hill Education Pvt. Ltd, New Delhi.*
3. *"Indeterminate Structural Analysis" by J.S.Kinney, Narosa Publication, 1987*

CE3002 WATER RESOURCES ENGINEERING II Cr-4

Flood: Methods of estimation-UH method-Flood frequency studies (Gumbel's method, Log Pearson type III method), Design flood**.** **(6 Hrs)**

Flood Routing: Basic equation-Hydrologic flood routing, Modified Pulse Method, Muskingham method of channel routing, hydraulic flood routing. **(6 Hrs)**

Flood Control works: Flood flows, types of flood control works, river training works. **(3 Hrs)**

Drainage: Drainage Command Area Drainage Issues ;(Water logging and salinity, sources of excess water), Drainage criteria, Design discharges, steady and non steady flow to drains, Planning and Design surface subsurface Drainage systems, Drainage system Operation and Maintenance. **(6 Hrs)**

Reservoirs: Preliminary concept of reservoir planning, types of reservoirs, selection of site, reservoir capacity from mass curves silting of reservoirs, Principle of Reservoir Operation. **(6 Hrs)**

Dams: Classification, Investigation, Site selection, economical height of dam. **(4 Hrs)**

Gravity dams: Forces acting on gravity dam, structural stability of gravity dam, Elementary profile of a Gravity dam High & low gravity dam, concept of design of gravity dam, construction of Galleries, joints, foundation treatment of gravity dam. **(3 Hrs)**

Earth Dams: Types of earth dams, causes of failure of earth dams, criteria for safe design of earth dams, determination of phreatic line and flow net, measures to control seepage through earth dams and their foundations, slope protection, concept of stability of slopes of earth dams by slip circle method. **(5 Hrs)**

Spillways: Description & Design Aspects of different type of spillways. **(4 Hrs)**

Overview on Water Power: Different power sources, classification of hydropower plants, important terms and definitions connected with hydropower, principal component of hydropower plant**.** **(5 Hrs)**

Text Books:

1. *"Irrigation Engineering & Hydraulic Structures" by S.K. Garg, Khanna Publishers*
2. *"Engineering Hydrology" by K. Subhrmanya, TMH Education Pvt. Ltd, New Delhi*

CE3003 WATER RESOURCES ENGINEERING-I Cr-4

Hydrology:-

Introduction: Hydrologic cycle, catchment area. **(2 Hrs)**

Precipitation: Meteorological aspects of precipitation-measurement-preparation & presentation of data-mean precipitation, DAD Curves. **(5 Hrs)**

Abstraction: Evaporation-measurement-empirical equation, Evapo-transpiration measurement-equation PET, Infiltration-process-measurement-infiltration capacity & indices. **(4 Hrs)**

Runoff: Process of stream flow measurement-Hydrograph, yield, flow duration curve, flow mass curve. **(7 Hrs)**

Hydrograph: Base flow, effective rainfall, Unit hydrograph-Derivation, synthetic UH, Instantaneous UH **(5 Hrs)**

Irrigation Engineering:-

Irrigation: Definition, necessity, Benefits & ill effects of irrigation, types of irrigation & methods of irrigation **(2 Hrs)**

Water Requirements of Crops: Agro meteorological Variables, Soil water plant relationship, base period, crop period, duty and delta relationships, factors affecting Duty, G.C.A., C.C.A., intensity of irrigation, kor-watering, kor period, kor depth, cash crop, crop rotation, determination of Irrigation requirement of crops, irrigation scheduling, Assessment of irrigation water, irrigation efficiencies, consumptive use. **(5 Hrs)**

Canal Irrigation systems: Classification of canals, Alignment, Different types of canals, Distribution system, Design of stable channels in India, Regime Channel, Kennedy's Theory, Use of Garret's diagram, Lacey's theory, Design procedure of irrigation channels, different types of lining and its construction. **(5 Hrs)**

Diversion Head works: Concept of weir & barrage, Layout of diversion heads works & its components (description).canal head regulator, head sluices, Theory of seepage, concept of Blight's creep theory, Lanes Weighted creep theory, Khosla'a theory on permeable foundation (elementary concept). **(5 Hrs)**

Canal Falls: (Description) Necessity. Location, Elementary concept of different types of canal falls. **(2 Hrs)**

Cross drainage works: (Description) Type of cross drainage works, elementary idea about different types of cross drainage works. **(3 Hrs)**

Overview on Groundwater: Forms of sub-surface water, water table, saturated formation, specific yield, Darcy's law, Wells (steady flow in confined and un-confined aquifers), Open wells. **(3 Hrs)**

Text Books

1. *"Irrigation Engineering & Hydraulic Structures" by S. K.Garg; 23rd Edition, Khanna Publisher*
2. *"Engineering Hydrology" by K. Subramanya; 4th Edition, Mc. Graw Hill, New Delhi*

Reference Book:

1. ***"**Applied Hydrology" by V.T.Chow, D.R.Maidment & L.W.Mays, McGraw Hill Book Co, Singapore, 1988*

CE3004 GEOTECHNICAL ENGINEERING II Cr-4

Stresses Distribution: Introduction , Boussinesq's formula for determining vertical stress under point load, Pressure bulb, Vertical stress distribution on horizontal and vertical plane, Vertical stress due to uniformly loaded line, strip, circular, square and rectangular footings, New marks's influence chart and its use, Approximate methods of finding vertical stress below loaded footings, contact pressure. **(8 Hrs)**

Bearing Capacity of Shallow Foundations: Introduction, Rankine's analysis for cohesion less soils, Terzaghis bearing capacity equation, Factors influencing bearing capacity of soil including effect of water table , size of footings and eccentricity of loading, plate load test, standard penetration test and static cone penetration test Selection of type of foundations, Depth of foundation, Floating Foundation, Bottom heaving, Dewatering of foundation trenches.

(10 Hrs)

Pile Foundations: Classification of piles, Load carrying capacity of single piles by static and dynamic formulae (Hilley's and Engineering News formula) Group action of piles, Settlement of pile groups, Negative skin friction, under reamed piles. **(8 Hrs)**

Earth Pressure and Retaining Structures: Active & passive earth pressure, Rankine's theory for active and passive earth pressure, Coulomb's theory and Rebha - Poncelet construction (for cohesion less soil), Culmann's construction for active and passive earth pressure (for cohesion less soils), Pressure against solid retaining walls without and with uniformly distributed load surcharge, Effect of submergence, Types of sheet pile walls, pressure against cantilever and Anchored bulkheads (free earth support method only), pressure against walling in deep trenches.

(10 Hrs)

Stability of Slopes: Stability of infinite slopes, Culmann's approach for finite slope, Swedish, slice method and friction circle method of analysis, stability of homogeneous finite earth slopes without surcharge with steady seepage and under sudden drawdown condition. **(8 Hrs)**

Site Investigations: Methods of exploration, Preservation, shipment and storage of sampling. **(2 Hrs)**

Introduction to Rock mechanics: Classification of rocks, Index properties of rocks, Laboratory test for determination of strength of rocks, Modes of failure of rock, Mohr-coloums failure criterion for rocks, shear strength of rocks, hardness of rock, In-situ stresses in rocks. **(2 Hrs)**

Text Book:

1. *"Principles of Foundation Engineering" by B.M.Das, 7th Edition, Cengage Learning India Pvt. Ltd, New Delhi.*
2. *"Geotechnical engineering handbook" by B.M.Das, J.Ross Publishing, Cengage learning.*

Reference Books:

1. *"Basic and applied soil mechanics" by Gopal Ranjan & A. S. R. Rao, New age international publication, 2007.*
2. *"Soil Mechanics & Foundation Engineering" by B. C. Punmia, Ashok Kumar Jain, Arun Kumar Jain, Laxmi Publications, New Delhi.*
3. *"Foundation Analysis and Design" by J. E. Bowls, TMH Education, New Delhi.*
4. *"Geotechnical Engineering Principles and Practices" by Donald P. Coduto, Man Chu Ronald Yeung & William A. Kitch, Prentice Hall, 2011.*

CE3005 GEOTECHNICAL ENGINEERING-I Cr-4

Introduction and Classification: Definition of soil, origin & formation of soil, General types of soil and soil deposits, Cohesive and cohesion less soils. Basic definitions, Relationship & inter-relationships. Index properties of soils & their determination. Classification base on grain size and plasticity characteristics.

(7 Hrs)

Permeability of soils: Darcy's law and its range of validity, Discharge velocity, Seepage velocity Laboratory determination of Co-efficient of permeability (K):-constant head permeability, Falling head permeability. Indirect determination of K, Factors affecting permeability, Permeability of stratified soils, Co-efficient in an inclined direction.

(5 Hrs)

Effective stress principle: Nature of effective stress, Effect of water table fluctuation on effective stress. Effective stress in a soil mass under different hydraulic conditions, Increase in effective stress due surcharge. **Capillarity of soil and capillary zones**. Effective stress in soils saturated by capillary action, Seepage pressure, Effective stress under steady seepage conditions, Quick Sand Condition. **(7 Hrs)**

Seepage analysis: Laplace's equation ,Stream and Potential Functions, flow net, characteristics of flow net, graphical method, flow net for anisotropic soils, flow net in non-homogeneous soil mass, uses of flow net.

(5 Hrs)

Shear strength: Basic concept, Mohr-coulomb-failure criteria. Methods of determination of shear strength parameters: Shear tests- Direct shear test, Triaxial compression test, Unconfined compression test, Vane shear test; advantage and disadvantage of direct shear and triaxial compression test, advantages of unconfined compression test and vane shear test.

(9 Hrs)

Compaction of Soils: Objects, Measurement of compaction: Determination of OMC & MDD by standard & modified proctor compaction test. Factors affecting compaction, Zero air voids line, field compaction control using of proctor - Needle. **(6 Hrs)**

Consolidations of Soils: Introduction, Principles of consolidation, soil spring analogy, consolidation characteristics of laterally confined soil, pressure void ratio diagram, Normally consolidated and over consolidated soils, Estimation of reconsolidation pressure, Terzaghi's theory of one dimensional consolidation, Laboratory consolidation test, Determination of coefficient of consolidation, Consolidation settlement.

(9 Hrs)

Text Book:

1. *"Soil Mechanics & Foundation Engineering" by B.C.Punmia, Ashok K.Jain & Arun Kumar Jain, 4th Edition, Laxmi Publication, New Delhi.*
2. *"Geotechnical Engineering" by C. Venkatramaiah, Newage International Publishors, New Delhi*

Reference Books:

1. *"Basic and applied soil mechanics" by Gopal Ranjan & A. S. R. Rao, New age international publication, 2007*
2. *"Principle of Geotechnical Engineering" by B. M. Das & Khaled , 8th Edition, Global Engineering USA .*
3. *"Soil Mechanics and Foundation Engineering" by K. R. Arora, Standard Publisher, 2005*
4. *"Soil Mechanics and Foundation Engineering" by V.N.S. Murthy, CBS Publisher, 2009*

CE3006 DESIGN OF CONCRETE STRUCTURES - II Cr-4

Design of combined footings. **(12 Hrs)**
Design of piles and pile caps. **(8 Hrs)**
Design of circular water tank. **(6 Hrs)**
Design of cantilever and counterfort retaining wall. **(12 Hrs)**

Introduction to prestressing systems, analysis of beam sections at transfer and service loads and losses in prestressing. **(10 Hrs)**

Text Book:

1. *"Design Of Reinforced Concrete structure" by S.Ramamruthum, 17th Edition, Dhanpat Rai & sons, New Delhi*.

Reference Books:

1. *"Design of Concrete Structures" by U.Pillai & D.Menon, TataMcgraw Hill publishing company ltd., New Delhi, 2003*
2. *"Advanced Reinforced concrete" by P C Varghese, Pentice-hall of India pvt. ltd. New Delhi, 2002.*
3. *"Reinforced Concrete limit state design" by A.K.Jain, Nem Chand & Bros, 2002.*
4. *"Limit state design of reinforced concrete" by P C Varghese, Pentice-hall of India pvt. ltd., New Delhi, 2002.*

CE3007 DESIGN OF STEEL STRUCTURE Cr-4

Properties of structural steel, IS rolled section. **(3 Hrs)**
Connections, simple and moment resistant bolted and welded connections. **(8 Hrs)**
Design of tension members. **(3 Hrs)**
Design of compression members, Design of lacings and battens. **(8 Hrs)**
Design of beams. **(6 Hrs)**
Design of plate girders including stiffeners. **(10 Hrs)**
Design of beam-column. **(6 Hrs)**
Design of column bases (slab base, gusseted base, grillage footing). **(4 Hrs)**

Text Book:

1. *"Design of steel structure", by S.K Duggal, Mc Graw Hill Education Pvt. Ltd*
2. *"Design of Steel Structures", by N. Subramanian, Oxford University Press, 2012*

Reference Books:

1. *"Design of steel structures by Limit state method as per IS 800-2007" by S.S.Bhavikatti, 2nd edition, I.K International publishing house pvt. Ltd.*
2. *"Design of Steel Structures V-II", by S. Ramchandra, Standard pub.*

CE3008 ENVIRONMENTAL ENGINEERING-II Cr-3

Wastewater Engineering: Physical, chemical and biological characteristics of sewage. Generation and collection of wastewater, sanitary, storm and combined sewerage systems, Quantities of sanitary wastes and storm water. Design of sewerage system. **(8 Hrs)**

Treatment of sewage: Primary- screening, grit chamber, skimming tanks, sedimentation, Secondary- Basics of microbiology, classification of secondary treatments, activated sludge process, trickling filter, Tertiary- Removal of nitrogen and phosphorus, Miscellaneous treatments- oxidation ponds, aerated lagoons. Sludge digestion and handling. Septic tank, Imhoff tank. Disposal of effluent and sludge in land and water bodies, Wastewater disposal standards. **(19 Hrs)**

Sewer Appurtenances: Manholes, Drop manholes, Lampholes, street inlets, catch basins, flushing tanks, storm water regulators, grease and oil-traps, inverted siphons. **(2 Hrs)**

Sanitary systems: Principles of house drainage, traps, sanitary fittings. **(2 Hrs)**

Municipal Solid Waste Management: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse, recycle, energy recovery, treatment and disposal). **(5 Hrs)**

Text Book:

1. *"Environmental Engineering Vol-I & Vol-II" by S.K.Garg, Revised Edition, Khanna Publisher, New Delhi.*

Reference Books:

1. *"Environmental Engineering", Peavy H.S., Rowe, D.R. and Tchobanoglous, G.. Seventh Edition,Tata McGraw Hill, 1985*

2. *"Wastewater Engineering: Treatment and Resource Recovery", Metcalf & Eddy, Inc., Arthur, J., Tchobanoglous, G., Burton, F., Tsuchihashi, R. and Stensel, D.H. Fifth Edition, McGraw Hill Companies Inc., 2013*
3. *"Water Supply and Sewerage", Terence J. McGhee. Sixth Edition, Tata McGraw Hill, 2014.*
4. *"Water and Wastewater Technology", M.J. Hammer. Seventh Edition, Prentice Hall, 2011.*
5. *"Handbook of Solid Waste Management", Tchobanoglous G. and Kreith, F., Second Edition; McGraw Hill, 2002.*
6. *"Water and Wastewater Engineering", Davis, Mackenzie. First Edition, McGraw Hill, 2010.*

CE3012 CONSTRUCTION PLANNING & MANAGEMENT Cr-3

Contracts: General conditions and principles, various types of contracts methods of tendering. Earnest Money, Security money. **(10 Hrs)**

Construction Management: Construction planning, scheduling & monitoring, Bar charts, elements of critical path method (CPM) , Program Evaluation & Review Techniques (PERT), Advantages & disadvantages, Elements of Network, Network rules, critical path analysis of CPM network, Activity times & Floats, Optimization through CPM technique PERT & Three time estimates. **(12 Hrs)**

Construction equipments: Selection of construction equipment, excavating & transporting equipments, Housing & conveying equipments. **(10 Hrs)**

Material Management: Objectives & Functions. **(4 Hrs)**

Text Book:

1. *"Construction Project Management" by Kumar Neeraj Jha, Pearson Education*

Reference Books:

1. *"Construction Planning & Management", by Dr.U.K. Shrivastava,* Galgotia Publications Pvt Ltd, May 2000
2. *"Construction Planning & Management", by Dr. A. K. Jha, Pearson Publication.*
3. *"Estimating and costing", by Dr. B. N. Dutta, UBSPD, 2013*
4. *"Construction Management & Planning", by B.Sengupta & H.Guha, TMH Education (P) Ltd, New Delhi*
5. *"Construction Planning Equipment and methods", by R.L.Peurity, McGraw-Hill Publishing Company, 2011*
6. *"Construction Planning and Plant", by A.J.Ackerman & C.H.Locher, McGraw Hill Company,1940*
7. *"Construction Equipment and its Planning and application", by M.Verma, Metropolitan Book Co. 1975.*
8. *"Civil Engineering Contracts and Estimating", by B.S.Patil & Orient Logman Ltd New Delhi*
9. *"Construction Planning & Managemen", by B.C. Punmia, laxmi Publications*

CE4001 TRANSPORTATION ENGINEERING II Cr-3

Railway Engineering:-

Introduction and Location survey: Role of railway in transportation, historical development of railway in India, advantages of railways, classification of Indian Railways. Requirements and factors of good railway track alignment. Principles of location survey, traffic survey, reconnaissance survey, preliminary survey, detailed survey or final location survey. **(1Hr)**

Permanent way: Requirement of an ideal permanent way, gauge in a railway track, different gauge in India and abroad, selection of gauge, railway track cross-section, coning of wheels. **Stress in a railway track:** Track modulus, stresses in: rails, sleepers and ballast, tractive resistances, hauling capacity of locomotive. **(2 Hrs)**

Rails: Function of rails, composition of rails, requirements of rails, types of rail sections, comparison of different types of rail, selection of rail, length of rail, corrugated or roaring rails, hogged rails, kinks in rails, buckling of rails, rail failures, wear on rail. **(1 Hr)**

Rail joints and welding of rails: Requirement of an ideal joint, types of rail joints, welding of rails, advantage of welding of rails, methods of welding of rails, length of welded rails.**Creep of rails:** Indication of creep, theories of creep, effect of creep, measurement of creep, prevention of creep. **(2 Hrs)**

Sleepers: Function of sleeper, requirements of sleeper, classification of sleeper, advantages and disadvantages of different type of sleepers, adzing of sleepers, spacing of sleepers and sleeper density. **Track fittings and fastenings:** Fish plate, spikes, bolts, chairs, blocks, keys, bearing plates. **Ballast:** function of ballast, requirements of ballast, types of ballast, size and section of ballast, renewal of ballast. **(2 Hrs)**

Geometric Design of the track: Necessity of geometric design, types of gradient, grade compensation, speed of the train, radius or degree of the curve, cant or super elevation, cant deficiency, negative super elevation, curves, length of transition curve, widening of gauge on curves. **(3 Hrs)**

Points and crossings: Necessity of point and crossings, turnout, left hand turnouts and right hand turnouts, point of switches and its component parts, crossings and its component parts, number of crossing and angle of crossing. **(2 Hrs)**

Signaling and inter locking: Objects of signaling, classification and types of signals, centralized traffic control system (CTC), automatic train control system (ATC), track circuiting. Necessity and functions of interlocking, methods of interlocking, mechanical device for interlocking. **(3 Hrs)**

Stations and yards: Definition, site selection for railway stations, requirements of railway station, classification of railway stations, platforms, loops, sidings, types of yards. **Level crossing:** Classification of level crossings. **Equipment in station yards:** Weigh bridge, engine sheds or loco sheds, as-pits, ash-pans, drop-pits, turn table, fouling mark, buffer stops. **Construction and renewal of track, Drainage and maintenance of track.** **(2 Hrs)**

Airport Planning & Design:-

Introduction, Classification of airports, General consideration for location and layout, direction of breeze use of wind-Rose diagram. Airport obstruction, Principle of design and construction of Runways, traffic, Aprons, Landing strips and hangers, Airport marking and lighting, Classification of airports, airport site selection, wind-rose diagram, airport obstruction, principle of design and construction of runways, Airport capacity, Taxiway, Aprons, Landing strips, hangers, Location of Administrative Building and control tower, Airport marking and lightening, Air traffic control.

(12 Hrs)

Docks & Harbors:

Introduction, Natural and artificial harbours, selection of site, layout of harbor, principles of constructions of breakwater, quays, jetties, study wind tides, wave action accretion and denudation, dry docks, wet docks and floating docks.

(6 Hrs)

Text Book:

1. *"A Text Book of Railway Engineering", by S. C. Sexena & S. P. Arora, 7th edition, 2006, Dhanpat Rai Publications.*
2. *"Airport Planning and Design", by S. K. Khanna, M. G. Arora, S. S. Jain, 6th edition, 2009, Nem Chand & Bros. Publications.*
3. *"Harbour, Dock and Tunnel Engineering", by R. Srinivasan, 26th edition, 2013, Charotar Publishing House.*

Reference Books:

1. *"Railway Engineering", by Satish Chandra & M. M. Agarwal, 2nd edition, 2013, Oxford University Press.*
2. *"Airport Engineering", by N. Ashport & P. H. Wright, 3rd edition, 1992, Willey-Interscience.*
3. *"Tunnel Engineering", by S. C. Sexena, latest edition, Dhanpt Rai & Sons.*

CE4031 CONCRETE TECHNOLOGY Cr-3

Concrete Materials: Types of material, cement types, testing of materials. **(3 Hrs)**

Fresh concrete: Workability, Factors affecting workability, type of tests. **(3 Hrs)**

Strength of concrete: Water cement ratio, gain of strength with age, effect of maximum size of aggregate, relationship between compressive and tensile strength, high strength concrete, high performance concrete. **(5 Hrs)**

Elasticity, shrinkage and creep of concrete. **(4 Hrs)**

Durability of concrete: permeability, carbonation, sulphate attack, alkali-aggregate reaction, chloride attack. **(5 Hrs)**

Concrete Mix design: concept & types, example. **(5 Hrs)**

Destructive and non destructive testing of hardened concrete. **(4 Hrs)**

Admixtures **(2 Hrs)**

Special Concrete: Lightweight Concrete. High density concrete. Hot weather and cold weather concreting, Polymer concrete. **(5 Hrs)**

Text Books:

1. *"Concrete Technology" by M. S. Shetty, 4th Edition, S. Chand Publisher, New Delhi*

Reference Books

1. *"Concrete Technology", by M. L. Gambhir, McGraw Hill Education, New Delhi, 2013.*
2. *"Properties of concrete", A.M. Neville, 4th Edition, Pearson Education Pvt. Ltd., New Delhi.*

CE4032 STRUCTURAL ANALYSIS-III Cr-3

Energy theorems: Total potential Energy, Complimentary Energy, Simple examples. **(8 Hrs)**
Influence Line Diagram of Indeterminate Beams by Muller-Breslau Principle. **(8 Hrs)**
Plastic Analysis of frames, Upper bound and lower bound theorem simple examples. **(8 Hrs)**
Matrix Analysis: Flexibility and stiffness methods of analysis for rigid jointed plane frame continuous beam, pin jointed plane frame. **(12 Hrs)**

Text Books

1. *"Matrix Analysis", by Pandit & Gupta, TMH Education, New Delhi*

Reference Books:

1 *"Indeterminate Structure", by J.S.Kinney, Addison Wesley Publication Co.*
2 *"Fundamental of Limit Analysis of Structure", by Manick Selvem, Dhanpat Rai Publication, 2012.*

CE4033 STRUCTURAL DYNAMICS Cr-3

Single degree of freedom system: Equation of motion, Damped and undamped free vibration, Response to harmonic, periodic, impulse load and general dynamic load, Duhamel's integral. **(14 Hrs)**
Multi degrees of freedom system: Equation of motion, Free vibration analysis, Dynamic response and modal analysis. **(14 Hrs)**
Free and Forced vibration of distributed mass system: Beam. **(8 Hrs)**

Text Book:

1. *Dynamics of Structures: Theory and Applications to Earthquake Engineering", by A. K. Chopra, Prentice Hall of India.*
2. *"Earthquake resistance design of structures", by Pankaj Agarwal & Manish Shikhande, Prentice hall (PHI).*

Reference Books:

1. ***"Dynamics of structures"**, by R. W. Clough and J. Penzien, McGraw-Hill Inc.*

CE4034 EARTHQUAKE ENGINEERING Cr-3

Parameters; India seismic zoning map. **(2 Hrs)**
Introduction to vibration problem; Un-damped and damped free vibrations with viscous damping; forced vibrations, vibration isolation. **(12 Hrs)**
Response spectra; study of shake tables. **(2 Hrs)**
Multi degree freedom systems; Rayleigh's method. **(6 Hrs)**
Free vibrations of un-damped systems determination of frequencies and mode shape by Holzer method and stodola method. **(6 Hrs)**
Continuous systems; Introduction of IS Codes (IS: 1893-2001). **(8 Hrs)**

Text Book:

1. *"Earthquake resistance design of structures", by Pankaj Agarwal & Manish Shikhande, Prentice hall (PHI).*

Reference Books:

1. *"Dynamics of structures (Theory and applications to Earthquake Engineering)", by Anil K. Chopra PH(I) New Delhi.*

CE4035 ADVANCED SOLID MECHANICS Cr-3

Introduction: Reviews of elementary solid mechanics. **(1 Hrs)**

Analysis of stress: surface forces and traction /stress vector, body forces and moments; components of stress matrix and its relation to stress vector; Normal and shearing stresses on a plane stress transformations and stress tensor, introduction to tensors. Principal stresses and axes; Maximum shearing stress; Equilibrium equations; Boundary conditions.

(5 Hrs)

Analysis of Deformation and strain: Deformation map, displacement gradient, straining of line element and strain components as measure of deformation. Strain-displacement relations, infinitesimal strain and linearization , physical interpretation of normal and shear strain components; infinitesimal rotation vector and relative displacement; straining of arbitrary line element, strain transformation and strain tensor , principal strains and axes; analogies with stress tensor; volumetric strain and cubical dilation; strain compatibility equations.

(5 Hrs)

Constitutive relations, Boundary value problems: Generalized Hooke's law, 3-D stress strain relation for linear elastic isotropic solid; Compatibility equations in terms of stress; types of boundary value problems (BVPs)-displacement and stress formulations, saint venant's principle. **(5 Hrs)**

Two Dimensional Elasticity in Cartesian and Polar Coordinates: Plane stress, plane strain; formulation of BVP using airy stress function, inverse and semi-inverse methods of solution; Problems in rectangular coordinates polynomial solutions, determination of displacements, fourier series solutions; Problems in polar coordinates-transformation of field equations in polar coordinate, axisymmetric problems, non-axisymmetric problems , stress concentrations; Use of symmetry in solving 2-D problems. **(5 Hrs)**

End Torsion of Bars (Prismatic, general cross section)" Review of torsion of circular sections; formulation of BVP using prandtl stress function and saint venant's semi-inverse method (Warping function method), Membrane analogy; Solutions for solid cross section bars torsion of thin walled open section and closed section (Multicalled) members. Formulation for torsion of multi celled thick walled cross-sections; finite difference method.

(5 Hrs)

Bending of Beams (Prismatic, general cross section): Preliminaries-sign conventions, area moments of inertia, their transformation, principal inertias; pure bending of beam with terminal couples; bending of beam with end shear -BVP formulation, examples , shear center and its determination. One-dimensional shear flow in open thin walled beams and shear center problem solving. **(5 Hrs)**

Bending of curved beams: (Prismatic, symmetric sectioned)-Assumption, derivation of basic results (kinematics, stresses) obtaining maximum stresses, determining deflections using energy methods. **(2 Hrs)**

Beams on Elastic Foundation: Basic problem of infinite beam with point load , various modifications of basic problem and application of superposition for solving them. **(3 Hrs)**

Text Books:

1. *"Advanced Mechanics of Solids", by L.S.Srinath, 2nd Edition, Tata Mc Graw Hill, 2003.*
2. *"Theory of elasticity", by S.P.Timoshenko & J.N.Goodier, 3rd Edition, Mc Graw Hill 1970.*

Reference Books

1. ***"****Advanced Mechanics of Material", by A.P.Boresi & R.J.Schmidt, 6th ed., Wiley, 2003.*

CE4036 ADVANCED STEEL DESIGN Cr-3

Design of Gantry girder.	**(6 Hrs)**
Design of cold formed light gauge steel beams and columns.	**(4 Hrs)**
Design of roof truss.	**(10 Hrs)**
Design of power transmission tower.	**(4 Hrs)**
Design of water tank with staging.	**(8 Hrs)**
Design of self supported steel chimney.	**(4 Hrs)**

Text Books:

1. *"Design of steel Structures (LSM)", by S.K Duggal Mc Graw Hill Education pvt Ltd.*
2. *"Design of Steel Structure", by N.Subramanian, 2nd edition, Oxford publication.*
3. *"Design of Steel Structure" by K.S.Sai Ram, Pearson Education Pvt. Ltd, New Delhi.*

Reference Books:

1. *"Design of Steel Structures V-II", by S. Ramchandra, Standard pub.*

2. *"Design of steel structure", by S.S Bhavikatti, I.K I Publishers.*
3. *"Design of steel structure", by Gaylord & Gaylord., TMH publication, 3 edition, 2010.*

CE4037 REINFORCED CONCRETE REPAIRS AND MAINTENANCE Cr-3

Introduction: Causes of deterioration of concrete structures. Effects of climate, moisture, temperature, chemicals, wear, erosion and loading on serviceability anddurability. Design and construction errors. Causes of seepage and leakage in concrete structures. Formation of cracks including those due to corrosion. **(3 Hrs)**

Condition Survey, Evaluation and Assessment of Damage: Diagnostic methods and analysis. Destructive, Semi destructive and Non-Destructive methods including Core test, Carbonation test , Chloride test, Petrography, Corrosion Analysis, Cover meter test, Rebound Hammer test,Ultrasonic Pulse Velocity test, Crack measurement techniques, Concrete Endoscopy and Thermal imaging, Pull-off test and Pull-out test etc.

(16 Hrs)

Materials and Methodology of Repairs: Repair analysis and design. Repair materials and their properties. Methodologies of crack and patch repair used of Polymer modified mortar, Polymer modified concrete, Polymer concrete. Injection grouting. Shortcreting. Joints and sealants. Rebar corrosion crack repair. **(6 Hrs)**

Protection of Concrete Structures: Protective materials and their properties for moisture barrier systems, Above-grade and below grade waterproofing of concrete structures. Systems like integral, crystalline, coatings, membranes etc,. Thermal protection coatings. (**4 Hrs)**

Rebar Corrosion Protection: Methods of Corrosion protection. Corrosion inhibitors, Corrosion resistant steels, Cathodic Protection, Pre-packaged zinc sacrificial anode, Snap-on zinc mesh anode CP system. **(4 Hrs)**

Maintenance of concrete structures: Facets of maintenance. Planned preventive maintenance. Maintenance cycles. Statutory legislation and obligation. **(3 Hrs)**

Reference Books:-

1. *"Concrete Repair and Maintenance", by Peter H .Emmons & Gajanan M. Sabnis, Galgotia Publication.*
2. *"Repairs and Rehabilitation", by Compilation from Indian Concrete Journal-ACC Publication.*
3. *"Guide to Concrete Repair and Protection", HB84-2006, A joint publication of Australia*
4. *"Concrete Repair Association", by CSIRO and Standards Australia.*
5. *"CPWD hand book on Repairs and Rehabilitation of RCC buildings" by DG(Works), CPWD, Government of India (Nirman Bhawan), http://www.cpwd.gov.in/handbook.pdf*
6. *"Guide to Concrete Repair", by Glenn Smoak, US Department of the Interior Bureau of Reclamation, Technical Service Center , http://books.google.co.in*
7. *"Management of Deteriorating Concrete Structures", by George Somerville, Taylor and Francis Publication*
8. *"Concrete Building Pathology", by Susan Macdonald, Blackwell Publishing.*
9. *"Testing of Concrete in Structures", by John H. Bungey, Stephen G. Millard & Michael G. Grantham, Taylor & Francis Publication.*
10. *"Durability of concrete and cement composites", by C.L.Page & M.M. Page,Woodhead Publishing*

CE4038 TUNNEL ENGINEERING Cr-3

Site investigations, Geotechnical Considerations of tunneling. **(3 Hrs)**
Design of Tunnels **(15 Hrs)**
Construction & Excavation methods, soft ground tunnels, Rock tunnels. **(8 Hrs)**
Micro tunneling techniques, Tunnel support design. **(5 Hrs)**
Ventilation of tunnels, tunnel utilities, safety aspects **(5 Hrs)**

Text Books:

1. *"Tunnel Engineering Handbook" by J O Bickel & T R Kuesel, Chapman & Hall, New York,2nd edition,1996*
2. *"Rock Mechanics Design in Mining & Tunneling" by Z T Bieniawski, Balkema Publication, Sept 1989*

CE4039 PAVEMENT MATERIALS Cr-3

Conventional aggregates: Source, preparation, grading, testing and their evaluation **(5 Hrs)**

Bituminous binders: Properties, testing and applications. **(5 Hrs)**
Bituminous mixes: Design, testing and evaluation; Modeling of bituminous binders and mixes. **(6 Hrs)**
Materials for cement concrete and semi-rigid pavements, Design of mixes for stabilized roads. **(8 Hrs)**
Non-conventional and new pavement materials: their application and limitations. **(6 Hrs)**
Modern methods of testing and evaluation of paving materials. **(6 Hrs)**

Text Books:

1. *"Principles of Transportation and Highway Engineering", by G. V. Rao, Tata Mc. Graw Hill, 1st Ed. 1995.*
2. *"Principles of Traffic and Highway Engineering" by N.J.Garber, L.A.Hoel and R.Sarkar, Cengage Learning India Pvt. Ltd., First Indian Reprint 2009.*

Reference books:

1. *"Manual for Construction and Supervision of Bituminous works", by Indian Roads Congress, New Delhi, 2005.*
2. *Relevant IRC, ASTM and AASHTO codes and specifications.*
3. *"Principles of Transportation Engg", by P. Chakraborty and A. Das, PHI Publication, 1st Ed. 2nd reprint 2005.*

CE4041 ENGINEERING GEOLOGY Cr-3

General Geology: Branches and scope of geology, Earth, its position in the solar systems, surface features and internal structure, work of natural agencies like lakes, oceans, atmosphere, wind, streams, sea, glacier, earth movements. Types of weathering, mountains and mountain building. **(4 Hrs)**
Mineralogy: Definition of crystal and a mineral, the study of the physical properties and occurrence of quartz, Feldspar, Mica, Kyanitie, clacite, tale, corundum, gypsum, fluorite, biotite, mus, covite, graphite, realgar, magnetite, limonite, pyrite , galena, barite dolomite, garnet, tourmaline, chal-copy-rite, opal, topaz, autite, hornblende, epidate, kaolinite, diamond. **(4 Hrs)**
Petrology: Formation and classification of rocks into three types, igneous, sedimentary and metamorphic rocks, description of physical properties for constructional purposes of granite, pegmatite, dolerite, gabbzo, basalt, sandstone, conglomerate, breccias, limestone, shale, schist, marble, quartzite, khondalite, slate, gneiss, and esite, stratigraphy of India(a general idea),principles of correlation, fossils, their preservation and significance. **(4 Hrs)**
Structural geology: strike and dip, out crops, volcanoes, overlaps, inliers and outliers, types classification of folds, faults, joints, unconformities, surface mapping, identification of potential zones of weakness or failure, analysis using stereonetes. **(4 Hrs)**
Engineering Geology: Ground water, zones of ground water, water table and perched water table, water bearing properties of rocks, occurrence of ground water, springs, selection of a site for well sinking and ground water investigations. **(4 Hrs)**
Earthquakes and landslides: Classification, causes and effects of earthquakes and landslides, seismic curve, seismographs, seismograms, accelograms, seismic problems of India, seismic zones of India, remedial measures to pr3event damage for engineering structures, case histories. **(3 Hrs)**
Geological investigation: Interpretation of geological maps, use of aerial maps in geological surveying, geophysical methods as applied to civil engineering for subsurface analysis (Electrical and seismic methods). **(3 Hrs)**
Geology of dams and reservoirs: Types of dams, requirements of dam site, preliminary and detailed geological investigations for a dam site, important international and Indian examples of failures of dams and their causes, factors affecting the seepage and leakage of the reservoirs and the remedial measures , silting of reservoirs. **(5 Hrs)**
Rock mechanics and tunneling: Purposes of tunneling and geological problems connected with tunneling, geological considerations in road alignment, roads in complicated regions problems after road construction, geology of bridge sites. **(5 Hrs)**

Text Books:

1. *"Engineering Geology", by Parbin Singh, S.K.Kataria and Sons, 2009*

Reference Books

1. *"Structural Geology", by H.P.Billings, Prentice hall publishers, third edition*

CE4042 EARTH AND EARTH RETAINING STRUCTURES Cr-3

Earth and Rock Fill Dam, Choice of types, material, foundation, requirement of safety of earth dams, seepage analysis **(5 Hrs)**

Mechanically Stabilized Earth retaining walls: General considerations, backfill and reinforced materials, construction details, design method, stability. **(10 Hrs)**

Soil nailing: applications, advantages, limitations, methods of soil nailing, case histories, analysis and design. **(8 Hrs)**

Reinforced Soil: Introduction, basic components, strength characteristics, soil-reinforcement interface friction. **(4 Hrs)**

Reinforced Earth wall: Stability analysis, construction procedure, drainage, design Procedure **(2 Hrs)**

Foundation on Reinforced Soil Bed: Pressure ratio, analysis of strip, isolated, square and rectangular footing on reinforced soil bed, ultimate bearing capacity of footing on reinforced earth slab. Fiber reinforced soil. **(7 Hrs)**

Text Books:

1. *"Reinforced soil and its engineering application",by Swami Saran, Second Edition, I. K. International Publishing House Pvt. Ltd, 2011*
2. *"Soil Mechanics and Foundation Engineering", by V N S Murthy, CBS Publisher, 2009*
3. *"Analysis and Design of Foundation", by J. E. Bowles,TMH Education, New Delhi.*

CE4043 MACHINE FOUNDATION ENGINEERING Cr-3

Vibration of elementary Systems: Vibration motion, vector representation of harmonic motion, Single degree of freedom system: Free Vibrations- damped and undamped, Forced Vibrations – damped and undamped. **(8 Hrs)**

Dynamics of soil-foundation System: types of machine foundation, design criteria, dynamic loads, physical modeling and response analysis, Barken's approach, Ford & Haddow's analysis, Hammer foundation, I. S. Codes. **(8 Hrs)**

Dynamic soil testing techniques: cyclic plate load test, block vibration test, shear modulus test, geophysical methods, Resonance-column test, Two & three borehole techniques, Model tests using centrifuge and shake table, recent developments. **(6 Hrs)**

Vibration isolation and control: vibration transmitted through soil media, active and passive isolation, vibration isolation – rigid foundation and flexible foundation, method of isolation, properties of material and media used for isolation, vibration control of existing machine, foundation isolation by barriers. **(7 Hrs)**

Guidelines for design and construction of machine foundation: data required for design of reciprocating, impact and rotary type machines, guidelines for the design of different type machines, construction guidelines, guidelines for providing vibration absorbers. **(7 Hrs)**

Text Books:

1. *" Foundation for Machine", by S. Prakash, Wiley, 1988*
2. *"Soil Dynamics and Machine Foundations", by Swami Saran, Galgotic Pulbication Pvt Ltd, New Delhi*
3. *"Vibrations of Soil and Foundations", by Richard, Hall & Wood, Prentice Hall, June 1970*
4. *"Dynamics of Structures", by Anil K. Chopra Prentice Hall, 4th edition 2012*
5. *"Vibration Analysis and Foundation Dynamics", by N. S. V. Kameswara Rao,* S. Chand *New Delhi*

CE4044 GROUND IMPROVEMENT ENGINEERING Cr-3

Introduction: Need – methods – suitability – Mechanical modification: principle - Surface compaction: Field compaction and equipments, compaction specification and controls. Vibration methods: dynamic consolidation, vibratory rollers, Vibro floatation. **(6 Hrs)**

Drainage methods: Well point systems, deep well drainage, vacuum dewatering system, design of dewatering system – field permeability tests, dewatering by electro osmosis. Preloading, sand drains, wick drains- Thermal methods case studies. **(6 Hrs)**

Chemical stabilization: cement stabilization- factors affecting soil cement mixing-admixtures- lime stabilization-effect of lime on soil properties construction of lime stabilized bases-bituminous stabilization- thermal stabilization- electrical stabilization. **(4 Hrs)**

Grouting: Classification – Methods – Types – grouts – equipments, grouting design and layout, grout monitoring – applications – Case studies. **(5 Hrs)**

Earth Reinforcement: mechanism and concept- stress strain relationship of reinforced soil-design theories and stability analysis of retaining wall-tie back analysis-coherent gravity analysis- application areas of earth reinforcement. **(8 Hrs)**

Geotextiles: Soil reinforcement with geotextiles- classification- concepts geotextiles as separators, filters, and drainage media-damage and durability of geotextiles. **(7 Hrs)**

Text Books:

1. *"Geotechnical Engineering", by Shashi K Gulhati and Manoj Datta, 9th Reprint edition, TMH Education Pvt. Ltd.*
2. *"Ground Improvement techniques",by P. Purushothama Raj, Laxmi publications Pvt. L, 2005*
3. *"Reinforced soil and its engineering application",by Swami Saran, Second Edition, I. K. International Publishing House Pvt. Ltd, 2011*
4. *"Principle and Practice of Ground Improvement", by Jie Han,1st Edition, Wily Publication*

Reference Books:

1. *"Foundation Analysis and Design",by J.E.Bowles, MCGRAW-HILL Higher Education, 5 Edition 1997 .*
2. *"Soil Improvement techniques and their evolution", by Van Impe, CRC Press ,Jan1989*
1. *"Foundation Engineering", by P.C.Verghese, PHI Learning Pvt. L. 2005*

CE4045 OPEN CHANNEL HYDRAULICS Cr-3

Uniform flow, determination of roughness coefficients and the factors affecting the roughness, computation of uniform flow, flood discharge, determination of normal depth and velocity, flow in composite roughness; Design of channels for uniform flow in non-erodible and erodible with grassed channels. **(8 Hrs)**

Dynamics of Gradually varied flow and classification of flow profile, methods of computation, Dynamics of spatially varied flow - analysis of flow profile and computation by method of numerical integration. **(10 Hrs)**

Rapidly varied flow, classification, flow over spillway, Hydraulic Jump, types with characteristics of jump, the surface profile and location of the jump, jumps as energy decapitator, rapidly varied flow through non-prismatic channels. **(10 Hrs)**

Unsteady flow, dynamics of gradually varied unsteady flow, solution of unsteady flow equations, rapidly varied unsteady flow, positive and negative surges, flood routing, principle and methods of flood routing. **(8 Hrs)**

Text Books:

1. *"Open Channel Flow", by F. M. Henderson, MacMillan Publishing Company, 1996.*

Reference Books:

1. *"Flow through Open Channel", K. G. Rangaraju, Tata McGraw Hill, New Delhi.*
2. *"Open Channel Hydraulics", by V.T Chow, McGraw-Hill Publishing Company, New Delhi, 1993.*
3. *"The Hydraulics of Open Channel Flow An Introduction", by H. Chanson, Elsevier.*
4. *"Flow in Open Channel", by K. Subramanya, Tata McGraw Hill, New Delhi.*
5. *"River Hydraulics, (Technical Engineering and Design Guides as adapted from the U.S. Army Corps of Engineers, No. 18) New York", ASCE Press.*
6. *"Engineering Hydraulics", by H. Rouse, John Wiley & Sons.*

CE4046 TRAFFIC ENGINEERING & TRANSPORTATION PLANNING Cr-3

Traffic Engineering: Importance of Traffic engineering; Road User Characteristics, Human factors governing road user behavior, vehicle characteristics, slow moving traffic characteristics in Indian conditions. **(6 Hrs)**

Traffic Engg. Studies: Traffic Volume, Origin and Destination, Speed and delay: Measurements; Speed- density-volume relationships; Shock waves in Traffic flow, Headway Distribution. **(8 Hrs)**

Highway capacity analysis: cases of different types of highways; Intersection; Parking types; Off street parking; Facilities. **(5 Hrs)**

Traffic control devices: Channelization, rotary and Traffic signals, Traffic Signs and making. **(5 Hrs)**
Transportation Planning: Brief ideas about urban and regional transportation systems; Components of transportation system planning; Land use planning, Trip generation and distribution. **(8 Hrs)**
Traffic assignment and modal split, Optimal scheduling; Economic evaluation of transportation plans. **(4 Hrs)**

Text books

1. *"Traffic Engg & Transportation Planning", by L. R. Kadyali, 4th Ed, Khanna Publishers, 2003*
2. *"Transportation Planning and Planning", by C. S. Papacostas and P. D. Prevedouros, 3rd Ed, PHI, 2002*

Reference books:

1. *"Transportation Engg: An introduction", by C. J. Khisty & B. K. Lall, 3rd Edition, PHI, 2006.*
2. *"Principles of Transportation Engg", by P. Chakraborthy and A. Das, 1st Edition, 2nd reprint 2005. PHI,*
3. *"Highway Traffic Analysis and Design", by R. J. Salter, ELBS Macmilan, 2nd Edition, 1990.*
4. *Relevant I.R. C. Codes.*

CE4047 GROUND WATER HYDROLOGY AND MANAGEMENT Cr-3

Hydrologic cycle, Water balance, Occurrence of ground water: Origin, geological formations as aquifers, type of aquifers, groundwater basins, springs. **(4 Hrs)**
Darcy's Law, validity of Darcy's Law permeability, laboratory and field measurement of permeability, groundwater Flow lines. **(6 Hrs)**
Well Hydraulics, steady flow to a well, steady radial flow to a well in confined aquifer and unconfined aquifer, unsteady radial flow into a confined aquifer, Non equilibrium Theis equation, Theis method of solution, multiple well system. **(6 Hrs)**
Methods of constructions of deep and shallow wells: The percussion (or cable tool) method of drilling, Direct circulation hydraulic rotary method, Down the hole hammer method, well logs-receptivity logging, testing of wells for yield. **(5 Hrs)**
Surface and Subsurface investigations of groundwater, Geophysical exploration, Electrical resistivity method, aerial photo interpretation, remote sensing applications to ground water exploration, test drilling. **(5 Hrs)**
Artificial recharge by water spreading, through pits and shaft, recharge through other methods. **(5 Hrs)**
Groundwater management: Concepts of Basin management, Equation of hydrologic equilibrium, groundwater basin investigations, conjunctive use of surface and groundwater. **(5 Hrs)**

Text Book:

1. *"Groundwater Hydrology", by D. K. Todd, John Wiley and Sons.*

Reference Books:

1. *"Groundwater and Tube Wells", by S. P. Garg, Oxford and IBH Publishing Co., New Delhi.*
2. *"Hand book of Applied Hydrology", by V. T. Chow, McGraw-Hill Publishing Company, New York.*
3. *"Ground Water", by H. M. Raghunath, New Age International Publishers; 3rd edition,Dec 2007*

CE4048 PAVEMENT DESIGN Cr-3

Introduction: Classification of pavements, Difference between highway and runway pavements, Factors affecting structural design, Characteristics of traffic loading, Concept of VDF and Computation of design traffic. **(4 Hrs)**
Principles of pavement design: Concepts of structural and functional failures, Performance criteria; Analysis of pavements: ESWL. **(5 Hrs)**
Analysis of flexible and concrete pavements. **(8 Hrs)**
Design of pavements: IRC, AASHTO and other important methods of design of bituminous and concrete pavements. **(12 Hrs)**
Pavement evaluation techniques: Benkleman beam, Falling weight deflectometer and other equipments. Concepts of pavement maintenance management. **(7 Hrs)**

Text books

1. *"Pavement Design", by R. Srinivasa Kumar, 1st Edition, University Press, 2013.*
2. *"Principles of Transportation Engineering", by P. Chakroborty & A. Das, PHI Publication, 1st Ed., 2nd reprint 2005*.

Reference books

1. *"Design and Performance of Road Pavements", by D. Croney & P. Croney, 3rd Edition, McGraw-Hill Professional; 1997.*
2. *"Principles of Transportation Engineering", by P. Chakroborty & A. Das, 1ST Edition, 1SPHI Publication, 2nd reprint 2005.*
3. *"Highway Engineering", by S. K. Khanna & C. E. G. Justo, Nemchand Bros, Roorkee, 8th edition 2001, Reprinted 2003.*
4. *"Pavement Analysis and Design", by Y. H. Huang, 2nd Edition, Prentice Hall, 2003.*
5. *Relevant I. R. C. and AASHTO Codes.*

CE4049 REMOTE SENSING & GIS Cr-3

Introduction to Remote Sensing system: data acquisition and processing, Applications, Multi concept in remote sensing. **(5 Hrs)**

Physical Basis of Remote Sensing: EMR nature, definition, nomenclature and radiation laws. Interaction in atmosphere-nature, its effects in various Wave-length regions, atmospheric windows; Interaction at ground surface soils Geometric basis of interaction. **(5 Hrs)**

Platform and Sensors: Terrestrial, aerial and space platforms, Orbital characteristics of space platforms, sun-and geo-synchronous; Sensor systems-radiometers, opto-mechanical and push broom sensor. **(4 Hrs)**

Resolution : spectral, spatial, radiometric and temporal; IFOV, FOV, GRE; geometric characteristics of scanners, V/H and S/N ratio; Data products from various air and space borne sensors-aerial photographs, LiDAR, Landsat, SPOT, IRS, ERS, IKONOS etc. **(5 Hrs)**

Image Interpretation: elements of interpretation; digital image processing and interpretation, Field verification. **(5 Hrs)**

Geographical Information systems: components of GIS-data acquisition, spatial and attribute data, pre-processing, storage and management; data structures raster and vector data. **(6 Hrs)**

GIS analysis functions: Errors and corrections; data presentation and generation of thematic maps. **(6 Hrs)**

Text books:

1. *"Remote Sensing and GIS", by M. Chandra and S. K. Ghosh, Narosa Pub, 2007.*
2. *"Remote Sensing and Image Interpretation", by T. M. Lillisand, R. W. Kaifer & J. W. Chipman, 6th Edition , John Wiley and sons Inc, Nov 2007.*

Reference Books:

1. *"An Introduction to GIS", by I. Heywood, S. Cornelius and S. Carver, 2nd Ed, Pearson Education, 2002.*

CE4051 FLOOD AND DROUGHT ESTIMATION AND MANAGEMENT Cr-4

Flood Estimation: Estimation of design flood- empirical methods, envelope curve method, unit hydrograph method, flood estimation in small watersheds, urban catchment and influence of urban drainage. **(9 Hrs)**

Flood Control and Management: Detailed study of various methods of flood control- flood plain identification, flood disaster monitoring and mitigation procedures, various methods of forecasting data, communication and warning, flood fighting. **(9 Hrs)**

Drought Classification: Importance, definition-NCA classification, direct and indirect losses. **(6 Hrs)**

Drought Estimation: Drought severity assessment, methods in meteorological, hydrological and agricultural aspects. **(6 Hrs)**

Drought Monitoring: Supply and demand oriented measures, drought prone areas programme (DPAP), short term and long-term strategies, drought management. **(6 Hrs)**

Text Books:

1. *"Irrigation Engineering & Hydraulic Structures" by S.K. Garg, Khanna Publishers*
2. *"Engineering Hydrology" by K. Subhrmanya, TMH Education Pvt. Ltd, New Delhi*

Reference Books:

1. *"Applied Hydrology", by Ven Te Chow, David, R. Maidment, Lary, W. Mays.,McGraw Hill Publications, 1995.*
2. *"Elementary Hydrology", by Vijay P. Singh, Prentice Hall of India, 1994.*
3. *"Hydrology", H.M. Ragunath , by Wiley Eastern Ltd. 1996.*
4. *"Handbook of Applied Hydrology", by Ven Te Chow, etal , McGraw Hill Publications,1995.*

CE4052 DISASTER MANAGEMENT Cr-3

Cyclones: Formation, Cyclonic precipitation, anti-cyclones. **(4 Hrs)**

Flood: Flood and its estimation, Flood warning, Flood protection measures. **(4 Hrs)**

Earthquake: Causes of earthquake, plate tectonics, seismic zoning map, Characteristics of strong ground motions & attenuation, damage assessment. **(6 Hrs)**

Rehabilitation and retrofitting of structures. **(6 Hrs)**

Environmental disaster: Impact assessment studies, computation and preparedness. **(6 Hrs)**

Disaster management: Developing appropriate technology for disaster mitigation, Role of management teams, importance of awareness, alertness and preparedness camp. **(10 Hrs)**

Text Book:

1. *"Earthquake resistant building construction", N. Sharma, S. K. Kataria & Sons, New Delhi.*

Reference books:

1. *"Engineering Hydrology", K. Subramanian, Tata McGraw Hill, New Delhi.*
2. *"Elementary Hydrology", V. P. Singh, Prentice Hall of India.*
3. *"Disaster Mitigation, Preparedness, Recovery and Response", V. P. Singh, SBS Publishers & Distributors Pvt. Ltd. Heinemann.*
4. *"Practical Guide to Environmental Management", F. B. Friedman, McGraw Hill.*

CE4053 SOLID AND HAZARDOUS WASTE MANAGEMENT Cr-3

Introduction to Solid and Hazardous waste management: Classification of solid waste – source-based and type-based. Functional elements of solid waste management. **(3 Hrs)**

Waste Generation aspects: Waste generation and composition, Waste characteristics, Effects on public health and environment. **(4 Hrs)**

Waste collection, storage, transport and disposal: Collection components, storage devices, collection operation, Transfer station, Waste collection system design, disposal options – sanitary landfill, landfill gas emission, leachate formation. **(4 Hrs)**

Waste Processing techniques: Mechanical volume and size reduction, component separation, drying and dewatering. **(4 Hrs)**

Source reduction, product recycling and recovery of biological conversion products: Basics of source reduction, Elements of recycling – source separation, drop-off, curbside programme, storage and collection of recyclables etc., Composting, Biogasification. **(9 Hrs)**

Incineration and energy recovery: Incineration technologies, Energy recovery, Air emission and its control. **(3 Hrs)**

Hazardous waste (HW): management and treatment. Identification and classification of HW, Management strategies of HW, HW treatment – physical, chemical and biological. **(4 Hrs)**

Integrated Waste Management (IWM): Characteristics of IWM, Planning for IWM, Implementation of IWM, Benefits of IWM. Introduction to life cycle assessment tool and its application in IWM. **(5 Hrs)**

Text Books:

1. *"Management of Municipal Solid Waste", by T.V. Ramachandra, Commonwealth of Learning, Canada and Indian Institute of Science, Bangalore, TERI Press, The Energy and Resources Institute, New Delhi, 2006.*
2. *"Integrated Solid Waste Management", by Tchobanoglous, Thisen & Vigil, McGraw Hill International.*

Reference Books:-

1. *"Solid Waste Management in Developing Countries", by A.D. Bhide, Nagpur publications*
2. *"Environmental Pollution Control Engineering", C.S. Rao, Wiley Eastern, Manual of solid waste of management, CPHEEO*
3. *" Hazardous Waste Management" by Lagrega, Buckingham & Evans, McGraw Hill International*

CE4054 CONSTRUCTION METHODS & EQUIPMENTS Cr-3

Construction Equipments: Factors affecting selection of equipment, Owning and Operating Cost. **(6 Hrs)**

Construction Equipment fundamentals: Classification of Construction Equipment, Earth moving Equipments, Hauling, Hoisting, Conveying Equipments, Aggregate and concrete production Equipments, Pile Driven Equipments, Cranes. **(12 Hrs)**

Analysis of production output and costs of Excavating Equipments, Characteristics and performances of equipment for Earth moving. **(10 Hrs)**

Deep excavation support systems: Diaphragm wall, sheet piling, secant pile, contiguous pile, strutting, ground anchors. **(8 Hrs)**

Text Book:

1. *"Construction Planning, Equipment and Methods", R. L. Peurifoy, P. E Clofford ,J Sehexnayder, P.E., Tata Mc Graw Hill Publishing ,N.D*

Reference Books:

1. *"Construction Equipment and Management" by S.C.Sharma, Khanna Publishers, New Delhi.*
2. *"Construction Equipment and its Planning and Application", by Dr.Mahesh Verma ,Metro Politan Book Company, New Delhi.*
3. *"Construction Planning and Equipment", by Satyanarayana & Saxena, Standard Publishers Distributors, Edition 3, 1985.*
4. *"Heavy Construction", by Vazirani & Chandolu, Khanna Publisher Delhi.*

CE4055 CONSTRUCTION FINANCE MANAGEMENT Cr-3

Construction accounting, Profit & Loss, Balance sheet, Income statement, Ratio analysis, Depreciation and amortization, Engineering economics, time value of money, discounted cash flow, NPV, ROR, PI, comparison, incremental rate of return, benefit-cost analysis, replacement analysis, break even analysis, risks and un-certainties. **(12 Hrs)**

Management decision in capital budgeting, taxation and inflation. **(6 Hrs)**

Work pricing, cost elements of contract bidding and award, revision due to unforeseen causes, escalation, **(4 Hrs)**

Turnkey activities, project appraisal and project yield, working capital management finance. International finance. **(2 Hrs)**

Budgeting and budgetary control, Performance budgeting appraisal through financial statements, **(4 Hrs)**

Practical problems and case studies, project cash flow **(4 Hrs)**

Text Books:

1. *"Engineering Economics" by R.Pannerselvam P.H.I, N.D. 2012*
2. *"Engineering Economics" by J.L.Riggs., Mc Graw Hill , 1976*

Reference Books:

1 *"Construction Planning & Management" by U.K.Shrivastava, Galgotia N.D, 2012*
3. *"Project Planning, Analysis, Selection, Implementation & Review" by Prasanna Chandra (Tata McGraw Hill Publishing Co Ltd,ND),2010*
4. *"Essentials of Management" by Harold Koontz and Heinz Weihrich (Mc Graw Hill)*
5. *"Principles of Management" by Dr. M. .M. Verma and Agarwal, Himalaya Publisher, 2008*
6. *"Essentials of Management" by B.P. Singh and J.N Chhabra, South Western College Publishing-1991*
7. *"Industrial Engg and Management" by Dr.O.P.Khanna, Khanna Publisher - 2008*
8. *"Construction Management and Planning" by B.Sengupta and H.Guha Tata Mc Graw Hill, ND 1995*
9. *"Principle of Construction Management" by Pilcher, Mc Graw Hill, 1981*

CE4056 COST EFFECTIVE HOUSING Cr-3

Income based classification of population. High, Middle, Low Income group and economically weaker section. **(3 Hrs)**

Basic shelter issues in India. Mindset of low income group and economically weaker section people. Problems associated with this group with relation to land, living condition and dwelling standards; Recommendation of housing and urban development corporation. **(9 Hrs)**

Traditional materials and techniques (rammed earth, sun dried bricks, wood, bamboo, jute); Alternate and developed methods / materials of construction: pressed soil blocks, use of stabilized soil, soil cement blocks, fly ash brick, by-product gypsum, foundation, arch foundation, walling- rat trap bond, roofing- filler slabs. Precast blocks and their use. **(9 Hrs)**

Laurie Baker's experiments in low cost housing. ; Modular constructions. Experimental observations/findings of CBRI. **(6 Hrs)**

Use of cost effective technologies (CECT) in building constructions, stub foundation, Rat trap bond (walls), brick arches (alternates to lintels) filler slab (roof). Use of Ferro cement. **(6 Hrs)**

Cost effective housing for natural disaster mitigation. **(3 Hrs)**

Text books:

1. *"Low cost Housing Technology", L. J. Goodman, R. P. Lama, R. Rajani, F. J. Burian,Pergamon Press, 1979.*
2. *International Association for Earthquake Engg. Guidelines for Earthquake Resistant Non-Engineered Construction.*

Reference books:

1. *"Are slums inevitable", L. Baker, Centre of science & technology for Rural Development, (COSTFORD) Ayanthple, Thrissur, Kerala.*
2. *"Houses - How to reduce the building cost", L. Baker, Centre of science & technology for Rural Development, COSTFORD Ayanthple, Thrissur-68003, Kerala.*

CE4058 WATER POWER ENGINEERING Cr-3

Concept of water power Engineering , Different heads such as Gross head, Effective head, Design head, rated head, critical head, classifications of water power plants based on hydraulic characteristics, topography, head , capacity of plant, load etc. Major hydroelectric schemes in India. **(6 Hrs)**

Planning a site selection of hydropower projects according to availability of Quantity and head of water , estimating of power potential using Mass curve and flow duration curves Economics of water power plants load factor, capacity factor, load curve, effect of pondage on flow duration curve. Estimation of unit cost of hydro power and comparison with unit cost of stream power station, General planning of hydropower projects. **(6 Hrs)**

Various types of intake structures. Penstocks of steel pipes economic diameter, number of penstocks wall thickness of steel penstocks, shell theory of design, welded and riveted steel pipes, Accessories of penstocks. Expansion joints anchor blocks and pipe supports. Tunnels. Dimensions and shape economic size of tunnel Tunnel lining. **(8 Hrs)**

Theory of water hammer, Arithmetic integration and graphical method of analysis, surge tanks and types of surge tanks theory of simple surge tank and design, Mathematical treatment f water surface oscillations including friction. Pressure relief valves stability of surge tank. Thoma formula, Balancing reservoir and fore bays Pressure. **(8 Hrs)**

Selection of type of turbines according to head & specific speed, various types casing of turbines. Determination of their shapes, main relative dimension of runner. Draft tube, its functions, draft tube theory. In take conduits, Preliminary power house dimensioning, general arrangement of power house**.** **(8 Hrs)**

Text Book

1. *"Water Power Engineering", by M.M.Dandikar & K.N.Sharma, Vikas Publication, 1979.*

Reference Book

1 *"Water Power Engineering", by H.K. Barrows 2nd Edition, McGraw-Hill, London, 1934*

2 *"Irrigation Water Resource & Water Power Engineering", by P.N.Modi, Standard Book House Dec 2008*

CE4062 WATER RESOURCES SYSTEMS Cr-3

Objective of water resources development, economic analysis and discounting techniques. **(5 Hrs)**
Conditions of project optimality, graphic optimization techniques for multipurpose projects. **(4 Hrs)**
Analytical optimization techniques for water resources projected by linear programming, non-linear programming and dynamic programming, optimization by simulation, mathematical models for large scale multipurpose projects, different case studies. **(9 Hrs)**
Stochastic optimization techniques, water quality subsystems. **(9 Hrs)**
Optimum operation model for reservoir systems by incremental dynamic programming, sequencing of multipurpose project. **(9 Hrs)**

Text Book:

1. *"Design of Water", by Arthur Mass et.al.,Harvard Univ. Press., Cambridge.*

Reference Books:

1. *"Water Resources Systems " by MacMillan& Co, Prentice Hall, 1962.*
2. *"Economics of Water Resources Planning", by L.D. James and R. R. Leo, McGraw Hill, New York, 1971.*
3. *"Water Resources Systems Engineering", by W.A. Hall and J.A. Dracup, McGraw Hill, New York, 1970.*

CE4064 ENVIRONMENTAL IMPACT ASSESSMENT & AUDITING Cr-3

Evolution of EIA; EIA at project; Regional and policy levels; Strategic EIA; EIA process; Screening and scoping criteria; Rapid and comprehensive EIA. **(6 Hrs)**
Specialized areas like environmental health impact assessment; Environmental risk analysis; Economic valuation methods; Cost-benefit analysis; Expert system and GIS applications; Uncertainties; Practical applications of EIA; EIA methodologies; Baseline data collection; Prediction and assessment of impacts on physical, biological and socio-economic environment. **(12 Hrs)**
Environmental management plan; Post project monitoring, EIA report and EIS; Review process. **(6 Hrs)**
Case studies on project, regional and sectoral EIA; Legislative and environmental clearance procedures in India and other countries, Sating criteria; CRZ; Public participation. **(8 Hrs)**
Resettlement and rehabilitation. Environmental auditing. **(4 Hrs)**

Text Books:

1. *"Introduction to Environmental Impact Assessment: A Guide to Principles and Practice" ,by B. M. Noble, Oxford University Press, USA, 2005.*
2. *"Introduction to Environmental Impact Assessment: Principles, and Procedures, Process, Practice and Prospects (The Natural and Built Environment Series"), by J. Glasson, Routledge; 3rd edition, 2005.*

Reference books:

1. *"Methods of Environmental Impact Assessment (The Natural and Built Environment Series)" , by P. Morris, 2nd edition, Spon Press, USA, 2001.*
2. *"Environmental Assessment", by R. K. Jain, L. V. Urban, G. S., Stacey, Harold, E. Balbach, 2 edition, McGraw-Hill Professional; 2001.*

CE6106 CONSTRUCTION ENGINEERING PRACTICES Cr-3

Concrete construction methods; form work design and scaffolding, slip form and other moving forms, pumping of concrete and grouting, mass concreting (roller compacted concrete), ready mixed concrete. **(10 Hrs)**
Various methods of placing and handling concrete, Accelerated curing, hot and cold weather concreting, under water concreting, pre-stressing. **(6 Hrs)**
Steel and composites construction methods; Fabrication and erection of structures including heavy structures, Prefab construction, industrialized construction, Modular coordination. **(6 Hrs)**
Special construction methods, Construction in Marine environments, high rise construction, Bridge construction including segmental construction. **(8 Hrs)**

Incremental construction and push launching techniques, River valley projects. **(6 Hrs)**

Text Books:

1. *"Formwork for Concrete Structures", by Robert L Peurifoy & Garold D.Oberiender, McGraw-Hill, 1996.*

Reference Books:

1. *"Formwork for Concrete", by M.K Hurd, Fifth Edition, Special Publication No-4, (American Concrete Institute, Detroit,1980).*
2. *"Guide for Concrete Formwork",American Concrete Institute. Box No 19150, Detroit, Michigan-48219.*

CE6134 PROJECT QUALITY AND SAFETY MANAGEMENT Cr-3

Introduction to quality planning and control of quality during design of structures, Quantitative techniques in quality control, Quality assurance during construction. **(6 Hrs)**

Inspection of materials and machinery in process inspection and test, Preparation of quality manuals, check list and inspection report, Establishing quality assurance system. **(4 Hrs)**

Quality standards/ codes in design and construction, Concept and philosophy of total quality management (TQM), Training in quality and quality management systems (ISO-9000). **(4 Hrs)**

Concept of safety, Factors affecting safety, Physiological, Psychological and Technological, Planning for safety provisions, Structural safety, Safety consideration during construction, demolition and during use of equipment. **(6 Hrs)**

Management of accidents/ injuries and provision of first aid, Provisional aspect of safety, Site management with regard to safety recommendations. **(6 Hrs)**

Training for safety awareness and implementation, Formulation of safety manuals, safety legislation, standards/ codes with regard to construction, Quality vs. Safety. Case studies. **(10 Hrs)**

Text book:

1. *"Construction Safety" ,by Jimmy W. Hinze, Prentice Hall Inc 1997.*

References Books:

1. *"Construction Safety and Health Management",by Richard j.coffe, jimmie Hinze and Theo C.Haud, Prentiee Hall Inc 2001.*
2. *Tamilnadu Factory Act.*
3. *"Construction Planning and Management", by UK Shrivastava, Golgotia Publication.*

CE6136 BUILDING SERVICES PLANNING Cr-3

Components of urban forms and their planning. **(6 Hrs)**

Concepts of neighborhood unit, Street system and layout in a neighborhood, Functional planning of buildings. **(4 Hrs)**

Optimization of space; Spatial Synthesis graphical techniques, heuristic procedures, formulation of linear and non-linear optimization problem. **(10 Hrs)**

Space requirements and relationships for typical buildings, like residential offices, hospitals, etc. Standard fire, fire resistance. **(8 Hrs)**

Classification of buildings, means of escape, alarms, Engineering services in a building as a systems, Lifts, escalators, cold and hot water systems, waster water systems, and electrical systems. **(10 Hrs)**

Text Book:

1. *"Environmental Control Systems", by Mooref ,McGraw Hill,Inc 1994*

Reference Books:

1. *"Building Services", by Peter R.Smith & Warren G.Jullian, Applied Science Publisher ltd, London.*
2. *"Hand book of Buildings and Enclosure" ,by A.J.Elder & Martix Vinder Bary, McGraw Hill Book Co, 1982.*

3. *"The fire Precautions Act in Practices 1987", by* Jane Taylor & Gordon Cooke, Architectural Press, June 1978

CE6138 ADVANCED REPAIRS AND REHABILITATION STRUCTURES Cr-4

Introduction: Need for strengthening due to various reasons such as ageing, natural calamities, increase of load, change of function and design, construction errors. **(3 Hrs)**

Structural Strengthening: Strengthening and retrofitting of columns, beams, walls, footings and slabs, piers of concrete structures by jacketing, external post-tensioning, replacing or adding reinforcement, plate bonding, textile reinforced concrete. **(13 Hrs)**

Specialized Repairs: Electro chemical repair using re-alkalization and chloride extraction techniques, Specialized repairs for chemical disruption, fire, marine exposure etc, Repair of damaged structures of water retaining structures, hydraulic structures, Pavements and Runways, Tunnels, Bridges, Piers and Flyovers, Parking Garages, Underwater repair, Masonary Repair, Repair and Restoration of Heritage Structures. **(8 Hrs)**

Retrofitting by composite materials: Fiber reinforced concrete, Ultra-high performance fibre reinforced concrete (UHPFRC), Fiber reinforced composites, Carbon fibre reinforced polymer (CFRP), Fibre wrapping (Carbon, Aramide, Glass). **(6 Hrs)**

Seismic Retrofitting: Seismic strengthening of existing RC structures, Use of FRP for retrofitting of damaged structures. **(2 Hrs)**

Post-Repair Maintenance of Structures: Protection & Maintenance schedule against environmental distress to all those structures. **(2 Hrs)**

Special cares in repair and rehabilitation of heritage structures. **(2 Hrs)**

Text Book:

1. *"Concrete Repair and Maintenance", Peter H .Emmons & Gajanan M. Sabnis, Galgotia Publication.*
2. *"Management of Deteriorating Concrete Structures", George Somerville, Taylor & Francis Publication.*

Reference books:

3. *"Repairs and Rehabilitation", Compilation from Indian Concrete Journal-ACC Publication.*
4. *"Guide to Concrete Repair and Protection", HB84-2006, A joint publication of Australia Concrete Repair Association, CSIRO and Standards Australia.*
5. *"CPWD hand book on Repairs and Rehabilitation of RCC buildings", published by DG(Works), CPWD, Government of India (Nirman Bhawan), http://www.cpwd.gov.in/handbook.pdf*
6. *"Guide to Concrete Repair", by Glenn Smoak, US Department of the Interior Bureau of Reclamation, Technical Service Center , http://books.google.co.in*
7. *"Concrete Building Pathology", Susan Macdonald, Blackwell Publishing.*
8. *"Testing of Concrete in Structures", John H. Bungey, Stephen G. Millard & Michael G. Grantham, Taylor & Francis Publication.*
9. *"Durability of concrete and cement composites", C.L.Page & M.M. Page,Woodhead Publishing.*
10. *"Concrete Repair, Rehabilitation and Retrofitting", M. Alexander, H. D. Beushausen, F. Dehn & P. Moyo, Taylor & Francis Publication.*
11. *"Concrete Repair Manual", Volume I & II, Published jointly by ACI, BRE, Concrete Society,ICRI.*

CE6231 FINITE ELEMENT METHOD Cr-3

Introduction: The Continuum, Equations of Equilibrium, Boundary Conditions, Strain displacement relations, Stress strain Relations, Plane stress and plane Strain problems, Different methods of structural analysis including numerical methods. Basics of finite element method (FEM), different steps involved in FEM, Different approaches of FEM, Direct method, Energy approach, Weighted residual Method. **(12 Hrs)**

One and Two Dimensional Problems: Detail formulation including shape functions. stress strain relations, strain displacement relations and derivation of stiffness matrices using energy approach, Assembling of element matrices, application of displacement boundary conditions, Numerical solution of one dimensional problems using bar, truss, beam elements and frames. Derivation of shape function using Lagrange's interpolation, Pascal's triangle, Convergence criteria. Finite Element modeling of two dimensional problems using Constant strain Triangle(CST) elements, Stress strain relations for isotropic and orthotropic materials, Four nodded rectangular elements, axisymmetric solids subjected to axisymmetric loading. **(12 Hrs)**

Isoparametric Elements: Natural coordinates, isoparametric elements, four node, eight node elements. Numerical integration, order of integration. **(6 Hrs)**

Plate Bending: Bending of plates, rectangular elements, triangular elements and quadrilateral elements, Concept of 3D modeling. **(6 Hrs)**

Text Books:-

1. *"Finite Element Analysis", by C.S.Krishnamoorthy 2nd Edition, TMH Education, New Delhi*
2. *"Concepts and Applications of Finite Element Analysis", by R.D.Cook, 4th Edition, John Wiley & Sons, 2003.*

Reference books:

1. *"An Introduction to the Finite Element Method", by N.Reddy, 3rd Edition, McGraw Hill Education, 2005.*
2. *"The Finite Element Method", by O.C.Zienkiewicz, Butterworth-Heinemann Ltd; 5th Revised edition, August 2000*
3. *"Finite Element Analysis", by M.Mukhopadhaya, ANE Books, Dec 2009*
4. *"Finite Element Procedures in Engineering Analysis", by K.J.Bathe, Klaus-Jurgen Bathe, 1ST edition, Feb 2007*

CE6232 DESIGN OF BRIDGES Cr-3

Introduction, historical review, engineering and aesthetic requirements in bridge design. Introduction to bridge codes. Economic evaluation of a bridge project, Loading standard, IRC specification, Impact factor. **(4 Hrs)**

Site investigation and planning: Scour - factors affecting and evaluation. **(3 Hrs)**

Bridge foundations: Open, pile, well and caisson. Piers, abutments and approach structures-reinforced earth structure; Superstructure - analysis and design of right, skew and curved slabs. **(14 Hrs)**

Girder bridges: Types, load distribution, design. Orthotropic plate analysis of bridge decks. Introduction to long span bridges - cantilever, arch, cable stayed and suspension bridges. Methods of construction of R.C Bridges, **(8 Hrs)**

Prestressed concrete bridges and steel bridges Fabrication, Launching & creation. Design and construction of construction joints (use of relevant codes of practice are permitted in the examination). **(7 Hrs)**

Text Books

1. *"Design of Bridge Structures", by T. R. Jagadeesh & M. A. Jayaram, 2nd Edition, PHI Learning Pvt. Ltd.*
2. *"Design of Concrete Bridges", by M.G.Aswani, V.N.Vazirani & M.M.Ratwani, 2nd Edition, Khanna Publishers, New Delhi, 2004.*

Reference Books

1. *"Essentials of Bridge Engineering", D. J. Victor, Oxford and IBH.*
2. *"Design of Bridges", N. Krishna Raju, Oxford and IBH.*
3. *"Concrete bridge Practice: Analysis, Design and Economics", V. K. Raina, Tata McGraw Hill.*
4. *"Dynamics of Railway Bridges", L. Fryba, Thomas Telford Ltd ,April 1996*

CE6234 PRE-STRESSED CONCRETE Cr-3

Different systems of prestressing, Characteristics of concrete and steel, Other suitable materials, Losses in prestress. **(8 Hrs)**

Analysis and design of section for flexure, shear and torsion. Design of compressive member. Limit state design as per IS code. Introduction to Partial prestressing. **(10 Hrs)**

Stress distribution in end-block of post tensioned section: Magnel's method, Guyen's method, Rowe's method and IS code method. **(4 Hrs)**

Deflection of prestressed structures- short term as well as long term deflections of uncracked and cracked members. **(3 Hrs)**

Indeterminate structures- Principles of design of prismatic continuous beams of two and three equal, unequal spans with variable moments of inertia. **(4 Hrs)**

Composite construction of prestressed and in-situ concrete. **(2 Hrs)**

Design of special structures- Circular tanks, Pipes, Mast, and Railway sleepers. **(5 Hrs)**

Text Book:

1. *"Prestressed Concrete", by N. Krishna Raju, TMH, New Delhi.*

Reference Books:

1. *"Design of Prestressed Concrete Structure", by T.Y. Lin, Asia Publishing House.*
2. *"Limit State Design of Prestressed Concrete", by Y. Guyan, Applied Science Publishers.*

CE6235 ADVANCED FOUNDATION ENGINEERING Cr-3

Machine Foundations: Types of Machine Foundations, Basic Definitions, Degree of Freedom of a Block Foundation, General criteria for design of Machine Foundations, Free Vibration, Forced Vibration, Vibration analysis of a Machine Foundation, Determination of Natural Frequency, Design Criteria for Foundations of Reciprocating machines, Reinforcement and construction Details, Mass of Foundation, Vibration Isolation and Control. **(14 Hrs)**

Liquefaction of foundation soils under earthquakes: Introduction, Liquefaction Phenomenon, Effect of Liquefaction on Build environment, Factors Affecting Liquefaction, Assessment of Susceptibility of a Soil to Liquefaction, Prevention of Liquefaction. **(6 Hrs)**

Foundations on Expansive soils: Expansive soils, Identification of Expansive soils, Classification of Expansive soils, Causes of moisture changes in soils, Effects of swelling on buildings, Preventive measures for expansive soils Modification of Expansive soils, Design of foundation in swelling soils, Drilled piers, Belled drilled pier, Under reamed piles, construction of under reamed piles. **(10 Hrs)**

Foundation Soil Improvement: Stabilization of soil with granular skeleton, chemical, cement, lime , ash, slag & bitumen, Thermal stabilization, Electrical stabilization, Vibration methods of ground improvement, Drainage methods of ground improvement, Pre-compression and vertical drains, Grouting and injection, Reinforced earth, Use of geotextile & modern materials Ground anchors & soil nails. **(6 Hrs)**

Text book:

1. *"Advanced Foundation Engineering", by V. N. S, Murthy, First Edition,CBS Publishers & Distributors.*
2. *"Foundation Analysis and Design", by J.E.Bowles, 5th Edition, McGraw Hill Higher Education, 1997 .*

Reference Book

1. *"Soil mechanics and foundation Engineering", by K.R.Arora. Standard Publisher, 2005*
2. *"Geotechnical engineering handbook" by B.M.Das, J.Ross Publishing, Cengage learning.*
3. *"Principles Of Foundation Engineering" by B.M.Das, 7th Edition, Cengage Learning India Pvt. Ltd, New Delhi.*
4. *"Geotechnical Engineering Principles and Practices" by Donald P. Coduto, Man Chu Ronald Yeung & William A. Kitch, Prentice Hall, 2011.*
5. *"Reinforced soil and its engineering application",by Swami Saran, Second Edition, I. K. International Publishing House Pvt. Ltd, 2011*
6. *"Geotechnical Engineering", by Shashi K. Gulhati & Manoj Datta, Tata Mcgraw Hill Publishing Co Ltd, 2014*
7. *"Foundation Engineering", by P.C.Verghese, PHI Learning Private Limited, July 2013*
8. *Ground Improvement techniques",by P. Purushothama Raj, Laxmi publications Pvt. L, 2005*

CE6239 COMPOSITE STRUCTURES Cr-3

Introduction: definition, Classification and characteristics of Composite materials, advantages and limitations, Current Status and Future Prospects. **(4 Hrs)**

Basic Concepts and characteristics: Homogeneity and Heterogeneity, Isotropy, Orthotropy and Anisotropy; Characteristics and configurations of lamina, laminate, micromechanics and macro-mechanics. Constituent materials and properties. **(6 Hrs)**

Elastic behavior of unidirectional lamina: Anisotropic, separately orthotropic and transversely isotropic materials, stress-strain relations for thin lamina, transformation of stress and strain, transformation of elastic parameters. **(8 Hrs)**

Strength of unidirectional lamina: Macromechanical failure theories: Maximum stress theory, maximum strain theory, Deviatoric strain energy theory (Tsai-Hill), Interactive tensor polynomial theory (Tsai-Wu).

(7 Hrs)

Elastic Behavior of multidirectional laminates: Basic assumptions, Stress-strain relations, load deformation relations, symmetric and balanced laminates, laminate engineering properties. Bending and vibration of laminated plates: Governing equations, Deflection of simply supported rectangular symmetric angle-ply, specially orthotropic, anti-symmetric cross-ply laminates. **(7 Hrs)**

Composite characterization: Destructive and Non-destructive testing **(4 Hrs)**

Text Books:

1. *"Engineering Mechanics of Composite Materials", by I M Daniel and O. Ishai, Oxford University press, 2005.*
2. *"Mechanics of Composite Materials", by Robert M. Jones, McGraw-Hill Book Company-1975.*

Reference Books:

1. *"Fiber-reinforced Composites", by P.K. Mallick, Marcel Dekker inc, 1993.*
2. *"An introduction to composite materials", by D. Hull and T W Clyne, Cambridge university press,1996.*

CE6242 SOIL-STRUCTURE INTERACTION Cr-3

Soil-Foundation Interaction: Introduction to soil-foundation interaction problems, Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behaviour, Time dependent behaviour. **(12 Hrs)**

Beam on Elastic Foundation- Soil Models: Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness. Plate on Elastic Medium: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions. **(14 Hrs)**

Elastic Analysis of Pile: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap. Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis **(10 Hrs)**

Text Book:

1. *"Foundation Analysis and Design" by J E Bowles- Tata-McGraw Hill*
2. *"Elastic Analysis of Soil-Foundation Interaction" by Selvadurai, A. P. S Elsevier*

Reference Books:

1. *"Pile Foundation Analysis and Design" by Poulos H. G. and Davis E. H.- John Wiley,1980.*
2. *"Design Analysis of Beams, Circular Plates and Cylindrical Tanks on Elastic Foundation" by E.S.Melersk.*
3. *"Beams of Elastic Foundation" by M.Hetenyi, University Michigan Press 1946*

CE6244 OPTIMIZATION TECHNIQUES Cr-3

Introduction: Importance of optimization techniques Linear programming: Formulation, graphical solution, simplex method, Big M Method, Duality, Sensitivity analysis. **(9 Hrs)**

Transportation problems: Assignment problems. **(5 Hrs)**

Decision theory, decision tree, Game theory. **(6 Hrs)**

Inventory models-deterministic models probabilistic model. Queuing theory, simulation applications. Introduction to non linear programming. **(7 Hrs)**

Dynamic programming and integer programming, forecasting techniques. **(9 Hrs)**

Text Books:

1. *"Optimization", by S. S. Rao, Wiley Eastern Ltd.*
2. *"Operation Research", by H. A. Taha, Mac-Millan*

Reference Books:

1. *"Graph Theory", by Narsingh Rao, Prentice Hall*
2. *"Operation Research", by Wagner, Wiley Eastern Ltd.*
3. *"Project Management", by Lick D., Gower Publication England*

CS-1001 PROGRAMMING IN C Cr-3

Introduction to Computer and Programming: **(5Hrs)**

Basic concepts of computer organization, CPU, Memory. I/O devices, Number Systems , Evolution of programming languages, structured programming, Compilation process, source code, object code, executable code, Operating systems, interpreters, linkers, loaders, Algorithms, flow charts, pseudo-code

Program Constructs: **(5Hrs)**

Character set, Identifiers, Keywords, Data Types, Constant and Variables, Operators: Precedence and associativity, Expressions, Statements, Input and Output functions, Control structures: Branching & Looping.

Functions: **(5Hrs)**

Library and User defined functions, Formal and Actual parameters, function prototypes, Parameter passing: Call-by-value, Call-by-reference, Recursion, Storage Classes.

Arrays and Strings: **(4Hrs)**

One dimensional Array, Multidimensional Array and their applications, String Manipulation.

Pointers: **(5Hrs)**

Pointer variable , Pointer Arithmetic, passing parameters by reference, pointer to pointer, pointers to functions, dynamic memory allocation.

Structures, Unions: **(4Hrs)**

Structures, Unions, pointer to structure & pointer to union, linked list.

File Handling: **(4Hrs)**

Declaration of file pointer, opening and closing files, Working with text and binary files.

Additional Features: **(4Hrs)**

Command line arguments, bit wise operators, enumerated data types, type casting, macros, Preprocessor directives.

Text Books

1. Computer fundamentals and programming in C – Pradip Dey & Manas Ghosh, Second Edition, 2013, OXFORD University Press

Reference Books

1. Programming in C – Byron Gottfried,Third Edition, 2010, TMH
2. The ‘C’ programming language , Ritchi, Kernighan, Second Edition, 2012 D.M.Ritchie, PHI
3. Programming in ANSI C – E. Balaguruswami, Sixth Edition, TMH
4. C The Complete Reference - H.Sohildt, Fourth edition,2000 TMH
5. Let us C - Y. Kanetkar, Twelfth Edition, 2012, BPB Publications
6. Computer Science - A Structured Programming Approach using C – B.A. Forouzan & R.F. Gillberg, Third Edition, 2007, Cengage Learning

CS-2001 DATA STRUCTURES & ALGORITHMS Cr-4

Introduction **(4Hrs)**

Structures and Unions, Pointers, Dynamic Memory Allocation, Algorithm Specification, Space and Time Complexity

Arrays **(7Hrs)**

Arrays, Abstract Data Type, Dynamically Allocated Arrays, Polynomials, Two-dimensional Array, Address Calculation, Matrix Addition and Multiplication, Sparse Matrix

Linked List **(8Hrs)**

Singly Linked Lists and Chains, Representing Chains in C, Polynomials, Sparse Matrix, Doubly Linked Lists, Circular & Header Linked lists,

Stacks and Queues **(8Hrs)**

Stacks, Stacks using Dynamic Arrays and Linked List, Queues, Queue using Linked List, Circular Queues using Dynamic Arrays, Evaluation of Expressions, Priority Queue, Dequeue

Trees **(8Hrs)**

Introduction, Binary Trees, Binary Tree Traversals, Threaded Binary Trees, Binary Search Trees, AVL Trees, m-way Search Trees, B-Trees, B+-Trees, Tree Operation, Forests,

Graphs **(5Hrs)**

The Graph ADT, Graph Operation-DFS, BFS, Connected Components

Sorting : **(4Hrs)**

Insertion Sort, Quick Sort, Merge Sort, Heap Sort, Bubble Sort, Selection sort, Radix sort

Searching : **(4Hrs)**

Linear Search, Binary Search, Static Hashing, Dynamic Hashing

Textbooks:-

1. Fundamentals of Data Structures In C, 2nd Edition, Horowitz, Sahani, Anderson Freed, Universities Press.

Reference Books:-

1. Data structure and program design in c, by Robert L. Kruse, PHI
2. Data Structures and Algorithm Analysis in C by Mark Allen Weiss

CS-2002 OPERATING SYSTEMS Cr- 4

Introduction: **(5Hrs)**
Operating system and functions, Evolution of operating system, Batch, Interactive, Time Sharing , Real Time System, Multi-Threading System.

Operating System Structure: **(5Hrs)**
System Components, System structure, Operating System Services.

Concurrent Processes: **(8Hrs)**
Process concept, Principle of Concurrency, Critical Section problem, Semaphores, Classical problems in Concurrency, Inter Process Communication, Introduction to monitor, Process Generation, Process Scheduling.

CPU Scheduling: **(8Hrs)**
Scheduling Concept, Performance Criteria Scheduling Algorithm, Evolution, Multiprocessor Scheduling.

Deadlock: **(7Hrs)**
System Model, Deadlock Characterization, Prevention, Avoidance and Detection, Recovery from deadlock combined approach.

Memory Management: **(9Hrs)**
Resident monitor, Multiprogramming with fixed partition, Multiprogramming with variable partition, Multiple base register, Paging, Segmentation, Virtual memory concept, Demand paging, Performance, Page replacement algorithms, Allocation of frames, Thrashing, Cache memory, Organization, Impact on performance.

I/O Management & Disk Scheduling: **(2Hrs)**
I/O devices and organization of I/O function, I/O Buffering, DISK I/O, Operating System Design Issues.

File System: **(2Hrs)**
File Concept, File Organization and Access Mechanism, File Directories, File Sharing, Implementation Issues.

Operating system Protection & Security: **(2Hrs)**
Introduction to distributed operating system, Case Studies - The UNIX operating system

Text Book

1. Operating System Concepts, A. Silverschwatz, P. Galvin & G.Gange , Willey

Reference Book

1. Operating System Concepts, Milenekovic, McGraw Hill
2. An introduction to operating system, Dietel, Addision Wesley
3. Operating system design and implementation, Tannenbaum, PHI

CS-2003: DATA STRUCTURE & JAVA PROGRAMMING Cr-4

Data Structure(24 classes)

Introduction: **(2Hrs)**
Elementary Data Organization, Data Structure Operations, Abstract Data Types, Analysis of Algorithms, Space and time complexity**.**

Array, Structure, and Pointer: **(3Hrs)**
Basic concepts of single and multi dimensional Array, Use of array through function, Declaration of structures, Use of structure through function, Pointer variable, Pointer Arithmetic, passing parameters by reference, pointers to functions, dynamic memory allocation, pointer to structure**.**

Linked Lists: **(6Hrs)**
Singly linked lists: Representation of linked lists in memory, Traversing, Searching, Insertion into, Deletion from linked list, Polynomial Addition, Doubly linked list, Circular Linked List**.**

Stacks and Queues: **(4Hrs)**
ADT Stacks, Implementation of stack ADT using array and linked list, Applications of Stacks: Conversion from Infix to Postfix, Evaluation of Postfix, ADT queue, Implementations of Queues, Circular Queue, concept of Priority Queue, Applications of Queue**.**

Trees: **(4Hrs)**
Tree Terminology, Binary Tree, Binary Tree traversal, Binary Search Tree (BST): Insertion, deletion, traversal**.**

Searching and Sorting: **(5Hrs)**
Linear search, Binary search, Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort**.**

Java Programming (24 classes)

Introduction : **(2Hrs)**
Introduction to object oriented programming, Java Development Kit (JDK), Java Characteristics, Byte Code, JVM, Simple Java programs**.**

Introduction to Java : **(14Hrs)**
Data types, operators and Expressions, control Statements: Selection statements, iteration statements, Jump Statements, Classes in Java, Declaring a class, Constructors; Inner classes; Inheritance, Overriding and overloading, Interface, Package, Exception handling**.**

Multithreading : **(4Hrs)**
Thread concepts, Thread class and Runnable interface, Synchronization**.**

Introduction to Applet : **(4Hrs)**
Applet Architecture, Applet life cycle, AWT components**.**

Text Book:

1. Data Structures with C 1st Edition, Seymour Lipschutz, Tata Mcgraw Hill Education Private Limited, 2010
2. Java - The Complete Reference, Herbert Schildt, 8th Edition, Tata McGraw Hill, 2011.

Reference Books:

1. Data Structures Using C & C++, Y.Langsam,M.j.Augenstein,Aaron M.Tanenbaum,PHI
2. Fundamentals Of Data Structures In C, Horowitz, Sahni , Universities Press
3. Introduction to JAVA Programming, Y. Daniel Liang, 6th Edition, Pearson Education, 2007.
4. Data Structures and Algorithm Analysis in Java, by Mark Allen Weiss, Third Edition, Addison-Wesley, 2012

CS-2004 DATABASE MANAGEMENT SYSTEMS Cr-4

Introduction **(5Hrs)**

General introduction to database systems; Database - DBMS Definition, approaches to building a database, data models, three-schema architecture of a database, challenges in building a DBMS, various components of a DBMS.

Relational Data Model: **12Hrs**

Concept of relations and its characteristics, schema-instance, integrity constraints, E/R Model - Conceptual data modelling - motivation, entities, entity types, various types of attributes, relationships, relationship types, E/R diagram notation,

Extended E/R Model, Converting the database specification in E/R and Extended E/R notation to the relational schema. Data Storage and Indexes - file organizations, primary, secondary index structures, hash-based indexing, dynamic hashing techniques, multi-level indexes, B^+ trees.

Relational Query Language: **(11Hrs)**

Relational Algebra operators: selection, projection, cross product, various types of joins, division, example queries, tuple relation calculus, domain relational calculus, QBE. Introduction to SQL, Data definition in SQL, Table, Key and Foreign key definitions, Data manipulation in SQL. Nested queries, Notion of aggregation, PL/SQL.

Relational Database Design: **(12Hrs)**

Dependencies and Normal forms - Importance of a good schema design, problems encountered with bad schema designs, motivation for normal forms, dependency theory - functional dependencies, Armstrong's axioms for FD's, closure of a set of FD's, minimal covers, definitions of 1NF, 2NF, 3NF and BCNF, decompositions and desirable properties of them, algorithms for 3NF and BCNF normalization, multi-valued dependencies and 4NF, join dependencies and definition of 5NF.

Transaction Processing: **(8Hrs)**

Concepts of transaction processing, ACID properties, concurrency control, locking based protocols, recovery and logging methods.

Text Book

1. Database System Concepts by Sudarshan, Korth (McGraw-Hill Education)
2. Fundamentals of Database System By Elmasari & Navathe- Pearson Education

Reference Book

1. An introduction to Database System – Bipin Desai, Galgotia Publications
2. Database Management System by Leon & Leon (Vikas publishing House).
3. Database Modeling and Design: Logical Design by Toby J. Teorey, Sam S. Lightstone, and Tom Nadeau, 4th Edition, 2005, Elsevier India Publications, New Delhi
4. Fundamentals of Database Management System – Gillenson, Wiley India.

CS-3001 DESIGN & ANALYSIS OF ALGORITHMS Cr-4

Introduction: **(8Hrs)**

Algorithm Design paradigms- motivation, concept of algorithmic efficiency, run time analysis of algorithms, Asymptotic Notations.

Divide and conquer: **(8Hrs)**

Structure of divide-and-conquer algorithms, max-min problem, Binary search, quick sort, randomized quick sort, merge sort, Analysis of divide and conquer run time recurrence relations.

Greedy Method: **(8Hrs)**

Overview of the greedy paradigm ,knapsack problem, Optimal storage on tapes, Job sequencing with deadlines, Activity selection problem, minimum cost spanning tree, Single source shortest path, Huffman's code.

Dynamic programming: **(8Hrs)**

Overview, difference between dynamic programming and divide and conquer, Applications: 0/1 knapsack, Shortest path in graph, Matrix chain multiplication, Traveling salesman Problem, longest Common subsequence.

Graph searching and Traversal: **(5Hrs)**

Overview, Traversal methods (depth first and breadth first search)

Back tracking: **(6Hrs)**

Overview, 8-queen problem, sum of subset, and Knapsack problem

Brach and bound: **(3Hrs)**

LC searching Bounding, FIFO branch and bound, LC branch and bound application: 0/1 Knapsack problem,

Traveling Salesman Problem

Computational Complexity: **(2Hrs)**

Complexity measures, Polynomial Vs non-polynomial time complexity; NP-hard and NP complete classes, examples, Approximation Algorithm for travelling sales person problem.

Text Book

1. T. H. Cormen, Leiserson, Rivest and Stein, "Introduction of Computer algorithm," PHI
2. E. Horowitz, S. Sahni, and S. Rajsekaran, "Funadmentals of Computer Algorithms," Galgotia Publication

Reference Book

1. Sara Basse, A. V. Gelder, " Computer Algorithms," Addison Wesley
2. Algorithm Design:Foundation, Analysis&Internet examples By Michael T.Goodrich, Roberto Tamassia , John Wiley & Sons

CS-3002 COMPILER DESIGN Cr-4

Overview of Compilation: **(5Hrs)**

Cousins of the Compiler, Phases of Compilation, Grouping of Phases, Lexical Analysis, Compiler construction tools, Lexical Analysis, Role of Lexical Analyzer, Input Buffering, Specification of Tokens, Finite state machines and regular expressions and their applications to lexical analysis, Implementation of lexical analyzers, LEX lexical analyzer generator.

Syntax Analysis: **(8Hrs)**

Context-free grammars, Top-down Parsing – Backtracking, LL(1), recursive descent parsing, Predictive parsing, Bottom-up parsing – Shift Reduce parsing, LR and LALR parsing, Error recovery in parsing, handling ambiguous grammar, YACC – automatic parser generator.

Semantic analysis: **(9Hrs)**

Intermediate forms of source Programs – abstract syntax tree, polish notation and three address codes. Attributed grammars, Syntax directed translation, Conversion of popular Programming languages language Constructs into Intermediate code forms, Type checker.

Symbol Tables: **(8Hrs)**

Symbol table format, organization for block structures languages, hashing, tree structures representation of scope information. Block structures and non-block structure storage allocation: static, Runtime stack and heap storage allocation, storage allocation for arrays, strings and records.

Code optimization: **(8Hrs)**

Consideration for Optimization, Scope of Optimization, local optimization, loop optimization, frequency reduction, folding, DAG representation.

Data flow analysis: **(7Hrs)**

Flow graph, data flow equation, global optimization, redundant sub expression elimination, Induction variable elements, Live variable analysis, Copy propagation.

Object code generation: **(3Hrs)**

Object code forms, machine dependent code optimization, register allocation and assignment generic code generation algorithms, DAG for register allocation.

Text Book

1. Compilers- Principles, Techniques and Tools, By A.V. Aho, M.S. Lam, R Sethi and J.D.Ullman, Pearson Education.

Reference Book

1. lex &yacc – John R. Levine, Tony Mason, Doug Brown, O'reilly
2. Engineering a Compiler, by Cooper & Linda, Elsevier.
3. Compiler Construction, K.C. Louden, Thomson Brooks/Cole.

CS-3003 FORMAL LANGUAGES & AUTOMATA THEORY Cr-4

Background: **(3Hrs)**

Strings, Alphabet, Language, Operations on languages, Inductive Proofs, Relations and Functions.

Regular Languages: **(20Hrs)**

Deterministic Finite Automaton, Non-deterministic Finite Automaton, Equivalence of DFA and NFA, Minimization of number of states in a DFA, Regular Expressions, Equivalence of Regular Expressions and Finite State Automata, Closure Properties of Regular Languages, Pumping Lemma for Regular Languages, Myhill-Nerode Theorem, Identification of some non-Regular languages, Decision Problems on Regular Languages, Regular grammars: right linear and left linear grammars, Equivalence of regular languages and regular grammars.

Context-Free Languages: **(15Hrs)**

Context-Free Grammars, Leftmost and Rightmost derivations, Sentential Forms and Derivation Trees, Parsing and Membership, Parse Trees, Ambiguity in Grammars and Languages, Simplification of Context-Free Grammars, Chomsky Normal Form, Greibach Normal Form, Pushdown Automata, Equivalence of PDA and Context-Free Grammars, Closure Properties of Context-Free Languages, Pumping Lemma for Context-Free Languages, Identification of some Languages that are not Context-Free.

Recursive and Recursively Enumerable Languages: **(10Hrs)**

Turing Machines, Turing Machines as Language Accepters, Church-Turing Thesis, Models of Turing Machines -- Multiple Tape, Multiple Tracks, Non-determinism, etc., Equivalence of TM Models, Recursive and Recursively Enumerable languages, Computability and Decidability, Halting Problem, Undecidability of the Halting Problem, Examples of some other undecidable problems.

Text Books:

1. An Introduction to Formal Languages and Automata, Peter Linz, Jones & Bartlett Publishers

Reference Books:

1. Introduction to Automata Theory Languages and Computation, J.E. Hopcroft, R Motwani and J.D. Ullman,Pearson Education.
2. Elements of the theory of computation, Lewis, Harry R. and Christos H. Papadimitriou Prentice-Hall, Englewood
3. The Theory of Computation, Bernard M. Moret, Pearson Education
4. Introduction to the Theory of Computation, Michel Sipser, Thomson Brooks/Cole
5. Theory of Computer Science, K L P Mishra and Chandrasekhran, PHI
6. Introduction to Automata Theory, Formal Languages and Computation, Kamala Krithivasan and R. Rama, Pearson Education

CS-3004 COMPUTER GRAPHICS Cr-3

Introduction: **(5Hrs)**

Introduction to Computer Graphics, Use of computer graphics, Elements of picture creation, Display technologies, Graphics display devices, Graphics input primitives and devices.

Two Dimensional Graphics: **(10Hrs)**

Two dimensional output primitives, Different forms of line drawing algorithms, Circle generating algorithms, Ellipse generating algorithm, Filled area primitives.

Geometric Transformation: **(11Hrs)**

The geometries of transformations, Translation, Rotation in plane, Rotation in space, Reflection, Homogeneous coordinates, Composite transformations, Polygons, Two dimensional viewing, Window to view port transformations, Line clipping, Polygon clipping, projection.

Three Dimensional Graphics: **(10Hrs)**

Three dimensional shapes representations: Spline, Bezier curves and surfaces, Octrees, BSP trees, Fractal geometry; Visible surface detection; Solid modeling; Shading; Advanced modeling techniques; Animation.

Text Book

1. Computer Graphics, C Version, D. Hearn and M. P. Baker, Pearson, 2nd Ed, 2003.

Reference Book

1. Computer Graphics - Principles and Practice, J. D. Foley, A. Van Dam, S. K. Feiner and J. F. Hughes, Second Edition in C, Addison Wesley, 2nd Ed, 2003.
2. Mathematical Elements for Computer Graphics, D. F. Rogers, J. A. Adams, McGraw Hill, 2nd Ed, 2001

CS-3005 COMPUTER ORGANIZATION AND ARCHITECTURE Cr-4

Basic Structure of Computers: **(8Hrs)**

Computer Types, Functional Units, Basic Operational Concepts, Bus Structures, Machine Instructions and Programs: Memory Location and Addressing mechanism, Memory Operations, Instructions and Instruction Sequencing. Assembly Language, Basic Input and Output Operations, Subroutines, Additional Instructions, Encoding of Machine Instructions , Addressing Modes, Types of instruction, instruction format, Instruction length.

Basic Processing Unit: **(10Hrs)**

Some Fundamental Concepts, Execution of a Complete Instruction, Single and Multiple Bus Organization, Hard-wired Control, Micro programmed Control unit.

Arithmetic: **(7Hrs)**

Multiplication of Positive Numbers, Signed Operand Multiplication, Fast Multiplication, Integer Division, Floating-point Numbers and Operations.

Memory System: **(9Hrs)**

Basic Concepts, Semiconductor RAM Memories, Read Only Memories, Speed, Size, and Cost, memory

module design, Cache Memories – Mapping Functions, Replacement Algorithms, Memory interleaving, Memory Performance Considerations Virtual Memories.

Input/ Output Organization: (9Hrs)

Accessing I/O Devices, Interrupts – Interrupt Hardware, Enabling and Disabling Interrupts, Handling Multiple Devices, Controlling Device Requests, Exceptions, Direct Memory Access. Interface Circuits, Standard I/O Interfaces – PCI Bus, SCSI Bus, USB

Parallel Processing: (5Hrs)

Flynn's classification, Introduction to Pipelining and hazards, RISC vs CISC.

Text Book

1. Computer Organization, Carl Hamacher, Zvonko Vranesic, Safwat Zaky, 5th Edition, TMH, 2002.

Reference Book

1. Computer Organization & Architecture, William Stallings, 7th Edition, PHI, 2006.

CS-3006 HIGH PERFORMANCE COMPUTER ARCHITECTURE Cr-4

Introduction: (7Hrs)

Review of basic computer architecture, quantitative techniques in computer design, measuring and reporting performance. CISC and RISC processors.

Pipelining: (12Hrs)

Basic concepts, instruction and arithmetic pipeline, data hazards, control hazards, and structural hazards, techniques for handling hazards. Exception handling. Pipeline optimization techniques. Compiler techniques for improving performance.

Hierarchical memory technology: (9Hrs)

Inclusion, Coherence and locality properties; Cache memory organizations, Techniques for reducing cache misses; Virtual memory organization, mapping and management techniques, memory replacement policies.

Instruction-level parallelism: (10Hrs)

Basic concepts, techniques for increasing ILP, superscalar, super-pipelined and VLIW processor architectures. Array and vector processors.

Multiprocessor architecture: (10Hrs)

Taxonomy of parallel architectures. Centralized shared-memory architecture: synchronization, memory consistency, interconnection networks. Distributed shared-memory architecture. Cluster computers. Non von Neumann architectures: data flow computers, reduction computer architectures, systolic architectures.

Text Book:

1. John L. Hennessy and David A. Patterson, Computer Architecture: A Quantitative Approach, Morgan Kaufmann.

References

1. John Paul Shen and Mikko H. Lipasti, Modern Processor Design: Fundamentals of Superscalar Processors, Tata McGraw-Hill.

2. M. J. Flynn, Computer Architecture: Pipelined and Parallel Processor Design, Narosa Publishing House.
3. Kai Hwang, Advanced Computer Architecture: Parallelism, Scalability, Programmability, McGraw-Hill.

CS-4001 ARTIFICIAL INTELLIGENCE Cr-4

Introduction: **(5 Hrs)**

Overview; Foundation; History; The State of Art.

Intelligent Agents: **(5 Hrs)**

Agents and environment; Rationality; The nature of environment; The structure of agents.

Solving Problems by Searching: **(7 Hrs)**

Problem-solving agents; Well defined problems & solutions; Formulating problems; Searching for solution; Uninformed search strategies: (BFS, DFS, DLS, IDDFS, Bidirectional Search)

Informed Search and Exploration: **(6 Hrs)**

Informed search strategies; Heuristic functions; On-line search agents and unknown environment.

Constraint Satisfaction Problems: **(4 Hrs)**

Constraint satisfaction problems; Backtracking search for CSPs; Local search for CSPs.

Adversial search: **(4 Hrs)**

Games; Optimal decisions in games; Alpha-Beta pruning.

Logical Agents: **(4 Hrs)**

Knowledge-based agents; The wumpus world as an example world; Logic: Propositional logic Reasoning patterns in propositional logic.

First-order Logic: **(4 Hrs)**

Syntax and semantics of first-order logic; Use of first-order logic.

Inference in First-Order Logic: **(5 Hrs)**

Propositional versus first-order inference; Unification and lifting; Forward chaining; Backward chaining; Resolution**.**

Introduction to Knowledge Representation & Planning: **(4 Hrs)**

Ontological engineering; Categories and objects, Actions, situations, and events. Planning: The planning problem; Planning with state-space approach.

Text Book

1. Artificial Intelligence: A Modern Approach – Stuart Russel, Peter Norvig, 3rd Edition, Pearson Education, 2009.

Reference Book

1. Artificial Intelligence - Elaine Rich, Kevin Knight and Shivashankar B Nair, 3rd Edition, Tata McGraw Hill, 2008.
2. Artificial Intelligence: A new Synthesis – Nils J. Nilsson, 1st Edition, Elsevier, 1997.
3. Introduction to Artificial Intelligence and Expert Systems- Dan W. Patterson 2nd Edition, PHI, 2009.

CS-4003 COMPUTER ORGANIZATION AND OPERATING SYSTEM Cr-4

Basic Structure of Computers: **(8Hrs)**
Functional Units, Basic Operational Concepts, Bus Structures, Machine Instructions and Programs, Memory Location and Addressing mechanism-Big and Little Endian, Instructions and Instruction Sequencing.

Basic Processing Unit: **(8Hrs)**
Some Fundamental Concepts, Execution of a Complete Instruction, Single and Multiple Bus Organization, Hard-wired Control, Micro programmed Control unit.

Memory System: **(8Hrs)**
Types of memory, Memory hierarchy, Cache Memories – Mapping Functions, Memory interleaving, Virtual Memories.
Pipelining : **(6Hrs)**
Basic concept, Arithmetic and instruction pipeline, pipeline performance, hazards

Introduction to OS: **(5Hrs)**
Operating system and functions, Evolution of operating system, Batch, Interactive, Time Sharing , Real Time System, Multi-Threading System, System Components, Operating System Services.
Process Concept: **(6Hrs)**
Process**,** process state**,** PCB, Process scheduling, Thread concept & it's benefit

CPU Scheduling : **(7Hrs)**
Basic concept, performance criteria, CPU scheduling algorithms, Introduction to deadlock.

Text Books:
1. "Computer Organization", Carl Hamacher, Zvonko Vranesic, Safwat Zaky, 5thEdition, TMH, 2002.
2. "Operating System Concepts", A.Silverschwatz,P.Galvin& G.Gange , , Willey

Reference Books:
1. Milenekovic, "Operating System Concepts", McGraw Hill
2. Dietel, "An introduction to operating system", Addision Wesley
3. "Operating system design and implementation", Tanenbum,PHI

CS-4021 PARALLEL AND DISTRIBUTED COMPUTING Cr-3

Introduction to parallel computing: **(2Hrs)**

Motivation, scope and issues.

Parallel Programming Platforms: **(5Hrs)**

Trends in microprocessor Architectures, Dichotomy of parallel Computing platforms, physical Organization of parallel platforms, communication costs in parallel Machines, Routing Mechanisms for interconnection Network, Impact of Process Processors mapping and mapping Techniques.

Principles of parallel Algorithm Design: **(6Hrs)**

Preliminaries, Decomposition Techniques, Characteristics of Tasks and Interactions, Mapping Techniques for load Balancing, Methods for containing interaction overheads, Parallel Algorithm Models.

Basic Communication Operations: **(7Hrs)**

One-to-All Broadcast and All-to-One Reduction, All-to-All Broadcast and reduction All-Reduce and Prefix sum operations, scatter and Gather, All-to-All personalized communication, circular shift, improving the speed of some communication operation.

Analytical Modeling of Parallel Programs: **(8Hrs)**

Performance Metrics for Parallel systems, Effect of Granularity of Performance, scalability of parallel system, Minimum Execution Time and Minimum Cost-optimal execution Time, Asymptotic Analysis of

parallel Programs, other scalability Metrics.

Programming Using the message passing Paradigm: (5Hrs)

Principle of Message – Passing Programming, Send and receive Operations, The message passing Interface, Topologies and Embedding, Overlapping communication with computation, collective communication and computation Operations, Groups and Communicators. Dense Matrix Algorithm

Sorting: (2Hrs)

Bubble Sort and its variants, Quick Sort.

Graph Algorithms: (2Hrs)

Minimum Spanning Tree (Prim's Algorithm) shortest path (Dijkstra's Algorithm)

Text Book

1. Introduction to Parallel Computing, Second Edition, Ananth Gram, Anshul Gupta, George Karypis, Vipin Kumar, Person Education.

2. Parallel programming in c with MPI and Open MP, M.J. Quinn, TMH.

Reference Book

1. Parallel Computer Architecture and Programming, D.E.Culler,J.P Singh & A Gupta, Morgan Kaufman.
2. Designing and Building Parallel Programs, I.Foster. Addison-Wesley.

CS-4022 SOFTWARE TESTING Cr-3

Basics of Software Testing: (3Hrs)

Human Errors and Testing; Software Quality; Requirements, Behavior and Correctness; Correctness versus Reliability; Testing and Debugging; Test Metrics, Software and Hardware Testing: Testing and Verification; Defect Management; Execution History; Test Generation Strategies, Static Testing, Model-Based Testing and Model Checking; Control-Flow Graph; Types of Testing; The Saturation Effect.

Test Generation From Requirements: (3Hrs)

Introduction; The Test-Selection Problem; Equivalence Partitioning; Boundary Value Analysis; Category-Partition Method; Cause-Effect Graphing, Test Generation from Predicates.

Structural Testing: (5Hrs)

Overview of Statement testing; Branch testing; Condition testing; Path testing. Procedure call testing; Comparing structural testing criteria; The infeasibility problem.

Dependence, Data Flow Models, Data Flow Testing: (5Hrs)

Definition-Use pairs; Data flow analysis; Classic analyses; From execution to conservative flow analysis; Data flow analysis with arrays and pointers; Inter-procedural analysis; Overview of data flow testing; Definition-Use associations; Data flow testing criteria; Data flow coverage with complex structures; The infeasibility problem.

Test Case Selection and Adequacy, Test Execution: (6Hrs)

Overview; Test specification and cases; Adequacy criteria; Comparing criteria; Overview of test execution; From test case specification to test cases; Scaffolding; Generic versus specific scaffolding; Test oracles; Self-

checks as oracles; Capture and replay.

Process: Test and analysis activities within a software process: (5Hrs)

The quality process; Planning and monitoring; Quality goals; Dependability properties; Analysis; Testing; Improving the process; Organizational factors. Integration and component-based software testing: Overview; Integration.

Testing Strategies: (5Hrs)

Testing components and assemblies. System, Acceptance and Regression Testing: Overview; System testing; Acceptance testing; Usability; Regression testing; Regression test selection techniques; Test case prioritization and selective execution, Mutation testing.

Object-Oriented Testing: (4Hrs)

Testing Object Oriented Software: Unit Testing in OO Context, Integration Testing in OO Context, OO testing methods, Class level testing, Interclass test case design, testing for real time system

Text Book

1. Foundations of Software Testing, Aditya P Mathur, Pearson Education.

2. Software Testing and Analysis Process Principles and Techniques, Mauro Pezze, Michal Young, Wiley India.

Reference Book

1. Software Testing Principles and Practices, Srinivasan Desikan,Gopalaswamy Ramesh, 2nd Edition, Pearson.
2. Software Testing, Ron Patton, 2nd edition, Pearson, 2004.
3. The Craft of Software Testing, Brian Marrick, Pearson, 1995.
4. Practical Software Testing, Ilene Burnstein, Springer-Verlag First Indian Reprint 2004.

CS-4023 REAL TIME SYSTEMS Cr-3

Introduction: (6Hrs)

Real-Time systems, applications of Real-Time systems, basic model of Real-Time systems, characteristics of Real-Time systems, types of Real-Time systems: hard, firm, soft, timing constraints, modeling timing constraints.

Real-Time task scheduling: (10Hrs)

Basic concepts, clock driven scheduling, table driven scheduling, cyclic, schedulers, hybrid schedulers, event driven scheduling, EDF Scheduling, RMA, DMA, resource sharing among RT tasks, Priority inversion, Priority Inheritance Protocol, Highest Locker Protocol, Priority Ceiling Protocol, Scheduling Real-Time tasks in multiprocessor and distributed systems.

(10Hrs)

Fault-tolerant scheduling of tasks, clocks in distributed Real-Time systems, Commercial Real-Time Operating Systems, timers, UNIX and Windows as RT OS, POSIX, PSOS, VRTX, QNX, RT Linux, other RT OS, benchmarking RT OS, RT communications, QoS framework, models.

(10Hrs)

Real-Time Communication in a LAN, IEEE 802.4, RETHER, Communication over Packet Switched Networks, Routing algorithms, RSVP, rate control, RT databases, Applications, characteristics of temporal

data, Concurrency control, Commercial RT databases.

Text Book

1. Real-Time Systems Design & Analysis, P. A. Laplante, Willey, 3rd Ed, 2004.

2. Real-Time Systems, R. Mall, Pearson, 2007.

Reference Book

1. Real-Time Systems, C. M. Krishna and K. G. Shin, McGraw Hill, reprinted 2004.
2. Real-time Systems, J. W. S.Liu, Pearson Education, 6th impression, 2008.

CS-4024 SERVICE ORIENTED ARCHITECTURE Cr-3

Introduction to SOA, Evolution of SOA: (5Hrs)

Fundamental of SOA; Common Characteristics of contemporary SOA; Common tangible benefits of SOA; An SOA timeline (from XML to Web services to SOA); The continuing evolution of SOA (Standards organizations and Contributing vendors); The roots of SOA (comparing SOA to Past architectures).

Web Services and Primitive SOA: (4Hrs)

The Web services framework; Services (as Web services); Service descriptions with WSDL; Messaging with SOAP.

Web Services and Contemporary SOA: (4Hrs)

Message exchange patterns; Service activity; Coordination; Atomic Transactions; Business activities; Orchestration; Choreography, Addressing; Reliable messaging; Correlation; Polices; Metadata exchange; Security; Notification and eventing.

Principles of Service – Orientation: (8Hrs)

Services-orientation and the enterprise; Anatomy of a service-oriented architecture; Common Principles of Service-orientation; Service orientation principles interrelate; Service-orientation and objectorientation; Native Web service support for service-orientation principles.

Service Layers: (7Hrs)

Service-orientation and contemporary SOA; Service layer abstraction; Application service layer, Business service layer, Orchestration service layer; Agnostic services; Service layer configuration scenarios.

Business Process Design: (5Hrs)

WS-BPEL language basics; WSCoordination overview; Service-oriented business process design; WSaddresing language basics; WS-ReliableMessaging language basics.

SOA Platforms: (3Hrs)

SOA platform basics; SOA support in J2EE; SOA support in .NET; Integration considerations.

Text Book

1. Service-Oriented Architecture Concepts Technology, and Design, Thomas Erl, Pearson Education.

Reference Book

1. Understanding SOA with Web Services, Eric Newcomer, Greg Lomow, Pearson Education.

CS-4026 ROBOTICS AND CONTROL Cr-3

Introduction to Robotics: **(6Hrs)**

History and Terminology of Robotics; Architecture of robotic systems; Accuracy and repeatability of Robotics; Classification; Robot anatomy: Components; Characteristics; Applications based on simple problems.

Robot Kinematics: **(5Hrs)**

Robots as Mechanisms; Matrix Representation; Representation of pure translation; Representation of pure rotation about an axis; Representation of combined transformations; Inverse of Transformation Matrices; Forward and Inverse Kinematics of Robots; DH Notation.

Fundamentals of Actuating Systems: **(4Hrs)**

Characteristics of Actuating Systems; Comparison of Actuating Systems; Hydraulic Devices; Pneumatic Devices; Electric Actuators; Electric Motors; Control of Electric Motors.

Sensors: **(5Hrs)**

Characteristics, Position Sensors; Velocity and Acceleration Sensors; Force and Pressure Sensors; Torque and Micro switches; Light and Infrared Sensors; Touch and Tactile Sensors; Proximity and Range finders; Sniff Sensors; Vision Systems; Voice Recognizers; Voice Synthesizer; Remote Centre Compliance Device.

Robot Dynamics and Control : **(5Hrs)**

Dynamics: Acceleration and Inertia; Dynamics: Explicit Form; PID control; Joint space control; Operational space control and Force control.

Robot Path Planning: **(5Hrs)**

Motion Planning; Shortest Path Algorithms; Dijkstra's Algorithm; Trajectory Planning; Applications of Path Planning in Computer Vision & Image Processing.

Robotic Programming and Applications : **(6Hrs)**

Fuzzy expert systems and Fuzzy-C-means clustering applied to image segmentation; Rule based path planningof a mobile robot using back propagation neural networks (BPNN); Application of GA in mobile robot path planning and navigation; Introduction to multi-agent co-operative robotics.

Text Book:

1. R. K. Mittal and I. J. Nagrath, "Robotics and Control", 1st Edition, TMH, 2003.

Reference Books:

1. Saeed B. Niku, "Introduction to Robotics Analysis, Control, Application", 2nd Edition, John Wiley & Sons, 2011.
2. John, J Craig, "Introduction to Robotics: Mechanics & Control", 3rd Edition, Addision Wesley Publishing Company, 2003.
3. Amit Konar, "Computational Intelligence, Principles, Techniques and Applications", Springer, 1st Edition, 2005.

CS-4032 RELATIONAL DATABASE SYSTEMS Cr-3

Introduction: **(6Hrs)**

Introduction to Database Systems; Database – DBMS Definition, Approaches to building Database, Data Models,

Three – Level Data Abstraction, Various components of DBMS.

Relational Data Model: **(10Hrs)**

Concept of Relations and its characteristics, Schema – instance, Integrity Constraints, E/R Model, Entities, Entity Types, Attribute Types, Relationship and types, E/R Diagram Notations, Extended E/R Model, Converting E/R Diagram to Relational Schema.

Relational Query Language: **(6Hrs)**

Relational Algebra Operators: Selection, Projection, Cross product, Types of joins, Division. Introduction to SQL, Data definition in SQL, Table, Primary key and Foreign key definitions, Data manipulation in SQL. Nested queries, Notion of aggregation.

Relational Database Design: **(10Hrs)**

Dependencies and Normal forms – Importance of a good schema design, Problems encountered with bad schema designs, Motivation for normal forms, Dependency theory – functional dependencies, Armstrong's axioms for FD's, closure of a set of FD's, Minimal covers, 1NF, 2NF, 3NF and BCNF, Denormalization.

Transaction Processing: **(4Hrs)**

Introduction to transaction, ACID property, Serializability, Concurrency control protocol.

Text Book

1. *Database Systems: Models, Languages, Design and Application Programming* – Ramez Elmasri, Shamkant B. Navathe – 6th Edition, Pearson India, 2013.

Reference Books

1. *Database System Concepts* – Abraham Silberschatz, S. Sudarshan, Henry F. Korth – 6th Edition, McGraw Hill, 2013.

CS-4033 COMPUTER ARCHITECTURE Cr-3

Basic Structure of Computers: **(9Hrs)**

Functional Units, Basic Operational Concepts, Bus Structures, Machine Instructions and Programs: Memory Location and Addressing mechanism, Instructions and Instruction Sequencing. Addressing Modes, Types of instruction, instruction format, Instruction length, Basic Input and Output Operations, Subroutines.

Basic Processing Unit: **(7Hrs)**

Fundamental Concepts, Execution of a Complete Instruction, Single and Multiple Bus Organization, Hard-wired Control, Micro programmed Control unit.

Memory System: **(7Hrs)**

Basic Concepts, Speed, Size, and Cost, Cache Memories – Mapping Functions, Replacement Algorithms, Memory interleaving, Memory Performance Considerations, Virtual Memories.

Input/ Output Organization: **(7Hrs)**

Accessing I/O Devices, Interrupts – Interrupt Hardware, Enabling and Disabling Interrupts, Handling Multiple Devices, Controlling Device Requests, Direct Memory Access. Standard I/O Interfaces – PCI Bus, SCSI Bus, USB

Parallel Processing: **(6Hrs)**

Flynn's classification, Introduction to Pipelining, hazards.

Text Book:

Computer Organization, Carl Hamacher, Zvonko Vranesic, Safwat Zaky, TMH

Reference Book:

Computer System Architecture, Morris Mano, PHI

CS-4041 PATTERN RECOGNITION Cr-3

Introduction: **(6Hrs)**

Basics of Pattern Recognition, Statistical and Syntactic Pattern Recognition

Pattern Recognization Methods: **(10Hrs)**

Bayes' Decision Theory, Maximum Likelihood Estimation, Nonparametric Techniques, Linear Discriminant Analysis, KL Dimensionality Reduction, Neural Networks for Pattern Recognition, Non-metric Methods, Algorithm Independent Machine Learning, Unsupervised Learning and Clustering, Statistical Learning Theory.

Formal Languages & Pattern Recognization: **(10Hrs)**

Introduction to Formal Languages, String Languages for Pattern Description, Stochastic Languages for Syntactic Pattern Recognition, Cluster Analysis for Syntactic Patterns

Applications of Pattern Recognization: **(10Hrs)**

Data Mining, Web Searching, Handwriting Recognition, Multimedia Data Retrieval, Speech Recognition, Network Traffic Analysis.

Text Book

1. Pattern Classification and Scene Analysis, Duda RO and Hart PE, John Wiley & Sons

Reference Book

1. Pattern Recognition and Image Analysis, Earl Gose, Richard Johnsonbaugh, Steve Jost, Prentice Hall
2. Introduction to Statistical Pattern Recognition, Keinosuke Fukunaga, Academic Press
3. Neural Networks for Pattern Recognition, Christopher M. Bishop, Oxford University Press.

CS-4042 EMBEDDED SYSTEMS Cr-3

Embedded Computing: **(4Hrs)**
Introduction, Complex Systems and Microprocessor, Embedded System Design Process, Formalisms for System Design, Design Examples.
The 8051 Architecture: **(5Hrs)**
Introduction, 8051 Micro controller Hardware, Input/Output Ports and Circuits, External Memory, Counter and Timers, Serial data Input/Output, Interrupts.
Basic Assembly Language Programming Concepts: **(4Hrs)**
The Assembly Language, Programming Process, Programming Tools and Techniques, Programming the 8051, Data
Transfer and Logical Instructions, Arithmetic Operations, Decimal Arithmetic. Jump and Call Instructions, Further Details on Interrupts.
Applications: **(4Hrs)**
Interfacing with Keyboards, Displays, D/A and A/D Conversions, Multiple Interrupts, Serial Data Communication.
Introduction to Real-Time Operating Systems: **(5Hrs)**
Tasks and Task States, Tasks and Data, Semaphores, and Shared Data; Message Queues, Mailboxes and Pipes, Timer, Functions, Events, Memory Management, Interrupt Routines in an RTOS Environment
Basic Design Using a Real-Time Operating System: **(5Hrs)**
Principles, Semaphores and Queues, Hard Real-Time Scheduling Considerations, Saving Memory and Power, An example RTOS like uC-OS (Open Source); Embedded Software Development Tools: Host and Target machines, Linker/Locators for Embedded Software, Getting Embedded, Software into the Target System.
Basic Design Using a Real-Time Operating System: **(4Hrs)**
Debugging Techniques: Testing on Host Machine, Using Laboratory Tools, An Example System.
Introduction to advanced architectures: **(5Hrs)**
ARM and SHARC, Processor and memory organization and Instruction level parallelism; Networked embedded systems: Bus protocols, I2C bus and CAN bus; Internet-Enabled Systems, Design Example-Elevator Controller.

Text Book

1. Computers and Components, Wayne Wolf, Elseveir.
2. The 8051 Microcontroller, Third Edition, Kenneth J.Ayala, Thomson.
3. An Embedded Software Primer, David E. Simon, Pearson Education.

Reference Book

1. Embedding system building blocks, Labrosse, via CMP publishers.
2. Embedded Systems, Raj Kamal, TMH.
3. Micro Controllers, Ajay V Deshmukhi, TMH.
4. Embedded System Design, Frank Vahid, Tony Givargis, John Wiley.
5. Microcontrollers, Raj Kamal, Pearson Education.

CS-4043 IMAGE PROCESSING Cr-3

Introduction to Digital Image Processing: (3Hrs)

Applications of Image Processing, Sampling, Quantization, Basic Relationship between Pixels, Imaging Geometry.

Image Enhancement: (4Hrs)

Image Enhancement in Spatial Domain, Gray Level Transformation, Histogram Processing, Enhancement Using Arithmetic and Logic Operation, Smoothing Spatial Filter, Sharpening Spatial Filter, Image Enhancement in Frequency Domain, Fourier Transform, Smoothing Frequency Domain Filter, Sharpening Frequency Domain Filter.

Image Restoration: (5Hrs)

Image Degradation and Restoration Process, Noise Models, Noise Reduction by Spatial Filtering, Noise Reduction by Frequency Domain Filtering, Inverse Filtering, Least Square Filtering, Geometric Mean Filter.

Image Data Compression: (6Hrs)

Image Compression Model, Elements of Information Theory, Error Free Compression, Lossy Compression, Image Compression Standards.

Image Segmentation and Object Reorganization: (5Hrs)

Edge Linking and Boundary Detection, Thresholding, Region Based Segmentation, Watershed Segmentation Algorithm, Shape Representation and Description, Boundary Descriptors, Regional Descriptors, Patterns, Object Reorganization Based on Decision-Theoretic Methods and Structural Methods.

Color Image Processing: (6Hrs)

Color Fundamentals, Color Models, Pseudocolor Image Processing, Color Transformation, Smoothing and Sharpening, Color Segmentation, Noise in Color Image, Color Image Compression.

Morphological Image Processing: (5Hrs)

Introduction, Dilation, Erosion, Hit-or-Miss Transformation, Morphological Algorithms; Boundary Extraction, Region Filling, Convex Hull, Thinning, Thickening, Skeletons, Pruning.

Motion Picture Analysis: (2Hrs)

Introduction to Motion Picture Analysis.

Text Book

1. Digital Image Processing, Rafael C. Gonzalez, Richard E. Woods, Low Price Edition

Reference Book

1. Digital Image Processing Using MATLAB, Rafael C. Gonzalez, Richard E. Woods, Steven L. Eddins, MGH.
2. Digital Image Processing and Analysis, B. Chanda, D. Dutta Majumder, PHI.
3. Fundamentals of Digital Image Processing, Anil K. Jain, PHI.

CS-4044 MICROPROCESSORS Cr-3

Introduction: (6Hrs)

Overview of Microcomputer Structure and Operation, Microprocessor Evolution and Types, 8086 Internal Architecture. 8086 Instruction Description and Assembler Directives, 8086 Family Assembler Language Programming – Instruction Templates, MOV Instruction Coding Format and Examples, MOV Instruction Coding Examples, Writing Programs for use with an Assembler, Assembly Language Program Development Tools

Implementing Standard Program Structures in 8086 Assembly Language: (6Hrs)

Simple Sequence Programs, Jumps, Flags, and Conditional Jumps, If-Then, If-Then-Else, and Multiple If-Then-Else Programs, While-Do Programs, Repeat-Until Programs, Instruction Timing and Delay Loops

Strings, Procedures, and Macros: (6Hrs)

The 8086 String Instructions, Writing and Using Procedures, Writing and Using Assembler Macros

8086 System Connections Timing: (6Hrs)

A Basic 8086 Microcomputer System, Addressing Memory and Ports in Microcomputer Systems, 8086 and 8088 Addressing and Address Decoding, How the 8088 Microprocessor Accesses Memory and Ports, 8086 Timing Parameters

8086 Interrupts and Interrupt Applications: (6Hrs)

8086 Interrupts and Interrupt Responses, Hardware Interrupt Applications, 8259A Priority Interrupt Controller, Software Interrupt Applications

Digital Interfacing: (6Hrs)

Programmable Parallel Ports and Handshake Input/output, Methods of Data Transfer, Implementing Handshake Data Transfer, 8255A Internal Block Diagram and System Connections, 8255A Operational Modes and Initialization, Constructing and Sending 8255A Control Words

Text Book

1. Microprocessors and Interfacing, Douglas V. Hall, Revised 2nd Edition, TMH, 2006.
2. 8086 microprocessor & Architecture by Liu, Gibson; PHI.

Reference Book

1. Advanced Microprocessors & IBM-PC assembly Language Programming, K.Udaya Kumar & B.S. Umashankar, TMH 2003.
2. The Intel Microprocessors, Barry B. Brey, Pearson/PHI 2006. 7th Edition
3. The Intel Microprocessor Family: Hardware and Software Principles and Applications, James L. Antonakos, Thomson, 2007.
4. Microprocessors and Microcomputer- Based System Design, M. Rafiquzzaman, UBS Publication.

CS-4045 OPTIMIZATION TECHNIQUES Cr-3

Formulation of engineering optimization problems : (6 Hrs)

Decision variables, objective function and constraints. Example of typical design, operation and maintenance problems in engineering shortest route problem, set covering problem, traveling salesman problems. Only physical problems and their mathematical models to be discussed.

Linear Programming Problem : (6 Hrs)

Formulation, Graphical solution, Simplex method, Duality theory, Dual simplex method, Formulation and solution of engineering problems of planning and scheduling.

Sensitivity Analysis, Transportation Problem, Assignment Problem, Network Models : (8Hrs)

Minimal Spanning Tree Problem, Maximal Flow Problem, Shortest Route Problem, Minimum Cost Flow Problem. Algorithms and applications to be covered.

Integer Linear Programming Problem: (10 Hrs)

Branch and Bound and Cutting Plane Methods., Knapsack Problem, Set covering Problem, Set Partitioning Problem,. Deterministic Dynamic Programming Problems. Applications and algorithms to be discussed, , Simple EOQ Models & Sequencing Problem.

Queueing theory, Game theory, Sequencing Problem. Non linear constraint and unconstraint problems solving techniques. **(6 Hrs)**

Text Book

1. H. A. Taha – Operations Research, Prentice Hall of India, 2004.

References :

2. D. T. Phillips, A Ravindran and J.J. Solaberg, Principles of Operation Research, John Wiley and Sons
3. Hiller/Lieberman –Introduction to Operations Research, TMH

CS-4061 DISTRIBUTED DATABASE SYSTEMS Cr-3

Introduction: (8Hrs)

Distributed data processing, what is a DDBMS, Advantages and disadvantages, Architecture, Transparencies in a distributed DBMS, Global directory issues. Distributed Database Design: Alternative design strategies, Distributed design issues, Fragmentation, Data allocation

Query Processing Issues: (10Hrs)

Objectives of query processing, Characterization of query processors, Layers of query processing, Query decomposition, Localization of distributed data. Optimizing Distributed Queries Factors governing query optimization, Centralized query optimization, ordering of fragment queries, optimization algorithms for a distributed query processing environment.

Distributed Object Management: (10Hrs)

Object model features, Fundamental object management issues, DOM architectures, Object caching, Object clustering, Object migration, Distributed object base systems

Transaction Management: (9Hrs)

The transaction concept, Goals of transaction management, Characteristics of transactions, Taxonomy of transaction models. Concurrency Issues in a distributed environment.

Text Book

1. Distributed Databases Principles and Systems, S. Ceri and G. Pelagatti, McGraw Hill.

2. Principles of Distributed Database Systems, M.T. Özsu and P. Valduriez. - Prentice-Hall.

Reference Book

1. M. Tamer Ozsu, Patrick Valduriez, Principles of Distributed Database Systems (2nd Edition) Pearson Education.

CS-4062 HUMAN COMPUTER INTERACTION Cr-3

Fundamental to HCI: **(7Hrs)**

Importance of the user interface-definition, importance of good design, brief history. Characteristics of graphical & web user interfaces-GUI and WUI. User interface design process. Knowing the client-understanding how people interact, important human characteristics and human considerations. Principles of good screen design-human considerations in screen design. Develop system menus & navigation schemes-structures, functions, content, formatting, phrasing, choices and graphical menus.

Windows Management: **(7Hrs)**

Select the proper kinds of windows-characteristics, components, presentation styles, types, management, organizing functions, operations. Device based controls-characteristics, selection. Screen based controls-operable, text entry/read-only, selection, combination entry/selection, and other operable controls, presentation controls, selection of proper controls. Write clear Text & Messages.

GUI Issues: **(8Hrs)**

Provide effective Feedback and guidance & Assistance. Provide effective Internationalization and Accessibility. Create meaningful Graphics, icons and images. Choose the proper Colors. Organize and Layout windows and pages.

Interaction Design: **(6Hrs)**

Introduction, goals, conceptualizing usability. Conceptualization of interaction-problem space. Conceptual models, interface metaphors, interaction paradigms. Understand users-Cognition, conceptual frameworks for cognition. Collaboration and communication- social mechanisms.

Principles of Interfaces Design: **(8Hrs)**

Understanding how interfaces affect users- affective aspects, expressive interfaces, user frustration, agents. Process of interaction design- activities, characteristics, practical issues, life cycle models. Design, Prototyping and construction- prototyping. Conceptual design, Physical design. Introducing evaluation-evaluation, frameworks.

Textbook:

1. Human-Computer Interaction, Third Edition by Alan Dix et al., Prentice Hall.

Reference

1. The Essential Guide to user Interface Design, Third Edition by Wilbert O. Galitz, Wiley.
2. Interaction Design: Beyond Human-Computer Interaction, Second Edition by Jenny Preece et al., John Wiley & Sons Ltd.
3. Designing the User Interface: Strategies for Effective Human Computer Interaction, Second Edition by B. Sheiderman et al., Addison Wesley.

CS-4063 SIMULATION AND MODELING Cr-3

Introduction: (5Hrs)

When simulation is the appropriate tool and when it is not appropriate; Advantages and disadvantages of Simulation; Areas of application; Systems and system environment; Components of a system; Discrete and continuous systems; Model of a system; Types of Models; Discrete-Event System Simulation; Steps in a Simulation Study. Simulation examples: Simulation of queuing systems; Simulation of inventory systems; Other examples of simulation.

General Principles, Simulation Software: (5Hrs)

Concepts in Discrete-Event Simulation: The Event-Scheduling / Time-Advance Algorithm; World Views; Manual simulation Using Event Scheduling; List processing. Simulation in Java; Simulation in GPSS.

Statistical Models In Simulation: (7Hrs)

Review of terminology and concepts; Useful statistical models; Discrete distributions; Continuous distributions; Poisson process; Empirical distributions.

Queuing Models: (7Hrs)

Characteristics of queuing systems; Queuing notation; Long-run measures of performance of queuing systems; Steady-state behavior of M/G/1 queue; Networks of queues.

Random-Number Generation, Random-Variate Generation: (5Hrs)

Properties of random numbers; Generation of pseudorandom numbers; Techniques for generating random numbers; Tests for Random Numbers. Random-Variate Generation:Inverse transform technique; Acceptance-Rejection technique; Special properties.

Input Modeling: (5Hrs)

Data Collection; Identifying the distribution with data; Parameter estimation; Goodness of Fit Tests; Fitting a non-stationary Poisson process; Selecting input models without data; Multivariate and Time-Series input models.

Output Analysis For A Single Model: (2Hrs)

Types of simulations with respect to output analysis; stochastic nature of output data; Measures of performance and their estimation; Output analysis for terminating simulations; Output analysis for steady-state simulations.

Text Book

1. Discrete-Event System Simulation, Jerry Banks, John S. Carson II, Barry L. Nelson, David M. Nicol, Pearson Education, 2007.

Reference Book

1. Discrete – Event Simulation: A First Course – Lawrence M. Leemis, Stephen K. Park, Pearson Education/ Prentice-Hall India, 2006.
2. Simulation, Sheldon M. Ross, Elsevier, 2006.
3. Simulation Modeling and Analysis – Averill M. Law, Tata McGraw-Hill, 2007.

CS-4064 COMPUTER VISION Cr-3

IMAGE FORMATION **(6 Hrs)**

Intorduction to Vision,Image Formation:Geometric Primitivity,2D and 3D transformation, Photometric image formation, Digitization, Sampling and Alising.

LOW LEVEL PROCESSING : **(6 Hrs)**

Linear filtering,Smoothing,Sharpening,Shift invariantlinear systems , Spatial Frequency and Fourier Transforms, Image Gaussian Pyramid.

FEATURE EXTRACTION : **(6 Hrs)**

Edges - Canny, Sobel, Line detectors (Hough Transform),Corners - Harris and Hessian Affine, Orientation Histogram, SI FT, SURF,Feature analysis,feature vectors, distance /similarity measures.

SEGMENTATION : **(6 Hrs)**

Clustering method, split and merge method ,Graph based
method, Applications: Shot Boundary Detection, Background Subtraction and Skin Finding.

OBJECT RECOGNITION : **(6 Hrs)**

Object detection: Face detection,Pedestrian detection ,Face recognition: Eigenfaces, Active appearance and 3D shape mo dels.

MOTION ANALYSIS : **(6 Hrs)**

Motion detection and tracking,Background Subtraction and Modeling, Optical Flow.

Textbooks

1. Richard Szeliski, Computer Vision: Algorithms and Applications, Springer-Verlag London Limited 2011.
2. Computer Vision: A Modern Approach, D. A. Forsyth, J. Ponce, Pearson Education, 2003.

References

1. Computer and Machine Vision Theory,Algorithms, Practicalities ,E.R Davis,Academic Press,4th Edition
2. R.C. Gonzalez and R.E. Woods, Digital Image Processing, Addison- Wesley, 1992.

CS-4065 DISTRIBUTED OPERATING SYSTEMS Cr-3

Introduction: **(8Hrs)**

Operating Systems for parallel computers, Performance Evaluation of parallel computers.

Issues in Distributed Systems: **(12Hrs)**

Characterization of distributed systems, Design goals, Communication and computer networks, Distributed processing, Distributed operating systems, Client Server Communications, Remote Procedure calls, File Service, Name Service, Distributed transactions and concurrency control, fault tolerance and security.

Distributed Algorithms: **(12Hrs)**

Synchronization & Coordination, Distributed Algorithms.

Advance Issue: **(4Hrs)**

Special topics in distributed operating systems.

Text Books

1. M. Singhal & N. G. Shivaratri,Advanced Concepts in Operating Systems, McGraw Hill.

IT-2001 OBJECT ORIENTED PROGRAMMING Cr-3

Object oriented paradigm: **(5Hrs)**
Evolution of programming paradigm, structured versus object-oriented development, elements of object-oriented programming, objects, classes, encapsulation and data abstraction, inheritance, delegation – object composition, polymorphism, exception handling.

Moving from C to C++ : **(3Hrs)**
Introduction, streams based I/O, scope resolution operator (::), variable definition at the point of use, variable aliases-reference variables, strict type checking, parameters passing by reference, inline function, function overloading, default arguments.

Object and Classes: **(6Hrs)**
Specifying and using classes, private and public data members, constructor and destructor, objects as function arguments, memory considerations for objects, new and delete operators, functions, static function, friend function.

Inheritance: **(8Hrs)**
Derived and base classes, Class hierarchies, public and private inheritance, constructors in derived classes, destructors in derived classes, constructors invocation and data members initialization, classes within classes, container classes.

Polymorphism: **(4Hrs)**
Pointer to objects, pointer to derived class, use of this pointer, run time and compile time polymorphism, virtual functions, abstract base classes, pure virtual functions, virtual destructors.

Files and Streams: **(3Hrs)**
Introduction, hierarchy of file stream classes, opening and closing of files, testing for errors, file modes, file pointers and their manipulators, sequential access to a file, I/O with multiple objects.

Exception handling: **(4Hrs)**
Introduction, error handling, exception handling model, exception handling constructs, handler throwing the same exception again, list of exceptions, catch all exceptions, handling uncaught exceptions.

Templates: **(3Hrs)**
Class templates with multiple parameters, function template with multiple parameters, components of STL.

Text Book

1. Object Oriented Programming with C++, Balaguruswamy, 6th edition, TMG Hill

Reference Book

1. C++ complete reference, Herbert Schildt, TMG Hill
2. Object Oriented Programming In Turbo C ++ , Robert Lafore , Galgotia Publications Pvt Ltd
3. C++ How to Program, Deitel and Deitel ,Pearson Education Asia
4. Object Oriented Programming with Ansi and Turbo C++, Ashok N Kamthane, Pearson Education

IT-2002 PROGRAMMING TOOLS & TECHNIQUES Cr: 4

Introduction to programming language: (4Hrs)
Language Design Issues, Importance of Programming language, Language Paradigm, Characteristic of a good Programming Language, Effects of Environment on Programming Language Design, assembler, linker, loader, complier, interpreter. Introduction to programming tools (Eclipse, JUnit, Gradle, VisualVM, FindBugs, Guava).

Eclipse: **(4Hrs)**
Overview of Eclipse. Integration of Gradle tools with Eclipse.

Web Development: **(4Hrs)**
HTML, Structure, Tags, images, links, tables, lists, form, frame etc. Use of **Gradle**for web page development.

Introduction to Java: **(6Hrs)**
Java and Java applications; Java Development Kit (JDK); Java Characteristics, Byte Code, JVM (use of Visual VM), Object-oriented programming, Simple Java programs, Data types, operators and Expressions, control Statements: Selection statements, iteration statements, Jump Statements. Use of Eclipse tool for Java program.

Classes, Inheritance, Interface, Package, String, Exceptions, Applets: **(15Hrs)**
Classes in Java, Declaring a class, Constructors; Creating instances of class, Inner classes. Inheritance, Super classes, sub class, Overriding and overloading, Dynamic method dispatch, Interface, Dynamic method look-up, Package, Class path variable, Exception handling, String Handling.

Debugging & Testing tools: **(5Hrs)**
Use of JUnit and FindBugs in Eclipse for debugging and testing of Java programs.

Java Utility Package:(5Hrs)
collections, string processing, I/O, etc. using Guava tool.

Applet: **(5Hrs)**
The Applet Class, Applet Architecture, Applet skeleton, Applet life cycle, Using the Status Window, The HTML APPLET tag, Passing parameters to Applets, getDocumentbase() and getCodebase().

Text Book:
1. Java - The Complete Reference, Herbert Schildt, 7th Edition, Tata McGraw Hill, 2007.
2. For tools: Web references.

Reference Books:
1. HTML Complete Reference, Powell, TMH
2. Introduction to JAVA Programming, Y. Daniel Liang, 6th Edition, Pearson Education, 2007.

IT- 2004 STATISTICAL TECHNIQUES Cr-4

Introduction to Statistics: **(10Hrs)**

Meaning of Statistics as a Science. Importance of Statistics. Scope of Statistics : In the field of Industry, Biological Sciences, Medical Sciences, Economics Sciences, Social, Sciences, Management Sciences, Agriculture, Insurance, Information Technology, Education and Psychology.
Measures of location : Arithmetic mean, median, mode, geometric mean and Harmonic mean and their properties.

Measures of dispersion : Range, Quartile deviation, mean deviation, Standard deviation, combined standard deviation, co-efficient of variation.

Measures of Skew ness and Correlation **(10 Hrs)**

Measures of Skew ness Karl Pearson's, Bowley's, kelly's and co-efficient of Skew ness and kurtosis based on moments. Correlation - Karl Pearson - spearman's rank correlation - concurrent deviation methods. Regression Analysis: Simple Regression Equations.

Curve fitting and Conditional probability **(10 Hrs)**

Curve fitting by the methods of least squares - Y = a x + b, Y = a x 2 + b x + c, Y = a x b, Y = a e bx
Sample Space - events - probability - Addition and Multiplication Theorem - conditional probability - Baye's Theorem. Mathematical expectation Addition and Multiplication theorem, Chebychev's Inequality.

Analysis of variance and Significance Testing **(10 Hrs)**

Analysis of variance - one and two way classifications - Basic principle of design of Experiments - randomisation, replication and local control. Standard distributions - Binomial, Poisson, normal distribution and fitting of these distributions. Test of Significance small sample and large sample test based on mean, S.D. correlation and proportion - confidence interval.

Simulation of random Numbers **(8 Hrs)**

Random-Number Generators: Introduction, Linear Congruential Generators, Other Kinds of Generators,, Testing Random –Number Generators.
Generating Random Variates: Introduction, General Approaches to Generating Random Variates, Generating Continuous Random Variates, Generating Discrete Random Variates.

Text Book:

1. Fundamental of Mathematical Statistics - S.C. Gupta & V.K. Kapoor - Sultan Chand

Reference Book:

1. Statistical Methods - Snedecor G.W. & Cochran W.G. oxford & +DII
2. Elements of Statistics - Mode . E.B. - Prentice Hall
3. StatisticalMethods - Dr. S.P. Gupta - Sultan Chand & Sons

IT-3001 COMPUTER NETWORKS

Cr-4

Introduction: **(4Hrs)**
Internet, Protocol, Network edge, Packet and circuit switching, Performance of network, Protocol layers and service model

Application Layer: **(5Hrs)**
Architecture and principles of network applications, Web and HTTP, FTP and Email, DNS, P2P Applications

Transport Layer: **(13Hrs)**
Introduction , Multiplexing and de multiplexing of data, Connection less transport, Principles of reliable data transfer, Go-back-to-N, Selective repeat, Connection oriented transport, Principles of congestion control, TCP congestion control

Network Layer: **(9Hrs)**
Introduction, Forwarding and routing, Virtual circuit and datagram networks, Internet protocol, IPv4 addressing, NAT, UPnP, ICMP, IP6 and transition to IPv6

Routing Algorithms: **(8Hrs)**
Link state, Distance vector , Hierarchical routing, RIP, BGP, Broadcast and multicast routing

Link Layer: **(7Hrs)**
Error detection and correction, Multiple access links and protocols, Switched local area networks, Ethernet, VLAN, MPLS, and Data centre networking, 802.11 MAC

Open Area Research: **(2Hrs)**
Introduction to Data centre networking, software defined networking, CDN.

(2Hrs)

Text Book

1. "Computer Networking: A top-down approach", by Kurose and Ross, 5th Edition, Pearson.

Reference Book

1. "Computer Networks", by Andrew S. Tanenbaum and David Wetherall, 5th Edition, Pearson.
2. "Computer Networks: A System Approach", Larry L. Peterson and Bruce S. Davie, 5th Edition, Morgan Kaufmann Publishers

IT-3002 **DATA ANALYTICS** **Cr 4**

Introduction To Big Data **(9Hrs)**
Introduction to Big Data Platform – Challenges of conventional systems – Web data – Evolution of Analytic scalability, analytic processes and tools, Analysis vs reporting – Modern data analytic tools, Stastical concepts: Sampling distributions, resampling, statistical inference, prediction error.

Data Analysis **(12Hrs)**
Regression modeling, Multivariate analysis, Bayesian modeling, inference and Bayesian networks, Support vector and kernel methods, Analysis of time series: linear systems analysis, nonlinear dynamics – Rule induction – Neural networks: learning and generalization, competitive learning, principal component analysis and neural networks; Fuzzy logic: extracting fuzzy models from data, fuzzy decision trees, Stochastic search methods.

Mining Data Streams **(8Hrs)**
Introduction to Streams Concepts – Stream data model and architecture – Stream Computing, Sampling data in a stream – Filtering streams – Counting distinct elements in a stream – Estimating moments – Counting oneness in a window – Decaying window – Realtime Analytics Platform(RTAP) applications – case studies – real time sentiment analysis, stock market predictions.

Frequent Itemsets And Clustering
(10Hrs)
Mining Frequent itemsets – Market based model – Apriori Algorithm – Handling large data sets in Main memory – Limited Pass algorithm – Counting frequent itemsets in a stream – Clustering Techniques – Hierarchical – K- Means – Clustering high dimensional data – CLIQUE and PROCLUS – Frequent pattern based clustering methods – Clustering in non-euclidean space – Clustering for streams and Parallelism.

FRAMEWORKS AND VISUALIZATION **(9Hrs)**
MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases – S3 – Hadoop Distributed file systems – Visualizations – Visual data analysis techniques, interaction techniques; Systems and applications:

TEXT BOOKS:
1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. Anand Rajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 2012.

REFERENCES:
1. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with advanced analystics, John Wiley & sons, 2012.
2. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007 Pete Warden, Big Data Glossary,O'Reilly, 2011.
3. Jiawei Han, Micheline Kamber "Data Mining Concepts and Techniques", Second Edition, Elsevier, Reprinted 2008.

IT-3003 SOFTWARE ENGINEERING Cr-4

Introduction: **(10Hrs)**
Software and its characteristics, application. Software engineering: a layered technology. The software process, software process Models: Classical waterfall model, iterative waterfall model, prototyping mode, evolutionary model, spiral model, RAD model.

Software Project Management: **(10Hrs)**
Responsibilities of a Software project manager, project planning, Metrics for project size estimation, Project estimation techniques, Empirical estimation techniques, COCOMO models, Scheduling, Organization &team structure, Staffing, Risk management, Software configuration management.

Structural Analysis & Design: **(10Hrs)**
Requirements Analysis, Requirements elicitation for software analysis, Analysis principles, Specifications (SRS document), Software Design: cohesion & coupling, neat arrangement, Function–Oriented software design: Structural Analysis, Structural Design (DFD and Structured Chart), Object Oriented Analysis & Design.

Testing Strategies: **(10Hrs)**
Coding, Code Review, Testing: - Unit testing, Black-box Testing, White-box testing, Debugging, Integration testing, System testing.

Software Reliability and Software Maintenance: **(8Hrs)**
Software reliability, SEI CMM, Characteristics of software maintenance, software reverse engineering, software reengineering.

Text Book

1. Fundamentals of Software Engineering, Rajib Mall , PHI
2. Software Engineering, A Practitioner's Approach, Roger S. Pressman ,TMG Hill.

Reference Book

1. Software Engineering, I. Sommerville, Pearson Education, Asia.

IT-3004 OBJECT-ORIENTED SYSTEM DESIGN Cr-4

Introduction: **(4Hrs)**
An Overview of Object Oriented Systems Development, Object Basics, Object-Oriented Systems Development Life Cycle.

Object Oriented Methodologies: **(8Hrs)**
Rumbaugh Methodology, Booch Methodology, Jacobson Methodology, Object Oriented Programming, Object Oriented Design, Object Oriented Analysis. Elements of Object Model.

UML : **(8Hrs)**
Unified Modeling Language, Conceptual Model of the UML, Iterative development, Unified approach. **(8Hrs)**

Object Oriented Analysis: **(8Hrs)**
Understanding requirements, Identifying use cases; Object Analysis: Classification; Identifying Object relationships, Attributes and Methods.

Object Oriented Design: **(8Hrs)**
Object-Oriented Design, Design Models: GRASP, Design Patterns, Framework, object-oriented testing, Process and Design Axioms; Designing Classes; Access Layer: Object Storage, Object Interoperability; Designing Interface Objects.

Object Oriented Data Model: **(4Hrs)**
Quarry Languages, OODBMS, Object Relational Database.

Text Book

1. Ali Bahrami, Object Oriented Systems Development, 2nd Edition, Tata McGraw-Hill, 2008
2. Criag Larman, Applying UML and Patterns, 3rd Edition Pearson Education,2012

Reference Book

1. Stephen R. Schach, Introduction to Object Oriented Analysis and Design, Tata McGraw-Hill, 2003.
2. The Unified Modeling Language Reference Manual, James Rumbaugh, Ivar Jacobson, Grady Booch, Addison Wesley, 1999.
3. Practical Object-Oriented Design with UML, Mark Priestley, 2nd Edition, Tata McGraw-Hill, 2003.
4. Object-Oriented Design with UML and JAVA, K. Barclay, J. Savage, Elsevier, 2008.

IT-3006 MOBILE COMPUTING

Cr-3

Wireless Communication Fundamentals: **(7 Hrs)**
Introduction, Wireless transmission, Frequencies for radio transmission, Signals, Antennas, Signal Propagation, Multiplexing, Modulations, Spread spectrum, MAC, SDMA, FDMA, TDMA,CDMA, Cellular Wireless Networks.

Telecommunication Networks: **(8Hrs)**
Telecommunication systems, GSM, GPRS, DECT, UMTS, IMT-2000, Satellite Networks, Basics, Parameters and Configurations, Capacity Allocation, FAMA and DAMA, Broadcast Systems, DAB,DVB.

Wireless LAN: **(8Hrs)**
Wireless LAN, IEEE 802.11, Architecture, services, MAC, Physical layer, IEEE 802.11a, 802.11bstandards, HIPERLAN, Blue Tooth.

Mobile Network Layer 9: **(9Hrs)**
Mobile IP, Dynamic Host Configuration Protocol, Routing, DSDV, DSR, Alternative Metrics.

Transport and Application Layers 7: **(4Hrs)**
Traditional TCP, Classical TCP improvements, WAP, WAP 2.0.

Text Book

1. Mobile Communications, Jochen Schiller, PHI/Pearson Education, Second Edition, 2003.
2. Wireless Communications and Networks, William Stallings, PHI/Pearson Education, 2002. (Chap 7, 10, 9)

Reference Book

1. Principles of Wireless Networks, KavehPahlavan, PrasanthKrishnamoorthy, PHI/Pearson Education, 2003.
2. Principles of Mobile Computing, Uwe Hansmann, LotharMerk, Martin S. Nicklons and Thomas Stober, Springer,New York, 2003.
3. Mobile Communication Systems, HazysztofWesolowshi, John Wiley and Sons Ltd, 2002.

IT-4001 ENTERPRISE RESOURCE PLANNING Cr -4

Introduction to ERP: (**6Hrs)**
Enterprise – An Overview Integrated Management Information, Business Modeling, Integrated Data Model, Risks & Benefits of ERP.

ERP and Related Technologies: **(10Hrs)**

Business Processing Reengineering(BPR), Data Warehousing, Data Mining, On-line Analytical Processing(OLAP), Supply Chain Management (SCM), Customer Relationship Management(CRM), Management Information System(MIS), Decision Support System(DSS), Executive Information System(EIS).

ERP Implementation (**10Hrs)**

Lifecycle, Implementation Methodology, Hidden Costs, Organizing the Implementation, Vendors, Consultants and Users, Contracts with Vendors, Consultants and Employees, Project Management and Monitoring

ERP Modules : (8Hrs)

Business modules in an ERP Package- Finance, Manufacturing, Human Resources, Plant Maintenance, Materials Management, Quality Management, Sales and Distribution

ERP Planning (8Hrs)

ERP & E-Commerce, Future Directives in ERP, ERP and Internet, Critical success and failure factors, Integrating ERP into organizational culture, Performance measurement of ERP system, Maintenance of ERP system.

ERP Market (6Hrs)

ERP Market Place, SAP AG, Peoplesoft, Baan, JD Edwards, Oracle, QAD, SSA

Text Book :

1. Alexis Leon ,"ERP Demystified", Tata McGraw Hill

Reference Book :

1. Vinod Kumar Garg and Venkitakrishnan N K, "Enterprise Resource Planning – Concepts and Practice", PHI

IT- 4003 DATA MINING Cr-4

Introduction: (6 Hrs)

Basic Data Mining Tasks, Data Mining Issues, Data Mining Metrics, Data Mining from a Database Perspective.

Data Mining Techniques: (6Hrs)

A Statistical Perspective on Data Mining, Similarity Measures, Data Preprocessing,

Association Rules : **(10Hrs)**

Basic Algorithms, Incremental Association Rules, Parallel and Distributed Algorithms, Measuring the Quality of Rules, Advanced Association Rule.

Classification : (10Hrs)

Statistical-Based Algorithms, Distance-Based Algorithms, Decision Tree-Based Algorithms, Advanced Classification methods (Genetic, Rough Set, Fuzzy Set)

Clustering: (10Hrs)

Hierarchical Algorithms, Partitional Algorithms, Clustering Large Databases, Clustering with Categorical Attributes.

Advanced Techniques : **(6Hrs)**

Web Mining, Spatial Mining, Temporal Mining.

Text Books

1. J. Han and M. Kamber. Data Mining: Concepts and Techniques, 3rd Ed. Morgan Kaufman. 2012.

References

1. M. H. Dunham. Data Mining: Introductory and Advanced Topics. Pearson Education. 2001.
2. I. H. Witten and E. Frank. Data Mining: Practical Machine Learning Tools and Techniques. Morgan Kaufmann. 2000.
3. D. Hand, H. Mannila and P. Smyth. Principles of Data Mining. Prentice-Hall. 2001.

Electives

IT-4022 MANAGEMENT INFORMATION SYSTEM Cr-3

Information Systems in Business: (4Hrs)
Introduction, The real world of Information Systems, Networks, The fundamental role of IS in business, Trends in IS, Managerial challenges of IT. System Concepts: Foundation, Components of an Information System, Information System Resources, Information System activities, Recognizing Information Systems.

Fundamentals of strategic advantages: (4Hrs)
Strategic IT, Competitive strategy concepts, The competitive advantage of IT, Strategic uses of IT, Building a customer-focused business, The value chain and strategic IS, Reengineering business processes, Becoming an agile company, Creating a virtual company, Building a knowledge-creating company.

Enterprise Business Systems: (5Hrs)
Introduction, Cross-functional enterprise applications, Enterprise application integration, Transaction processing systems, Enterprise collaboration systems. Functional Business Systems: Introduction, Marketing systems, Manufacturing systems, Human resource systems, Accounting systems, Financial Management Systems, overview of ERP and E-Commerce.

Decision support in business: (6Hrs)
Introduction, Decision support trends, Decision support systems (DSS),Management Information Systems, On-line analytical processing, Using DSS, Executive information systems, Enterprise portals and decision support, Knowledge management systems, Business and Artificial Intelligence (AI), An overview of AI, Expert systems.

Security, Ethical and societal challenges of IT: (5Hrs)
Introduction, Ethical responsibility of business professionals, Computer crime, Privacy issues, other challenges, Health issues, Societal solutions.

Security management of IT: (6Hrs)
Overview, Tools of security management, Internetworked security defenses, other security measures, System Controls and audits.

Managing IT: (4Hrs)
Business and IT, Managing IT, Business / IT planning, Managing the IS function, Failures of IT management.

Managing global IT: (2Hrs)
The International Dimension, Global IT Management, Cultural, Political and Geo – Economic challenges, Global Business/ IT strategies, Global Business / IT applications, Global IT Platforms, Global data access issues, Global Systems development.

Text Book

1. Management Information Systems, James A. O' Brien, George M. Marakas, Tata McGraw Hill.

Reference Book

1. Management Information System, Managing the Digital Firm, Kenneth C. Laudon and Jane P. Laudon, Pearson Education.
2. Information Systems -The Foundation of E-Business, Steven Alter, Pearson Education.
3. Management Information Systems, W.S. Jawadekar, Tata McGraw Hill.

IT-4023 BIO-INFORMATICS Cr-3

Molecular Biology Primer: **(4Hrs)**
Genetic Material, Function of Genes, Structure of DNA, transcription and translation, Protein structure, DNA analysis, Gene variation, Need of Bioinformatics.

Exhaustive Search: **(4Hrs)**
Restriction Mapping, Impractical restriction mapping algorithm, A practical restriction mapping algorithm, Regulatory motifs in DNA Sequences, Profiles, The motif finding problem, Search trees, Finding trees, Finding median string.

Greedy Algorithm: **(2Hrs)**
A greedy approach to Motif Finding.

Dynamic Programming Algorithms: **(5Hrs)**
The power of DNA sequence comparison, Edit distance and alignments, Longest common sub sequences, Global sequence alignment, Scoring alignments, Local sequence alignments, Alignment with gap penalties, Multiple alignment, Gene Prediction, Statistical approaches to gene prediction, Similarity based approaches to gene prediction, Spliced alignment.

Combinational Pattern Matching: **(7Hrs)**
Repeat finding, Hash tables, Exact pattern matching, Keyword trees, Suffix trees, Heuristic similarity search algorithms, Approximate pattern matching, BLAST-Comparing a sequence against a database.

Graph Algorithms: **(8Hrs)**
Graphs, Graphs and genetics, DNA sequencing, Shortest super string problem, DNA arrays as an Alternative sequencing technique, Sequencing by hybridization, SBH as an Hamiltonian path problem, SBH as an Eulerian path problem, Fragment assembly in DNA sequencing.

Clustering and Trees: **(6Hrs)**
Gene expression analysis, Hierarchical clustering, k-means clustering, Clustering and corrupted cliques, Evolutionary trees, Distance based tree reconstruction, Reconstructing trees from additive matrices, Evolutionarytrees and hierarchical clustering, Character based tree reconstruction, Small parsimony problem, Large parsimony problem.

Text Book

1. An Introduction to Bioinformatics Algorithms, N.C. Jones & P.A. Pevzner, The MIT Press-2004.

Reference Book

1. Introduction to Bioinformatics, A. M. Lesk, Oxford University Press.
2. Fundamental concepts of Bioinformatics, D.E. Karne& M.L. Raymer, Benjamin Cummings.

IT-4024 SOFTWARE PROJECT MANAGEMENT Cr-3

Introduction to Software Project Management: **(3Hrs)**
Software Project Management, Software Project vs other types of Projects, Activities, Plan methods, Methodologies, Categorization, Management control.

Project evaluation and Programme Management: **(4Hrs)**
Project Portfolio Management, Evaluation, Cost-benefit Evaluation, Risk Evaluation, Managing Allocation of Resources, Benefits Management.

An Overview of Project Planning: **(2Hrs)**
Stepwise Project Planning

Selection of Project Approach: **(3Hrs)**
Choosing Methodologies and Technologies, Agile Methods, Dynamic System Development Method, Managing Iterative

Process, Selecting Process Model.

Software Effort Estimation: **(6Hrs)**
Estimates, Effort Estimation, top-down, Bottom up, Function Points, COCOMO.

Activity Planning and Resource Allocation: **(6Hrs)**
Project Schedules, Network Planning Models, Sequencing and Scheduling. Resource Allocation, Scheduling Resources, Cost Schedules.

Risk Management, Monitoring and Control: **(4Hrs)**
Risk, Categories of Risk, Identification, Assessment, Planning, Management and Control, Creating Framework, Cost Monitoring, Prioritizing Monitoring, Change Control.

Managing Contracts & People and Team Working: **(4Hrs)**
Types of Contract, Contract Management, Understanding Behaviour, Organization Behaviour, Motivation, Oldham-Hackman Job Characteristics Model, Some Ethical and Professional Concerns, Decision Making, Organization Structure, Dispersed and Virtual Teams, Leadership.

Software Quality: **(4Hrs)**
Defining Software Quality, ISO 9126, Product vs Process Quality Management, Quality Management System, Process Capability Models, Testing, Quality Plans**.**

Text Book

1. Bob Hughes and Mike Cotterell, Rajib Mall, Software Project Management, TMH, 5e, 2011

Reference Book

1. Henry.J ,Addison, Software Project Management – A Real-World Guide to Success, Wesley, 2004.
2. Pankaj Jalote, Software Project Management in Practice, Pearson Education, 4e, 2011.
3. S.A. Kelkar, Software Project Management, A Concise Study, Prentice-Hall India, 3e, 2010.
4. Jerome D. Wiest, Ferdinand K. Levy, *A Management Guide to PERT/CPM,* PHI, 2e, 2008
5. Ince D., Sharp H. and Woodman M.,Introduction to Software Project Management and Quality Assurance, McGraw-Hill, 1993.

IT-4025 CLOUD COMPUTING Cr-3

Introduction **(8Hrs)**

Introduction to Cloud Computing, Roots of Cloud Computing: Fundamental concepts of Distributed Systems, Cluster Computing, Grid Computing, and Mobile Computing.

Cloud Models : **(10Hrs)**

Basics of Cloud Computing Concepts, Characteristics of Cloud Computing, Need for Cloud, Cloud Deployment models: private, public, hybrid and community cloud, Cloud Services: Resource-as-a-Service (RaaS), Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (PaaS), Examples of each services.

Cloud Services: (**10Hrs)**

RaaS: Usage of Physical resources like servers, networks, data center etc, IaaS: Virtualization, Virtual Machine provisioning and Migration Services, Scheduling techniques of Virtual machines for resource reservation. PaaS: Integrated lifecycle platform: Google App Engine, Microsoft Azure, Anchored life cycle platform: Salesforce platform, SaaS: Characterizing SaaS, Salesforce's software environment.

Cloud Application **(8Hrs)**

Cloud Application, Cloud challenges, Cloud Security and privacy issues, Mobile Cloud, Integration of Cloud with Wireless Sensor Network and its application.

Text Book:

1. "Cloud Computing Principles and Paradigms", edited by Rajkumar Buyya, James Broberg and Andrzej Goscinski, Wiley Publication.

Reference Book:

2. "Cloud Computing for Dummies", Judith Hurwitz, Robin Bloor, Marcia Kaufman and Fern Halper, Wiley Publication.

3. "New frontiers in information and software as a service", Divyakant Agrawal, K. SelcukCandan, Wen-Syan Li (Eds.), Springer Proceedings.

IT-4026 NATURAL LANGUAGE PROCESSING Cr-3

Introduction: **(6Hrs)**
Basic Probability & Information Theory: Introduction to NLP, Main Issues, Basics on Probability Theory, Elements of Information Theory, Language Modeling in General and Noisy Channel Model, Smoothing and EM Algorithm.

Linguistics: **(4Hrs)**
Phonology and Morphology, Syntax (Phrase Structure vs. Dependency).

Words & Lexicon: **(8Hrs)**
Word Classes and Lexicography, Mutual Information, The t-score, The Chi-square Test, Word Classes for NLP Tasks, Parameter Estimation, Partitioning Algorithm, Complexity Issues of Word Classes, Programming Tricks &Tips.

Hidden Markov Models & Tagging: **(7Hrs)**
Markov Models, Hidden Markov Models (HMMs), Trellis Algorithm, Viterbi Algorithm. Estimating the Parameters of HMMs, The Forward-Backward Algorithm, Implementation Issues, Task of Tagging, Tagsets, Morphology, Lemmatization, Tagging Methods, Manually Designed Rules and Grammars, Statistical
Methods, HMM Tagging (Supervised, Unsupervised), Evaluation Methodology (examples from tagging), Precision, Recall, Accuracy, Statistical Transformation Rule-Based Tagging, Maximum Entropy, Maximum Entropy Tagging, Feature Based Tagging, Results on Tagging, Various Natural Languages.

Grammars & Parsing Algorithms: **(6Hrs)**
Introduction to Parsing, Generative Grammars, Properties of Regular and Context-free Grammars, Overview on Non-statistical Parsing Algorithms, Simple Top-Down Parser with Backtracking, Shift-Reduce Parser, Treebanks and Treebanking, Evaluation of Parsers, Probabilistic Parsing. PCFG: Best Parse, Probability of String.

Statistical Parsing & Machine Translation: **(5Hrs)**
Lexicalized PCFG, Statistical Machine Translation (MT), Alignment and Parameter Estimation for MT.

Text Book

1. Foundations of Statistical Natural Language Processing, Manning, C. D. and H. Schutze, The MIT Press.

Reference Book

1. Speech and Language Processing, Jurafsky, D. and J. H. Martin, Prentice-Hall.
2. Natural Language Understanding, Allen, J., TheBenajmins/Cummings Publishing Company Inc.
3. Elements of Information Theory, Cover, T. M. and J. A. Thomas, Wiley.
4. Statistical Language Learning, Charniak, E., The MIT Press.
5. Statistical Methods for Speech Recognition, Jelinek, F., The MIT Press.

IT-4041 INFORMATION RETRIEVAL Cr-3

Introduction: **(6Hrs)**
Definition, Objectives, Functional Overview, Relationship to DBMS, Digital libraries and Data Warehouses. Information Retrieval System Capabilities: Search, Browse, Miscellaneous. Cataloging and Indexing: Objectives, Indexing Process, Automatic Indexing, Information Extraction.

Data Structures: **(5Hrs)**
Introduction, Stemming Algorithms, Inverted file structures, N-gram data structure, PAT data structure, Signature file structure, Hypertext data structure.

Automatic Indexing: **(8Hrs)**
Classes of automatic indexing, Statistical indexing, Natural language, Concept indexing, Hypertext linkages, Document and Term Clustering: Introduction, Thesaurus generation, Item clustering, Hierarchy of clusters.

User Search Techniques: **(9Hrs)**
Search statements and binding, Similarity measures and ranking, Relevance feedback, Selective dissemination of information search, Weighted searches of Boolean systems, Searching the internet and hypertext, Information Visualization: Introduction, Cognition and perception, Information visualization technologies.

Text Search Algorithms: **(8Hrs)**
Introduction, Software text search algorithms, Hardware text Search Systems. Information System Evaluation: Introduction, Measures used in system evaluation, Measurement example – TREC results.

Text Book

1. Information Retrieval Data Structures and Algorithms, Frakes, W.B., Ricardo Baeza-Yates, Prentice Hall, 1992.

2. Information Retrieval Systems: Theory and Implementation, Kowalski, Gerald, Mark T Maybury, Kluwer Academic Press, 1997.

Reference Book

1. Modern Information Retrieval, Yates, Pearson Education.
2. Information Storage &Retieval, Robert Korfhage John Wiley & Sons.

IT - 4042 M – COMMERCE Cr-3

Electronic Commerce: **(8Hrs)**
Introduction – The e- commerce environment – The e-commerce marketplace – Focus on portals, Location of trading in the marketplace -
Commercial arrangement for transactions – Focus on auctions – Business models for e-commerce – Revenue models – Focus on internet start – up companies – the dot – com – E-commerce versus E-business.

Mobile Commerce: **(7Hrs)**
Infrastructure Of M–Commerce – Types Of Mobile Commerce Services – Technologies Of Wireless Business – Benefits And Limitations, Support, Mobile Marketing & Advertisement, Non – Internet Applications In M–Commerce – Wireless/Wired Commerce Comparisons

Mobile Commerce: Technology: **(7Hrs)**

A Framework For The Study Of Mobile Commerce – NTT Docomo's I – Mode – Wireless Devices For Mobile Commerce – Towards A Classification Framework For Mobile Location Based Services – Wireless Personal And Local Area Networks – The Impact Of Technology Advances On Strategy Formulation In Mobile Communications Networks

Mobile Commerce: Theory And Applications: **(8Hrs)**
The Ecology Of Mobile Commerce – The Wireless Application Protocol –Mobile Business Services – Mobile Portal – Factors Influencing The Adoption Of Mobile Gaming Services – Mobile Data Technologies And Small Business Adoption And Diffusion – M–Commerce In The Automotive Industry – Location – Based Services: Criteria For Adoption And Solution Deployment – The Role Of Mobile Advertising In Building A Brand – M–Commerce Business Models

Business – To – Business Mobile E-Commerce: **(6Hrs)**
Enterprise Enablement – Email And Messaging – Field Force Automation (Insurance, Real Estate, Maintenance, Healthcare) – Field Sales Support (Content Access, Inventory) – Asset Tracking And Maintenance/Management – Remote IT Support – Customer Retention (B2C Services, Financial, Special Deals) – Warehouse Automation – Security.

TEXT BOOKS:

1. Dave Chaffey, "E-Business and E-Commerce Management", Third Edition, 2009, Pearson Education

REFERENCE

2. Brian E. Mennecke, Troy J. Strader, "Mobile Commerce: Technology, Theory and Applications", Idea Group Inc., IRM press, 2003.
3. P. J. Louis, " M – Commerce Crash Course", McGraw – Hill Companies February 2001.
4. Paul May, "Mobile Commerce: Opportunities, Applications, and Technologies of Wireless Business" Cambridge University Press March 2001.
5. Michael P. Papazoglou, Peter M.A. Ribbers, 'e – business organizational and Technical foundation ',Wiley India 2009
6. Dr.Pandey , Saurabh Shukla E-commerce and Mobile commerce Technologies , Sultanchand ,2011

IT-4043 INFORMATION SECURITY Cr-3

Introduction: **(6Hrs)**
Principles of Security, Classic Crypto, Modern Crypto History, Taxonomy of Cryptography, Information Hiding.

Symmetric- and Asymmetric- Key Crypto: **(8Hrs)**
Stream Cipher, Block Cipher, Fiestel Cipher, DES and Variations, AES, RSA, Diffie-Hellman Key Exchange, Uses of Public Key Crypto, Public Key Infrastructure.

Hash Functions & Cryptanalysis: **(4Hrs)**
Birthday Problem, Non-Cryptographic Hashes, Tiger Hash, HMAC, Uses of Hash Functions, Linear and Differential Cryptanalysis.

Access Control & Authorization: **(4Hrs)**
Authentication Methods, Passwords, Biometrics, Captcha, Firewall, Intrusion Detection.

Software Flaws & Malwares: **(6Hrs)**
Software Flaws, Malware, Software-based Attacks, Software Reverse Engineering, Software Tamper Resistance, Digital Rights Management.

Network Security: **(8Hrs)**
TCP/IP Vulnerability, Concept of Hacking for Penetration Testing, Port Scanning, Packet Sniffing, MAC Flooding, Session Hijacking, IP Spoofing, Denial of Service Attack, Web Server Vulnerabilities, Network Operating System Vulnerabilities, SQL Injection Techniques, Wireless Network Security.

Text Book

1. *Mark Stamp's Information Security, Principles and Practice* – Deven N. Shah – 1st Edition, Wiley India.

Reference Book

1. Cryptography and Network Security – Behrouz A. Forouzan, DebdeepMukhopadhyay – 2nd Edition, Tata McGraw Hill Education Private Limited.
2. Cryptography and Network Security, Principles and Practice – William Stallings – 5th Edition, Pearson.

3. Applied Cryptography – Bruce Schnier – 2nd Edition, John Wiley & Sons.

IT-4044 INTERNET OF THINGS Cr-3

Introduction: **(12Hrs)**

The Internet of Things: an Overview: The flavour of the Internet of Things, The "Internet" of "Things", The Technology of the Internet of Things, Enchanted Objects, Who is Making the Internet of Things?

Design Principles for Connected Devices: Calm and Ambient Technology, Magic as Metaphor, Privacy, Web Thinking for Connected Devices, Affordances.

Internet Principles: Internet Communications: An Overview (IP, TCP, The IP Protocol Suite (TCP/IP), UDP), IP Addresses (DNS, Static IP Address Assignment, Dynamic IP Address Assignment, IPv6), MAC Addresses, TCP and UDP Ports, Application Layer Protocols.

Prototyping: **(14 Hrs)**

Thinking About Prototyping: Sketching, Familiarity, Costs versus Ease of Prototyping, Prototypes and Production, Open Source versus Closed Source, Tapping into the Community.

Prototyping Embedded Devices: Electronics, Embedded Computing Basics, Developing on the Arduino, Raspberry Pi, Beaglebone Black, Electric Imp, Mobile Phone and Tablets, Plug Computing: Always-on Internet of Things.

Prototyping the Physical Design: Preparation, Sketch, Iterate, and Explore, Non-digital Methods, Laser Cutting, 3D Printing, CNC Milling, Repurposing/Recycling.

Prototyping Online Components: Getting Started with an API, Writing a New API, Real-Time Reactions, Other Protocols.

Techniques for Writing Embedded Code: Memory Management, Performance and Battery Life, Libraries, Debugging.

Prototype to Reality: **(10Hrs)**

Business Models: A Short History of Business Models, The Business Model Canvas, Who Is The Business Model For?, Models, Funding an Internet of Things Startup, Lean Startups.

Moving to Manufacture: What Are You Producing?, Designing Kits, Designing Printed Circuit Boards, Manufacturing Printed Circuit Boards, Mass-Producing the Case and Other Fixtures, Certification, Costs, Scaling Up Software,

Ethics: Characterizing the Internet of Things, Privacy, Control, Environment, Solutions.

Text Book:

1. Adrian McEwen, Hakim Cassimally, "Designing the Internet of Things", Wiley publication, 1st Edition, November 2013, ISBN: 978-1-118-43062-0.

IT-4045 SERVER SIDE COMPUTING Cr-3

Introduction to client: **(11Hrs)**

Server paradigm, advantages and disadvantages of server side processing, Introduction to java servlets and Java server pages, Enterprise application development.

Java Server faces: **(11 Hrs)**

Introduction to Java Server faces, JSF architecture, Exploring request processing cycle, Managing application flow using JSF navigation model. constructing JSF application-creating views- handling user events. using AJAX with JSF.

Bean: **(14 Hrs)**

Stateful and stateless beans, session beans and strategies, Message driven beans. Web Services - interoperability with JAX-WS-accessing services from clients. Java persistence API - JPA architecture - core operations.

Text Book:

The Java EE 7 Tutorial, Eric Jendrock, Ricardo Cervera-Navarro, Ian Evans, Kim Haase, William Markto, Addison-Wesley Professional, ISBN 978-0321994929.

IT-4061 INFORMATION CODING TECHNIQUES Cr-3

Information Theory: **(6Hrs)**
Uncertainty and information, average mutual information and entropy, Perfect secrecy.
Source Coding: Source coding theorem, Shannon-Fano coding, Huffman coding, arithmatic coding, Lempel Ziv algorithm, run length coding.

Channel capacity & coding: **(3Hrs)**
Channel models, channel capacity, channel coding, information capacity theorem, random selection of codes.
Error control coding: **(5Hrs)**
Block codes: single parity check codes, product codes, repetition codes, Hamming codes, minimum distance of codes
Linear codes: **(3Hrs)**
Generator matrices, parity check matrices, error syndromes, error detection and correction, shortened and extended linear codes.

Cyclic codes: **(5Hrs)**
Generator polynomials, encoding and decoding cyclic codes, parity check polynomials, dual cyclic codes, generator and parity check matrices of cyclic codes.

BCH Codes: **(5Hrs)**
Galois fields, Definition & construction of BCH codes, error syndromes in finite fields, RS codes, The Berlekemp algorithm, Error evaluator polynomial.

Convolution codes: **(9Hrs)**
Encoding convolution codes, generator matrices for convolution codes, generator polynomials for convolution codes, The viterbi decoder, Tree codes, Turbo codes, Trellis codes.

Text Books:

1. Ranjan Bose, "Information Theory, Coding and Cryptography", TMH

Reference Books

2. Salvatore Gravano "Introduction to Error Control Codes", Oxford

3. Wade Trape, Lawrence C Washington, "Introduction to Cryptography with Coding Theory", Pearson.

IT-4062 CYBER LAW AND INTELLECTUAL PROPERTY RIGHTS Cr-3

Cyber World: **(5 Hrs)**

An Overview, The internet and online resources ,Security of information, Digital signature

An Overview Cyber Law: **(11Hrs)**

Introduction about the cyber space , Regulation of cyber space – introducing cyber law Scope of Cyber laws – e-commerce; online contracts; IPRs (copyright, trademarks and software patenting); e-taxation; e-governance and cyber crimes, Cyber law in India with special reference to Information Technology (Amendment) Act, 2008

IPR: **(5Hrs)**
Introduction : Origin and Genesis of IPR , Theories of IPR – Locke's, Hegel and Marxian Ethical, moral and human rights perspectives of IPR, Intellectual Property Rights: International Relevance, Internationalization of IP protection –

Paris Convention, Berne Convention, TRIPS Agreement – basic principles and minimum standards – limits of one-size-fit for all flexibilities under TRIPS

Intellectual Property: Issues and Challenges: (8Hrs)
Geographical Indications, Layout designs of Integrated Circuits and Protection of Plant Varieties and Farmers' Rights. Copyright protection with reference to performers rights and Artist rights, Global governance towards Patents , Trade Marks: Legal recognition, Comparative analysis in India, EU and USA, Trade secrets : Legal recognition, Comparative analysis in India, EU and USA

Intellectual Property: Contemporary Trends (7Hrs)
Benefit sharing and contractual agreements – International Treaty on Plant Genetic Resources for Food and Agriculture – issues on patent policy and farmers' rights-CBD, Nagoya Protocol and Indian law, UNESCO – protection of folklore/cultural expressions Developments in WIPO on traditional knowledge and traditional cultural expressions

TEXT BOOKS:

1. Duggal Pavan, Cyber Law - An exhaustive section wise Commentary on The Information Technology Act along with Rules, Regulations, Policies, Notifications etc. UNIVERSAL LAW PUBLISHING CO. PVT. LTD. C-FF-1A, Dilkhush Industrial Estate, (Near Azad Pur Metro Station) G. T. Karnal Road, Delhi - 110033, INDIA2014

REFERENCE BOOK

1.Intellectual Property Rights in India : General Issues and Implications Prankrishna Pal
2.JonathanRosenoer, "Cyberlaw: the Law of the Internet", Springer-verlag, 1997.
3. W. Cornish & Llewelyn – Intellectual Property: Patent, Copyrights, Trade Marks
& Allied Rights", London Sweet & Maxwell.
4.Nard Madison- The Intellectual Property, Aspian Publication.
5.Carlosm Correa- Oxford commentaries on GATT/ WTO Agreements trade
Related aspects of Intellectual Property Rights, Oxford University Press.
6. Cornish William – Intellectual Property. Cambridge University Press

IT-4063 SOFT COMPUTING Cr-3

Introduction to Neura Fuzzy And Soft Computing: (5Hrs)
Introduction, Soft Computing Constituents and Conventional AI, Neuro-Fuzzy and Soft Computing Characteristics

Fuzzy Set Theory: (10Hrs)
Fuzzy Sets, Basic Definition and Terminology, Set-theoretic Operations, Member Function Formulation and Parameterization, Fuzzy Rules and Fuzzy Reasoning, Extension Principle and Fuzzy Relations, Fuzzy If-Then Rules, Fuzzy Reasoning, Fuzzy Inference Systems, Mamdani Fuzzy Models, Sugeno Fuzzy Models, Tsukamoto Fuzzy Models, Input Space Partitioning and Fuzzy Modelling.

Optimization: (5Hrs)
Derivative-based Optimization, Descent Methods, The Method of Steepest Descent, Classical Newton's Method, Step Size Determination, Derivative-free Optimization, Genetic Algorithms, Simulated Annealing, Random Search, Downhill Simplex Search.

Neural Networks: (10Hrs)
Supervised Learning Neural Networks, Perceptrons, Adaline, Backpropagation Mutilayer Perceptrons, Radial Basis Function Networks, Unsupervised Learning Neural Networks, Competitive Learning Networks, Kohonen Self-Organizing Networks, Learning Vector Quantization, Hebbian Learning, Hop-field networks.

Neuro Fuzzy Modelling: (6Hrs)
Adaptive Neuro-Fuzzy Inference Systems, Architecture, Hybrid Learning Algorithm, Learning Methods that Cross-fertilize ANFIS and RBFN, Coactive Neuro Fuzzy Modeling, Framework Neuron Functions for Adaptive Networks,

Neuro Fuzzy Spectrum. Introduction to Neuro Fuzzy Control.

Text Book

1. Neuro-Fuzzy and Soft Computing, J.S.R.Jang, C.T.Sun and E.Mizutani, PHI/Pearson Education.

Reference Book

1. Fuzzy Logic with Engineering Applications, Timothy J.Ross, McGraw-Hill, 1997.
2. Genetic Algorithms: Search, Optimization and Machine Learning, Davis E.Goldberg, Addison Wesley, N.Y.,1989.
3. Neural Networks: A Comprehensive Foundation, Simon Haykin. Prentice Hall
4. Neural Network Design, M. T. Hagan, H. B. Demuth, Mark Beale, Thomson Learning, Vikash PublishingHouse.
5. Neural Networks, Fuzzy Logic and Genetic Algorithms, S. Rajasekaran and G.A.V.Pai, PHI, 2003

IT-4064 MULTIMEDIA APPLICATIONS Cr-3

Introduction: (4Hrs)

Definition, Evolution, Multimedia presentation and production, Characteristics of a multimedia presentation, Components and Structure, Hardware and Software Specifications, Digitization concepts, Application domains.

Text, Image & Graphics: (6Hrs)

Types of text, ASCII codes, Unicode standards, Font, Insertion of text, OCR, Text File formats, Image types, Color and color models, Scanner, Digital camera, Interface standards, Specification of digital images, Color management systems, Device independent color models, Gamma and gamma correction, Image processing steps and software, Image File formats, Image output on monitor and printer, Components of a Graphics System.

Audio & Video: (8Hrs)

Nature of sound waves, Musical sound and noise, Tone and note, Psycho-acoustics and decibels, Microphone, Amplifier, Speakers, Digital audio specifications, Synthesizers, Musical Instrument Digital Interface (MIDI), Sound card, Audio processing steps and software, Audio File formats, Video frames and frame rate, Analog video camera, Video signal formats, Television broadcasting standards, Digital video, Digital video standards, PC Video, Video processing steps and software, Video File formats.

Compression: (8Hrs)

CODEC, Types of compression, Types of redundancies, Lossless compression techniques, Lossy compression techniques, Run length encoding, Huffman coding, Arithmetic coding, Lempel-Ziv-Welsh coding, Differential pulse code modulation, GIF standard, JPEG standard, H.261/H.263/ H.264, MPEG-1, MPEG-2, MPEG-4, MPEG-7, AMR, AAC.

Multimedia Architecture & Transmission: (6Hrs)

Windows multimedia support, Windows API, Graphic libraries, DirectX, OpenGL, Distributed multimedia applications, Videoconference, Video on demand, Real time transport protocols, Streaming, Windows Media Framework, Quicktime Architecture, Ogg Framework, Temporal relationships, Synchronization.

Multimedia Database: (4Hrs)

Limitations of textual descriptions of media, Content based storage and retrieval (CBSR), Image color, Image texture, Image shape, Audio speech and music discrimination.

Text Book

1. Principle of Multimedia – Ranjan Parekh – 2nd Edition, Tata McGraw Hill, India.

Reference Book

1. Fundamentals of Multimedia – Ze-Nian Li & Mark S. Drew – PHI India.
2. Multimedia Computing, Communications & Applications – Ralf Stenmetz & Klara Nahrstedt – Pearson Education.
3. Multimedia Communications: Applications, Networks, Protocols and Standards – Fred Halsall – Pearson India.

IT-4065 INTRODUCTION TO DATA MINING & WARE HOUSING Cr 3

Introduction: **(6Hrs)**
Basic Data Mining Tasks, Data Mining Issues, Data Mining Metrics, Data Mining from a Database Perspective.

Data Mining Techniques: **(6Hrs)**
A Statistical Perspective on Data Mining, Similarity Measures, Data Preprocessing,

Association Rules: **(6 Hrs)**
Basic Algorithms, Incremental Association Rules, Measuring the Quality of Rules, Advanced Association Rule.

Classification: **(6 Hrs)**
Statistical-Based Algorithms, Distance-Based Algorithms, Decision Tree-Based Algorithms

Clustering **(6Hrs)**
Hierarchical Algorithms, Partitional Algorithms, Clustering Large Databases, Clustering with Categorical Attributes.

Data Warehousing and Online Analytical Processing: **(6 Hrs)**
Basic Concepts, Data Cube and OLAP, Data Warehouse Design

Text Books

1. J. Han and M. Kamber. Data Mining: Concepts and Techniques, 3rd Ed. Morgan Kaufman. 2012.

References

1. M. H. Dunham. Data Mining: Introductory and Advanced Topics. Pearson Education. 2001.
2. I. H. Witten and E. Frank. Data Mining: Practical Machine Learning Tools and Techniques. Morgan Kaufmann. 2000.
3. D. Hand, H. Mannila and P. Smyth. Principles of Data Mining. Prentice-Hall. 2001.

ELECTRICAL ENGINEERING COURSES

EE 1001 ELECTRICAL SCIENCE Cr-3

Introduction to Networks: Terminology: Electric Field, Electric Potential, Work, Power, Energy, Capacitance; Capacitor Charging and Discharging, Energy stored in a Capacitor, Active elements, Passive elements, Electric circuits, Simple problems. **(3 Hrs)**

DC Circuits: Series and Parallel Networks, Ohm's law, Kirchhoff's law, Star-Delta Transformation, Mesh Analysis, Nodal Analysis, Superposition Theorem, Thevenin's theorem, Norton's theorem, Simple problems. **(6 Hrs)**

AC circuits: Generation of A.C. Voltage and current, Comparison between AC and DC, Definitions related to basic terms, Derivation of RMS Value, Average Value, Phasor Algebra, AC in series and parallel circuits, Power in AC Circuits, Resonance (series and parallel AC circuits), Three phase AC circuits: Comparison between 1-phase and 3-phse supply system, star and delta connections, Measurement of power and power factor by two-wattmeter method, Simple problems. **(6 Hrs)**

Magnetic circuits: Basic terms, Magnetic circuit in series and parallel, leakage flux, Analogy between Electric Circuit and Magnetic Circuits, B-H curve, hysteresis and eddy current loss, Faraday's Laws of Electromagnetic Induction, Growth and decay of current in inductive circuit, Energy stored in a magnetic field, Simple problems. **(4 Hrs)**

Electrical Conversion: DC Generator: Principle, Different parts, EMF Equation, Types, characteristics and uses; DC Motor: Principle, Back EMF, Toque Equation, Speed equation, Types, characteristics and uses; Single-phase transformer: Types, Construction, EMF equation, Losses and Efficiency, Auto transformer; Three-Phase Induction Motor: Principle, Types & Uses, Single Phase Induction Motor: Types and uses; Three-phase alternator: Principle, Types & Uses, EMF equation (No Derivation is required), Simple problems. **(6 Hrs)**

Measurement of Electrical Quantity: Classification, Moving coil instruments Moving Iron Instruments, Extension of range, Dynamometer type wattmeter, Induction type energy-meter, Multimeter, Megger, Earth Tester, Simple problems. **(3 Hrs)**

Power System: Power plants, Comparison of power plants; Power system Components, General lay out of Power System, General rules for wiring, Types and comparison between different electric wiring, Methods of earthing, Types of fuses, Electrical safety in Industry. **(4 Hrs)**

Illumination: Terminology: Luminous Flux, Luminous Intensity, Lumen, Candela Power, Illumination, Brightness, Types of lamps: Incandescent lamp, Fluorescent Tube Lamp, Compact Fluorescent lamp, Light Emitting Diode Lamp, Commercial specifications of a lamp. Simple problems. **(4 Hrs)**

Text Books:

1. Electrical Technology by Hughes, Edward, 1995,Longman Scientific & Technical, Wiley Edition, in English - 7th Ed. / rev. by Ian McKenzie Smith.
2. Principles of Electrical Engineering and Electronics- V K Mehta, Rohit Mehta, S Chand and Company, New Delhi. (Revised Edition,2013)

Reference Books:

1. Basic Electrical Engineering- T.K.Nagsarkar and M.S.Sukhija, Oxford University Press.
2. Electrical Engineering, Concepts and Applications, P.V.Prasad and S.Sivanagarraju, CENGAGE Learning.
3. Basics Electrical Engineering Sanjeev Sharma, I.K.International, New Delhi.(Third Reprint 2010).
4. Basic Electrical Engineering Abhijit Chakrabarti, Sudip Nath, Chandan Kumar Chnada, Tata McGraw-Hill publishing Limited, New Delhi.
3. Basic Electrical Engineering, by G.K.Lal, 3D Publishers, Ranchi, 2005.

EE 2001 ELECTRICAL MACHINES-I Cr-4

D.C. Machine:

Construction, Principle of operation, Armature winding, Simplex Lap and wave winding. Dummy coil, equalizer rings. Emf equation, Armature reaction, effect of armature reaction upon flux distribution curve, Effect of brush shifts, Demagnetizing and cross magnetizing ampere turns commutation, Interpoles and compensating winding. **(10 Hrs)**

D.C. Generator:

Types – Separate and self excited generators, no load and load characteristics. Voltage-build up in shunt generator, Critical field resistance and critical speed. Voltage regulation, Application **(6 Hrs)**

D.C. Motor:
Principle, Back emf, Torque and speed formula. Various types and their characteristics. 3-point and 4-point starters. Grading of starting resistance, speed control of D.C. motor, Losses and efficiency, Testing-Brake test, Swinburn's test and Hopkinson's test. **(12 Hrs)**

Single Phase Transformer:
Construction, Types, Application, Principle of operation, emf equation, Voltage and current ratio, operation at no load and under load. Phasor diagram, equivalent circuit, Voltage regulation. Losses and efficiency, all day efficiency. Testing – Open circuit and short circuit tests, Sumpner test and parallel operation. **(12 Hrs)**

Auto Transformer:
Construction, Principle of operation, ***Copper saving,*** equivalent circuit phasor diagram. Application. **(2 Hrs)**

Three-phase Transformer:
Construction, transformer connection and vector group, open delta connection. Phase transformation: 3- phase to 6- phase, 3-phase to 12-phase, 3-phase to 2-phase. Three winding transformers. Various constants and equivalent circuit. Time harmonics in single phase and 3 phase transformer, Parallel operation. Timing in phenomena. **(6 Hrs)**

Text Books:

1. Electric Machinery, by E. Fitzagerald, C. M. Kingsley (Jr) and S. D. Umans, , Tata McGraw Hill, 2003.
2. A Text Book of Electrical Technology, Vol. –II, AC & DC Machines, By B. L Theraja, A. K Theraja, S. Chand and Sons, 2006

Reference Books:

1. Electrical Machines, Ashfaq Hussain, Dhanpat Rai, Delhi, 2nd Edition, 2008.
2. Electrical Machinery, P. S Bimbhra, 7th Edition, Khanna Publishers, 2008.
1. Electric Machines, C. I. Hubert, , Pearson Education, 2003.
2. Electric Machines ,by Kothari. D P and I J Nagrath, , 3rd Edn, Tata McGraw-Hill, New Delhi. 2004.
3. Electric Machinery, an Integrated Treatment of AC and DC Machines by A.E. Fitzgerald and Charles Kingsley, Jr, McGraw-Hill, 2012 (Reprint).

EE 2002 ELECTRICAL MACHINES-II Cr-4

Synchronous Machine: Construction – Cylindrical and salient pole machines, 3 phase A.C. winding, different types, pitch factor and distribution factor, emf equation. Generation of harmonic emfs and their elimination. Armature resistance and leakage reactance, armature reaction, rotating magnetic field. **(9 Hrs)**

Synchronous Generator:
Cylindrical rotor theory, Phasor Diagram, Equivalent circuits, armature reaction reactance, Synchronous reactance and impedance, open circuit and short circuit test, short circuit ratio, voltage regulation - emf method, mmf method, modified mmf method, zero power factor characteristics, Potier reactance and load characteristics, power angle equation. Salient pole theory: Blondel's two reaction theory, phasor diagram, direct and quadrature axis reactance. Slip test. Power angle equation. **(14 Hrs)**

3-Phase Synchronous Motor:
Principle of operation, phasor diagram, V curves and inverted V-curves, Power angle equation for both salient and cylindrical rotor machine, starting methods. Synchronous condenser and power factor correction, Hunting, Application. **(5 Hrs)**

Three phase Induction Motor:
Construction**:** Squirrel cage and Slip ring type. Principle of operation, Slip, equivalent circuit and phasor diagram. Mathematical analysis power and torque relations, Expression for torque, maximum torque, Slip-torque characteristic. Effect of rotor resistance. Performance calculation by equivalent circuit and circle diagram. No load and blocked rotor test. Various methods of starting for squirrel cage and slip ring motor,Speed Control: Voltage control, frequency control, variation of rotor circuit resistance, pole changing, cascade method and slip power recovery scheme. **(12 Hrs)**

Single Phase Induction Motor:

Construction, principle of operation, revolving field theory and cross field theory. Split phase capacitor start and run. Repulsion start. Repulsion induction motor. Shaded pole motor. Performance curve and Application; Plain series motor, Compensate series motor. Repulsion motor their construction, principle of operation, phasor diagram. Performance curve and Application. Single phase reluctance and Hysteresis motor. Linear induction motor. **(8 Hrs)**

Text Books:

1. Electric Machinery, A. E. Fitzagerald, C. M. Kingsley (Jr) and S. D. Umans, , Tata McGraw Hill, 2003.
2. Induction and synchronous machines by K. Murgesh Kumar Vikash Publishing House Pvt. Ltd, New Delhi, 2010.

Reference Books:

1. Electric Machinery & Transformers,B.S.Guru & H.R.Hiziroglu-‘ -3rd Ed-Oxford Press, 2010.
2. Electric Machinery ,A. E. Fitzagerald, C. M. Kingsley (Jr) and S. D. Umans, , Tata McGraw Hill, 2003.
3. Electric Machinery and Fundamentals, Stephen J. Chapman - McGraw Hill International Edition, (Fourth Edition), 2005.
4. Electrical Machines and Power Systems, by Vincent Del Toro, Prentice-Hall, 1985
5. M.G. Say Alternating Current Machines (4th.ed.) Pitman Publishing Ltd. 1976.

EE 2003 NETWORK ANALYSIS Cr-4

Network Topology:

Concepts of Network graph, Terminology, Element, Tree, Branch, Link, Twigs, formation of incidence matrix, loop matrix, cut-set matrix, Relation between branch voltage and current, loop current network topology analysis. **(3 Hrs)**

Network Theorems:

Maximum Power transfer theorem, Millman’s Theorem, Tellegen’s theorem, Reciprocity Theorem. **(3 Hrs)**

Coupled Circuits:

Self & mutual inductance, coefficient of coupling, Dot conventions for coupled circuits, tuned coupled circuits. **(4 Hrs)**

Transients Response:

Transient response of RL, RC and RLC circuits with constant and sinusoidal excitation in time domain by Introduction to different Signals, periodic and non periodic function, Laplace transformation method, response to step, impulse and ramp inputs. **(6 Hrs)**

Two Port Networks:

Open circuit, Short Circuits, hybrid and transmission parameters, T and Π circuit representation, Interconnection of two port networks (Cascade, Series and Parallel). **(6 Hrs)**

Network Function and Responses:

Concept of complex frequency, driving point and transfer Functions of one port and two –port network, Calculation of the network functions, Restrictions on poles and zero location of network function, impulse response, time domain behavior from pole zero plot using Laplace transformation **(8 Hrs)**

Synthesis of Passive Network:

Causality & Stability, Hurwitz polynomial, Positive real Function. properties of Driving point function, synthesis of LC, RC and RL driving point function by Cauer-1 & II, Foster-I & II forms. **(6 Hrs)**

AC Circuits With Non-Sinusoidal Waveforms:

Fourier series representation of complex waves, symmetry in Fourier series, Average and RMS values of periodic complex wave. **(6 Hrs)**

Filter Design:

Introduction, Active and passive filters, Design of low pass , high pass, band pass and band elimination fillers, Circuit analysis using SPICE and PSICE. **(6 Hrs)**

Text Books:

1. Network Analysis 3rd Edition, by M. E. Van Valkenburg, Pearson Education, 2006.
2. Circuit Theory, Analysis and Synthesis, A. Chakrabarti , Dhanpat Rai Publishing Company (P) Limited, 5th Edition,2008.

Reference:

1. Circuits and Networks Analysis and Synthesis (Second Edition) A Sudhakar Shyammohan S Palli, Tata McGraw-Hill, 2011.
2. Network Analysis 3rd Edition, by M. E. Van Valkenburg, Pearson Education, 2006.

3. Basic Circuit Analysis (Second Edition) John O'Malley , Schaum's Outlines, Tata McGraw-Hill, 2010 (Reprint).
4. A Course in Electrical Circuit Analysis: with Solved Examples, by M. L. Soni, J. C. Gupta, 3rd edition, D. Rai, 1976.

EE 2004 ELECTRICAL MEASUREMENTS & INSTRUMENTATION Cr-4

Measuring Instruments:
Introduction, classification, absolute & secondary instruments, indicating instruments. Control, balancing & damping. Characteristics, Errors in measurements, Moving iron: Constructional details, extension ranges(both Moving Iron & Moving Coil). **(5 Hrs)**
Wattmeter: Electrodynamometer type, Induction type, single & three phase wattmeter, calibration device, error's in wattmeter, compensation, Measurement of 3-ph power. **(4 Hrs)**
DC/AC Bridge:
General equation of bridge balance, Wheatstone bridge, Kelvin's double bridge, m/m of self inductance: Maxwell's inductance, Maxwell's inductance - capacitance bridges, Hay's Bridge, Anderson bridge, Owens bridges, Schering bridge, errors, Wagner's earth device. **(8 Hrs)**
Energy Meter:
Induction type single & three phase energy meter, compensation, creep errors, testing. **(4 Hrs)**
Galvanometer:
General principle and performance equation of D'Arsonval Galvanometer, vibration galvanometer and ballistic galvanometer. Under damped, undamped, critically damped motion of galvanometer, measurement of charge and flux by ballistic galvanometer. **(5 Hrs)**
Frequency Meter:
Vibration reed type and Electrical resonance type. **(2 Hrs)**
Power factor Meter:
Single and three –phase electrodynamometer power factor meter Advantages & Disadvantages. **(2 Hrs)**
Instrument Transformers:
Potential and current transformers, construction, ratio and phase angle errors, phasor diagrams, uses, testing. **(3 Hrs)**
Potentiometer:
DC potentiometer- Crompton meter, standardization, applications, AC potentiometer- Drysdale polar meter, Gall Tinsley coordinate type meter, standardization, measurement. **(3 Hrs)**
Transducers:
Stain gauge, Thermistors, Thermo couples, LVDT, Capacitance transducers, torque meter, inductive torque transducers, Tachometers. **(4 Hrs)**
Electronic Instruments:
Electronic voltmeter, block diagram, principle of operation, accuracy of multimeter, Digital Multi-meter, Digital Frequency meter, block diagram, principle of operation, accuracy of measurement. CRO: Block Diagram, Sweep Generator, Vertical amplifiers, Use of CRO for measurement of frequency, phase, amplitude, rise time. **(8Hrs)**

Text Books:

1. Electronic Instrumentation and Measurement Techniques, By William David Cooper, PHI,2010.
2. A Course in Electrical and Electronics Measurement and Instrumentation by A.K.Sawhney, 10th edition, Dhanpat Rai,1994.

Reference Books:
1. Electronics Instruments and Measurements – David A. Bell – PHI,2012.
2. Electrical Measurements and Measuring Instruments, By Edward William Golding, F. C. Widdis, 5th edition,Pitman, 1951.

EE 2006 INTRODUCTION TO ELECTRICAL MACHINES AND POWER ELECTRONICS Cr-3

DC Generator:
Introduction, Construction of DC Machines, Types and uses, Principle of operation of DC generator, EMF Equation of DC Generator from 1st principle, Different characteristics. **(4 Hrs)**

DC Motor:

Introduction, Principle of operation of DC Motors, torque equation, Types and uses of DC Motors, Different characteristics, Speed control and starting of D.C. shunt and series motors. **(6 Hrs)**

Induction Motors:

Construction, Types and uses of 3-Ø induction motor, principle of operation, torque/slip curve, speed control and starting of 3-Ø induction motor, Principle and uses of single phase Induction motors, Stepper Motor. **(6 Hrs)**

Alternator:

Introduction, Construction, Types and uses, principle of operation, EMF equation of Alternator, Voltage regulation by synchronous impedance method. **(6 Hrs)**

Transformer:

Definition, Types, Construction and uses of transformers, Voltage transformation ratio, Working principle, EMF Equation, No load phasor diagram, Losses and Efficiency, Voltage regulation, Principle and uses of 1-Phase Auto transformer, Connections of 3-phase transformers. **(7 Hrs)**

Power Electronics and Applications:

Power Semiconductor Devices: Thyristor, TRIAC, IGBT, Thyristor characteristics, Turn on methods**,** Turn off methods**,** Ratings, Simple Industrial Application. **(7 Hrs)**

Text Books:

1. Electrical Machinery, P. S Bimbhra, 7th Edition, Khanna Publishers, 2008.
2. Electrical Technology, Volume I & II. B. L. Theraja, S .Chand Publications. 2010.
3. Power Electronics By P S Bhimbra**,** Khanna Publishers

Reference Books:

1. Induction and synchronous machines, K. Murgesh Kumar Vikash Publishing House Pvt. Ltd, New Delhi

EE 2008 ELECTRICAL MACHINES Cr-4

DC Generator:

Construction, Principle of Operation, emf equation, Types of generators, no-load and load characteristics, voltage build up of shunt generator, voltage regulation-Application **(8 Hrs)**

DC Motor:

Construction, Principle of operation, back emf, speed and torque formula, motor characteristics and performance curve, Speed control of DC shunt and series motor, Necessity of starter, 3-point starter , Losses and efficiency, Industrial Application. **(8 Hrs)**

Transformer:

Single phase transformer, Construction , Principle of operation, emf equation, equivalent circuit and phasor diagram, Open circuit and short circuit test, regulation losses and efficiency. **(8 Hrs)**

Three-phase synchronous motor:

Construction , Principle of operation, V-curves, method of starting and application **(8 Hrs)**

Three-Phase induction motor:

Construction, squirrel cage and slip ring type, principle of operation and equivalent circuit and phasor diagram, Torque slip characteristics , starting torque and maximum torque, starting and speed control and application. **(8 Hrs)**

Single-phase Induction Motor

Construction, Staring method and application **(4 Hrs)**

Universal motor:

Construction and principle of operation, Application **(4 Hrs)**

Text Books

1. Electrical Machinery, P. S Bimbhra, 7th Edition, Khanna Publishers, 2008.
2. Electrical Technology, Volume I & II. B. L. Theraja, S .Chand Publications. 2010.

Reference Books

1. Electrical Machines, Ashfaq Hussain, Dhanpat Rai, Delhi, 2nd Edition, 2008.

2. Electrical Machinery, P. S Bimbhra, 7th Edition, Khanna Publishers, 2008.
3. Electric Machines, C. I. Hubert, , Pearson Education, 2003.
4. Electric Machines ,by Kothari. D P and I J Nagrath, , 3rd Edn, Tata McGraw-Hill, New Delhi. 2004.

EE 3001 ELECTRIC POWER TRANSMISSION AND DISTRIBUTION Cr-4

Introduction:
Single and 3-phase transmission, concept of complex power, per unit system, introduction to different sources of Energy: Thermal power, Terminology: Load factor, Diversity factor, **(5 Hrs)**

Supply System:
Comparison of AC and DC Transmission, Advantages of high transmission voltage, Various system of power transmission, power factor improvement, advantages and disadvantages of EHV(AC) & HVDC. **(5 Hrs)**

Line Constants
Resistance, Inductance: GMD Calculation, Transposition of power lines and Capacitance of single & 3-phase systems with symmetrical and unsymmetrical spacing, Charging current due to capacitance effect, effect of earth on capacitance line, Bundled conductors, skin and proximity effect. **(9 Hrs)**

Performance of Transmission Line
Analysis of short, medium and long lines. Equivalent circuit Representation. ABCD constants and its calculation Ferranti Effect. Surge impedance and surge impedance loading, Power flow through transmission lines: Circle diagram. **(8 Hrs)**

Corona
Critical Disruptive Voltage, corona loss, factor effecting corona , advantages and disadvantages of corona, line design based on corona, radio interference, inductive interference between power and communication line(Electromagnetic and electrostatic effect) **(4 Hrs)**

Mechanical Design of Over Head Transmission Lines
Insulators, potential distribution over a string suspension insulator, methods of equalizing the potential. Sag and stress calculation, effect of ice and wind loading, vibration dampers. **(5 Hrs)**

Underground Cables
Types and construction, grading of cables, insulation resistance of cable. Capacitance in 3-core cable, dielectric losses, over head lines versus underground cables. **(6 Hrs)**

Distribution System
Classification of distribution systems, Type of AC and DC Distributors, voltage drop and load calculation for concentrated and distributed loads, Ring main distributor, Economic choice of conductor size, Kelvin's law. **(6 Hrs)**

Text Books:
1. Electrical Power System , C.L. Wadhwa, New Age International(P) Limited , Publishres,2009.
2. W. D. Stevenson, Elements of Power System analysis, McGraw Hill, 1982.

Reference Books:
1. A Course in Power System , J. B. Gupta, S K Kataria & Sons Publishers and Distributors, 2011.
2. Power System Analysis & Design- By B. R. Gupta, S. Chand Publications, 3rd Edition, Reprint, 2003.
3. Principle of Power System by V.K.Mehta, S.Chand Publishers,2012

EE 3002 POWER SYSTEM OPERATION AND CONTROL Cr-4

Symmetrical and Unsymmetrical Fault analysis:
Introduction, Transients in transmission line, Short circuit of synchronous machine, Symmetrical components, Sequence impedance and sequence network of power system, Symmetrical Fault analysis, Unsymmetrical Fault analysis: LG, LL, LLG. **(10 Hrs)**

Load Flow Studies:
Importance of load flow studies, bus classification, Nodal Admittance matrix, formulation of load flow problem, Approximate load flow solution by Gauss Siedel Method both PV and without PV (acceleration of convergence), Newton Raphson Method, Decoupled and fast decoupled method. **(10 Hrs)**

Economic Operation of Power System:

Introduction, optimal operation of generators, Distribution of load on various generating units, penalty factor and Transmission loss as a function of plant generation, Automatic load dispatch. **(8 Hrs)**

Automatic Generation & Voltage Control:
Introduction, load frequency control, turbine speed governing system, Modeling of speed governing system, turbine model, generator load model, integrated representation of various models, steady state analysis, dynamic response , control area concept, proportional plus integral control, two area load frequency control, automatic voltage regulator, Excitation system – DC Exciter, AC Exciter & Static Exciter . **(10 Hrs)**

Stability Analysis:
Introduction to stability, dynamics of synchronous machines, swing equation, power angle curve and its equation, steady state stability, equal area criterion, effect of clearing time on stability. **(10 Hrs)**

Text Books:

1. Power System Analysis- By John. J. Grainger & W. D. Stevenson, Jr., TMH, 2003 Edition, 15th Reprint.
2. Power System Analysis Operation and Control, Abhijit Chakrabarti, Sunita Halder, Third Edition, PHI Learning Private Limited.

Reference Books:

1. Power System Analysis by T K Nagsarkar & M S Sukhija, 1st Edition, Eighth impression 2012, Oxford University Press.
2. Modern Power System Analysis, I. J. Nagrath, D. P. Kothari, 3rd Edition, Tata McGraw-Hill Publishing Company Ltd, New Delhi.

EE 3003 LINEAR CONTROL THEORY Cr-4

Introduction:
Classification of systems, Causal and non-causal, Basic concept of Control System, Classifications, Differential Equation & Transfer Function, Order and type of the system.
(3 Hrs)
Feedback Theory:
Feedback & Non-feedback System, Effect of Feedback on Gain, Stability, Sensitivity & Noise of the System.

(4 Hrs)
Control System & Components:
Servo Motors: A.C. Servomotor, D.C. Servomotors – Field Control & Armature Control, Position Control System : A.C. & D.C., Regulators, Synchros – Transmitter, Error Detector, Sensors, Encoders, A.C. Tachometer, A.C. Tachogenerator, Potentiometer, Hydraulic Controller, Pneumatic Controller. **(8 Hrs)**

Description of Physical System:
Mathematical Modeling of Electrical System & Mechanical System (Translational & Rotational Mechanical System), Analogous System, Block Diagram Algebra, Developing Block Diagram from a Mathematical Model, SFG, Mason's Gain Formula, SFG from Block Diagram (SFG Terminology, Construction & Procedure), Problem Practice based on application of SFG to Control System. **(6 Hrs)**

Time Domain Analysis:
Standard Test Signals (Step Input, Ramp Input, Parabolic Input & Impulse Input)**.** Time Response of First Order & Second Order System to the Test Signals, Type & Order of the System, Time Response Specifications, Generalized Error Co-efficient, Steady State Error & Design Specifications, Error Constants, Effect of adding Poles & Zeros to Transfer Function, Response with P, PI, PD & PID Controllers. **(8 Hrs)**

Concept of Stability:
The Concept of Stability, Necessary Condition for Stability, R-H Stability Criterion, Relative Stability Analysis, Application of R-H Criterion to Linear Control System. **(4 Hrs)**

The Root Locus Technique:

Root Locus Concept, Construction of Root Locus, Rules for the Construction of the Root Locus, Effect of adding Poles & Zeros to G(s) H(s), Determination of Gain from Root Locus. **(6 Hrs)**

Frequency Domain Analysis:
Introduction, Correlation between Time & Frequency Response, Polar Plots, Bode Plots, Nyquist Stability Criterion, Stability Analysis & Relative Stability. **(6 Hrs)**

Compensators:
Realization of basic compensators, Cascade Compensation & Feedback Compensation. **(3 Hrs)**

Text book:

1. Modern Control Engg. by D.Roy Choudhury PHI publication, 5th Edition,2009.
2. Control Systems by Smarjit Ghosh, Pearson, second Impression,2013.

Reference book:

1. Automatic control systems by Prof. B.S. Manke & S.N.Verma , Khanna publication, 2012.
2. Automatic control system by Hasan Saeed, sixth revised edition 2008, S.K. Kataria & Sons.
3. Modern Control Engg. by K. Ogata PHI publication, 5th Edition,2010.
4. Automatic Control Systems by Benjamin C. Kuo, Prentice-Hall,7th Edition,2009.
5. Control System Engg, by I.J.Nagrath & M Gopal ,New age international publication, 4th Edition,2011.

EE 3004 ELECTROMAGNETIC FIELDS Cr-3

Coordinate System:
Rectangular, Cylindrical and spherical, Transformation. **(3 Hrs)**

Vector Calculus:
Gradient, Divergence and curl operation. **(3 Hrs)**

Static Electrical Field:
Coulomb's Law, Electric field intensity due to continuous line charge, surface charge and volume charge. Gauss's law Maxwell's equation, Application of Gauss' law. Electric potential, equipotential surface, electric dipole. **(6 Hrs)**

Electric Field in Material Space
Electric properties of material, Convection current, Conduction current, Continuity equation, Poisson's and Laplace's equation **(4 Hrs)**

Steady Magnetic Field:
Magnetic forces, Biot-savart's law. Ampere's circuital law, Magnetic scalar and vector potential, Energy stored in magnetic field, Inductor's and inductance. **(6 Hrs)**

Time Varying Field:
Charged particles moving in a static magnetic field. Moving conductor in a static magnetic field, Faraday's law, General case of induction, Displacement current, Maxwell's equation. **(5 Hrs)**

Electromagnetic Waves:
Wave equation, wave propagation in lossy, lossless dielectric. Plane wave in free space. Pointing vector. Reflection and Refraction in plane wave and normal and oblique incidence. **(5 Hrs)**

Transmission Line:
Transmission line equations, transmission line parameters. Transmission line arc circuit element. **(4 Hrs)**

Text Book:

1. Engineering Electromagnetic by Hayt & Buck, 7th Edition Tata Macgraw Hill,2006.
2. Element of Electromagnetics by M.N.O Sadiku, 2nd edition, Oxford,2010.

Reference Books:

1. Electromagnetic waves and Radiating Systems E.C. Jordan & K.G. Balmin, 2nd Edition. PHI Pvt.Ltd,2009.
2. C. R. Paul, K. W. Whites, S. A. Nasor, Introduction to Electromagnetic Fields, 3rd,TMH,2011.

EE 3005 POWER ELECTRONICS Cr-4

Introduction to Power Electronics:
Advantages of power devices operating in the switch mode to those operating in the active region.

(2 Hrs)

Power Electronics Devices:
Thyristor characteristics, Turn on methods**,** dynamic characteristics of thyristors , Ratings , Protection, Two Transistor model of Tyristor Characteristics & constructions of power MOSFETs ,comparison between power MOSFET & power BJT. Characteristics and constructions of IGBT, forward & reverse blocking capability , latch up, switching characteristics , safe operating area, snubber protection . GTO - turn on and turn off methods, IGCT characteristics. TRAIC and DIAC characteristics and applications

(10 Hrs)

AC to DC Converters :
single phase converters - Half wave , with R,RL,RLC load and freewheeling diode , single phase full wave converters with R and RLC load , Line commutated Inverters , Single phase semi converters , 3 - phase converters , Dual converters , 3 phase semi converters , effect of source Inductance on performance of single phase converters.

(10 Hrs)

Thyristor Forced Commutation Circuits:
Inverters: 1 phase Half Bridge & Full bridge inverters, 3 phase inverters ,180^0 and 120^0 conduction , voltage control of inverters : single pulse and multiple pulse width modulation ,sinusoidal pulse width modulation ,concept of current source inverters. **(10 Hrs)**

DC to DC Converters :
Step up & step down choppers 2 & 4 quadrant choppers for control of DC motor. **(6 Hrs)**

AC to AC Converters :
Single phase AC to AC controllers with R and RL load , single phase Cycloconverters with R and RL load.

(5 Hrs)

SMPS :
Advantages of switch mode power supply over conventional power supply , Flyback converters. **(5 Hrs)**

Text Book:

1. Power Electronics By M. H. Rashid, Pearson Education, 3rd Edition, 2009.
2. Power Electronics, by P S Bhimbra, , Khanna Publishers, 5th Edition, 2011.

Reference:

3. Power Electronics By M. H. Rashid, Pearson Education, 3rd Edition, 2009.
4. Power Electronics, Converters, Applications & Design N. Mohan, Undeland & Robbins, John Wiely & Sons , Third Edition ,2009.
5. Power Electronics, by P S Bhimbra, , Khanna Publishers, 5th Edition, 2011.

EE 3022 POWER APPARATUS DESIGN Cr-3

Electrical Engineering Materials:
conducting, Insulating and magnetic materials **(2 Hrs)**

Magnetic Circuit Design:
Calculation for mmf in air gap and teeth of rotating machine. **(2 Hrs)**

Thermal Design:
Heating and cooling curves. Calculation of maximum temperature rise in various parts of machine. **(2 Hrs)**

Design of Transformer:
Output equation, Emf per turn. Design of core, Yoke and window, Design of L.V. and HV winding. Calculation of no load current losses efficiency and temperature rise. Cooling of transformers, Design tank and tubes.

(8 Hrs)

Design of D.C. Machines:

Specific electric and magnetic loading. Output equation, Design of main dimension, Design of armature winding, Conductor and slot. **(6 Hrs)**

Design of Field System:
Magnetic circuit calculation Design of shunt and series field winding. Design of commutator and commutating poles. Losses, efficiency and temperature. **(4 Hrs)**

Design of 3-Phase Induction Motor:
Output equation and main dimension. Design of stator winding, slots. Design of rotor, rotor winding of cage and slip-ring induction motor. Calculation of no load and short circuit current performance calculation by circle diagram. **(6 Hrs)**

Design of 3-Phase Alternator:
Output equation and main dimension, Design of stator core and winding. Design of field system. Losses, efficiency and temperature rise. **(6 Hrs)**

Text Books:

1. Principles of Electrical Machine Design, Agarwal R.K., S.K.Kataria and Sons,2009.
2. Electrical Machine Design By A.K. Sawheny. Dhanpat Rai , 6th edition,2010.

Reference Books:

1. Design of Electrical Machines, K. G. Upadhyay, New age International,2008
2. Design And Testing Of Electrical Machines , M.V. Deshpande,PHI,2010.
3. Electrical Machine Design - The Design and Specification of Direct and Alternating Current Machinery By Alexander Gray, Read Books, 2008.
4. Electrical Machine Design Data Book, By A. Shanmugasundaram, R. Palani, New Age International Publishers, Reprint 2005.

EE 3024 PRINCIPLE OF INDUSTRIAL INSTRUMENTATION Cr-3

Characteristics of Measurement System:
Functional Units, Classification, Performance characteristics, Dynamic Calibration, Errors: An Overview, Statistical Error Analysis, Reliability. **(6 Hrs)**

Pressure, Temperature and Flow Measurement:
Pressure Measurement: Electrical types, Vacuum Measurement, Sound pressure level measurement, Temperature Measurement: Electrical Types temperature sensors. Flow Measurement: Electrical type flow meters, Open Channel flow measurement; Level Measurement: Hydrostatic type, Thermal effect type, Solid level measurement. **(8 Hrs)**

Instruments for Analysis:
Introduction, Gas Analyzers, Liquid Analyzers, X-ray Methods, Chromatography, Mass spectrography. **(6 Hrs)**

Telemetry:
Introduction, Pneumatic Means, Electrical Means, Frequency Telemetering, Multiplexing, Modulation, Modulation of Digital Data, Transmission Channels, Briefing of a Telemetry System in Operation. **(6 Hrs)**

Power Plant Instruments:
Introduction, Power Plant Scheme, Vibration and Expansion, Analysis, Flue Gas Analysis. Turbine – Monitoring and Control: Turbine measurements: electrical, mechanical and process parameters. Turbine control systems: safety and process. Lubrication system for Turbo Alternator and its control. Turbo Alternator cooling system. **(6 Hrs)**

Display, Recording, Alarm:
Introduction, Display methods, Recorders, Alarm annunciation, Data logging system. **(4 Hrs)**

Text Book:

1. Principles of Industrial Instrumentation, Third Edition, D Patranabis, Tata McGraw Hill Education Private Limited, New Delhi

Reference Books:

1. Power Plant Instrumentation – K.Krishnaswamy, M.Ponnibala, PHI publications,2009.
2. Power Plant Engineering - P.K Nag, Tata McGraw-Hill,2010.

EE 3026 ELECTRICAL ENGINEERING MATERIAL Cr-3

Atoms and Aggregate of Atoms:
Structure of atom, electronic configuration, Bonds and bonding, crystallization of materials. Crystal symmetry and structure. Lattice arrangement of atom in materials, molecules and its structures, metallic and amorphous structures. Insulating materials: Dielectric properties of insulators in static fields. The static dielectric constant, Polarization and dielectric constant. The atomic interpretation of the dielectric constant of monatomic gases. Qualitative remarks on the dielectric constants on polyatomic molecules, Quantitative discussion of the dielectric constant of polyatomic gases, the internal field in solid and liquids, the static dielectric constant of solids, Spontaneous polarization, Piezoelectricity.

(10 Hrs)

Behavior of Dielectrics in Alternating Fields:
Frequency dependence of the electric polarization, Ionic polarization as function of frequency, the complex dielectric constant of non-polar solids. Dipolar relaxation, Dielectric losses. Magnetic properties of Materials: Summary of concepts pertaining to magnetic fields; The magnetic dipole moment of a current loop, The magnetization from a microscopic view point, Orbital magnetic dipole moment and angular momentum of two simple atomic models, Lenz's Law and induced dipole moments. **(8 Hrs)**

Classification of Magnetic Materials:
Diamagnetism, The origin of permanent magnetic dipoles in matter, Paramagnetic spin system, Some properties of ferromagnetic materials, Spontaneous magnetization and the Curieweiss Law,Ferromagnetic domains and coercive force, Antiferromagnetic materials, Ferromagnetic materials, Mechanism of Conduction in Semiconductors: Classifying materials as semiconductors, The chemical bond in Si and Ge and its consequences. The density of carriers, intrinsic semiconductors, the energy gap, the conductivity of intrinsic semiconductors, Carrier densities in n-type semiconductors, P-type semiconductors, Hall effect and carrier density.

(9 Hrs)

Conducting Materials:
General properties and specifications of pure copper and aluminum, factors affecting resistivity, wiedemanm Franz law, Materials and alloys for high conductivity, Characteristics of brass and different types of bronzes, Different types of solders, Metals and alloys for different types of fuses, fusing current and fuse ratings. Materials used for highly loaded metal contacts, electrical carbon material, characteristics of different carbon and graphite brushes. Materials of high resistivity, alloys for use in electrical resistance, arc-lamps and electric furnaces, introduction to superconductivity. Nano materials: Introduction, synthesis, and characterization; Description of basic energy carriers and nanostructures.

(9 Hrs)

Text Book:
1. Electrical engineering Materials by R. K. Shukla & A. Singh, Tata Mc Grow-Hill Publishing Company Ltd, New Delhi,2010.
2. Material Science, by V. Rajendran & A Marikani, Tata Mc Grow-Hill Publishing Company Ltd, New Delhi,2009.
3. Material Science, by M.S. Vijay & G. Rangarajan, Tata McGrow-Hill Publishing Company Ltd New Delhi,2011.

Reference Book:
1. Electronic Properties of Materials, by Rolf E Hummel, Springer (India) Pvt Ltd, New Delhi,2010.
2. Electrical Engineering Materials, by A.J. Dekker, Prentice-Hall of India Pvt Ltd, New Delhi,2009.

EE 3028 POWER ELECTRONIC CIRCUITS Cr-3

Introduction to Power Electronics: Advantage of power devices operating in the switch mode to those operating in the active region. **(2 Hrs)**

Power Electronic Devices: Thyristor characteristics , Turn ON methods, Dynamic Characteristics of thyristors, Ratings, Protection, Two Transistor Model of Thyristor, Characteristics & construction of Power MOSFETS, Comparison between Power MOSFET & Power BJT,Characteristics & construction of IGBT, Switching characteristics. GTO – turn on and turn off methods, SiC based power devices, TRIAC and DIAC Characteristics and applications. **(8 Hrs)**

AC to DC Converters: Single Phase Converters – Half Wave, with R, RL, RLE load and Free Wheeling diode, Single Phase Full Wave converters with R & RLE Load, Line Commutated Inverters, Single Phase Semi Converters, 3 Phase converters. **(7 Hrs)**

DC to DC Converters: Step up & Step Down choppers, 2 and 4 quadrant choppers for control of DC motor. Buck- Boost converter **(5 Hrs)**

Inverters: 1 Phase Half Bridge & Full Bridge Inverters, 3 Phase Inverters, 180° and 120^0 conduction, Voltage Control Of inverters:, Sinusoidal Pulse Width Modulation, Concept of multi level inverters. **(6 Hrs)**

AC to AC Converters: Single phase AC to AC Controllers with R and RL load, Single Phase Cycloconverters with R and RL load. **(4 Hrs)**
SMPS : Advantage of Switch Mode Power Supply over Conventional Power Supply, Flyback converters. **(4 Hrs)**

Text Book:

1. Power Electronics By Dr. P S Bhimbhra, Khanna Publishers, 4th edition, 2012,

Reference Books:

1. Power Electronics By M. D. Singh and K. B. Khanchandani, Tata McGraw-Hill publishers, Second Edition, 2007.
2. Power Electronics By M. H. Rashid, Pearson Education, 3rd Edition, 2014.
3. Power Electronics, Converters, Applications & Design N. Mohan, Undeland & Robbins, John Wiely & Sons , Third Edition, 2002.

EE 4001 ELECTRIC DRIVES Cr-4

Introduction:
Basic elements of an electric drive, four quadrant operation of an electric drive, dynamics of Motor load combination, types of loads, stable operating condition of various motor load combinations.
(4 Hrs)

Rating and Heating of Motors:
Thermal model for motor heating and cooling. Classes of Motor duty, determination of power rating of motors for various applications, equivalent current and equivalent torque. Effect of load inertia over motor rating, Load equalization. **(7 Hrs)**

DC motor:
Review of characteristics of DC motors, Modification of characteristics of DC shunt and series motors. Methods of starting DC motor. Fundamental parameters of speed control. Methods of speed control of DC shunt and series motors. Concept of Electric Braking, regenerative, Dynamic & Counter current braking of DC motors. **(12 Hrs)**

Induction Motors:
Review of characteristics of three phase Induction motors. Modification of speed torque characteristics due to variation of: stator voltage, Stator frequency & rotor resistance. Methods of starting, Squirrel Cage and slip ring Induction motors. Methods of speed control of Induction motors: Voltage control, V/f control & Rotor resistance control, Slip Power recovery. Electric Braking of Induction Motors: Regenerative Braking, DC Dynamic braking and plugging. **(10 Hrs)**

Solid State Control of DC drive:
Phase controlled and Chopper controlled DC Separately excited motor and series motor drives. four quadrants drive using dual converter. Closed loop control scheme for DC motor. **(6 Hrs)**

Solid State Control of Induction Motors:

Control of IM by three phase AC-AC Voltage controller. Chopper control of rotor resistance. Speed control using slip power recovery schemes. PWM Inverter fed induction motor drives. Current source inverter fed induction motor drives; Comparison of VSI & CSI fed drives. Closed loop control (V/f control). **(6 Hrs)**

Industrial Application of Electric Drives:
Applications of electric drives in Steel Plants Mills, Cement Plants and Textile mills. **(3 Hrs)**

Text Book:
1. Bimal K. Bose, Power Electronics and Motor Drives: Advances and Trends, Academic Press, 2006.
2. Fundamentals of Electrical drive By G.K. Dubey, 2nd Edition, Narosha Publishers, 2008.

Reference Books :
1. S. K. Pillai : A First Course On Electrical Drives, Second Edition, New Age International Publishers,2007.
2. N. K. De, P. K. Sen: Electric Drives, 7th Edition, PHI Learning Pvt. Ltd., 2004

EE 4003 SWITCH GEAR & PROTECTION Cr-3

Introduction to Switchgear:
Requirement of circuit breakers, characteristics of an electric arc, principle of AC and DC arc interruption, Recovery voltage, re-striking voltage and effect of current asymmetry upon them, current chopping, resistance switching. **(5 Hrs)**

Circuit Breakers:
Types of AC and DC circuit breakers in general, oil circuit breaker, plain break and controlled break, minimum oil circuit breaker, air blast circuit breaker, vacuum and SF_6 circuit breaker, introduction to miniature case circuit breaker and moulded case circuit breaker, Calculation of fault MVA for symmetrical short circuits and determination of circuit breaker capacity, circuit breaker ratings. **(6 Hrs)**

Substation and Earthing:
Types of substations, arrangement of circuit breakers, isolators and bus bars, limiting reactors in power system, Methods of neutral grounding (solid earthing, resistance earthing and Peterson coil earthing and its effects on fault conditions). H.R.C, Fuse, its construction, capacity and characteristics. **(6 Hrs)**

Protective Devices:
Philosophy of protection, requirement of ideal protective scheme, definition of different terms in protective systems, Basic elements in protective scheme, Construction and Principle of operations of Electromagnetic type, induction type: over current, directional, distance relays. **(6 Hrs)**

Alternator Protection:
Different types of faults, differential protection with biasing, restricted earth fault protection, negative sequence protection, automatic field suppression and neutral circuit breakers. **(2 Hrs)**

Transformer Protection:
Buchholz relay, Biased differential protection, restricted earth fault protection, harmonic restraint, protection of combined alternator and transformer. **(2 Hrs)**

Bus Bar Protection:
Differential scheme for both phase and line faults, frame leakage scheme, introduction to digital protective relay and microprocessor based relays. **(2 Hrs)**

Feeder protection:
Time graded protection: radial, parallel & ring feeders; over current and earth fault protection, calculation of graded time setting, split core protection of feeders, carrier current protection and introduction to microwave pilot system, arrangement of relay contacts. **(3 Hrs)**

Pilot Wire Protection:
Circulating current differential protection (Merz-Price protection), Biased or percentage differential protection scheme, opposed (balanced) voltage differential protection system, Translay scheme; static relays. **(2 Hrs)**

Protection Against Surges:
Ground wire, Surge diverters: rod gap, horn gap lighting arresters; surge absorbers. **(2 Hrs)**

Text Book:

1. Switchgear Protection and Power Systems, Sunil S. Rao, Khanna Publishers, 2009.
2. Power System Protection and Switchgear by B Rabindranath and M Chander , Wiley Eastern (1977)

Reference Books:

1. A Course in Power Systems, J. B. Gupta, S. K. Kataria & Sons Publishers and Distributors, 2009.
2. Principles of Relaying", Van Warrington, Y. G. Paithankar. TMH, 2009.
3. Fundamentals of Power System Protection", Y. G. Paithankar, S. R. Bhide, Eastern Economy Edition, 2nd edition, Prentice Hall of India Private Limited, New Delhi, 2011.

EE 4005 RENEWABLE ENERGY SYSTEMS Cr-3

Fundamentals of Energy :

Science and Technology: Energy Consumption and standard of living, Classification of Energy Resources, Importance of Non-Conventional Energy Sources, Common Forms of Energy, Advantages and Disadvantages of Conventional energy Sources, Salient Features of Non-Conventional Energy Sources, Environmental Aspects of Energy, Word Energy Status, World Energy Status, Energy Scenario in India

(4 Hrs)

Solar Energy:

Basics: Extraterrestrial and Terrestrial Radiations, Spectral Energy Distribution of Solar Radiation, Depletion of Solar Radiation, Solar Radiation Data, Solar Time (Local Apparent Time), Solar Radiation Geometry, Solar Day Length, Empirical Equations for Estimating Solar Radiation, Availability on Horizontal Surface for Cloudy Skies, Hourly Global, Diffuse and Beam Radiations on Horizontal Surface Under Cloudless Skies, Solar Radiation on Inclined Plane Surface. **(5 Hrs)**

Solar Thermal Systems:

Solar Collectors, Solar Water Heater, Solar Passive Space – Heating and Cooling Systems, Solar Refrigeration and Air Conditioning Systems, Solar Cookers, Solar Furnaces, Solar Green House, Solar Dryer, Solar Distillation (or Desalination of Water), Solar Thermo-Mechanical Systems. **(6 Hrs)**

Solar Photovoltaic Systems

Solar Cell Fundamentals, Solar Cell Characteristics, Solar Cell Classification, Solar Cell, Module, Panel and Array Construction, Maximizing the Solar PV Output and Load Matching, Maximum Power Point Tracker, (MPPT), Balance of System Components, Solar PV Systems, Solar PV Applications.

(5 Hrs)

Wind Energy:

Origin of Winds, Nature of Winds, Wind Turbine Sitting, Major Application of Wind Power, Basics of Fluid Mechanics, Wind Turbine Aerodynamics, Wind Turbine Types and Their Construction, Wind Energy Conversion Systems (WECS), Wind – Diesel Hybrid System, Effects of Wind Speed and Grid Condition (System Integration), Wind-Energy Storage, Environmental Aspects, Wind – Energy Programme in India.

(5 Hrs)

Biomass Energy:

Photosynthesis Process, Usable Forms of Biomass, their Composition and Fuel Properties, Biomass Resources, Biomass Conversion Technologies, Urban Waste to Energy Conversion, Biomass Gasification, Biomass Liquefaction, Biomass to Ethanol Production, Biogas Production from Waste Biomass, Energy Farming, Biomass Energy Programme in India. **(4 Hrs)**

Geothermal Energy:

Applications, Origin and Distribution of Geothermal Energy, Types of Geothermal Resources, Analysis of Geothermal Resources, Exploration and Development of Geothermal Resources, Environmental Consideration, Geothermal Energy. **(3 Hrs)**

Ocean Energy:

Tidal Energy, Wave Energy, Ocean Thermal Energy. **(2 Hrs)**

Emerging Technologies:

Fuel Cell, Hydrogen Energy. **(2 Hrs)**

Text Books :

1. N. K. Bansal, Manfred Kleemann, Michael Meliss, " Renewable energy sources and conversion technology", Tata Mc Graw Hill, 1990.
2. B.H.Khan, "Non – Conventional Energy Resources" Tata Mc Graw Hill,2nd edition 2009.

References:

1. Kothari D.P., "Renewable energy resources and emerging technologies", Prentice Hall of India Pvt. Ltd,2006.
2. Rai G.D, "Non-Conventional energy Sources", Khanna Publishers, 4th Edition 2000.
3. Ashok V. Desai, "Nonconventional Energy", New Age International Publishers Ltd, Reprint 2003.

EE 4021 POWER STATION ENGINEERING Cr-3

Introduction:
Introduction to different sources of Energy. Discussion on application of energy sources to power station. **(1 Hrs)**

Thermal Power :
Layout of thermal power plant, Main Equipment, Coal Handling plant, Boiler, Super heater, Reheater, Economizer ,Air Preheater steam turbine, Ash handling plant, condenser, Cooling tower and ponds, Feed water heater, E.S.P, Power supply to auxiliaries.

(6 Hrs)

Hydro Power Plant:
Classification according to (i) Water Flow (ii) Load (iii) Head surge tank, Penstock, spillway, Tail Race, Types of turbine (i) Pelton turbine, (ii) Francis turbine, (iii) Kaplan turbine, Governor, specific speed, Plant auxiliaries. **(6 Hrs)**

Nuclear Power Plant:
Location, Layout of nuclear power plant, Fission, Fusion, controlled chain reaction, Classification of Nuclear reactors – Advanced Gas cooled Reactor, Pressurized Water Reactor, Boiling Water Reactor, Fast Breeder Reactor, and Reactor Control & Cooling.

(6 Hrs)

Diesel Electric Power plant:
Introduction, Selection of site, Layout and Main components, Application. **(6 Hrs)**

Gas Turbine:
Principle of operation. **(1 Hrs)**

Electrical System:
Testing and commissioning of generators and power transformers.HT, EHT and LV Substation arrangements. Station batteries and battery chargers. **(4 Hrs)**

Economic Aspects:
Load curve, Load duration curve, connected load Maximum demand, demand factor, average demand, Load factor, diversity factor, Plant capacity Factor, Plant Use Factor Tariffs-Types, power factor improvement. **(6 Hrs)**

Text Books:

1. M.V. Despande, Elements of electrical power system design, PHI,2010
2. Generation of Electrical Energy, B.R. Gupta, S.Chand Publication, 2009.

Reference Books:

1. B. G. A. Skrotzki & W. A. Vopat, Power Station Engineering & Economy, McGraw Hill, Digitized on Dec 2007.
2. P. K. Nag, "Power Plant Engineering", 3rd Edition, Tata McGraw Hill Publication ,2002

EE 4023 INSTALLATION, COMMISSIONING AND MAINTENANCE OF ELECTRICAL EQUIPMENTS Cr-3

Installation and Commissioning of DC Machine:
Inspection of arrival of machine, location for foundation of machine and its switch gear, foundation preparation-leveling, alignment, fittings & IER related to installation.

(4 Hrs)

Installation ,Commissioning and Testing of Transmission and Distribution Lines:
planning the route of H.T. Lines, Planning the route of distribution lines, planning of construction work ,erection & setting poles guys, cross arms, insulator and jumpers etc, fixing of guarding , anticlimbing devices & danger plates, concept of right of way, service connection, installation of energy meter.

(4 Hrs)

Installation ,Commissioning and Testing of Cables:
Inspection on arrival of cables, transportation, handling and storage of cables, consideration for selection of cables, current rating of cables, various causes of faults and testing of cables, joints in cable& various method of joining. **(4 Hrs)**

Installation ,Commissioning & Testing of Transformers:
Dispatch, inspection, storage and handling of transformer ,civil construction feature regarding connection like ventilation, noise level, space for free movement, foundation, drainage of oil, cabling, cable box, fire protection, provision for bushing supports, location of switch gear ,various steps for commissioning fitting of all accessories, filling of oil, drying out, charging the breather with fresh silica gel, cleaning of bushing, fixing conductor and cables, earthing tank and cover, neutral earthing, fixing of protection circuit, setting of relays.

(8 Hrs)

Installation ,Commissioning & Testing of Sub-station:
Design and planning of indoor substation, layout with key diagram, consideration for safe operation of substation, installation of outdoor substation, testing and commissioning of substation , installation of control and relays panel, installation of outdoor circuit breaker, civil works, various step for installation, pre-commissioning checks/test. **(8 Hrs)**

Maintenance:
Fundamental of maintenance, preventive maintenance, maintenance planning, advantage of preventive maintenance-daily, weekly, monthly, half yearly, yearly maintenance. break down maintenance ,list of tools/instruments & material used for maintenance, making of maintenance schedule of DC machines, induction machines, synchronous machine, transformer, transmission line ,distribution lines, underground cables, circuit breaker, switch gear protective relays & substation, batteries in substation. **(8 Hrs)**

Text Book:

1. Installations, Commissioning and Maintenance of Electrical Equipments by Tarlok Singh, S.K.Kataria & Sons, New Delhi, Reprint,2008.

EE 4027 INSTRUMENTATION FOR POWER INDUSTRIES Cr-3

Overview of Power Generation:
Introduction, Basic overview of power generation in thermal power plants, P& I diagram, Cogeneration of power, Importance of instrumentation and control in power generation. **(6 Hrs)**

Instrumentation and Control in Water Circuit:
Introduction, Measurements in water circuit: water flow, steam flow, water and steam pressure, water and steam temperature, boiler drum water level, Measurement of impurities in water and steam, Controls in water circuit: boiler drum level, superheated steam temperature, steam pressure.

(12 Hrs)

Instrumentation and Control in Air-Fuel Circuit:
Introduction, Measurements in air-fuel circuit: flow, pressures, temperatures and level. Controls in air-fuel circuit: combustion and furnace draft. Analytical measurements in air-fuel circuit: oxygen and carbon dioxide in flue gas, combustibles analyser, and infrared flue gas analyser, smoke detector, dust monitor, fuel analysers and chromatography, Pollution monitoring instruments. **(10 Hrs)**

Turbine – Monitoring and Control:
Introduction, Turbine measurements: electrical, mechanical and process parameters. Turbine control systems: safety and process, Lubrication system for Turbo Alternator and its control. Turbo Alternator cooling system. **(8 Hrs)**

Text Books

1. Power Plant Instrumentation – K.Krishnaswamy, M.Ponnibala, PHI publications,2nd Edition.
2. Power Plant Engineering - P.K Nag, Tata McGraw-Hill, 3rd Edition.

Reference Books

1. Standard Boiler Operations - S.M. Elonka and A.L Kohal, Tata McGraw-Hill.
2. 2. Mechanical and Industrial Measurements - R.K Jain, Khanna Publishers.
3. Power Plant Engineering - E.AlWakil, Tata McGraw-Hill.

EE 4032 POWER QUALITY Cr-3

Power Quality
Electric power quality phenomena – IEC and IEEE definitions – Power quality disturbances-voltage fluctuations-transient –unbalance waveform distortion –power frequency variations.

(6 Hrs)

Constraints of Power Quality
Voltage variations, voltage sags and short interruptions-flicker-longer duration variations- sources variation rage and impact on sensitive circuit-standard solutions and mitigation-equipment techniques. **(8 Hrs)**

Transient
Transient- origin and classification-capacitance switching transient- lightning load switching- impact on users- protection-mitigation. **(6Hrs)**

Harmonics
Harmonics- sources-definition and standards-impacts-calculation and simulation- harmonic power flow- mitigation and control techniques- filtering- passive and active . **(6 Hrs)**

Power Quality Coordinators
Power quality coordinators-Shunt and Series compensators- DSTATCOM-Dynamic voltage restorer-Unified power quality conditioners- case studies. **(10 Hrs)**

Text Books:

1. Heydt, G T Electric Power Quality, Stars in a circle publications, Indiana 2nd edition-1994
2. Bollen M H J, Understanding Power Quality Problems,: Voltage Sag and interruptions, IEEE press NY-2000.

Reference Books:

1. Arrillaga J and Watson RN, Chen S, Power system Quality Assessment, Wiley New York-2000.

EE 4033 MODERN CONTROL THEORY Cr- 3

State Space and State Solution:
Concept of State, State Space, Concept of Physical variables and phase variables, Modeling of Mechanica, Electrical, Electro Mechanical Systems in State Space; Transfer Function Decomposition Controllable Canonical Form, Observable Canonical Form, Cascade Form, Parallel Form, Non Uniqueness of State Model, Diagonalization: Similarity Transformation, State Transition Matrix: Concept, Resolvant Matrix Method, Infinite Series (Sylvester) Method, Cayley Hamilton Theorem; State Solution.

(12 Hrs)

State Feedback Design:
Concept of Controllability , Kalman and Gilbert Test, Stabilizability, Concept of Observability: Kalman and Gilbert Test, State Feedback Controller Design: Ackerman's Formula. Observer Design: Separation Principle, Ackerman's Formula, Full Order State Observer. **(8 Hrs)**

Compensator Design:
Design of lag, lead, lag-lead compensator in Frequency Domain. **(4 Hrs)**

Discrete Time Control Systems:
Sampled Data Control Systems, Concept of Sampling: Impulse Sampling, Shanon's Sampling Theorem, Concept of Hold Operation: Zero Order Hold, Z-Transform: Properties, Inverse-Z Transform, Principle of Discretization: Impulse, Step Invariance Methods, Bilinear Transformation, Relationship Between s-plane and z-plane. Stability: Routh Hurwitz in Discrete Domain and Jury's Test. **(12 Hrs)**

Text book:

1. Modern Control Engg. by K. Ogata PHI publication, 5th Edition,2010.
2. Digital Control and State Variable Methods, Gopal, 4th Edition, TMH Publishers, 1st reprint,2013.

Reference book:

1. Control systems Engineering by R.Ananda Natarajan & P.Ramesh Babu (SCITECH), 2nd Edition,2009.
2. Discrete time control systems by K. Ogata (PHI), 2nd Edition,2009.
3. Automatic Control Systems by Benjamin c Kuo, Prentice-Hall,7th Edition,2009.
4. Control System Engg, by I.J.Nagrath & M Gopal ,New age international publication, 4th Edition,2009.
5. Automatic control system by Hasan Saeed, sixth revised edition 2008, S.K. Kataria & Sons.

EE 4034 ADVANCED POWER ELECTRONICS Cr-3

AC – DC Converters:
Rectifier Circuit Design, L & C filter design, Design of Heat Sinks. Power factor improvement of rectifier circuits. **(4 Hrs)**

DC to DC converters:
Continuous and Discontinuous conduction of buck and boost converters. Buck -boost & Cuk converters. Chopper Circuit Design. **(4 Hrs)**

PWM Inverters:
Review of Inverter circuits. Bipolar & Unipolar switching scheme. Modulation Strategies, Performance of 3 phase Sinusoidal PWM Inverters. Trapezoidal modulation. **(5 Hrs)**

Resonant Converters:
Hard switching and Soft switching. Series resonant Inverter, Series Resonant Inverter with bidirectional switches, frequency response. ZCS and ZVS resonant converters. Electronic Ballasts. **(6 Hrs)**

SMPS:
Flyback Converters, Forward Converter, Current Mode Control. Magnetic Materials suitable for high frequency transformers, Design of High Frequency transformers and Inductors. **(5 Hrs)**

FACTS:
Review of the principles of power transmission. Shunt compensation. Thyristor controlled reactor. Static VAR compensator. Principles of series compensation. Thyristor controlled series capacitor. Series static VAR compensator. Unified Power Flow Compensator. **(6 Hrs)**

Gate drive Circuits :
Gate drive circuits for thyristor, MOSFET, IGBT, BJT, GTO **(3 Hrs)**

Static Switches:
AC switches and DC switches **(3 Hrs)**

Text Books:

1. Power Electronics By M.H. Rashid Pearson Education , 3rd Edition,2009.
2. Power Electronics , Converters , Applications & Design N . Mohan , Underland & Robbins , John Wiely & Sons, Third Edition,2011.

Reference Books:

1. *Power Electronics* By M.D . Singh and K.B. Khanchandani , Tata McGraw - Hill publishers , second edition ,2008.
2. Modern Power Electronics , P.C Sen, Wheeler publishing Co, First Edition,2009.
3. Elements of Power Electronics" By Philip T. Krein,Oxford University Press,25 Sept 1997.

EE 4035 UTILIZATION OF ELECTRIC POWER Cr-3

Electric Tariff:
Classification of costs, Formulation of Electric Tariff, Various kinds of Tariff, Economics of generation. Effect of load factor, Diversity factor and power factor on tariff, power factor improvement. **(6 Hrs)**

Electric Heating :
Advantage of Electric heating, Heating Methods, Resistance furnace, Some heating alloys, Causes of failure of heating elements, Temperature control of resistance furnace, Arc furnace, Induction heating, Dielectric heating, Generation of dielectric heat, dielectric heating principle, Comparison between dielectric and induction heating. **(8 Hrs)**

Electrical Welding:
Electric welding- Arc welding, Resistance welding circuit used in electric welding, Electric welding equipments and arc welding, Welding accessories. **(4 Hrs)**

Illumination :
Terms used – Light, luminous flux, luminous intensity, Lumen candle power, Illumination Lux, Lamp efficiency, Brightness Glare, Space height ratio, Co-efficient of utilization, Maintenance factors, Depreciation factors, Laws of illumination, Solid angle, Sources of light-Arc Lamp, Incandescent Lamp, Sodium vapour Lamp, Mercury Vapour Lamp, Fluorescent lamp, Neon lamp, Types of lighting scheme , Design of lighting.

(8 Hrs)

Electrolytic Process :
Faradays law of electrolysis, Extraction of metal, Electroplating. **(3 Hrs)**

Electric Drive :
Types of Drive, Types of load, Selection of electric drive **(3 Hrs)**

Electric Traction :
System of Track electrification, typical speed-time curve, Tractive effort calculation, Specific energy consumption calculation, Electric traction motors, Electric braking, Power Supply for Electric traction. **(4 Hours)**

Text Books:

1. Generation, Distribution and Utilization if Electrical Power by CL Wadhwa, Wiley Eastern Ltd., New Delhi
2. Utilization of Electric Power and Electric Traction by J B Gupta, S K Kataria & Sons, Delhi, 2011.

Reference Books:

1. Utilization of Electrical Power by Er. R K Rajput, Lakshmi Publications pvt ltd, 1st edition 2006.
2. Art and science of Utilization of Electrical Energy by H. Pratab, Dhanpat Rai and Co., Third edition, 2013

EE 4036 HIGH VOLTAGE ENGINEERING Cr-3

Generation of High Voltage and Currents:
Generation of High Voltage AC – By Tesla coil, Resonant Circuits and Cascade Transformers. Generation of High Voltage DC-voltage Double Circuits, Cockeroft Walton voltage multiplier circuit, Ripple voltage, voltage regulation, Van-de-Draft Generators, principle of series and shunt type voltage stabilizers. Generation of Impulse Voltage – Standard impulse wave shapes, Analysis of impulse Generator Circuit of series R-L-C type, Restriction on the ratio of the generator and load capacitances, Waveshape control. Multistage impulse Generators-Marx Circuit, Constructional details, tripping and synchronization. Generation of switching surge voltage. Generation of Impulse currents.

(7 Hrs)

Measurement of High Voltage and Currents:
Measurement using Electrostatic voltmeters, Generating Voltmeters, Sphere gap, Potential Dividers, cathode Ray Oscilloscope. Peak reading a.c. Voltmeter-Chuub-Frotscue method. **(4 Hrs)**

High Voltage Testing of Electrical Apparatus:
Indian Standard Specification for D.C., A.C. and impulse and High frequency testing of Insulators, Bushings, Isolators and Circuit Breakers, Cables Lighting Arrestor, Transformer. Introduction to Non-destructive testing materials and Electrical apparatus. **(5 Hrs)**

Conduction and Breakdown in Gases:
Concept of Electrical stags, Ionization process, General Characteristics of Gaseous Insulation, Electrical Breakdown of gases, Townsend current growth Equation. Townsend's criterion for breakdown. Experimental determination of ionization coefficients, Breakdown in Electronegative gases. Time lags for breakdown. Pashen's law, Streamer theory of breakdown Introduction to partial discharge phenomenon, lighting phenomenon.

(6 Hrs)

Conduction and Breakdown in Liquid Dielectrics:
Pure and Commercial Liquids, conduction and Breakdown in Commercial liquids, Electronic, Cavitation and suspended particle theory. **(3 Hrs)**

Breakdown in Solid Dielectrics
Intrinsic, Electromechanical, Thermal, Treeing and Tracking, Breakdown in composite dielectrics.

(2 Hrs)

Design of High Voltage Laboratories

Test facilities provided in High Voltage laboratories, Classification of High Voltage laboratories, selection and rating of HV test equipment, layout and clearance, Shielding and grounding of high voltage Laboratories, Introduction to the problem of Electromagnetic interference. **(4 Hrs)**

Introduction to D.C. Power Transmission Technology

Comparison of AC and DC Transmission, Description and Application of DC Transmission. Planning for HVDC Transmission, Modern Trend in DC Transmission. **(5 Hrs)**

Text Books:

1. J. Kuffel and W. S. Zaengl, High Voltage Engineering: Fundamentals, Newnes, 2000.
2. M. S. Naidu and V. Kamaraju, High voltage Engineering, Tata McGraw Hill, 1995.

Reference Books:

1. C.L. Wadhwa : High Voltage Engineering, 2nd Edition, New Age International, 2007.
2. Ravindra Arora and Wolfgang Mosch: High Voltage Insulation Engineering, New Age International Publishers, 2011.

EE 4038 HIGH VOLTAGE AC & DC TRANSMISSION Cr-3

Calculation of Inductance Matrix of a 3-Ph. System:

3-Ph. Line with ground return, 3-Ph. Line with single ground wire, 3-ph. Line with double ground wire, 3-Ph. Double circuit transmission line, regularly and irregularly transposed line, calculation of sequence impedance matrix **(6 Hrs)**

Calculation of Capacitance Matrix of a 3-Ph. System:

3-Ph. Line with ground return, 3-Ph. Line with single ground wire, 3-ph. Line with double ground wire, 3-Ph. Double circuit transmission line, regularly and irregularly transposed line, calculation of sequence capacitance matrix and line charging capacitance **(6 Hrs)**

Over Voltages in Transmission System:

Methods for calculation of over voltages- graphical, Analytical, Numerical, and by using a transient network analyzer (TNA). Modelling of transmission lines (Lumped and distributed)-03L. Frequency domain analysis-03L. Time domain analysis-03L of single phase and three phase lines. **(6 Hrs)**

Protection Against Over Voltage:

Various protection schemes against over voltages, surge arrestors, their types ratings and applications, protection of T/m lines against lightning, various design methods viz. Empirical and Electro-geometric model. **(4 Hrs)**

HVDC Transmission System:

Control and protection of HVDC system- characteristics of convertor, constant ignition angle control, constant current control, compounding of convertors, harmonics & filter **(8 Hrs)**

Reactive Power Compensating Devices:

Principles of series and shunt compensation, various types of compensating devices, static and dynamic compensation, study of FACTS devices and their application in power system control, TCR-FC, TSC-TSR, SVC, STATCOM, UPFC **(6 Hrs)**

Text Books

1. EHVAC Transmission Engineering by R. D. Begamudre, New Age International Publication, 4th Edition, 2011.
2. HVDC Power Transmission Systems by K. R. Padiyar, New Age International Publication, 3rd Edition, 2012

Reference Books

1. Power System Grounding & Transients, by APS Meliopoulos, Marcel Dekker Inc, NY, 1988
2. Overhead Power Lines-Planning design & Construction by F. kiessling, P. nefzger, J.F. Nolasco and U. Kainzyk, Springer – Verlag, Germany, 2003.

EE 4040 ELECTRIC TRACTION AND DRIVE Cr-3

Introduction to Traction
General features of Electric traction, Measurement of train movement **(4 Hrs)**

Tractive Effort :
Calculation of tractive effort, Electrical Motors for traction, Power Electric converters in modern **(8 Hrs)**

AC Drives in Electric Traction
Diesel electric traction, reference of Indian Standards, AC drives in Electric Traction. **(4 Hrs)**

Vector Controller Induction Motor Drive:
Dynamic d-q model of 3 phase induction motor d-q equivalent circuit(stator, rotor, synchronously rotating reference frames model), equation of flux linkage, small signal equations of induction motor, dynamic model state space equations, Principles of vector control, direct vector control, implementation with voltage source, Derivation of indirect vector control scheme. **(10 Hrs)**

Parameter Compensation :
Parameter sensitivity of the indirect vector controller induction motor drive, Parameter Sensitivity compensation, Speed-Controller design for an indirect vector controller induction motor drive, Sensorless vector control. **(10 Hours)**

Text Books

1. Fundamentals of Electric Drives by G K Dubey Narosa publishing House , 3rd Edition , 2002
2. Bimal K. Bose, Power Electronics and Motor Drives: Advances and Trends, Academic Press, 2006.

Reference Books

1. S. K. Pillai : A First Course On Electrical Drives, Second Edition, New Age International Publishers,2007.
2. N. K. De, P. K. Sen: Electric Drives, 7th Edition, PHI Learning Pvt. Ltd., 2004

EE 6121 COMPUTER APPLICATION IN POWER SYSTEM Cr-3

Introduction to Computer Method:
Network matrices, reference frame, network graph, Tree, branch, basic loop and cut sets Basic Incidence matrices Augmented matrices, Primitive networks Network matrices by singular and non singular transformation with Bus frame of reference, Branch frame of reference, Loop frame of reference. **(10 Hrs)**

Three Phase Network:
Elements in impedance and admittance form, Balance excitation, Un-balance excitation, Transformation matrices for symmetrical components, Incidence and network matrix for 3-phase elements, Formation of Z bus, Addition of branch, Addition of link problems. **(12 Hrs)**

Representation of Three Phase Elements in Short Circuit Study:
Short circuit study by balance network by Z bus, LG fault**,** L-L fault**,** 3-ph fault with and without fault impedance**,** problems. **(6 Hrs)**

Transient stability Analysis:
Load representation**,** Network performance equation, Swing equation, Machine equation, Solution techniques in transient stability study, Modified Euler's method, RK 4th order method, problems. **(8 Hrs)**

Text Books:

1. Computer Methods in Power System Analysis Glenn W. Stagg, Ahmed H. El-Abiad, McGraw-Hill Book Company, International Editions,2009.
2. Power System Dynamics and Stability By Jan Machowski, James Richard Bumby Wiley Publications 1998.

Reference Books:

1. Advanced Power System Analysis and Dynamics, L. P. Singh, New Age International (P) Limited, Publishers, Revised 4th Edition,2011.
2. Power System Dynamics and Stability by Jan Machowski, James Richard Bumby, Wiley Publications 1998.

3. Power System Analysis by N.V.Ramana, Pearson Publication,2011
4. Computer application techniques in Power System: M.A.Pai, TMH, 2006.

EE 6122 COMPUTATIONAL INTELLIGENT CONTROLLERS Cr-3

Neural Networks and Pattern Association

Differences between biological and artificial neural networks – Typical architecture – Common activation functions – McCulloch – Pitts neuron – Simple neural nets for pattern classification – Linear separability – Hebb net – Perceptron – Adaline – Madaline – Architecture – Algorithm and simple applications – Training algorithms for pattern association – Hebb rule and delta rule – Hetero associative – Auto associative and iterative auto associative net – Bidirectional associative memory – Architecture – Algorithm – Simple applications.

(10 Hrs)

Neural Networks Based on Competition

Kohonen self organising maps – Learning vector quantization – Counter propagation – Architecture – Algorithm and applications. **(4 Hrs)**

Adaptive Resonance And Back propagation Neural Networks

ART1 and ART2 – Basic operation and algorithm – Standard back propagation architecture – Derivation of learning rules – Boltzmann machine learning – Architecture – Algorithm and simple applications **(6 Hrs)**

Fuzzy Sets And Membership Functions

Properties and operations on classical and fuzzy sets – Crisp and fuzzy relations – Cardinality – properties and operations – Composition – Tolerance and equivalence relations – Simple problems –Features of membership function – Standard forms and boundaries – Fuzzification – Membership value assignments – Fuzzy to crisp conversions – Lambda cuts for fuzzy sets and relations – Defuzzification methods. **(10 Hrs)**

Applications of Neural Networks and Fuzzy Logic

Applications of neural networks – Pattern recognition – Image compression – Communication – Control systems – Applications of fuzzy logic – Fuzzy pattern recognition – Fuzzy image compression – Fuzzy logic controllers. **(6 Hrs)**

Text Books:

1. Sivanandam, S.N., Sumathi, S. and Deepa, S.N., "Introduction to Neural Networks Using Matlab 6.0", Tata McGraw-Hill, 2005.
2. Laurene Fausett, "Fundamentals of Neural Networks", Pearson Education, 2004.
3. Timothy Ross, "Fuzzy Logic with Engineering Applications", McGraw-Hill, 1998.

Reference Books:

1. Zimmermann, H.J., "Fuzzy Set Theory and Its Applications", Allied Publishers Ltd, 1999 .
2. Klir G J, Folger T, "Fuzzy Sets, Uncertainty and Information", Prentice Hall of India, 5th Indian reprint, 2002.
3. Zurada, J.M., "Introduction to Artificial Neural Systems", Jaico Publishing House, 2006.
4. Mohammad H. Hassoun, "Fundamentals of Neural Networks", Prentice Hall of India, 2002.

EE 6123 POWER MARKET REFORMS Cr-3

Power Sector in India

Introduction to various institutions in Indian Power sector such as CEA, Planning Commissions, PGCIL, PFC, Ministry of Power, state and central governments, REC, utilities and their roles. Critical issues / challenges before the Indian power sector, Salient features of Electricity act 2003, Various national policies and guidelines under this act.

(06 Hrs)

Power Sector Restructuring and Market Reform

Different industry structures and ownership and management models for generation, transmission and distribution. Competition in the electricity sector- conditions, barriers, different types, benefits and challenges Latest reforms and amendments. Different market and trading models / arrangements, open access, key market entities- ISO, Genco, Transco, Disco, Retailco, Power market types, Energy market, Ancillary service market, transmission market, Forward and real time markets, market power. **(10 Hrs)**

Electricity Markets Pricing and Non-Price Issues

Electricity price basics, Market Clearing price (MCP), Zonal and locational MCPs. Dynamic, spot pricing and real time pricing, Dispatch based pricing, Power flows and prices. Optimal power flow Spot prices for real and reactive power. Unconstrained real spot prices, constrains and real spot prices. Non price issues in electricity restructuring (quality of

supply and service, standards of performance by utility, environmental and social considerations) Global experience with electricity reforms in different countries. **(10 Hrs)**

Transmission Planning and Pricing

Transmission planning, Different methods of transmission pricing, Different transmission services, Congestion issues and management, Transmission cost allocation methods, Locational marginal price, firm transmission right. Transmission ownership and control, Transco and ISO, Transmission pricing Model in India, Availability based tariff, role of load dispatch centers (LDCs) Salient features of Electricity act 2003, Price based Unit commitment, concept of arbitrage in Electricity markets, game theory methods in Power System, security constrained unit commitment. Ancillary services for restructuring, Forward ancillary service auction.Power purchase agreements. **(10 Hrs)**

Text Books:

1. Kankar Bhattacharya, Math H.J. Boller, Jaap E.Daalder, 'Operation of Restructured Power System' Klumer Academic Publisher,2010.
2. Mohammad Shahidehpour, and Muwaffaq alomoush, - "Restructured electrical Power systems" Marcel Dekker, Inc.,2009

Reference Books:

1. Loi Lei Lai; "Power system Restructuring and Deregulation", Jhon Wiley & Sons Ltd., England.
2. Know Your Power", A citizens Primer On the Electricity Sector, Prayas Energy Group, Pune
3. Sally Hunt, "Making Competition Work in Electricity", 2002, John Wiley Inc.

EE 6132 SOLAR POWER ENGINEERING Cr-3

Design of Solar Cells

Limits of cell parameter, losses in solar cell, solar cell design, Analytical techniques. **(6 Hrs)**

Solar Cell Technologies

Production of Si, Growth of solar PV industry and Si requirements, Production of MGS and EGS, Si wafer based solar cell technology, Thin film solar cell technologies, Concentrator PV cells and Systems, Emerging solar cell technologies and concepts. **(6 Hrs)**

Solar PV Application

Solar radiation, Sun tracking, estimating solar Radiation Empirically, Measurement of solar Radiation, Solar PV modules, Mismatch in series and parallel connection, Design and structure of PV Modules ,power output. **(8 Hrs)**

Balance of Solar PV Systems

Basic of electrochemical cell, Factors affecting the battery performance, Batteries for PV systems, Algorithm of MPPT, Charge controller. **(8 Hrs)**

Photovoltaic System Design

Introduction to Solar PV systems, Stand alone PV system configurations, Design methodology PV systems, Wire sizing in PV system, Precise sizing of PV systems , Hybrid PV systems, Grid connected PV systems, Simple payback period, Life cycle costing(LCC). **(8 Hrs)**

Text Books

1. Solar Photovoltaics Fundamentals, Technologies and Applications by Chetan Singh Solanki, PHI Publication.
2. Wind and solar systems by Mukund Patel, CRC Press.

Reference Books

1. Solar Photovoltaics for terrestrials , Tapan Bhattacharya.
2. Energy Technology – S. Rao, Parulkar

EE 6134 BIO-POWER ENGINEERING Cr-3

Introduction

Biomass and solid wastes, Broad classification, Production of biomass, photosynthesis, Separation of components of solid wastes and processing techniques, Agro and forestry residues utilization through conversion routes: biological, chemical and thermo chemical, Bioconversion into biogas, mechanism.

(8 Hrs)

Composition and Conversion

Composting technique, Bioconversion of substrates into alcohols, Bioconversion into hydrogen, Thermo chemical conversion of biomass, conversion to solid, liquid and gaseous fuels, pyrolysis, gasification, combustion, Chemical conversion processes, hydrolysis and hydrogenation, Solvent extraction of hydrocarbons, Fuel combustion into electricity, case studies.

(10 Hrs)

Biomass Gasification

Bio-methenation technology, Bio-diesel, improved wood stove, Bio-hydrogen generation, Quality of Fuel Gas from Gasification and Bio-Methenation, Electricity from bio-mass.

(8Hrs)

Bio Fuel

Solid, liquid and gaseous fuels, Coal as a source of energy and chemicals in India, Coal preparation, Carbonization, Gasification and liquefaction of coal and lignite, Principle of combustion, Petroleum and its derived products, Testing of liquid fuels, Petroleum refining processes, Inter-conversion of fuels, Natural gases and its derivatives, sources, potential, Gas hydrates, Combustion appliances for solid, liquid and gaseous fuels, Introduction to nuclear fuel, RDF, Bio-fuels, etc.

(10 Hrs)

Text Books

1. Non-conventional Energy Systems – Mittal, Wheelers Publication

Reference Books

1. Energy Technology by S. Rao. & B. B Parulekar, Khanna Publisher Delhi, 1999.
2. Non conventional Energy Sources, by G D Rai, Khanna Publisher, 2005.

EE 6136 WIND POWER ENGINEERING Cr-3

Wind Power

Wind Power in India, IEC Standards for Wind Turbines, State Government Policy for Wind Power Project Investment. Wind Characteristics: Power in the wind: Conversion of Wind to Electric Energy:

(6 Hrs)

Wind Power Plant

Types of Wind Power Plant:Components of Wind Power Plants:Working of Wind Power Plants: Aerodynamic Power Regulation of Wind Power Plants:Specifications of Wind Power Plants: Electrical Power Control Strategies:

(8 Hrs)

Major Power Electronics Components in Wind Power Plants

Power Electronics Wind Power Plants: Type-A WPP with Squirrel cage Induction generator:
Type-B WPP with Wound Rotor Induction generator: Type-C WPP with Doubly-fed Induction generator:Type-D WPP with Wound Rotor Synchronous generator: Type-D WPP with Permanent Magnet Synchronous generator.

(10 Hrs)

Economics of Wind Power Plants

Wind Power Quality and Electrical Generators: Grid Integration of Wind Power Plants: Wind resource Assessment: Siting Of Wind Power Plants: Economics of Wind Power Plants: Choice of Wind Turbines: Wind Power Project development.

(6 Hrs)

Maintenance of Wind Power Plant components

Wind Power Policy: Wind Power and the Environment: Wind Power Planning: Public Perception and Acceptance: Operation and Maintenance Issues of Wind power Plants: Maintenance of Wind Power Plant components.

(6 Hrs)

Text Books

1. Wind Power Plants and Project Development by Joshua Earnest , Tore Wizelius, PHI Publication.

2. Wind Energy Technology – Njenkins, John Wiley & Sons.

Reference Books

1. Solar & Wind energy Technologies – McNeils, Frenkel, Desai, Wiley

EE 6138 ENERGY MANAGEMENT AND AUDIT Cr-3

General Aspects:

Definitions of Energy Efficiencies, Estimation of Energy efficiencies in supply side and demand side, definition of energy conservation, management and audit, similarities and dissimilarities in financial audit and energy audit, approach, data collection and data analysis methodologies, demand and supply matching methodologies, optimization methodologies in input and output, economical and ecological implications on management & auditing systems, auditing on emission, pollution, safety and reliability. **(12Hrs)**

Procedure and Techniques:

Input and output analysis of an product and process systems, Data collection and analysis methodologies, applications of computers in data analysis, Data collection methodologies in thermal, electrical, chemical energy systems, loss analysis methodologies in thermal, electrical and chemical systems and evaluation of energy & material saving opportunities, cost benefit analysis on saving opportunities, development of total energy systems. **(12Hrs)**

Applications of Energy Audit:

Energy auditing methodologies in boiler and firing systems, Energy conservation opportunities in power stations through energy auditing, auditing in transmission and distribution systems, process industries, service industries, building and habitat systems, Implication methodologies of enhancing energy efficiencies, Audit report preparation methodologies.

(12 Hrs)

Text Books:

1. W.R. Murphy and G. McKay, "Energy management", Butterworth & Co Publishers, Oxford, UK, 2001.
2. Energy Audit of Building systems: An Engineering approach, by:Moncef krarti, CRC PRESS, Second Edition,2009.

Reference Books:

1. A Workbook for Energy Management in building by: Tarik Al-Shemmeri, Wiley-Blackwell.
2. Energy audit: Thermal power , combined cycle, and co-generation plants, by:Y.P Abbi, TERI, 2011

EE 6139 ILLUMINATION ENGINEERING Cr-3

Introduction

Light and electromagnetic radiation, sources of light- thermal radiator-blackbody radiator, laws of thermal radiation, daylight and artificial light, spectral power distribution (SPD) of light sources. **(6 Hrs)**

Visual system

Structure, external factors of vision, continuous adjustment- photopic, scotopic and mesopic capabilities, perception, CIE standard observer, Glare- discomfort & disability glare.

(4 Hrs)

Colorimetric

Dichromatic vision, RGB colour specification system, CIE 1931 XYZ colour specification system, source colour & object colour specification, CIE standard illuminant. Radiometric and photometric quantities, relation between Lumen and Watt, photometric standards.

(6 Hrs)

Photometry

Measurement of luminous flux, illuminance, luminance, luminous intensity distribution.

Computation of lumen output from luminous intensity distribution of a source, computation of CCT and CRI from CIE 1931 chromaticity diagram. **(6 Hrs)**

Different types of Lamps

Its characteristics & Applications, Luminaire- its function and classification, Lamp and luminaire specifications. **(4 Hrs)**

Basic concepts of lighting design

design objectives, design parameters, qualitative & quantitative evaluation of lighting systems, Energy management in illumination, Energy efficient illuminating system components, energy oriented new and retrofit installations, Power Quality, Demand side management (DSM).

(6 Hrs)

Maintenance of lighting system

Indoor and outdoor, maintenance schedule, scheme, Relamping-spot and group, Equipment and materials used for maintenance job, General guidelines on disposal of burnt out lamps.

(4 Hrs)

Text Books

1. Energy Management in Illumination Systems – Kao Chen,CRC Press,2009.
2. Lamps and Lighting – Edited by J.R.Coaton and A.M.Marsden, 2010.

Reference Books

1. Lighting for energy efficient luminous environments- Ronald N.Helms & M Clay Belcher. Prentice Hall,2012.
2. Fundamentals of Illumination Engineering – V.V.Meshkov , Mir Publication, Russia, 2008.
3. The Scientific Basis of Illuminating Engineering – P.Moon Dover Publications, 2008.

ELECTRONICS & TELECOMMUNICATION ENGINEERING COURSES

EC1001 BASIC ELECTRONICS Cr-3

Semiconductors: Energy band concept of materials, difference between metal, insulator and semiconductor, Intrinsic and extrinsic semiconductors (n-type & p-type), current conduction in semiconductor, Photodiode, photo-transistor, LED and seven-segment display. **(4 Hrs)**

Junction Diodes: Operation of p-n junction diode, diode characteristics, half-wave, full-wave and bridge rectifiers, rectifiers with C, LC and LC π filter, clipper and clamper circuits, breakdown mechanisms, Zener diode and voltage regulator. **(7 Hrs)**

Bipolar Junction Transistor (BJT): Transistor operation and current components in p-n-p and n-p-n transistors, CE, CB, CC configurations and characteristics, biasing, load line analysis. **(6 Hrs)**

Field Effect Transistors (FET): Operations of p-channel and n-channel JFETs, characteristics of JFET, operation of MOSFET and its characteristics. **(3 Hrs)**

Power Amplifiers: Class A, B, C and push-pull amplifiers. **(2 Hrs)**

Feedback Concept: General feedback structure, properties and advantages of negative feedback, Barkhausen criteria for oscillation. **(2 Hrs)**

Operational Amplifiers (OPAMP): Ideal OPAMP, CMRR, virtual ground, Inverting and non-inverting OPAMPs, summing amplifiers, Differential amplifier, integrator & differentiator. **(4 Hrs)**

Digital Electronics: Number systems, conversions and codes, Logic gates & Truth tables (OR, AND, NAND, EX-OR), flip-flops (RS flip-flop, D flip-flop, JK flip-flop and MS flip-flop). Shift register, Asynchronous (ripple) counter. **(5 Hrs)**

Electronic Instruments: Operation of CRO and its applications, Signal Generator. **(3 Hrs)**

Text Books

1. *Electronic Devices and Circuits – D. A. Bell - 5th Edition (Oxford)*
2. *Electronics –Fundamentals & Applications –D. Chattopadhyay and P. C. Rakshit – 11th Edition (New Age International)*

Reference Books

1. *Electronic Devices & Circuits – R. L. Boylestad & L. Mashelsky – 10th Edition (Pearson)*
2. *Electronic Principles – A. Malvino & D. J. Bates – 7th Edition (TMH)*
3. *Digital Principles and Applications– A. Malvino and Leach – 7th Edition (TMH)*
4. *Integrated Electronics – J. Millman, Halkias & Parikh – 2nd Edition (TMH)*

EC2001 ANALOG ELECTRONIC CIRCUITS – I Cr–4

Transistor Biasing Circuits: Different types of biasing circuits for BJT & FET, Stability factors & Bias compensation. **(6 Hrs)**

Small Signal Analysis of BJT: The transistor model-hybrid model, Graphical determination of h-parameters. Low frequency small signal analysis of CE, CC and CB configurations without feedback, Simplified CE & CC hybrid model, CE amplifier with an emitter Resistance. **(9 Hrs)**

Small Signal Modeling and Analysis of FETs: Signal Model of FET, Analysis of JFET CS & CD configuration, Analysis of Enhancement and Depletion MOSFET amplifiers. **(3 Hrs)**

BJT and JFET Frequency Response: Classification of Amplifiers, Distortion in amplifiers, Frequency response of an amplifier, Lower Cut Off frequency and higher Cut Off frequency of an amplifier, Step response of an amplifier, Band pass of cascade stages, Low frequency response of RC coupled BJT and FET amplifier, High frequency modeling and analysis of BJT and FET amplifiers, Miller effect capacitance.

(9 Hrs)

Compound Configurations: Differential amplifier, Differential amplifier circuit configurations, DC Analysis, AC Analysis, Constant current bias, current mirror, level translator, Cascade, Cascode and Darlington connections.

(6 Hrs)

Feedback and Oscillator Circuits: Feedback concept, Feedback amplifier topologies, General characteristics of negative feedback amplifier, input and output resistance with negative feedback, Method of analysis of feedback amplifiers with practical examples, Positive feedback, Barkhausen Criterion of Oscillation, Sinusoidal Oscillator, LC Oscillators, RC phase shift oscillator, Crystal Oscillator.

(11 Hrs)

Power Amplifiers: Definition of class A, B and C power amplifiers, Distortion analysis, Series fed and transformer coupled power amplifier, Push-pull amplifiers, Conversion efficiency **(4 Hrs)**

Text Book:

1. *Integrated Electronics- Analog and Digital Circuits and Systems – J. Millman & Halkias, C.D. Parikh- 2nd/ 2013 (10th Reprint)– Mc-Graw Hill India*

Reference Book:

1. *Electronics Devices and Circuit Theory – Robert L. Boylestad and Lewis Nashelsky – PHI (9th Edition)*

EC2002 ANALOG ELECTRONIC CIRCUITS – II Cr–4

Op-amps and its Parameters: Block diagram representation, Analysis of equivalent circuit, Types of IC Op-amp, Power Supply for IC Op-amp, Input offset voltage, Input Bias current, Input offset current, total output offset voltage, Thermal drift, PSRR, Common mode configuration and CMRR, Noise in Op-amp, Slew rate.

(3 Hrs)

Op-amp with Negative Feedback: Op-amp circuits using negative feedback (voltage series, voltage shunt feedback), Differential amplifiers. **(3 Hrs)**

Frequency Response of an Op-amp : Frequency response, Compensating Networks, Frequency response of compensated and non-compensated Op-amp, high frequency Op-amp equivalent circuit, open loop voltage gain as a function of frequency, Closed loop frequency response, Circuit stability. **(5 Hrs)**

Op-amp Applications: Instrumentation amplifiers, Voltage to current converter and vice versa, Integrator, differentiator, first and second order active filter, Phase shift oscillator, Wien bridge oscillator, voltage to frequency converter, comparator : Zero crossing detector & Schmitt Trigger, Sample and Hold circuit, the 555 timer as Monostable and Astable mode, PLL and its applications, IC voltage regulators.

(15 Hrs)

Linear Wave Shaping Circuits: High pass and low pass circuit, Response of RC circuit to various inputs such as sinusoidal, step, pulse, square wave, exponential and ramp. High pass RC circuit as a differentiator. Low pass RC circuit as an integrator, Attenuator and its application. **(11 Hrs)**

Negative Resistance Devices: Tunnel diode & UJT, their V – I characteristics and performance analysis.

(2 Hrs)

Voltage Time Base Generators: General feature of time base signal, exponential sweep circuit. Miller & Bootstrap time base generator. **(7 Hrs)**

Current Time Base Generators: Simple current sweep, Linearity correction and Transistor current time base generator. **(2 Hrs)**

Text Books:

1. Op-amp & LIC – R. K. Gayakwad – PHI
2. Pulse, Digital and Switching waveforms –J. Millman & H. Taub – TMH

Reference Books:

1. LIC – D. Ray Choudhury & Shail Jain (New Age)
2. Pulse Digital Circuit – Anand Kumar - PHI

EC2003 SIGNALS AND SYTEMS Cr-3

Signals: Introduction, Classification, Signals and vectors analogy, Concept of Vector space and Orthogonality, Sampling and reconstruction of band limited signals, Representation of analog and discrete time signals in terms of impulses, Representation of discrete time signals and Basic operation on signals.

(8 Hrs)

Systems: Introduction, Classification, LTI systems, Linear Convolution, Causality and stability of LTI systems, Representation of causal LTI systems, Order of systems, IIR and FIR systems, Correlation.

(8 Hrs)

Fourier Analysis: Significance of Fourier series in LTI systems, Continuous time Fourier series formula and derivation, Dirichlet conditions & properties, Approximation of Fourier series to Fourier transform for aperiodic signals, Properties, examples ,amplitude and power spectra, Analysis of LTI systems using Fourier Transform

(7 Hrs)

Laplace Transform: Introduction, Properties with examples, Relationship between Fourier and Laplace transform, Pole-Zero plot, Analysis of LTI systems, Transfer function. **(6 Hrs)**

Z-transform: Introduction, Definition, ROC of the Z – Transform, System Transfer Function, Poles and zeros, Properties of Z – Transform, Inverse Z – Transform, Solution of difference equations using one sided Z – Transform, Response of pole-zero systems with Non-Zero initial conditions, Causality and stability of LTI systems in the Z-domain.

(7 Hrs)

Text Books:

1. *Signals & Systems – Alan V Oppeinhem, Alan S Willsky– 2nd/ 2011–PHI*

Reference Books:

1. *Signals & Systems – P. Ramesh Babu –Scitech*

EC2004 INTRODUCTION TO DIGITAL COMMUNICATION Cr-4

Signal:

Signals in time domain, Fourier transform, Periodic and non periodic signal Analysis, spectral density.

(6 Hrs)

Analog Modulation:

Types of analog modulation, Need for modulation, principles of AM, Types of AM (DSB, SSB, VSB), power relationship, principle of FM & PM, Types of FM, spectrum of FM, Bandwidth of FM (Carson's rule). **(13 Hrs)**

Pulse Modulation:
Sampling Theorem, PAM, PWM, PPM, TDM, FDM. **(5 Hrs)**

PCM & Delta Modulation:
Quantization process, PCM, Noise consideration in PCM system, Delta and Adaptive Delta modulation.
(6 Hrs)

Digital Modulation Techniques & Data Transmission:
ASK, FSK, PSK, DPSK, QPSK, probability of error, BER calculation, matched filter, relationship between Bit error rate and symbol error rate, comparison of modulation system, Data Communication systems, parity, Asynchronous and Synchronous transmission, low speed, medium speed and high speed modems.
(12 Hrs)

Basic Information theory:
Information and Entropy, Binary symmetric channel and Binary error channel, Shannon's channel capacity theorem, capacity of Gaussian channel, Basics of source and channel coding (Huffman, Cyclic codes).
(6 Hrs)

Text Book:

1. Communication Systems – Simon Haykin, 4th Edition, John Wiley

Reference Books:

1. Principle of Communication System – H. Taub & D. Schlling, TMH
2. Data & Computer Communication – W. Stallings, Pearson

EC2005 SEMICONDUCTOR DEVICES Cr-3

Energy bands & Current Carriers in Semiconductors: Bonding Forces in Solids, Energy Bands theory in crystals (Qualitative Analysis), Metals, Semiconductors, & Insulators, Fermi-Level, Intrinsic and Extrinsic Semiconductors, Concept of Holes, Carrier Concentration. and Mobility, diffusion and drift of carriers, continuity equation, Injected minority carrier charge, Recombination and generation of charge carriers.
(10 Hrs)

P- N Junction: Physical Description of p-n junction, current flow at a junction, I –V characteristics, Quantitative analysis of p-n diode characteristics, equivalent circuit, temperature dependence, Capacitance of p-n junction diode (transition & storage), junction Breakdown (Avalanche &Zener), Step and linearly graded junction, diode switching characteristics, M – S junction (Schottky barrier, Ohio contact and rectifying contact), Hetero-junction.
(10 Hrs)

BJT: Junction transistors, Charge transport in BJT, base narrowing (Early effect), Avalanche breakdown & Punch Through, transistor switching, Coupled-Diode model, Ebers-Moll equations. **(4 Hrs)**

MOSFET: MOS structure, Basic operation of Enhancement & Depletion mode MOSFET, MOS capacitance (Operation with band diagram, threshold voltage & Characteristics), CCD and applications.
(6 Hrs)

Opto–Electronics: Optical absorption in semiconductors, photovoltaic effects, solar cells (p-n junction), Photoconductors, Photodiode, PIN photodiode, Avalanche photodiode, Phototransistor, LED, Semiconductor Laser (p-n junction) (**6 Hrs)**

Text Books:
1. Solid State Electronic Devices by Streetman & Banerjee, 6^{TH} Edition/2013, PHI.

Reference Books:

1. *Semiconductor Devices: Basic Principles by Jasprit Singh, John Wiley & Sons, 2000.*
2. Integrated Electronics: Analog and Digital Circuits and Systems by *Jacob Millman, Christos Halkias, ChetanParikh , Second Edition, TMH 2010.*
3. *Semiconductor Physics and Devices: Donald Neaman and Drubesh Biswas, TMH,4TH Edition, 2012*
4. *Semiconductor Physics: Device & Technology: S. M. Sze& M-K Lee, John Wiley & Sons, 2012*

EC2006 ANALOG COMMUNICATION TECHNIQUES Cr-4

Introduction: Introduction to communication system, dB, dBm, Concept of bandwidth, spectral efficiency, Auto-correlation and Cross-correlation, Hilbert Transform, Pre-envelope, base-band and band-pass signals

(5 Hrs)

Amplitude Modulation and Demodulation: AM DSB-FC, DSB-SC, Modified SSB, Concept of Pilot Carrier, Independent Sideband, Calculation of transmitted power, Efficiency, SSB-SC, Independent side band, concepts of pilot carrier, VSB, method of recovery of the base signal, Square law demodulator, Envelop detector, FDM

(12 Hrs)

Angle Modulation and Demodulation: Phase and frequency modulation, Relationship between PM & FM, Threshold in FM**,** Phase and frequency deviation, Spectrum of an FM signal, Some features of Bessel's coefficient, Effect of modulation index on Bandwidth, Phasor diagram for FM signals, FM generation, parameter variation method, Armstrong system for NBFM, Frequency multiplier. An example of an Armstrong FM system, FM Demodulators, FM detection using PLL, Pre-emphasis and De-emphasis

(9 Hrs)

AM Radio Receiver: AM Super heterodyne receiver and characteristics of a receiver, Principle Block Diagram, Typical features, Front end output S/N, Sensitivity, Selective, and Fidelity. **(4 Hrs)**

FM Radio Receiver: Block Diagram of FM Receiver, Noise in RF Amplifier, FM Detector: Slope Detector, Discriminator, Phase-locked loop, Selectivity, sensitivity of FM Receiver. (**4 Hrs)**

Pulse Modulation and Demodulation : Sampling theorem (low pass and Band pass signals), Natural sampling, Flat – top sampling, signal recovery through holding, Pulse Amplitude modulation, Channel bandwidth for PAM signal, TDM, PWM, PPM. **(5 Hrs)**

Noise in Communication Systems: Sources of noise, Types of Noise, Frequency domain representation of noise, Effect of filters on the PSD of noise, SNR of DSB/FC, DSB/SC, SSB/SC system, Comparison of AM, SSB, DSB, VSB modulation schemes. Calculation of output SNR of FM system, Comparison between FM and PM,

(9 Hrs)

Text Books:

1. *Communication Systems – Simon Haykin, John Wiley,4th edition,2011*.
2. *Modern Digital and Analog Communications Systems* - B.P. Lathi - *Hardcover, Oxford Univ Pr,4th edition,2011*

Reference Books:

1. *Principles of Communication System – H. Taub & D.L.Schilling – TMH,3rd edition,2011*

EC2007 ANALOG ELECTRONICS Cr-4

Bipolar junction transistor and its circuits: Review of transistor theory, transistor characteristics. Early effect and punch through. Biasing of BJT (Fixed bias, collector to base bias, emitter bias), concept of stability and compensation of biasing circuits (qualitative only) Small signal modeling of BJT, Analysis of transistor amplifiers (CB, CE and CC) using BJT small signal model, Applications of Miller's theorem.

(8 Hrs)

Junction field effect transistor and its circuits: Review of JFET physics, Punch through and its transfer and output characteristics, Biasing of JFET (CS and CD configuration), Small signal modeling of JFET, Analysis of JFET amplifiers using JFET small signal model. **(5 Hrs)**

MOS devices and circuits: MOS structure and capacitance, MOS as switch and CMOS as inverter, MOSFET biasing circuits (CS and CD), Small signal modeling of MOSFET, Analysis of MOSFET amplifiers using small signal model. **(8 Hrs)**

Amplifiers and feedback circuits: Types of amplifiers and their equivalent circuits (voltage amplifier, current amplifier, transconductance and transresistance amplifier).Concept of feedback, types of feedback topology and identification of topologies in practical circuits (qualitative only), Frequency response of amplifiers with and without feedback, Barkhausen criterion, RC and LC phase shift oscillators (circuit and qualitative description), output frequency of the oscillators. **(9 Hrs)**

Power amplifiers: Class A, B, AB and C power amplifiers, distortion in power amplifiers. **(3 Hrs)**

Differential amplifier and current mirror circuits: DC and AC analysis of differential amplifiers under balanced and unbalanced conditions, differential and common mode gain, current mirror. **(3 Hrs)**

Operational amplifiers: characteristics of ideal and non-ideal op amp, equivalent circuit for op amp, AC and DC parameters, inverting and non inverting op amp, basic and practical differentiator circuit, basic and practical integrator circuit, instrumentation amplifier, precision rectifier, V-I converter and vice versa, op amp as comparator, zero crossing detector and Schmitt trigger, Triangular and rectangular wave generator using op amp, 555 timer and Voltage controlled oscillator (**12 Hrs)**

Text Books:

1. *Microelectronics circuits- A. S. Sedra and K. C. Smith- 5th edition, 2011 - Oxford University Press.*
2. *Electronics Devices and Circuit Theory – Robert L. Boylestad and Lewis Nashelsky – PHI (9th Edition)*

Reference Books:

1. *Electronic Devices and Circuits- Mottershed Allen-PHI.*
2. *Integrated Electronics- Analog and Digital Circuits and Systems – J. Millman & Halkias, C.D. Parikh- 2nd/ 2013 (10th Reprint)– Mc-Graw Hill India*

EC2008 MEASUREMENTS & INSTRUMENTATION Cr–4

Measurement & Error: Calibration of Instruments, Accuracy, Precision & Resolution, Types of Errors, Statistical analysis, Probability of error, Limiting error. **(4 Hrs)**

A.C. & D.C. bridges: General equation for bridge balance, DC bridges: Wheatstone bridge, Kelvin's double bridge; General form of AC bridge; Maxwell's inductance-capacitance bridge, Anderson's bridge, Schering bridge, Wien's bridge; Sources of error in bridge measurement, Wagner's earthing device.

(9 Hrs)

Electrical measuring instruments: Classification of instruments, Overview of PMMC, Moving iron, Dynamometer type instruments, Overview of Ammeter, Voltmeter, Multimeter, True RMS voltmeter, Potentiometer, Current transformer, Potential transformer, Strip chart recorders. **(10 Hrs)**

Transducers: Strain Gauges, LVDT, Thermistor & Thermocouples, Piezo – electric transducer and Bourdon tube.

(9 Hrs)

Electronic measuring instruments & CRO: Q-meter, Digital Voltmeter, Digital frequency meter, CRO: construction, Time base circuit, measurements with CRO, CRO probes. **(10 Hrs)**

Signal generator & waveform analyzing instruments: Function generator: Square, triangular & sinusoidal waveform generator & Spectrum analyzer **(3 Hrs)**

Analysis instruments: Principle of operation of pH meter, Liquid chromatograph, Spectrophotometer **(3 Hrs)**

Text Books:

1. *Electrical and Electronic Measurements & Instrumentation By A.K. Sawhney – Dhanpat Rai*
2. *Electronic Measurement & Instrumentation By H. Cooper – PHI.*

Reference Book:

1. *Electronics Instruments & Measurement by David A. Bell – PHI.*

EC2009 DIGITAL ELECTRONIC CIRCUITS Cr-4

Introduction to Boolean Algebra: Signed binary number, Binary arithmetic, Codes—BCD, Gray, Excess-3, Error detection & Correcting code-Hamming code, Universal gates, Boolean Algebra, Basic theorems & properties of Boolean Algebra, De-Morgan's theorem, Minterms &Maxterms, K-map representation, simplification and realization with logic gates. **(11 Hrs)**

Combinational Circuits: Adders (Half and Full adders, parallel binary adders, look ahead carry adder generator), Magnitude comparator, decoders (3 to 8, BCD to Decimal decoder, BCD to SSD) and Encoders, Priority Encoder, Multiplexer and Multiplexer-tree, De-multiplexer, Parity generator/checkers. **(10 Hrs)**

Sequential Logic: Shift Register (SISO, SIPO, PIPO, PISO, Bidirectional), Counter (ripple and synchronous), Ring and Johnson Counters. **(7 Hrs)**

Memory: Memory concepts, RAM, ROM, uv EPROM, EEROM, Flash memory, Optical memory. **(2 Hrs)**

Programmable Logic Devices: PAL, PLA, PROM, FPGA and Programmable ASIC. **(2 Hrs)**

Finite State Machine (FSM): Model of Finite State Machine---State diagram, Mealy and Moore models, Logic diagrams, State table, State reduction, State assignment, Excitation table. Realization of memory elements (S-R, J-K, T, Master-Slave), State diagram, state table, Excitation table, Synthesis of Synchronous sequential circuits (Sequence detector, parity-bit generators), Minimization of completely specified sequential machine, Simplification of incompletely specified machine. **(8 Hrs)**

Logic Families: Transistor as switch, Characteristics (Propagation delay, Speed-power product, Noise margin, Fan-in, Fan-out), Standard logic families (RTL, TTL, ECL, CMOS). **(4 Hrs)**

D/A and A/D: Digital to Analog converter (Binary weighted resister network & R-2R ladder network), Analog to Digital converter (Flash type, Counter type & Successive approximation type). **(4 Hrs)**

Text Books:

1. *Fundamentals of Digital Logic – Anand Kumar - PHI, 2nd Edition, 2011*
2. *Digital Logic and Computer Design – M. Morris Mano – PHI,2011*

Reference Books:-

1. *Digital Principles and Applications – Malvino & Leach –TMH, 7th edition, 2011*
2. *Digital Fundamentals – T. L. Floyd & Jain – Pearson Education, 10th edition, 2011*

EC3001 **ELECTROMAGNETIC THEORY** **Cr-4**

Static Electric and Static Magnetic Fields: Orthogonal Co-ordinate systems, statements of Coulomb's and Gauss's laws, boundary conditions for electrostatic fields, electrostatic energy density, Poisson's and Laplace's equations, Statement of Ampere's circuital law, Lorentz's force equation, vector magnetic potential, Biot-Savart law and applications, boundary conditions for magentostatic fields. **(18 Hrs)**

Time Varying Fields and Maxwell's Equations: Faraday's law, Maxwell's Equations in point form and integral form, displacement current, electromagnetic boundary conditions, interface between a dielectric and a perfect conductor, wave equations and their solutions, source-free wave equations, Helmholtz's wave equation in free space, principle of duality. **(6 Hrs)**

Plane Electromagnetic Waves: Plane waves in lossless media, polarization of plane waves, plane waves in lossy media, low-loss dielectrics, skin depth, group and phase velocities, flow of electromagnetic power and Poynting vector, normal and oblique incidences of electromagnetic waves (parallel & perpendicular polarized) at plane perfect conducting and dielectric boundaries , Brewster's angle.

(10 Hrs)

Theory and Applications of Transmission Lines: General transmission-line equations, wave characteristics on an infinite transmission line, transmission line parameters, attenuation constant from power relations, wave characteristics of finite transmission lines, transmission lines as circuit elements, transmission lines with resistive termination and arbitrary termination, transmission line circuits, transients on transmission lines, voltage reflection and current reflection diagrams**, S**mith chart, quarter wave transformer, single stub and double stub matching. **(7 Hrs)**

Waveguides and Cavity Resonators: Transverse electric and transverse magnetic wave propagations in rectangular and circular waveguides, wave impedances, rectangular cavity resonator, quality factor of the rectangular cavity resonator. **(7 Hrs)**

Text Books:

1. *Field and Wave Electromagnetics (Second Edition) By David K. Cheng, Pearson Education, 1989*
2. *Principles of Electromagnetics (Fourth Edition) by Matthew N.O Sadiku, Oxford University Press, 2009.*

Reference Books:

1. *Engineering Electromagnetics (Seventh Edition) by William H. Hayt, Jr and John A. Buck, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2007.*
2. *Electromagnetic Waves and Radiating Systems by Edward C. Jordan and Keith G. Balmain, Prentice Hall of India, New Delhi.*

EC3002 **ANTENNA AND WAVE PROPAGATION** **Cr-4**

Radiation and Thin Linear Antennas: Vector magnetic potential, retarded potential, radiation from an oscillating electric dipole, radiation resistance of quarter-wave monopole and half-wave dipole. **(6 Hrs)**

Basic Antenna Parameters and Theorems: Radiation patterns, E-plane & H-plane, directivity, gain, efficiency, effective length, effective aperture, wave polarization & cross-polarization, LHCP & RHCP, FRISS transmission formula, antenna noise temperature, applications of reciprocity theorem and other theorems in antennas. **(6 Hrs)**

Antenna Arrays: Uniform n-element linear array, broadside & end-fire arrays, grating lobes, principle of pattern multiplication, design of linear array using Tchebyscheff distribution, phased array, adaptive array, basic concept of smart antennas. **(7 Hrs)**

Biconical Antenna and Wire Antennas: Impedance of infinite & finite biconical antennas, helical antenna, loop antenna, V-antenna, rhombic antenna. **(5 Hrs)**

Reflector Antennas: Parabolic disc antenna, losses in disc antenna, tilted & off-set fed discs, Cassegrain reflector antenna. **(4 Hrs)**

Slot, Horn and Complementary Antennas: Slot antenna feedings and radiation pattern of slot antennas, Babinet's principle and complementary antennas, impedance of complementary screens & slot antennas, Horn antennas, radiation from horn antenna. **(4 Hrs)**

Broadband and Frequency-Independent Antennas: Broadband antennas, Rumsey's principle, frequency-independent planar log-spiral antenna, log-periodic antenna array, Yagi-Uda array . **(4 Hrs)**

Microstrip Antennas: Radiation mechanism of microstrip antenna, advantages & disadvantages, bandwidth enhancement of microstrip antennas using stacked, proximity-coupled and aperture-coupled microstrip antennas. **(5 Hrs)**

Radio Wave Propagation : Surface wave, space wave, tropospheric wave propagation, tropospheric scatterer, ducting, inospheric layers, inospheric wave propagation, critical frequency, MUF, skip distance, fading, effect of the earth's magnetic field, absorption of millimeter wave by rain and atmospheric gasses. **(7 Hrs)**

Text Books:

1. *Antennas for All Applications - J. D. Kraus & R. J. Marhefka, Tata McGraw Hill.*
2. *Electromagnetic Waves and Radiating Systems - E. C. Jordan & K. G. Balmain, PHI.*

Reference Books:

1. *Antenna Theory - Analysis and Design - C. A. Balanis, John Wiley & Sons, Inc.*
2. *Antennas and Radio Wave Propagation - R. E. Collin, McGraw Hill.*

EC3003 MICROPROCESSORS & MICROCONTROLLERS Cr–4

8085 Microprocessor Architechure: Introduction, 8085 Architecture, Pins & signals. **(5 Hrs)**

Instruction Set Of 8085 And Software Development: Addressing Modes, Timing Diagrams, 8085 Instructions, Assembler Directives, Sample programs, Software development tools. **(10 Hrs)**

8085 Interrupts: Hardware Interrupts, Selective masking, Interrupt structure. **(4 Hrs)**

Memory Interfacing: Memory chips (27 series EPROM and RAM chips), Memory interfacing. **(3 Hrs)**

Interfacing Chips: Programmable peripheral Interface (8255), Priority Interrupt Controller (8259), Concepts of serial communication and USART (8251). **(9 Hrs)**

16 bit processor (intel 8086): Introduction, Architecture, Pins & Signals, Interrupts, Memory interfacing. **(10 Hrs)**

8051 Family Of Microcontrollers : Introduction, Overview of 8051 family, Architecture & Memory organization, Pins & signals, Addressing Modes, 8051 Instructions & sample programs, Timers, Counters and serial communication. **(7 Hrs)**

Text Books:

1. *Microprocessor architecture, Programming and Applications with the 8085 – Ramesh S. Goankar – Penram International Publishing (India) 6th edition,*
2. *Microprocessors and Interfacing, Programming & Hardware – Douglas V. Hall – TMH 3rd edition, 2012*

3. *Microcontroller Theory & Applications – Deshmukh – TMH, 2005*

Reference Books:

1. *Introduction to microprocessors – A. P. Mathur – eTMH Publication – 3rd edition, 2011*
2. *Microprocessors & Microcomputer based System Design – Md. Rafiquzzaman, 2nd edition*
3. *Advanced Microprocessor & Microcontrollers – Prof. S. K. Venkat Rama - Laxmi Publications- 1st edition*
4. 8051 MICROCONTROLLER - Hardware, Software & Applications – V Udayashankara&M Mallikarjunaswamy–*TMH – 1st edition*
5. *The 8051 Microcontroller & Embedded Systems – M. A. Mazidi – Pearson – 2nd edition, 2011*

EC3004 VLSI DESIGN Cr-3

VLSI Methodologies: Introduction to VLSI design, Moore's Law, VLSI Design flow, Design hierarchy, VLSI Design style: Full custom, Gate array, standard-cell, Macro cell based design, Field programmable devices, design quality. **(5 Hrs)**

MOSFET: Electrical characteristics of MOSFET, Threshold voltage, Body effect, current expression (gradual channel approximation method), Channel length modulation, MOSFET scaling: constant field and constant voltage scaling, Short-channel effects. **(5 Hrs)**

Unit process in VLSI and IC fabrication: Unit process in VLSI: Wafer preparation, Oxidation, Diffusion, Ion implantation, Deposition, Metallization, Etching and Lithography. nMOS fabrication, n-well and p-well process . **(3 Hrs)**

CMOS Logic Circuits: General CMOS logic structure, VTC of inverter, noise margin, Different types of inverter (resistive load, enhancement and depletion nMOS load and CMOS), Switching characteristic (propagation delay and parasitic capacitance estimation), NAND, NOR and other complex CMOS logic circuits, Sizing of CMOS logic circuits, CMOS Power: static and dynamic power dissipation, latch-up, sizing for large capacitive load,. Dynamic CMOS logic circuits, charge leakage and charge sharing problem, dynamic gate cascading problem, Domino and NORA logic, Introduction of sequential CMOS logic circuits, Stick diagram. Layout and Layout design rules**.** **(18 Hrs)**

Physical Design Automation: Objectives and goals of partitioning, floor planning and placement, Global routing**.** **(5 Hrs)**

Text Books:

1. *CMOS Digital Integrated Circuits – S. Mo. Kang and Yusuf Leblebici, 3rd Ed, TMH*

Reference Books:

1. *Digital Integrated Circuits A Design Perspective -Jan M. Rabaey, Prentice-Hall Publication*
2. *Basic VLSI Design – D. Pucknell&Eshraghian _PHI*
3. *Principle of CMOS VLSI Design – Neil H. E. Weste – Pearson Edition*
4. *CMOS Circuit Design – R. Jacob Baker, Harry W. Li, David E. Boyce –PHI*

EC3005 DIGITAL COMMUNICATION TECHNIQUES Cr-4

Introduction: Brief Idea of Probability, Random Variable, Random Process, Cumulative Distributive Function, Probability Density Function, Mean, Variance, Power spectral density, Gaussian, Rayleigh, Exponential and Poisson PDF. **(7 Hrs)**

PCM, Delta Modulation and Demodulation: Pulse Code Modulation, Electrical representation of Binary Digit, PCM system, companding, Multiplexing of PCM signals, Differential PCM, Delta Modulation, Adaptive Delta Modulation, Linear predictive coder, Comparison of PCM and DM.

(10 Hrs)

Noise in PCM and Delta – Modulation: Quantization noise, output signal power, output SNR in PCM, quantization noise in DM, output SNR in DM and DPCM **(8 Hrs)**

Digital Modulation and Demodulation Techniques: Band-pass transmission system, Gram-Schmidt orthogonalization, BPSK, DPSK (Differential Encoded PSK), QPSK, π/4 QPSK, OQPSK, M-ary PSK., BFSK, M-ary FSK, Minimum shift keying (MSK), GMSK, Comparison of BPSK, QPSK, π/4 QPSK, OQPSK, BFSK, GMSK, QAM. Comparison of modulation schemes in terms of probability of error and spectral efficiency

(13 Hrs)

Data Transmissions: Base-band Signal Receiver, Probability of Error, The Optimum Filter, White noise, the Matched filter, Probability of Error of Matched Filter, Coherent Reception: PSK, FSK, Non-coherent Detection of FSK, Differential PSK and QPSK, Error probability of BPSK, BFSK & QPSK, MSK & GMSK, QAM. Bit encoding, Symbol-by-symbol encoding, Relationship between bit error rate and symbol error rate.

(10 Hrs)

Text Books:

1. *Principles of Communication Systems – H. Taub& D.L. Schilling, G.Saha – 4th edition,2013- McGrawHill*

Reference Books:

1. *Communication System – Simon Haykin, John Willey - 4thedition,2011*
2. *Modern Analog & Digital Communication System – B.P.Lathi Oxford University Press- 4th edition,2011*

EC3006 DATA COMMUNICATION AND NETWORKING Cr-4

Introduction: Overview of analog and digital data transmission, Historical background of data network, Protocol and their function, OSI model and layering. **(4 Hrs)**

Physical Layer Issues: Transmission impairments, transmission media: twisted pair, coaxial cable, optical fiber and wireless transmission. Line coding formats, typical feature and performance. Types of data and corresponding signal with examples: digital data-analog signal, analog data-digital signal, digital signal-digital data and analog data-analog signal, Asynchronous and synchronous transmission, transmission topology, MODEM, Time division and statistical multiplexing. **(8 Hrs)**

Link Layer Protocols: Circuit switching and packet switching. Framing, Error detection and correction, Retransmission Mechanisms (ARQ), Go Back N, Selective Repeat, Sliding window Protocol. **(6 Hrs)**

Multiple Access Protocols: Aloha System, Carrier Sensing (CSMA, CSMA/CD, CSMA/CA), Examples of Local area networks: Ethernet (IEEE 802.3), Wi-Fi (IEEE 802.11), WiMAX (IEEE 802.16). **(8 Hrs)**

Internetworking: Bridging, Global Internet, IP protocol and addressing (IP V4), Subnetting and supernetting, Classless Inter-domain Routing (CIDR), IP address lookup, Domain Name Systems (DNS), Network Address Translator (NATs), Unicasting, broadcasting and multicasting, Routing in Internet: Link-state, RIP, OSPF, BGP, MPLS. ICMP. **(8 Hrs)**

End-to-End Protocols: TCP and UDP, Congestion Control, Additive Increase/Multiplicative Decrease, Slow Start, Fast Retransmit/ Fast Recovery. **(6 Hrs)**

Queuing Models of Networks: Traffic Models, Little's Theorem, Markov chains, M/M/1 and other Markov systems. **(4 Hrs)**

Introduction to Wireless/Ad-hoc Networking: IEEE 802.11 based ad-hoc networks **(2 Hrs)**

Introduction to Cross-layer Networking: Layered vs. cross-layer architecture, recent developments.

(2 Hrs)

Text Books:

1. *James F. Kurose and Keith W. Ross: Computer Networking – A top-down approach featuring the Internet, 2nd Edition, Pearson Education, Asia, 2004.*
2. *B A Forouzan, Data Communications and Networking, McGraw-Hill, 4thEddition, 2011.*

Reference Books:

1. *D. E. Comer. Internetworking with TCP-IP: Principles, Protocols and Architecture, Vol I, 2nd Edition, Prentice Hall, 1991.*
2. *D. Bertsekas and R. Gallagar. Data Networks, 2nd Edition, Prentice Hall, 1992. W. R. Stevens. UNIX Network Programming, Prentice Hall, 1990.*
3. *Anurag Kumar, D Manjunath and Joy Kuri: Communication Networking – An analytical Approach, Morgan Kaufmann, 2004.*

EC3007 DIGITAL SIGNAL PROCESSING Cr-4

Fourier Transforms: Brief idea about the DSP, Review of Fourier Transform and Z-transform**,** Discrete Time Fourier Transform, Conditions and properties of DTFT, Discrete Fourier Transform, Properties of DFT, Inverse Discrete Fourier Transform, Circular Convolution, Properties of Circular Convolution, Sectioned convolution, Fast Fourier Transform, Properties of FFT, Radix 2 Decimation in Time (DIT), Radix 2 Decimation in Frequency (DIF), Chirp-Z transform algorithm. (**14 Hrs)**

Digital filters: Introduction to Digital Filter, Design of IIR filters: Butterworth, Chebyshev and elliptic analog filter design,Conversion to digital IIR Filter using impulse invariance technique, Bilinear Transformation, and approximation of derivatives, Realization of Digital Filters, Direct form – I realization Direct form – II realization, Design of FIR Filter: Rectangular, Berlitt, Blackmann Hamming, Hanning and Kaiser window, Frequency Transformations in the Analog domain, Frequency Transformations in the Digital domain. **(12 Hrs)**

Multi-rate DSP: Introduction to multi-rate DSP, Decimation and interpolation, Polyphase decomposition, Uniform DFT filter banks, Quadrature mirror filters and perfect reconstruction, Introduction to finite register length effects on digital filter performance, Introduction to spectral density and spectral estimation. **(12 Hrs)**

Adaptive filters: Introduction to Adaptive Filters, Application of Adaptive Filters: System Identification or System Modeling, Adaptive Channel Equalization, Adaptive Line Enhancer, Adaptive Noise Cancelation. **(10 Hrs)**

Text Books:

1. Digital Signal Processing – J. G. Proakis& D. G. Manolakes, 4th edition – PHI
2. Adaptive Signal Processing – B. Widrow& S. D. Sterns – Pearson, 2002.

Reference Books:

1. Digital Signal Processing – Oppenheim & Schafer, PHI
2. Digital Signal Processing – P. Ramesh babu, Scitech Publication,

EC3008 INTRODUCTION TO DIGITAL SIGNAL PROCESSING Cr-4

Introduction to Signals & System: Introduction, Classification of Signals Sampling and reconstruction of band limited signals, Representation of analog and discrete time signals in terms of impulses, Representation of discrete time signals and Basic operation on signals. Introduction, Classification of systems, LTI systems, Linear Convolution, Causality and stability of LTI systems, Representation of causal LTI systems, Order of systems, IIR and FIR systems, Correlation.
(12 Hrs)

Fourier analysis: Significance of Fourier series in LTI systems, Continuous time & Discrete time Fourier series. Continuous Time Fourier transform: Properties, examples, amplitude and power spectra, Introduction to Discrete Time

Fourier Transform, Conditions and properties of DTFT, Analysis of LTI system using DTFT, Discrete Fourier Transform, Properties of DFT, Inverse Discrete Fourier Transform, Properties, Fast Fourier Transform, Radix 2 Decimation in Time (DIT), Radix 2 Decimation in Frequency (DIF) algorithm.

(16 Hrs)

Laplace Transform: Introduction, Properties with examples, Relationship between Fourier and Laplace transform, Pole-Zero plot, Analysis of LTI systems, Transfer function.

(6 Hrs)

Z-transform: Introduction, Definition, ROC of the Z – Transform, System Transfer Function, Poles and zeros, Properties of Z – Transform, Inverse Z – Transform (Partial Fraction & Power Series expansion) , Solution of difference equations using one sided Z – Transform, Response of pole-zero systems with Non-Zero initial conditions, Causality and stability of LTI systems in the Z-domain.

(6 Hrs)

Filter Design: Introduction to Digital Filter, Design of IIR Filter using impulse invariance technique, Bilinear Transformation, Design of FIR Filter using rectangular & Hamming window, Frequency Transformations in the Analog domain, Frequency Transformations in the Digital domain.

(8 Hrs)

Text Book :

2. *Digital Signal Processing : S .Salivahanan , C Gnanapriya – 2nd ed. Tata Mc GrawHill*
3. *Principles of Signal Processing & Linear Systems: B.P.Lathi- 1st Edition, Oxford University Press*

Reference Book :

1. *Signals & Systems – Alan V Oppeinhem, Alan S Willsky, 2nd/ 2011 Pearson*
2. *Digital Signal Processing – J. G. Proakis & D. G. Manolakes, 4th edition – PHI*
3. *Digital Signal Processing – P. Ramesh babu-Scitech*

EC3009 COMMUNICATION ENGINEERING Cr-4

Introduction: Brief Idea of Probability, Random Variable, Random Process, Cumulative Distributive Function, Probability Distributive Function, Mean, Variance, Gaussian and Rayleigh PDF, White Noise, Colored Noise, Signal to Noise Ratio **(8 Hrs)**

Signals: Signals in time domain, Fourier transform and Series, properties of FT and FS, Unit impulse and unit step function **(4 Hrs)**

Amplitude Modulation: Principle of AM, side bands, Power Relationship, Assignable Frequency spectrum, Sideband Transmission, DSB, SSB, VSB, Balanced Modulator. **(8 Hrs)**

AM Radio Receiver: Super heterodyne Principle, Block Diagram, Typical features, Front end output S/N, Sensitivity, Selectivity, Fidelity. **(2 Hrs)**

Angle Modulation: Principle of FM,Frequency Deviation, Spectrum of FM wave, Power in Modulated wave, Narrow band FM, Pre-emphasis, De-emphasis, Block Diagram of FM Transmitter, Reactance modulator, Typical Characteristic features. **(6 Hrs)**

FM Radio Receiver: Block Diagram of FM Receiver, Noise in RF Amplifier, FM Detector: Slope Detector, Discriminator, Phase-locked loop, Selectivity, sensitivity of FM Receiver **(4 Hrs)**

Pulse Modulation and Demodulation: Sampling Process, Pulse Amplitude Modulation, Time Division Multiplexing, Frequency Division Multiplexing, The Quantization Process, Pulse Code Modulation, Noise consideration in PCM systems **(6 Hrs)**

Digital Modulation: Data Form, Principles involved in ASK, PSK (BPSK, QPSK, π/4 QPSK), FSK.

(7 Hrs)

Modern Communication Systems: Introduction to Modems, Block diagram Description of satellite communication, Fiber optic communication and Mobile communication. **(3 Hrs)**

Text Books:

1. Communication System – Simon Haykins, 4th edition 2012 – John Wiley,

2. Modern Digital and Analog Communications Systems -B.P. Lathi - *Hardcover, Oxford Univ Press*

Reference Books:

1. Principles of Communication System – H. Taub& D.L.Schilling – TMH

EC3022 ADVANCED MICROPROCESSORS Cr-3

8086 Microprocessor: Review of 8086 Architechure, Pins and Signals, Minimum and maximum mode configurations, Interrupts and Memory Interfacing.

8086 Addressing modes and Instructions, Multiprocessor configurations, 8086 Coprocessor. **(19 Hrs)**

Intel 80286: Introduction, Multiuser and Multitasking concepts, Virtual memory, Memory management, Architecture, Pins and signals, Real and protected modes of operation, Limitation of 80286.

(7 Hrs)

Intel 80386 : Introduction, Register organization, Pins & signals, Real and protected modes, Virtual – 86 mode, 80386 privilege levels and protection, Call gates, Task switching, Memory management, Segmentation, Paging, TLB

(5 Hrs)

Intel 80486: Introduction, Enhanced features **(1 Hr)**

Pentium Processor: RISC features, Architecture, Pipelining, Superscalar execution, Branch prediction & handling. **(4 Hrs)**

Text Books:

1. *Microprocessors & Interfacing, Programming & Hardware by D. V. Hall-TMH – 3rd edition, 2012*
2. *The Intel Microprocessors 8086/8088, 80186/80188, 80386, 80486, Pentium and Pentium Pro-Processor by B. B. Brey – PHI – 8th edition*
3. *The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware and Applications by Triebel and Singh- Pearson Edn. – 4th edition*

Reference Books:

1. *Microprocessors & Microcomputers based System Design by Md. Rafiquzzaman– UBS – 2nd edition*
2. *Advance Microprocessor and Peripherals – Architecture, Programming and Interfacing by A. K. Ray and K. M. Bhurchandi – TMH – 3rd edition*
3. *Microcomputer System: The 8086/8088 family: Architecture, Programming and Design by Liu & Gibson- PHI – 2nd edition*
4. *An Introduction to the Intel Family of Microprocessors by James L. Antonakos - Pearson Education – 3rd edition*

EC3024 EMBEDDED SYSTEMS Cr-3

Overview of Embedded System: Embedded System, Embedded Processor in System, Components of Embedded System, Brief introduction to Embedded software in system, Design Process in Embedded System

(4 Hrs)

Embedded Hardware:

Processor & Memory: Brief overview of 8051 Architecture and real world interfacing, Introduction to advanced Processor Architectures-ARM, Processor and Memory organization, Parallelism in instruction level, Processor and memory selection.

(3 Hrs)

I/O Types: Serial and Parallel communication Ports, Timer and Counting devices, Watchdog timers, real time clock, Serial bus Communication Protocols- I2C, CAN, and Parallel Communication Protocol-ISA.

(4 Hrs)

Interrupt Service Mechanism: Concept of ISR, different interrupt sources, Interrupt handling Mechanism, Multiple Interrupts, Interrupt Latency and deadline.

(3 Hrs)

Embedded Software Development-

Software Development: Programming concept in ALP (assembly language programming) and High level language-C, Processor directives, functions and macros and other programming elements, Embedded C++ concept only.

(5 Hrs)

RTOS(Real time operating System)- OS overview, Process, Interrupt and memory management, RTOS overview, Basic Design rule using RTOS, Task scheduling using Priority based scheduling, cyclic scheduling and round robin scheduling.

(4 Hrs)

Embedded system Design using PIC microcontroller: Introduction to Microchip PIC16 family, PIC16F873 processor architecture- features, memory organization, on chip peripherals, Watchdog timer, ADC, Data EEPROM, Asynchronous serial port, SPI mode, I2C mode, Interfacing with LCD, ADC, sensors, stepper motor, key board, DAC.

(10 Hrs)

Case study of different types of Embedded System: Design of Automated Chocolate Vending Machine, Digital Camera.

(3 Hrs)

Text Books:

1. *Ajay V. Deshmukh, Microcontrollers Theory and Application, TMH, 2011.*
2. *Raj Kamal, Embedded Systems: Architecture, Programming & Design, TMH, 2011*

Reference Books:

1. *Embedded System Design: A unified Hardware/ Software Introduction, by Frank Vahid, Willey, 2011.*
2. *J. B. Peatman, Design with PIC Microcontrollers , Pearson India,2008*

EC3026 COMPUTATIONAL INTELLIGENCE Cr-3

Introduction to Soft Computing: **(2 Hrs)**

Soft computing constituents and conventional Artificial Intelligence, Neuro-Fuzzy networks.

Fuzzy Sets Theory and applications: **(12 Hrs)**

Introduction, Basic definitions and terminology, Set-theoretic operations, MF Formulation and parameterization, More on fuzzy union, intersection, and complement. Extension principle and fuzzy relations, Fuzzy if-Then rules, Fuzzy reasoning, Mamdani fuzzy models, Sugeno Fuzzy Models, Tsukamoto fuzzy models, other considerations.

Derivative-free optimization: **(4 Hrs)**

Genetic algorithm, simulated annealing, random search, Downhill simples search.

Adaptive Networks: **(4 Hrs)**

Architecture, Back propagation for feed forward networks, Extended back propagation for recurrent networks, Hybrid learning rule.

Neural Networks: **(10 Hrs)**

Supervised learning neural networks: Perceptions, Adaline, Back propagation multi layer perceptions, Radial Bias Function networks, modular network.Unsupervised learning and other neural networks: Competitive learning networks, Kohonen self organizing networks, learning vector Quantization, Hebbian learning, principal component networks, and The Hopfield network. Reinforcement learning.

Adaptive Neuro-Fuzzy Inference Systems: **(4 Hrs)**

ANFIS architecture, Hybrid learning algorithms, Learning methods that cross-fertilize ANFIS and RBNF, Simulation examples.

Text Book:

1. *Neuro Fuzzy and Soft Computing by J. S. R. Jang, C.T. Sun, E. Mizatani, PHI*
2. *Neural Networks and Learning Machines by Simon Haykin, PHI*

Reference Book:

1. *Genetic Algorithms in search, Optimization and Machine learning by David E. Goldberg, 1st Edition, PEARSON*

EC4001 RF AND MICROWAVE ENGINEERING Cr-4

Microwave Vacuum Type Amplifiers and Sources: Limitations of conventional vacuum tubes, Klystron amplifier, Reflex Klystron oscillator, Travelling Wave Tube (qualitative), Backward Wave Oscillator (qualitative), Magnetron Oscillator. **(11 Hrs)**

Microwave Solid State Devices & Sources: TED, RWH theory, Gunn Effect, two-valley model theory, modes of operation of Gunn, READ diode, PIN diode, IMPATT diode, TRAPATT diode and BARITT diode. **(9 Hrs)**

Microwave Components: Scattering matrix representation, variable attenuators, linear and rotary phase shifters, E-plane, H-Plane and Magic Tees, rat race power divider, two-hole and Bethe hole directional couplers, slotted section, matched terminations, coupling probes, crystal detector, Faraday rotation in ferrites, Faraday rotation isolator, Faraday rotation 3-port and 4-port circulators. **(10 Hrs)**

Microwave Integrated Circuits: Introduction to microwave integrated circuits, strip line, microstrip line, slot line, CPW, coupled microstrip lines. **(4 Hrs)**

Periodic Structures and Microwave Filters: Circuit analysis and wave analysis of periodic structures, microwave filters, filter design by insertion loss method and characterization by power loss ratio, design of Chebyshev filter, frequency transformation and expansion, low pass to high pass and low pass to band pass transformations, impedance and admittance inverters. **(10 Hrs)**

Microwave Measurements: Power, frequency and impedance measurements, Gain and radiation pattern measurement of antennas. **(4 Hrs)**

Text Books:

1. *Microwave Devices & Circuits – S. Y. Liao, 3rd edition, 2013 - PHI*
2. *Microwaves: Introduction to Circuits, Devices and Antennas – M. L. Sisodia and V. L. Gupta, New Age International.*

References Books:

1. *Microwaves– K. C. Gupta, Wiley Eastern Limited.*
2. *Basic Microwave Techniques and Laboratory Manual - M. L. Sisodia and G. S. Raghuvanshi, Wiley Eastern Limited.*
3. *Microwave Engineering – D. M. Pozar – John Wiley & Sons, Inc.*

EC4003 WIRELESS & MOBILE COMMUNICATION ENGINEERING Cr-4

Mobile Communication Principle: Cellular Concept System Architecture, Spectrum Allocation, Frequency Reuse, Channel Assignment Strategies, Co-channel Interference & System Capacity, Hand off, Hand off structure, Practical

Hand off consideration, Prioritizing Hand off, Power Control, Near – Far Problem, System capacity, Improvement Techniques: Cell splitting, Sectoring, Micro cell Zone concept. **(11 Hrs)**

RF Propagation & Multi-path Model: Free space propagation model, propagation mechanism, Large Scale fading, Diffraction & Scattering by high – raise structures, shadowing and path loss, Small Scale Fading, Doppler and time-delay spread, coherence Bandwidth and coherence-Time, Types of Small – Scale Fading. **(9 Hrs)**

Modulation Techniques: Overview of QPSK, Offset QPSK, $\pi/4$ QPSK, MSK, GMSK, QAM. **(4 Hrs)**

Equalization and Diversity Techniques: Fundamentals of Equalization, Adaptive equalizer, Concept of diversity, Types of diversity (space, time, frequency, polarization, Rake receiver . **(4 Hrs)**

Spread Spectrum modulation: Spread Spectrum Modulation and principle, PN sequence and its properties, Direct sequence SS and frequency – hopped SS (DS – SS and FH – SS), TH – SS. (**4 Hrs)**

Multiple Access Techniques: Multiplexing and multiple access, TDD and FDD techniques, Description of FDMA, TDMA, CDMA systems, Description and special features of GSM and IS – 95, Wireless data communication and services, Mobile communication standards, Transmitting and Receiving Antenna Systems. **(6 Hrs)**

Multicarrier Modulation: Data transmission using multiple carriers, OFDM, Multi carrier CDMA. **(5 Hrs)**

Multiple Antennas and space time communications: Concept of Multi Input Multi Output Antenna system, Narrow band MIMO model, MIMO channel capacity, MIMO Diversity gain, Space time Modulation. **(5 Hrs)**

Text Books:

1. *Wireless Communication Principle & Practice – T.S.Rappaport – 2nd edition 2012 - Pearson Education.*
2. *Wireless Communication – Andrea Goldsmith – Cambridge Press, Latest Edition*

Reference Books:

1. *Wireless and Cellular Communication – C. Y. Lee – McGraw Hill, Latest Edition*
2. *Mobile Communication – Schillar – Pearson Education, Latest Edition*
3. *Communication System – Simon Haykin – John Willey , Latest Edition*
4. *Fundamentals of Wireless Communication – Tse&Viswanath –Cambrige.*

EC4021 RADAR & TELEVISION ENGINEERING Cr-3

Basic Television System, Scanning Principle & Composite Video Signal: Principle of Television, Aspect ratio & flicker, Concept of scanning & No. of scanning lines, Interlaced scanning, Video Bandwidth, Video signal & DC component, Blanking pulse, Horizontal & Vertical sync/ pulse, Equalizing pulse **(9 Hrs)**

Signal Transmission, Channel Bandwidth & TV Transmitting & Receiving Antenna: Need of vestigial Transmission, Channel Bandwidth for monochrome, transmission, Transmitting (Turnstile) & receiving, Antenna (Yagi), Co-axial & twin wire cable &Balun transformer . **(4 Hrs)**

Monochrome Television Reciever: Monochrome TV receiver: Block diagram, RF tuner, Video amplifier, Video detector, inter carrier sound detection, Sync separator, AGC, SMPS Power Supply. **(5 Hrs)**

Colour Television Principle: Luminance & chrominance signals, Channel bandwidth & frequency interleaving, Color subcarrier and modulation of R-Y, B-Y and signals, color burst signal, Color TV receiver block diagram. **(4 Hrs)**

Principle of Radar System: Radar block diagram, its operation & radar range equation, Pulse repeating frequency and range ambiguities **(4 Hrs)**

CW & CW-FM Radar: Doppler Effect, CW radar & block diagram, FM-CW radar principle & CWFM altimeter. **(3 Hrs)**

MTI & PULSE Doppler Radar: MTI radar block diagram & its operation, delay line canceller, blind speed & its minimization. **(3 Hrs)**

Tracking Radar: Principle of Tracking radar, sequential lobing, conical scanning &Monopulse tracking radar. **(4 Hrs)**

Text Books:

1. *Introduction to Radar system by M.I. SKOLNIK – 3rd edition , 2013 McGrawHill*
2. *Monochrome & colour Television by R. R. GULATI – 3rd edition, 2014 – New Age.*

Reference Books:

1. *Microwave & Radar Engineering by M. KULKARNI*
2. *T. V & Video Engg. by A. M. Dhake*

EC4023 ADAPTIVE SYSTEMS & SIGNAL PROCESSING Cr-3

Discrete random processes: Random variables, random processes, filtered random processes. Ensemble averages, correlation, covariance, power spectrum, cross power spectrum. Ergodicity, time averages, biased & unbiased estimators, consistent estimators. **(8 Hrs)**

Linear prediction: Direct form linear prediction filtering, Normal equations for linear prediction filtering, Levinson algorithm, linear prediction lattice filtering. **(9 Hrs)**

Digital Wiener filtering: Wiener smoothing and prediction filters, Application of Wiener smoothing to noise cancelling, Application of Wiener prediction filters, Constrained, linear MMSE filtering, Minimum variance beam-forming. **(9 Hrs)**

Adaptive filtering: LMS adaptive algorithm. Properties of LMS adaptive filter, Normalized forms, Finite precision effects, Adaptive beam-forming, Frequency domain adaptive filters, Adaptive lattice filters, Godard algorithm, Neural networks and multi-layer perceptrons, Adaptive IIR filtering. **(10 Hrs)**

Text Books:

1. *Adaptive Filter Theory, S. Haykin, Prentice-Hall, 4-th edition, 2001.*

Reference Books:

1. *Fundamentals of Adaptive Filtering, Ali H. Sayed, John Wiley, 2003.*
2. *Statistical and Adaptive Signal Processing: Spectral Estimation, Signal Modeling, Adaptive Filtering and Array Processing, D. Manolakis, V. Ingle, S. Kogan, McGraw Hill, 1999.*
3. *Adaptive Signal Processing, B. Widrow, S. Stearns, Prentice-Hall, 1985.*

EC4025 OPTICAL & SATELLITE COMMUNICATION Cr-3

Introduction: Optical Frequencies, Principle of Light Propagation in a fiber, Advantages of optical fiber communication. **(2 Hrs)**

Wave Propagation in optical fiber: Relation between refractive index and velocity of light, basic structure and ray diagram of optical path in an optical fiber, Acceptance cone, Numerical aperture. Concept of modes, Different types of mode in optical fibers, Cut-off condition for guided modes, Boundary conditions, single mode / multi mode fiber, Concept of V number and its importance. **(4 Hrs)**

Losses in fiber: Material or impurity losses, Rayleigh scattering loss, Absorption loss, Bending loss, Concept of dispersion, Intermodal dispersion, Intramodal dispersion, Wave guide and material dispersion, Minimization of dispersion. **(4 Hrs)**

Optical sources: Characteristics of good optical source, Principle of operation of LED, Principle of operation of laser diode, Intensity modulation using both LED and Laser diode. **(4 Hrs)**

Optical detectors: Principle of operation of PIN diode, Principle of operation of APD, Comparison of PIN / APD, Noises at optical receiver, Thermal noise, Short noise, SNR and Noise equivalent power. **(4 Hrs)**

Fiber link: Optical link budget, Concept of WDM **(2 Hrs)**

Satellite Communications Introduction : Frequency spectrum for satellite communication, Types of orbits, Kepler's Laws of planetary motion, Orbital perturbations, geostationary orbit, Satellite launching , General satellite communication, Block diagram uplink, Downlink frequencies, Types of modulation techniques used, Common Satellite applications **(4 Hrs)**

Losses / Attenuation: Signal loss on transmission through earth's atmosphere, Atmospheric losses, Ionospheric effects, Rain attenuation. **(3 Hrs)**

Satellite link budget: Transmission losses, Interference, System noise temperature, Link power budget **(4 Hrs)**

Satellite sub-systems: Antenna sub-systems, Attitude and orbit control sub-system, Power sub-system, Communication sub-system, TTC&M sub-systems. **(5 Hrs)**

Text Books:

1. *Optical Fiber Communication - G. Kaiser –5th edition, 2013- Tata Mc-Graw Hill*
2. *Satellite Communication – Pratt, Bostien, Allnut – 2nd edition, 2013 - John Willey Publications*

Reference Books:

1. *Optical Fiber Communication – J. C. Palais – Pearson Education*
2. *Satellite Communication – Denish Rsode - Tata Mc-Graw Hill*

EC4028 SMART ANTENNAS Cr – 3

Introduction: Basics of linear antenna arrays, circular antenna arrays and phased array antenna, concept of adaptive antennas and smart antennas, adaptive processing using minimum variance distortionless technique. **(6 Hrs)**

Direct Data Domain Least Square Approaches to Adaptive Processing: Direct data domain least square procedures, eigenvalue method, forward method, backward method, forward-backward method, main beam construction for prevention of signal cancellation. **(6 Hrs)**

Mutual Coupling in Adaptive Smart Antennas: Mutual coupling among an array of dipoles (qualitative), compensation using open-circuit voltages and minimum norm formulation, effect of mutual coupling for constant jammers and constant signals, compensation for mutual coupling for constant jammers and constant signals. **(12 Hrs)**

Direction of Arrival (DOA) Estimation and Adaptive Signal Processing for Smart Antennas: Problem formulation, transformation matrix to compensate undesired electromagnetic effects, DOA estimation for a semicircular array, adaptive processing using a single snapshot from a non-uniformly spaced array in presence of mutual coupling and near-field scatterers, DOA estimation using a phased array on a conformal hemispherical surface, DOA estimation using cyclostationarity, Optimization of base station location for indoor wireless communication. **(12 Hrs)**

Text Books:

1. *Smart Antennas – T. K. Sarkar, M. C. Wicks, M. Salazar-Palma and R. J. Bonneau, Wiley-Interscience, 1st Ed., 2003.*

Reference Books:

1. *Smart Antenna Engineering - Ahmed El-Zooghby, Artech House, 1st Ed., 2005.*
2. *Smart Antennas for Wireless Communication: With MATLAB- F. Gross, McGraw Hill, 1st Ed., 2005.*

EC4029 INDUSTRIAL DATA NETWORKS Cr-3

Rs – 232 and Rs – 485: **(4 Hrs)**
ISO-OSI model – EIA 232 Interface standard – EIA 422 interface standard – 20mA current loop – Serial interface converters.

Modbus Data Highway (Plus) And Hart Protocols : **(8 Hrs)**
MODBUS protocol structure – Function codes – Troubleshooting – Data highway (plus) protocols – Review of HART Protocol.

As – Intreface And Devicenet: **(8 Hrs)**
AS interfaces:- Introduction, Physical layer, Data link layer and Operating characteristics.
Device net: - Introduction, Physical layer, Data link layer and Application layer.

Profibus PA/DP/FMS and FF: **(8 Hrs)**
Profibus:- Introduction, Profibus protocol stack, Profibus communication model,Communicationobjects, System operations and Troubleshooting – Foundation fieldbus versus Profibus.

Industrial Ethernet and Wireless Communication : **(8 Hrs)**
Industrial Ethernet:- Introduction, 10Mbps Ethernet and 100Mbps Ethernet – Radio and wireless communication:- Introduction, Components of radio link, radio spectrum and frequency allocation and radio modems – Comparison of various industrial networks.

Text books:
1. Computer Buses, Buchanan, W, 2000, CRC Press
2. Computer Networks, Tanenbaum, 5th Edition, PEARSON

Refrence books:
1. *Practical Industrial Data Networks Design, installation and Troubleshooting, Steve Mackay, 1st Edition, 2004.*
2. *Wireless Communication and networks, Stallings, 2nd Edition, 2007, PHI*

EC4034 TELEMETRY AND REMOTE CONTROL Cr-3

Fundamental concepts– Significance, Principle, functional blocks of Telemetry and Telecontrol system- Methods of telemetry –Electrical, Pneumatic, Hydraulic and Optical Telemetry – State of the art-Telemetry standards. basic scheme, voltage, current and frequency telemetry, line length limitations, wired and wireless types, Concepts of Information transfer, Coding – Overview of source coding and channel coding. **(10 Hrs)**

Modulation codes: PAM, PFM, PTM, PCM, Bit error rate, Inter symbol, noise, parity checking, Review of modulation and multiplexing: FM-AM, FM-FM, PAM-AM, PAM-FM, PCM-AM, etc, Quantization and conversion methods, error in quantization, bandwidth consideration. **(8 Hrs)**

FDM and TDM systems, IRIG standards in FDM systems in FDM telemetry, SCO's, Mux and Demux circuits, Detectors and Demodulators, Pulse averaging, Quadrature FM and PLL, Mixers, TDM systems (architecture)- TDM- PAM, PAM-PM, TDM- PCM systems. **(6 Hrs)**

Overview of Digital modulation, Modem Protocols, Synchronous protocols, Satellite telemetry, TT and C services, Subsystems, Earth station, Global Positioning System, Overview of wave propagation, Basics of remote sensing, Concept of GIS. **(6 Hrs)**

Fiber optic Telemetry- The Fibre as transmission medium, Interconnections, Repeaters, Sources, Detectors, WDM, Remote control: concept and example from a typical industrial situation. **(6 Hrs)**

Text Books:
1. Handbook of telemetry and remote control, Gruenberg. L, McGraw Hill ,New York, 1987.

2. Telemetry and data transmission, Baral R. N. ,S K Kataria and Sons, 2nd Edition, 2009.

Reference Books:

1. Telemetry Engineering, Young R.E, Little Books Ltd, London 1988.
2. Data communication and teleprocessing system, Housley T, Prenctice Hall International, Englewood Cliffs, New Jersey, 1987.
3. Communication Systems, Bruce Carlson A, 3rd edition, McGraw Hill, New York 1987.
4. Telecommunication and Switching systems and Networks, Viswanathan T, Prentice Hall, New Delhi, 1992

EC4044 INFORMATION THEORY & CODING Cr-3

Source Coding: Introduction to information theory, definitions of self-information and mutual information, conditional self-information, average mutual information and entropy, binary entropy function, FLC & VLC, prefix code and Kraft inequality, source coding theorem, code efficiency, redundancy, Shannon-Fano algorithm, discrete memory less source and Markov source, Huffman coding. **(10 Hrs)**

Channel Capacity & Coding: DMC, BSC, BEC & other special channels, channel capacity, channel coding, code rate, channel coding theorem, Information capacity theorem, Shannon limit. **(6 Hrs)**

Speech Coding: Characteristics of speech signals, frequency domain speech coding, sub-band coding, adaptive transform coding, Vocoders (channels vocoders, formant vocoders, cepstrumvocoders). **(2 Hrs)**

Error Control Coding : Code, codeword, weight of a codeword, generator polynomial, vector, matrices, Galois field, liner code, linear block code, matrix description of linear block code, parity check matrix, systematic code, decoding of a linear block code, standard array, syndrome decoding, error probability after coding, Hadamard code & Hamming code, optimal linear code, maximum distance separable code. **(10 Hrs)**

Cyclic codes: Method for generating cyclic codes, burst error correction, Fire code, Golay code, CRC codes, circuit implementation of cyclic codes. **(4 Hrs)**

BCH Codes: Primitive element, minimal polynomial, method of generating BCH code, examples of BCH codes, decoding of BCH code, Reed-Solomon code. **(2 Hrs)**

Convolutional Codes: Tree & Trellis codes, Convolutional codes, Viterbi decoding, **(2 Hrs)**

Text Books:

1.
2. *Information Theory, Coding and Cryptography – Ranjan Bose, Tata McGraw Hill – 2nd edition 2011*
3. *Principles of Digital Communication – J. Das, P. K. Chatterjee& S. K. Mullick, New Age Internationals, 2008*

Reference Books:

1. *Elements of Information Theory- T. M. Cover & J. A. Thomas, Wiley-Interscience – 2nd edition, 2010*
2. *Digital Communications – J. G. Proakis, McGraw Hill Education – 4th edition*

EC4046 MODERN DIGITAL COMMUNICATION TECHNIQUES Cr-3

Introduction: Review of probability theory and stochastic process in digital message transmission, Principles of detection theory: Binary and m-ary hypothesis testing, Multi-hypothesis testing, sufficient statistics, Bay's likelihood ratio test. **(8 Hrs)**

Digital Modulation Schemes: Memory-less modulation method, QAM signaling with memory, Continuous –Phase frequency Shift Keying (CPFSK), Continuous –Phase Modulation (CPM), Power Spectral Density (PSD): digital signal

with memory, linearly modulated signal with finite mean, PSD of CPFSK and CPM signals.

(7 Hrs)

Optimum Receiver for AWGN Channels: Correlation Receiver, Matched filter receiver, optimal detection, error probability for band limited signal, optimal detection, detection of signaling schemes with memory (maximum likelihood sequence detection, optimum receiver for PCM signals). **(8 Hrs)**

Synchronization: Carrier phase estimation (maximum likelihood, phase lock looped, decision-directed loop), symbol time estimation (maximum likelihood, non-decision-directed timing estimation).

(6 Hrs)

Digital Communication through Band-Limited Channels: Band-limited channel: Characterization, optimal receiver for band-limited channels with ISI and AWGN, Linear equalization (peak distortion criterion, Mean Square Error (MSE) criterion), decision feedback equalizer. **(7 Hrs)**

Text Books:

1. *John G. Proakis and MasoudSalehi: Digital Communication, 5th Edition, McGrahill International, 2008*
2. *Amos Lapidoth, A Foundation in Digital Communications, Cambridge University Press, 2009*

Reference Books:

1. *Carlson A. and Paul Crilly, Communication Systems, 5th Edition. McGraw Hill, 2009.*
2. *Simon Haykin, Digital Communications, John Wiley & Sons, 2000*

EC4048 MOBILE COMMUNICATION ENGINEERING Cr-3

Mobile Communication Principle: Cellular Concept System Architecture, Spectrum Allocation, Frequency Reuse, Channel Assignment Strategies, Co-channel Interference & System Capacity, Hand off, Hand off structure, Practical Hand off consideration, Prioritizing Hand off, Power Control, Near – Far Problem, System capacity, Improvement Techniques: Cell splitting, Sectoring, Micro cell Zone concept.

(10 Hrs)

RF Propagation & Multi-path Model: Free space propagation model, propagation mechanism, Large Scale fading, Diffraction & Scattering by high – raise structures, shadowing and path loss, Small Scale Fading, Doppler and time-delay spread, coherence Bandwidth and coherence-Time, Types of Small – Scale Fading.

(8 Hrs)

Modulation Techniques: Overview of QPSK, Offset QPSK, $\pi/4$ QPSK, MSK, GMSK, QAM. **(4 Hrs)**

Equalization and Diversity Techniques: Fundamentals of Equalization, Adaptive equalizer, Concept of diversity, Types of diversity (space, time, frequency, polarization, Rake receiver **(4 Hrs)**

Spread Spectrum modulation: Spread Spectrum Modulation and principle, PN sequence and its properties, Direct sequence SS and frequency – hopped SS (DS – SS and FH – SS), TH – SS

(4 Hrs)

Multiple Access Techniques: Multiplexing and multiple access, TDD and FDD techniques, Description of FDMA, TDMA, CDMA systems, Description and special features of GSM and IS – 95, Wireless data communication and services, Mobile communication standards, Transmitting and Receiving Antenna Systems.

(6 Hrs)

Text Books:

1. *Wireless Communication – T.S.Rappaport – Pearson Education*

Reference Books:

1. *Wireless Communication – Andrea Goldsmith – Cambridge Press*
2. *Wireless and Cellular Communication – C. Y. Lee – McGraw Hill*
3. *Mobile Communication – Schillar – Pearson Education*
4. *Wireless Communication – Tse &Viswanath – Cambrige Press*

EC6102 TELECOMMUNICATION SWITCHING NETWORKS & PROTOCOLS Cr-3

Introduction: Evolution of Telecommunication, Switching system, Classification of switching, Elements of Telecommunication, Telecommunication standard **(4 Hrs)**

Telephone System: PSTN, Modern Telecom System, Telephone Network, Telephone numbering plan, Central battery system, Transmission impairments, two/four wire transmission, subscriber loop design **(5 Hrs)**

Telecommunication Traffic: Telecommunication traffic, Grade of service, Traffic measurement, Mathematical model for telecommunication traffic **(4 Hrs)**

Switching Systems : Switching, Types of switching, Circuit switching, Message/Packet switching, Functions of switching system, Electronics switching system, Multiplexing, TDM (E1/E2, T1), FDM, Implementation of switching system, Blocking and Non-blocking Switches, Single stage and Multistage switches, Space switching, Time switching, Hybrid switching, Path finding, Complexity, Blocking probability of switch. (**12 Hrs)**

Telephone exchange: Stored program controlled exchange, Electronic exchange, Example of modern exchange (C-DOT exchange), availability of parallel exchange **(4 Hrs)**

Signaling systems: Types of signaling information, forms of signaling, Channel Associated Signaling (CAS), Common Channel Signaling, CCITT No-7 system, SS 7 Signaling Architecture **(7 Hrs)**

Text Books:

1. *Telecommunication Switching, Traffic and Networks – J. E. Flood –1st edition, 2011 Pearson LPE.*
2. *Digital Telephony – John C. Bellamy, John Wiley, 3rd Edition, 2000.*

Reference Books:

1. *Telecommunication Switching Systems and Networks – T. Viswanathanam – PHI Publication, 2011*
2. *Signaling in Telecommunication Networks, - John G. van Bose and Fabrizio U. Devetak, Wiley Interscience, 2nd Edition, 2007*
3. *Signaling in Telecommunication Networks, - John G. van Bose and Fabrizio U. Devetak, Wiley Interscience, 2nd Edition, 2007*

EC6108 DIGITAL IMAGE PROCESSING Cr-3

Introduction: Historical Background of image processing, fundamental steps in image processing elements of digital image processing systems. Digital image representation, Different image processing tasks: Image enhancement, Image restoration, Image compression and image analysis. **(2 Hrs)**

Digital Image Fundamentals: Elements of visual perception, A simple image model, sampling and quantization, relationship between pixels, image geometry: translation, rotation, perspective transformation, camera model, camera calibration, stereo imaging. **(4 Hrs)**

Image Transforms: Review of mathematical preliminaries : matrix theory results: Toeplitz and circulant matrices, orthogonal and unitary matrices, positive definiteness and quadratic forms ,block matrices and Kronecker products, separable operators, introduction to image transforms, Two dimensional orthogonal and unitary transforms, properties of unitary transforms, 2-D DFT, Walsh Transforms, Hadamard transform, Discrete Cosine Transform (DCT), Discrete Sine Transform (DST), Haar Transform, Slant Transform, Brief introduction to wavelet transform and multi-resolution analysis, Karhunan-Lauve (K-L) Transform, SVD Transform.

(6 Hrs)

Image Enhancement : Introduction spatial domain methods, frequency domain method, enhancement by point processing : Histogram equalization, spatial filtering : Low pass median, Sharpening filter, High boost filters, derivative filters, enhancement in frequency domain, Homomaorphic filtering.

(5 Hrs)

Color Image Processing: RGB, CMY and YIQ color models conversion from RGB to HIS and HIS to RGB.

(2 Hrs)

Image Restoration : Introduction, degradation model, algebraic approach to restoration, inverse filtering, Weiner filter, constrained least squares restoration, restoration in spatial domain. **(4 Hrs)**

Image Compression : Introduction and motivation, fundamental concepts : Data redundancy (coding redundancy, interpixel redundancy and psycho visual redundancy), fidelity criteria, image compression models, elements of information theory, image compression techniques: pixel coding (PCM run-length – coding, bit-plane coding), Predictive coding, Delta modulation, DPCM etc., Transform coding (Zonal coding, Thresh holding, coding with different transforms), Other techniques such as vector quantization and hybrid coding, Image compression standards.

(8 Hrs)

Morphological Image Processing: Dilation and erosion, Opening and closing, some basic morphological algorithms.

(2 Hrs)

Image Segmentation: Detection of discontinuities, Edge linking and boundary detection, Thresholding, Region based segmentation. **(3 Hrs)**

Text Books:

1. *Digital Image Processing - R.C.Gonzalez and R. E. Woods – Prentice Hall*

Reference Books:

1. *Fundamentals of Digital Image Processing- A. K. Jain – Prentice Hall*
2. *Digital Image Processing- S.Jayaram, S.Esakkirajan, T.Veerakumar – TMH*

EC6112 COMMUNICATION & NETWORK SECURITY Cr-3

Introduction: Cryptography, Watermarking, Steganography, Escrow & Crypt Analysis, ISO/OSI reference model & security, Security threatening attacks & actions, Reviews of mathematical foundations (Logarithms, Prime Number, GCD, Groups, Rings, Fields, Fermat's Theorem, Euler's Theorem, Exclusive-Or, Random Numbers).

(10 Hrs)

Ciphers &Algorithm: Symmetric Ciphers, Asymmetric Ciphers systems, Elliptic Curve Crypto systems, RSA Algorithm. **(9 Hrs)**

Cryptographic Key distribution system: Key Distribution, Merkle's Puzzle Method, Shamir's Key Distribution Method, Digital Signature. **(6 Hrs)**

Communication Security layer classification: A synergistic security frame work, Firewalls & Gateways, Security Cross- portfolios, attacks and security in the internet, TACACS. **(5 Hrs)**

Network security: Wireless system: WLAN security, IEEE 802.11i robust security network and vulnerabilities, GSM Security, B3G/4G Security Concerns, Wimax Security, and Communication Satellite network security, Wireless Adhoc Network Security. **(6 Hrs)**

Text Books:

1. *Cryptography & Network Security by B A Forouzan and D Mukhopadhyay, Mc-Graw Hill, India.*
2. *Security of Information and Communication Network by S V. Kartalopoulos, Wiley-IEEE Press., 2009.*

Reference Books:

1. *Handbook of Information and Communication Security by Stavroulakis, Peter; Springer, 2010*
2. *Secure Broadcast communication in Wired and Wireless Communication. By Adrian Perrig& Doug Tygar, Kluwer Publication.*
3. *Modern Cryptography: Theory and Practice by W Mao, Pearson Education, India.*

EC6128 WIRELESS SENSOR NETWORK Cr-3

Introduction: Basic Concepts, Platforms, Standardization, architecture and protocols, Applications in military, environment, healthcare, industry and energy, factors influencing WSN Design. **(6 Hrs)**

Physical & MAC Layer: PHY layer standard (IEEE 802.15.4), MAC challenges, MAC protocols for Sensor Network - Contention based (S-MAC, B-MAC, CC-MAC), reservation based-(TRAMA) & Hybrid MAC (Zebra MAC). **(9 Hrs)**

Network & Transport layer: Routing challenges, Data Centric and Flat- architecture protocol(SPIN), Hierarchical protocol (LEACH),Geographical routing protocol (MECN), QoS based Protocol(SAR).Challenges of Transport layer ,Transport Layer protocols (PSFQ & CODA). **(9 Hrs)**

Cross Layer Solutions: Interlayer Effects, Cross layer Interactions (MAC-Network, MAC-Application, Network and PHY, Transport –PHY), cross layer module. **(3 Hrs)**

Localization: Challenges in localization, Ranging Techniques, Range based Localization protocols, Range-Free Localization Protocol. **(3 Hrs)**

Time Synchronization: Challenges for Time synchronization, Timing Sync protocol for sensor network (TPSN), Time Diffusion Synchronization protocol (TDP), Rate based diffusion protocol (RDP). **(6 Hrs)**

Text Books:

1. *Wireless Sensor Networks – Ian F. Akyildiz and Mehmet Can Vuran -John Wiley and Sond Ltd, Publication*

Reference Books:

1. *Wireless Sensor Networks- Feng Zhao and Leonidas Guibas –Elsevier.*
2. *Protocols & Architecture for Wireless Sensor network –Holger Karl & Andreas Willig – Wiley Publication.*
3. *Wireless Sensor network – Raghavendra – Springer.*

EC6224 LOW POWER VLSI DESIGN Cr: 3

Basics of MOS circuits: MOS transistor structure and device modeling, MOS inverters, MOS combinational circuits - different logic families. **(5 Hrs)**

Sources of power dissipation in CMOS circuits: static power dissipation - diode leakage power, subthreshold leakage power, gate and other tunnel currents; dynamic power dissipation - short circuit power, switching power, gliching power;

degrees of freedom, energy delay product, power delay product. **(10 Hrs)**

Supply voltage scaling approaches: technology Level - feature size scaling, threshold voltage scaling; logic level - gate sizing for voltage scaling; **(4 Hrs)**

architecture level - parallelism and pipelining; algorithm level - transformations to exploit concurrency; dynamic voltage scaling. Switched capacitance minimization approaches: system level - power down, system partitioning; **(8 Hrs)**

algorithm level - concurrency, locality, regularity, data representation; architecture level - concurrency, signal correlation; logic level - gate sizing, logic styles; layout level - layout optimization; technology level - advanced packaging, SOI. **(5 Hrs)**

Leakage power minimization techniques: threshold voltage scaling: MTCMOS, VTCMOS and Multiple-Vt CMOS circuits; gate sizing. Low power memory design: ROM, SRAM (4T, 6T), DRAM. **(4 Hrs)**

Text Books

1. *CMOS Digital Integrated Circuits, Sung-Mo Kang and Yusuf Leblebici, 3rd edition, TMH,2011*
2. *Digital Integrated Circuits: A Design Perspective, J. M. Rabaey, Anantha Chandrakasan and Borivoje Nikolic, 2nd Edition, PHI,2001*

Reference Book

1. *CMOS VLSI Design: A circuits and Systems Perspective, West, Harris and Banerjee, 3rd edition, Pearson Education,.*
2. *A. Bellamour, and M. I. Elmasri, Low Power VLSI CMOS Circuit Design, Kluwer Academic Press.*
3. *Anantha P. Chandrakasan and Robert W. Brodersen, Low Power Digital CMOS Design, Kluwer Academic Publishers,2002.*
4. *Kaushik Roy and Sharat C. Prasad, Low-Power CMOS VLSI Design, Wiley-India,2011.*
5. *Essentials of VLSI Circuits and Systems, Eshraghian, Puckness and Eshraghian, 2nd edition, Pearson Education,*

EC6236 MEMS DESIGN Cr-3

An introduction to MEMS; Evolution of microsensors & MEMS; Materials & microelectronic technologies for MEMS; fabrication process. **(4 Hrs)**

Micromachining – surface and bulk micromachining: basic process flow, release, stiction, material choices, residual stress, stringers and planarization, wet etch-based, dissolved wafer process, SOI MEMS, Scream, Hexsil MEMS; **(12 Hrs)**

Micromachined microsensors : mechanical, inertial, thermal; Micromachined microactuators; Integrated smart sensors and MEMS; Interface electronics for MEMS; **(10 Hrs)**

Microsensors & MEMS applications; MEMS for RF applications (RF MEMS); MEMS for Biomedical applications (BioMEMS); Microfluidics & their applications; Bonding & packaging of MEMS; **(10 Hrs)**

Text Books

1. *Microsystem Design, Stephen D. Senturia*
2. *Micromachined Transducers Sourcebook, Gregory T. Kovacs*

Reference Book

1. *S.M. Sze, VLSI Technology, 2nd ed., McGraw-Hill Publishing company, NY, 1988*
2. *Sorab K. Ghandhi, VLSI Fabrication Principles – Silicon and Gallium Arsenide, 2nd ed., John Wiley and Sons, Inc., NY, 1994.*

EC- 6313 OPTIMIZATION TECHNIQUES IN ENGINEERING Cr – 3

Introduction: Optimal problem formulation, Design variables constraints, Objective function, Variable bounds, Engineering optimization problems, Optimization algorithms. (**4 Hrs)**

Single-variable Optimization Algorithm: Optimality Criteria, Bracketing methods: Exhaustive search methods, Region-Elimination methods; Interval halving method, Fibonacci search method, Point estimation method; Successive quadratic estimation method **(6 Hrs)**

Gradient-based Methods: Newton-Raphson method, Bisection method, Secant method, Computer programmes. **(4 Hrs)**

Multivariable Optimization Algorithm: Optimality criteria, unidirectional search, Direct search methods: Evolutionary optimization method, Simplex search method, Hooke-Jeeves pattern search method, Cauchy's (Steepest descent) method, Newton's method, multi-objective optimization, Pareto optimization. **(6 Hrs)**

Constrained Optimization Algorithm: Characteristics of a constrained problem. Direct methods: The complex method, Cutting plane method, Indirect method: Transformation Technique, Basic approach in the penalty function method, Interior penalty function method, Convex method. **(8 Hrs)**

Advanced Optimization Algorithms: Genetic Algorithm (GA), working principles, GA operators, selection methods, advanced GAs, computer programmes, simulated annealing. Particle swarm optimization (PSO), differential evolution (DE) algorithm, bacterial foraging algorithm, ant colony optimization algorithm. **(8 Hrs)**

Text Books:

1. *Optimization for Engineering Design-Algorithms & Examples – K. Deb, PHI, 2nd Ed., 2012.*
2. *Multi-objective Optimization Using Evolutionary Algorithms-K. Deb, John Wiley & Sons, 1st Ed., 2001.*

Reference Book:

1. *Optimization: Theory and Applications - S.S. Rao, Wiley Eastern Ltd, 2nd Ed., 1979.*

EC6316 MICROWAVE INTEGRATED CIRCUITS Cr-3

Introduction: Introduction to Microwave Integrated Circuits (MIC) and Monolithic Microwave Integrated Circuits (MMICs), their advantages over discrete circuits, MMIC fabrication techniques, Thick and Thin film technologies and materials, encapsulation and mounting of active devices in MIC and MMIC. **(6 Hrs)**

Planar Transmission Lines-I: Strip line & microstrip line, field configurations, quasi-TEM mode in microstrip line, analysis of microstrip transmission line, concept of effective dielectric constant, impedance of Strip line & microstrip line, dispersion and losses in microstrip line, discontinuities in microstrip. **(8 Hrs)**

Planar Transmission Lines-II: Slot Line, approximate analysis and field distribution of slot line, transverse resonance method and evaluation of slot line impedance, comparison with microstrip line. Fin lines & Coplanar Lines, analysis of Fin lines by transverse resonance method, conductor loss in Fin lines, coplanar wave guide (CPW). **(10 Hrs)**

Parallel-coupled Microstrip Lines and Power Dividers: Coupled microstrip lines, even mode and odd mode characteristic impedances, semi-empirical formulae for coupled line parameters, coupled-region length, coupler directivity, crosstalk between microstrip lines, design of microstrip branch-line power divider and rat-race ring power divider. **(8 Hrs)**

MIC Measurement, Testing and Applications: MIC measurement system, microwave test fixtures and probes, measurement techniques of S- parameters, noise measurement. **(4 Hrs)**

Text Books:

1. *Microstrip Lines and Slot Lines - K.C. Gupta, R. Garg. , I. Bahl, P. Bhartia, Artech House, 2nd Ed., 1996.*

2. *Foundation for Microstrip Circuit Design-T. C. Edwards, John Wiley & Sons Ltd, 2nd Ed., 1992.*

Reference Books:

1. *Stripline-like Transmission lines for Microwave Integrated Circuits, B. Bhat, S. K. Koul, Wiley Eastern Ltd, 1st Ed., 1989.*
2. *Microwave Integrated Circuits, K.C. Gupta and A. Singh, Wiley Eastern Limited, 1st Ed., 1975.*

ELECTRONICS AND ELECTRICAL ENGINEERING COURSES

EL3001 CONTROL SYSTEMS Cr-4

Introduction: **(2 Hrs)**

Basic concepts of Control Systems, Classifications, Servomechanism and Regulators.

Depreciation of Physical System: **(6 Hrs)**

Differential Equation of Physical System,Transfer function, Block Diagram Algebra, Signal flow graph, Mason's gain formula, application of signal flow graph to control system.

Feedback Theory: **(3 Hrs)**

Feedback and non feedback systems, Reduction of parameter variation by use of feedback, Control of the Effects of Disturbance Signals by use of feedback, Regenerative Feedback.

Control Systems & Components: **(3 Hrs)**

Electrical Systems: A. C. Servomotor, D.C. Servomotor, A.C. Tachometer, Potentiometers, Sychoros, A.C. and D.C. position control system, hydraulic Systems, Preumatic Systems.

Time domain Analysis, Design Specification & Performance Indices: **(2 Hrs)**

Standard Test Signal: Step, Ramp, Parabolic, Impulse.

Time Response of First-order System: **(4 Hrs)**

Response of the Unit step Input, Response to the Unit Ramp Input.

Time Response of second-order System: **(6 Hrs)**

Response to the Unit Step Input, Time Response specifications, Steady state Error and Design specification, Error constant of 2nd order system, Derivative and Integral control PID control, Design consideration for higher order systems, Performance indices, Optimization using ITAE.

Concept of Stability: **(4 Hrs)**

The concept of stability, necessary conditions for stability, Hurwitz Stability Criterion, Routh Stability Criterion, Application of Routh Stability Criterion to Linear Feedback Systems.

Root of Stability: **(6 Hrs)**

Root Locus Concept, Construction of Root Loci, Construction Rules, Determination of gain from Root Locus.

Frequency Domain Analysis: **(12 Hrs)**

Introduction, Bode diagram, Polar Plots, Log magnitude versus Phase Plots, Nyquist stability criterion, Stability Analysis, Relative stability, Closed Loop Frequency Response: Constant M-Circles, Nichols Chart, Use of MATLAB for performance studies.

Text Books:

1. *Control System Engg. I. J. Nagrath & M. Gopal, 5th edition New Age International (P) Ltd*

Reference Books:

1. *Modern Control Engg, K. Ogata, PHI, 3rd Edn, 1997*
2. *System Dynamics & Control: Eronini Umez-Eronini, 1999 Edn, PWS Publishing International Thompson Publishing Company*
3. *Control Systems Engineering, Norman Nise, Wiley, 3rd Edn.*

EL3022 ADVANCED CONTROL SYSTEMS Cr-3

Introduction to Design: (3 Hrs)

Cascade and feedback compensation, Lead and Lag compensation design using Bodes plot.

Cascade Compensation in Frequency Domain: (7 Hrs)

Correlation of time and frequency domain specifications, Lead and Lag compensation design using Bode plot, Comparison of Lead & Lag Compensation, Feedback compensation in Frequency domain.

PID and Robust Control System Design: (3 Hrs)

Zigler Nichols rules for Turning PID controllers, Modifications of PID control Scheme. Robust control System Design Examples.

State-space Analysis : (3 Hrs)

(Linear Continuous time) Concept of state variables and state model State representation using physical variables and using phase variables & canonical variable.

Solution of stage equations, State Transform matrix: (5 Hrs)

Properties, Computation by Laplace Transform and using Caley-Hamilton Theorem. Transfer function from state equations. Characteristics equation eigen values & eign vectors. Digitalization using similarly Transform, Vander monde Matrix and Modal matrix.

Controllability & Observbility Test: (4 Hrs)

Pole placement using stage feedback for Regulator Type Systems, Full order state observer design, Ackermann's formula, Effect of observer on classed loop system.

Nonlinear Systems: (7 Hrs)

Definitions, examples, Vander Pole's equations

Linearization of nonlinear system, Around equilibrium points, Phase plane method, Singular points, Method of Isoclines, Stability of nonlinear systems, Limit cycles, Phase plane trajectories of simple nonlinear control system.

Discrete-Time System: (4 Hrs)

Sampled data digital control system, Uniform periodic sampling, Mathematical description of sampling process, Spectrum analysis, sampling theorem, aliasing, signal reconstruction, using zero order hold.

Z transform of signals and discrete sequences Z transform theorems Conversion of G (&) to G(Z), Difference equation, Inverse Z-transform methods. The Z transfer function (pulse transfer function)

Difference equation Solution, Z & S domain relationship, Impulse response and step transient response, Error constants, steady state error.

Text Books:

1. Control System Engg, J. Nagrath & M. Gopal 3rd Edition New Age International Publisher

2. Modern Control Engg., By K. Ogata 3rd Edition PHI

Reference Books:

1. *Discrete Time Control System, K. Ogata 2nd Edition Pearson Education*

EL4001 **INDUSTRIAL AUTOMATION AND CONTROL** **Cr-3**

Sensors, Actuators and Signal conditioning: **(8 Hrs)**

Sensors: Displacement sensors, Force sensors, Ultrasonic sensors, Temperature sensors, Pressure sensors etc

Actuators: Dc motors, Servo motors, Stepper motors, Piezo electric actuators, Pneumatic actuators etc.

Signal Conditioning: Filtering, Amplifying, Isolation, ADC, DAC, Sensor protection circuits, Signal transmission and noise suppression, Estimation of errors and calibration.

Controller tuning: **(6 Hrs)**

PI controller, PD controller, PID controller and tuning methods: *Ziegler-Nichols tuning method, Cohen coon tuning method,* Implementation of PID controllers (digital and analog).

Automation: ***(12 Hrs)***

PLC (Programmable logic controllers): Overview, operation and architecture, PLC programming, Application examples.

DCS (D*istributed control systems)*: *Overview, Advantages, Functional requirements of Distributed control systems, Communication for distributed control, Application examples*

SCADA (*supervisory control and data acquisition): Introduction to SCADA, SCADA system components, architecture and communication, SCADA applications.*

Advanced control techniques: **(10 Hrs)**

Feed forward control, Ratio control, Cascade control, Adaptive control, Duplex or split range control, Override control, internal mode control.

Text books:

1. "Computer-Based Industrial Control", Krishna Kant,2nd edition Prentice Hall of India Ltd.

2."Chemical Process Control – Theory and Practice", Stephanopoulous, Prentice Hall of India Ltd, 1984.

3."Fundamentals of Industrial Instrumentation and Process Control", William C. Dunn, TataMcGrawHill, 2009.

Reference books:

1. "Modern Automation Systems", Muhammad Abdelati, University Science Press, 2009.

2. "Modern Control Engineering", 4th edition, Ogata, Prentice Hall of India

ELECTRONICS & INSTRUMENTATION ENGINEERING COURSES

EI2002 **MATERIAL SCIENCE** **Cr-3**

Classification of engineering Materials **(1 Hr)**

Crystal Structures: **(4 Hrs)**

Types of crystal, Unit Cells and Basis Vectors, Miller Indices, Crystal Structure of materials (SCC, BCC, FCC, HCP), Classification of crystals – ionic, covalent and molecular crystals.

Crystal Defects: Point defects, Line Defects, Planar or Surface defects. **(4 Hrs)**

Dielectric Materials and Insulators: **(11 Hrs)**

Polarization, Dielectric constant of mono-atomic and polyatomic gases; Dielectric constant of solids, spontaneous polarization, ferroelectric materials, Curie-Weiss Law, Dielectrics in ac fields, complex polarizability and complex dielectric constant, Dielectric Losses.

Magnetic Properties of materials: **(5 Hrs)**
Dia, Para, ferro, anti-ferro and ferrimagnetism, Magnetic hysteresis, Ferrites and their applications, Hard and soft magnetic materials.

Piezoelectric Materials: **(4 Hrs)**
Electrostriction, Displacement strain and stressin solids, Quartz- Its piezoelectric properties, applications, Pyroelectric.

Superconductivity **(3 Hrs)**
Review of superconductivity, Application of superconductivity- SQUID, Cryotron.

Advance Materials: **(4 Hrs)**
Brief description of other materials such as Corrosion Resistant materials, Nano-phase materials, Shape Memory Alloys, SMART materials, Biomaterials.

Text Books:
1. *Electrical Engineering Materials: A.J. Dekker, 1st Edition,PHI*
2. Material Science: V. Rajendra and A. Marikani,1st Edition, TMH

Reference Books:
1. *Material Science and Engineering: W.D. Callister, 2nd Edition , WILEY*
2. *Material Science and Engineering: V. Raghavan,5th Edition, PHI*
3. *Material Science and Engineering : M.S. Vijaya and G. Rangarajan, 1st edition, TMH*
4. *Material Science for Engineers, James F. Shackelford and M.K. Muralidhara,6th edition, PEARSON*

EI2004 ELECTRICAL & ELECTRONIC MEASUREMENTS Cr-4

Introduction: **(3 Hrs)**
Measurement and its significance, Methods of measurement, Classification of instruments, Errors in measurement, Types, Accuracy and Precision, Significant figures, Units and standards of measurement, classification, Electrical standards, IEEE standards.

Measurement of Resistance, Inductance and Capacitance: **(8 Hrs)**
Resistance: Measurement of low and medium resistance, DC bridges - Wheatstone bridges, Limitations of Wheatstone bridge, Kelvin's double bridge, Measurement of high resistance-Megohm bridge. Inductance: Maxwell's, Hay's, Anderson and Owen's bridge.

Capacitance: Schering &Wein's bridge. Errors in bridge measurement and Wagner's earthing device.

Measurement of voltage and current: **(8 Hrs)**
Galvanometer: Construction, principle of operation of D'Arsonval and Ballistic, sensitivity and Galvanometer constants.

Ammeter and Voltmeter: Construction, theory and principle of operation of PMMC, MI, Electro dynamometer, Inductive, Electrostatic type.

DC Potentiometer: Construction, theory and Principle of Basic slide wire DC potentiometer, Crompton and Vernier potentiometers. AC potentiometers: Drysdale , Gall – Tinsley.

Sensitivity, Loading effect on measurements, Range extension and calibration of Voltmeter and Ammeter.

Measurement of Power, Energy and Power factor: **(8 Hrs)**
Power: Construction, Theory and principle of operation of electro dynamometer, electrostatic Wattmeter, Measurement of 1Φ and 3 Φ power by Wattmeter.

Energy: Construction, Theory and principle of operation of 1Φ and 3Φ Induction watt-hour meter, Errors and compensation.

Theory and operation of frequency, power-factor meters, calibration of Wattmeters and Energymeters.

Current Transformers and Potential Transformers: **(4 Hrs)**
Construction, Theory, characteristics and testing of CT_S and PT_S.

Electronic Instruments for measurement of basic parameters: **(5 Hrs)**
Introduction, Electronic DC & AC Voltmeters, Chopper amplifier type, True RMS Voltmeter, Peak response Voltmeter, Q-meter, Digital Voltmeters (Block diagram only).

Oscilloscope: **(8 Hrs)**
CRO, Block diagram, sweep circuits, Delay line, multiple trace, and oscilloscope probes. Introduction to analog and digital storage oscilloscope, Measurement of frequency, phase angle and time delay using oscilloscope.

Frequency Counters, Function Generators and Spectrum analyzers: **(4 Hrs)**
Frequency Counters, Function generators, spectrum analyzers: Block diagram, working, types.

Text Books:
1. *A Course in Electrical and Electronic Measurements and Instrumentation, A K Sawhney, Dhanpat Rai & Co, Reprint, 2013.*
2. Modern Electronic Instrumentation and Measurement Techniques, Helfrick & Cooper, 2nd Edition. PHI,

Reference Books:
1. *Electrical Measurements and Measuring Instruments, Golding &Widdis , 5th edition, Reem Publication,*
2. *Electronic Instrumentation, H S Kalsi , 3rd Edition, TMH.*
3. *Electronic Instrumentation &Measurements, David A. Bell, 3rd Edition, Oxford University press.*
4. *Elements of electronic instrumentation and measurement, Joseph J. Carr, 3rd Edition.*

EI3001 INSTRUMENTATION – I Cr-4

Introduction: **(6 Hrs)**
Instrument and measurement system and its functional elements
Input – Output configuration, correction methods

Performance characteristics of Instrumentation system: **(6 Hrs)**
Static and dynamic characteristics, loading effect, Impedance concept.

Statistical analysis: **(6 Hrs)**
Statistical concepts, probability distribution function, chi-square test, curve fitting techniques, Reliability.

Primary sensing elements and Transducers: **(15 Hrs)**
Primary sensing elements: Mechanical, Pressure and flow sensing elements.
Transducers: Introduction, classification, characteristics and selection
Resistive transducers – Potentiometers, strain gauge, RTD, Thermistor, Photo Conductive cell, pirani gauge.
Inductive transducers: Variable inductance, LVDT, RVDT, Synchro, Resolver.
Capacitive, Hall-effect, Proximity sensors, opto-electronic, ultrasonic and fibre-optic transducers.Voltage generating transducers – thermocouple, piezoelectric and pyroelectric transducers, moving coil generator.
Magnetic type transducers – eddy current, magnetostrictive and magneto resistive types
Digital transducers.

Signal conditioning: **(8 Hrs)**
Introduction, signal conditioning circuits using DC bridges (Wheatstone bridge), AC bridges with push-pull transducer - Blumlein bridge, Diode circuits, Op-Amps, Attenuators, Filtering, Modulation and Demodulation techniques, A/D and D/A conversion in measurement.

Measurement of non-electrical quantities: **(7 Hrs)**
Measurement of force, weight, stress and strain, velocity and acceleration and torque, Shock measurement, Introduction to vibration measurement and monitoring.

Text Books:
1. *Transducers and Instrumentation – D. V. S. Murthy, 2nd edition, 2013 - PHI Learning.*
2. *Principle of Measurement Systems – J. P. Bentley 4th edition, Pearson Education.*

Reference Books:

1. *Measurement System Application and Design – E. O. Doeblin,5th edition, TMH*
2. *Sensors & Transducers - D. Patranabis, 2nd edition, PHI*
3. *Introduction to Measurement and instrumentation – A.K. Ghosh, 2012, PHI.*
4. *The Measurement, Instrumentation and Sensors Hand book – John G Webster, CRC press.*

EI3002 INSTRUMENTATION – II Cr-4

Temperature measurement: (8 Hrs)

Temperature scales, ITS90.Filled in systems, Bimetal elements, RTD, Thermocouple, Semiconductor temperature sensors, Radiation pyrometers.

Pressure & vacuum measurement: (8 Hrs)

Manometer types, Elastic type, D/P Transmitters. Electronic type: capacitive, piezoresistive and resonator type, Installation of pressure measuring devices, accessories.
Vacuum: McLeod gauge, thermal conductivity gauge, ionization gauge.

Level measurement: (8 Hrs)

Gauge glass, float, displacers and hydrostatic types, D/P type, capacitive type, conductive type, ultrasonic type, microwave type, radiation type, vibration type.

Flow measurement: (11 Hrs)

Basic principles of flow measurement, Differential pressure devices: orifice, venturi, flow nozzle, pitot tube, annubar, Area flow meter: Rotameter and piston type. Mass flow meter: Coriolis, thermal & impeller types. Electromagnetic type, ultrasonic type, vortex type, turbomagnetic type, target type, positive displacement type, open channel flow measurement, solid flow rate measurement.

Viscosity, density, conductivity and humidity measurements : (8 Hrs)

Capillary Viscometer, Saybolt viscometer, float viscometer, plastometer, vibrating type, oscillating type, ultrasonic type. Measurement of density: liquid density measurement, gas densitometers, Conductivity measurement.Humidity measurement.

Instrumentation in hazardous locations: (5 Hrs)

Area, material & temperature, classification, explosion proof enclosures, intrinsic safety, Pressurization, non incendive systems, Combustible gas detectors, Enclosure classification: IP & NEMA standards.

Text books:

1. Industrial instrumentation & control, S. K. Singh , 3rd Edition, TMH.
2. Industrial instrumentation, K.Krishnaswamy, S.Vijayachitra, 2nd Edition, New age international.

Reference books:

1. Instrument engineers handbook, Vol-1, B.G Liptak, CRC press
2. Measurement System Application and Design – E. O. Doeblin,5th edition, TMH

EI3004 PROCESS CONTROL-I Cr-4

Introduction to design: (8 Hrs)

Cascade and feedback compensation, PI, PD, AND PID Controller design, Lead, Lag and Lag-Lead compensators design . Comparison of Lead - Lag compensation. Feedback compensation.

State-space analysis: (8 Hrs)

Modelling-Concept of state variables and state model (Linear continuous time), State representation using physical variables, phase variables & canonical variable. Solution of state equations, State transform matrix-Properties, Computation by Laplace Transform and using Caley-Hamilton Theorem. Transfer function from state equations. Characteristics equation Eigen values & Eigen vectors. Vander monde matrix and modal matrix. Controllability & Observability test.

Process dynamics and modeling: (12 Hrs)

Need for process control. Mathematical model of flow, Level, Pressure and Thermal Processes, CSTR. Interacting and non-interacting systems, Degrees of freedom, Continuous and batch processes, MIMO processes. Transient response of control systems, servo and Regulatory operations, Proportional control of single capacity, two-capacity, three-capacity processes.Linearization of nonlinear systems.

Basic control schemes: **(8 Hrs)**

On-off control, proportional control, PI,PD,PID Control, Frequency response of controllers, Comparison of control actions. Pneumatic, Hydraulic, Electronic controllers.

Controller tuning: **(4 Hrs)**

Performance criteria Tuning methods: Process Reaction Curve method, Continuous cycling method and Damped oscillation method, Zeigler-Nichols method, Cohen - Coon method.

Complex control schemes: **(12 Hrs)**

Ratio control, Split range control, Cascade control, Feed forward control, selector control, Inverse derivative control, Antireset control. Multivariable control systems Dead time compensation-Smith predictor, selective and Adaptive control systems.

Text Books

1. *Process Dynamics & control – Dale E-Seborg, Duncan A. Mellichamp, Thomas F. Edger, Francis J. boyle, John wiley & sons, 3rd Edition*
2. *George Stephanopoulos, Chemical Process control, An Introduction to Theory and Practice, 1st Edition, PHI.*

Reference Books

1. *Harriott Peter, Process control, 1st Edition, 2009, Tata Mc Graw Hil.*
2. *Principles of Process Control –, D Patrnabis, 3rd Edition, TMH.*
3. *Process control principle and Application- Surekha Bhanot, 1st Edition, Oxford.*
4. *Process Control: Concepts, Dynamics and Applications – SK Singh, 2009 PHI.*

EI4001 ANALYTICAL INSTRUMENTATION Cr-4

Fundamentals of Analytical Instruments: **(2 Hrs)**

Elements of an Analytical Instrument, Intelligent Analytical Instrumentation Systems, PC-based Analytical Instruments.

Spectrophotometry: **(8 Hrs)**

Ultraviolet and Visible Absorption Spectroscopy.Colorimeters. Different types of Spectrophotometers. Sources of Errors and Calibration. Infrared Spectrophotometers, Basic Components and Types, Sample Handling Techniques. Flame Photometers, Principle, Constructional Details, Types and accessories. Atomic Absorption Spectrophotometers and their instrumentation.

Chromatography: **(8 Hrs)**

Gas Chromatograph , Basic Parts of a Gas Chromatograph, Methods of Measurement of Peak Areas. Liquid Chromatograph, Types, High Pressure Liquid Chromatograph.

Electro Chemical Instruments: **(3 Hrs)**

Electrochemical cell. Types of Electrochemical methods, Potentiometry, Conductivity meters, Voltametry.

Ph Meters And Ion Analyzers : **(4 Hrs)**

Principle of pH Measurement, Electrodes for pH Measurement, pH Meters, Ion Analyzers.

Analyzers: **(5 Hrs)**

Blood gas analyzers, Measurement of Blood pCO_2 and pO_2. Industrial Gas Analyzers, Paramagnetic Gas Analyzer, The Electrochemical methods, Infrared Gas Analyzers, Analyzers based on Gas density, Method based on Ionization of gases.

Mass Spectrometer: **(3 Hrs)**

Principle, Types, components of a mass spectrometer.

NMR &ESR Spectrometer: **(3 Hrs)**

Principle, Types and Construction details of NMR Spectrometers. Introduction to ESR spectrometer.

Radiochemical Instruments: **(4 Hrs)**
Fundamentals of Radiochemical Methods, Radiation Detectors, Liquid Scintillation Counters, Gamma Spectroscopy.

X-RAY Spectrometer: **(4 Hrs)**
Instrumentation for X-Ray Spectrometry, X-Ray Diffractometers, X-Ray Absorption Meters, Electron Probe Microanalyzer.

Pollution Monitoring Instruments: **(4 Hrs)**
Air pollution due to carbon monoxide, sulphur dioxide, Nitrogen oxides, Hydrocarbons, Ozone, Water pollution monitoring instruments.

Text books:
1. *Handbook of Analytical Instruments – by R.S. Khandpur, 2nd edition, TMH*

Reference books:
1. *Instrumental Methods of Analysis , Hobart H. Willard, 2012, 7th edition, CBS publisher*
2. *Principles of Industrial Instrumentation, D. Patranabis, 3rd edition, TMH.*

EI4003 PROCESS CONROL-II Cr-3

Computer Aided Process Control: **(1 Hr)**
Introduction, Overview on computer control of process plants.

Digital control systems: **(8 Hrs)**
Sampled data digital control system, sampling theorem, signal reconstruction. Z-plane analysis of discrete time control systems, stability analysis in Z-plane, steady state error analysis of sampled data digital control systems. Direct Digital Control, structure, Digital implementation of PID controller, Controller design by S-Z plane transformation. Microprocessor based DDC structure.

Programmable Logic Controller: **(5 Hrs)**
Introduction, Architecture, relay ladder logic, programming, software, configuration and applications.

Distributed control system and SCADA: **(6 Hrs)**
Introduction.DCS system architecture and elements, configuration and applications, The basic SCADA structure, hardware and software.

Final control elements: **(8 Hrs)**
Actuators: Pneumatic Actuators, Electrical Actuators and drive circuit, Control valves: Ball valve, Butterfly valve, Globe valve, Saunders valve. Valve characteristics, Quick opening, Linear, and Equal percentage, Valve sizing and selection, Valve positioners, P-I and I-P converters. Connecting elements in Flow, Level, Pressure and Temperature control loops. Introduction to P&I diagram.

Plant process control: **(4 Hrs)**
Boiler control- Control schemes, combustion control, optimizing air-flow, feed water control, furnace pressure control, and steam temperature control. Distillation column- Control schemes, Batch process control-Control schemes.

Industrial control applications: **(4 Hrs)**
Cement plant, Thermal power plant, and Steel plant- objectives, automation strategy, and their DCS structure.

Text Books:
1. *Digital control systems, Benjamin C. kuo, OXFORD,1st Edition.*
2. *Process control principles and applications, Surekha Bhanot, OXFORD, 1st Edition.*

Reference books:
1. *B. G. Liptak, Instrument Engineers Handbook , Volume-II & III, Chilton Book Co., Philadelphia.*
2. *Computer Aided Process Control, S.K.Singh, 2005, PHI.*
3. *Programmable Logic Controllers : Programming Methods and Applications (With CD) (English) , Hackworth, 1st Edition.*

EI4021 INDUSTRIAL INSTRUMENTATION Cr - 3

Temperature measurement (4 Hrs)
Bimetal elements. RTD, Thermocouple, Semiconductor temperature sensors, Radiation pyrometers, thermistor.

Pressure & vacuum measurement (6 Hrs)
Manometer types, Elastic type, D/P Transmitters. Electronic type: capacitive
Vacuum: McLeod gauge, thermal conductivity gauge, ionization gauge**,** Bourdon tube.

Level measurement (4 Hrs)
D/P type, capacitive type, ultrasonic type, microwave type, radiation type**.**

Analytical measurements (10 Hrs)
Spectrophotometry: Ultraviolet and Visible Absorption Spectroscopy, Infrared Spectrophotometers.
Mass Spectrometer: Principle, Types, Components of a mass spectrometer.
Chromatography: Gas chromatograph, Basic parts of gas chromatograph, Methods of measurements of peak areas.
Pollution Monitoring Instruments: Air pollution due to carbon monoxide, sulphur dioxide, Nitrogen oxides, Hydrocarbons, Ozone, Water pollution monitoring Instruments.

Power Plant Instrumentation (12 Hrs)
Over view Of Power Generation: Introduction, Basic overview of power generation in thermal power plants, P & I diagram, Cogeneration of Power, Importance of Instrumentation and control in power generation.
Instrumentation and Control In Water Circuit: Introduction, Measurements in Water Circuit Water flow, steam flow, water and steam pressure, water and steam temperature, boiler drum water level, Measurement of impurities in water and steam.
Controls in water circuit: Boiler, drum level, superheated steam temperature, steam pressure.
Turbine – Monitoring and Control: Introduction, Turbine Measurements Electrical, Mechanical and Process parameters, Turbine control systems Safety and process, Lubrication system for Turbo Alternator and its control, Turbo Alternator cooling system.

Text books:
1. Industrial instrumentation & control, S. K. Singh , 3rd Edition, TMH.
2. Power plant Instrumentation-K .Krishnaswamy, M. Ponnibala, 2nd edition,PHI publication

Reference books:
1. *Industrial instrumentation, K. Krishnaswamy, S. Vijayachitra, 2nd edition, New age international.*
2. *Instrument engineers handbook, Vol-1, B.G Liptak, CRC press*
3. *Handbook of Analytical Instruments- by R. S. Khandpur, 2nd edition, TMH*

EI4022 VIRTUAL INSTRUMENTATION Cr-3

(Introduction: (4 Hrs)
Virtual Instrumentation – Definition, flexibility – Block diagram and Architecture of Virtual Instruments – Virtual Instruments versus Traditional Instruments Data flow techniques-graphical programming in dataflow– Review of Popular softwares in virtual Instrumentation.

VI Programming Techniques: (6 Hrs)
VI- sub VI- Loops-structures-charts- arrays- clusters –graphs- formulae nodes –math script- local and global variable-strings- file I/O-execution control- Instrument drivers.

Data Acquisition in VI: (10 Hrs)
Introduction to data acquisition-signal conditioning-classes of signal conditioning-field wiring and signal measurement-ground loops-A/D, D/A converters, plug-in DAQ boards- Analog input/output cards -Digital Input/Output cards-counter and timer I/O boards-Isolation-techniques- Opt isolation -Data acquisition modules with serial communication.

Communication networked modules: (8 Hrs)

Introduction to PC Buses – Local bus: ISA – PCI –RS232 – RS422 – RS485 – Interface Bus – USB, PCMCIA, VXI, SCXI, PXI. Instrumentation buses: Modbus – GPIB – Networked bus – ISO/OSI Reference model, Ethernet, and VISA.

Real time control and Applications: **(8 Hrs)**
Design of ON/OFF controller- PID controller –electronic prototyping and testing with ELVIS- real-time data acquisition-transducer analysis-signal processing with DSP module-real-time embedded control with CRIO.

Text Books:

1. Virtual Instrumentation Using LabView, Jerome, 1st Edition, PHI

2. LabView Graphical Programming, Gary W. Johnson, Richard Jennings, 4th Edition, TMH

Reference Books:
1. *Practical Data Acquisition for Instrumentation and Control Systems, John Park and Steve Mackay, 2003, Newnes*
2. *labview based advanced instrumentation system, psumathi, 1st edition,2007, springer science elsevier*

EI4023 FIBER OPTIC INSTRUMENTATION Cr-3

Optical Sources: **(3 Hrs)**
Light Emitting Diodes (LEDs), LED Structures, Light Source Materials, Quantum Efficiency and LED Power, Modulation of an LED.

LASER diodes: **(4 Hrs)**
Principle of Operation, Modes and Threshold Conditions, Optical output power and drive current, Quantum efficiency, Resonant frequencies, Radiation Pattern, Single Mode Lasers, Modulation of Laser diode.

Optical Detectors: **(8 Hrs)**
P-n junction Photo diodes, Power relationship, Responsivity Versus wavelength, Equivalent Circuit of a p-n Photo diode, Bandwidth, p-i-n photo diode and APD, Principle of operation, Sources of noise, Noise Equivalent Circuits, Signal to noise ratio for p-i-n and APD.

Optical Fiber: **(8 Hrs)**
Fiber Materials, Ray Propagation in Step-Index Fibers, Total internal reflection, Ray Propagation in Graded Index Fibers, Mode Theory, Monomode Fibers, Attenuation in Optical Fibers – absorption, scattering and bending losses

Power Launching and Coupling: **(4 Hrs)**
Source-to- Fiber Power Launching, Power-coupling calculation, Equilibrium Numerical Aperture, Lensing Schemes for coupling Improvement.

Fiber-Optic Sensors: **(5 Hrs)**
Intensity Modulated Sensors, Phase Modulated Sensors, Fiber-optic Mach-ZehnderInterferometric sensor, Fiber-optic Gyroscope, Spectrally Modulated Sensors, Distributed Fiber Optic Sensors,Fiber optic Bragg grating senor.

Optical Amplifiers: **(4 Hrs)**
Semiconductor Optical amplifiers (SOA), Erbium Doped Fiber amplifiers,Fiber Raman ampliflier.

Text Books:
1. *Optical Fiber Communication by Gerd Keiser, 4th Edition ,McGraw Hill International Edition*
2. *Fiber Optics and Opto electronics by R. P. Khare, 1st Edition, Oxford University Press*

Reference Book:
1. *Optical Fiber Communications Principles and Practice by John M. Senior, 3rd Edition Pearson Education*
2. *Optoelectronics and Fiber Optics Communication by C.K.Sarkar and D.C Sarkar, 2nd Edition. New Age International*

EI4024 NEURAL NETWORKS AND FUZZY LOGIC CONTOL Cr-3

Neural Networks and Pattern Association: (8 Hrs)
Differences between biological and artificial neural networks – Typical architecture – Common activation functions – McCulloch – Pitts neuron – Simple neural nets for pattern classification – Linear separability – Hebb net – Perceptron – Adaline – Madaline – Architecture – Algorithm and simple applications – Training algorithms for pattern association – Hebb rule and delta rule – Hetero associative – Auto associative and iterative auto associative net – Bidirectional associative memory – Architecture – Algorithm – Simple applications.

Neural Netwroks based on Competition: (6 Hrs)
Kohonen self organising maps – Learning vector quantization – Counter propagation – Architecture – Algorithm and applications

Adaptive Resonance and Backpropagation Neural Networks: (6 Hrs)
ART1 and ART2 – Basic operation and algorithm – Standard back propagation architecture –
Derivation of learning rules – Boltzmann machine learning – Architecture – Algorithm and simple applications
Fuzzy sets and Membership Functions: (10 Hrs)
Properties and operations on classical and fuzzy sets – Crisp and fuzzy relations – Cardinality – properties and operations – Composition – Tolerance and equivalence relations – Simple problems –Features of membership function – Standard forms and boundaries – Fuzzification – Membership value assignments – Fuzzy to crisp conversions – Lambda cuts for fuzzy sets and relations –Defuzzification methods

Applications of Neural networks and Fuzzy logic: (6 Hrs)
Applications of neural networks – Pattern recognition – Image compression – Communication – Control systems – Applications of fuzzy logic – Fuzzy pattern recognition – Fuzzy image compression – Fuzzy logic controllers

Text Books:
1. *Fundamentals of Neural Networks, Laurene Fausett, 2004, Pearson Education.*
2. *Fuzzy Logic with Engineering Applications, Timothy Ross, 1998, McGraw-Hill.*

References:
1. *Introduction to Neural Networks Using Matlab 6.0, Sivanandam, S.N., Sumathi, S. and Deepa, S.N, 2005, TMH.*
2. *Fundamentals of Artificial Neural Networks, Mohammad H. Hassoun, 1st edition,2010, PHI*
3. *Neural Networks and Fuzzy Systems, Bark Kosko, 1st edition, PHI*

EI4025 PRINCIPLE OF ANALYTICAL INSTRUMENTATION Cr-3

Fundamentals of Analytical Instruments: (1 Hrs)
Introduction, Elements of an Analytical Instrument.

Spectrophotometry: (7 Hrs)
Ultraviolet and Visible Absorption Spectroscopy. Different types of Spectrophotometers. Sources of Errors and Calibration. Infrared Spectrophotometers, Basic Components and Types, Sample Handling Techniques. Flame Photometers, Principle, Constructional Details, Types and accessories. Atomic Absorption Spectrophotometers and their instrumentation.

Chromatography: (6 Hrs)
Gas Chromatograph , Basic Parts of a Gas Chromatograph, Methods of Measurement of Peak Areas. Liquid Chromatography, principle, construction.

Ph Meters And Ion Analyzers : (4 Hrs)
Principle of pH Measurement, Electrodes for pH Measurement, pH Meters, Ion Analyzers.

Analyzers: (5 Hrs)
Blood gas analyzers, Measurement of Blood pCO_2 and pO_2. Industrial Gas Analyzers, Paramagnetic Gas Analyzer, The Electrochemical methods, Infrared Gas Analyzers, Analyzers based on Gas density, Method based on Ionization of gases.

Spectrometers: (6 Hrs)

X-RAY Spectrometer: X-Ray Diffractometers, Electron Probe Microanalyzer. Massspectrometer: Principle, construction. NMR &ESR Spectrometer: Principle, construction

Radiochemical Instruments: **(3 Hrs)**
Radiation Detectors, Liquid Scintillation Counters, Gamma Spectroscopy.

Pollution Monitoring Instruments: **(4 Hrs)**
Air pollution due to carbon monoxide, sulphur dioxide, Nitrogen oxides, Hydrocarbons, Ozone, Water pollution monitoring instruments.

Text books:
2. *Handbook of Analytical Instruments – by R.S. Khandpur, 2nd edition, TMH*

Reference books:
3. *Instrumental Methods of Analysis , Hobart H. Willard, 2012, 7th edition, CBS publisher*
4. *Principles of Industrial Instrumentation, D. Patranabis, 3rd edition, TMH.*

EI4032 BIOMEDICAL INSTRUMENTATION Cr-3

Fundamentals of Biomedical Instrumentation: **(5 Hrs)**
Sources of Biomedical Signals, Basic Medical Instrumentation System, Intelligent Medical Instrumentation Systems, PC Based Medical Instrumentation Systems, General Constraints & Regulations of Medical Devices.

Biomedical Signals & Electrodes: **(7 Hrs)**
Origin of Bioelectric Signals-Repolarization, Depolarization, Resting Potential Recording Electrodes – Ag-AgCl Electrodes, Electrodes for ECG, EEG, EMG, Microelectrodes, Skin Contact Impedance, Motion Artifacts, Transducers used in biomedical applications.

Blood pressure measurements: **(8 Hrs)**
Manual / automatic systems, invasive and non invasive types, Sphygmomanometer, Blood flow measurements using ultrasonic and electromagnetic flowMeters.

Heart: **(8 Hrs)**
Engineering analog of heart, model of heart, electrocardiograph-principle of instrument, detail instrumentation, noises and interference in the measurement, its solutions, other systems of diagnosing the heart.
Pacemaker – general description and instrumentation details, Defibrillator.

X-ray imaging: **(2 Hrs)**
Range for medical use, principle of X-ray generation, instrumentation of X- ray image.

Computer aided tomography (CAT): **(2 Hrs)**
Basic principle, image acquisition, mathematical modeling for reconstruction of image, block diagram representation of the instrument and detailing of some parts.

Biotelemetry: **(2 Hrs)**
Techniques and Applications.

Patient Safety: **(2 Hrs)**
Electric Shock Hazards, Leakage Currents, Safety Codes for Biomedical Equipment.

Text Books:
1. *Hand Book of Biomedical Instrumentation- by R. S. Khandpur, 2nd Edition, Tata McGraw Hill.*
2. *Biomedical Instrumentation and Measurements- by Leslie Cromwell, Fred J. Weibell, Erich A. Pfeiffer, 2nd Edition, PHI learning Pvt. Ltd.*

Reference Books:
1. *Introduction to Biomedical Equipment Technology- by Joseph J. Carr, John M. Brown, 4th Edition. Pearson Education.*

EI4034 NONLINEAR CONTROL THEORY Cr-3

Introduction to nonlinear phenomena: **(4 Hrs)**
Nonlinear systems-introduction-behavior of nonlinear systems-jump resonance-limit cycles, Common physical nonlinearities-saturation-friction-backlash-dead zone-relay, Multivariable nonlinearities (definition).

Phase plane analysis: **(10 Hrs)**
The phase-plane method-basic concepts-singular points-nodal point-saddle point-focus point-vortex point, Construction of phase trajectories-analytical method-graphical methods-isocline method, delta method, Example problems.

Describing function analysis: **(10 Hrs)**
Describing function method-basic concepts, derivation of describing functions-dead zone and saturation, relay with dead-zone and hysterisis, backlash, Stability of nonlinear systems- analysis bydescribing function-using Nyquist stability criterion- limit cycles-Reliability of describing function analysis.

Lyapunov Stability Theory: **(12 Hrs)**
Stability of nonlinear systems-Lyapunov theory (review)- autonomous and non-autonomous systems ,equilibrium points, Stability in the sense of Lyapunov, asymptotic stability and exponential stability, Linearization and local stability, Lyapunov's direct method, positive definite functions and Lyapunov functions, Lyapunov theorem for local stability and global stability, Analysis based on Lyapunov's direct method-LTI systems-Krasovskii's method, Variable gradient method for constructing Lyapunov functions-simple examples, Popov's stability criterion. Stability of non-autonomous systems (basic concepts only)-Lyapunov's direct method –simple problems.

Text Books:
1. Systems and control, Stanislaw H. Zak, 1st Edition, oxford university press
2. Control System Engg. I. J. Nagrath & M. Gopal, 5th edition ,New Age International (P) Ltd

Reference Books:
1. *Nonlinear Systems Analysis, M. Vidyasagar, Englewood Cliffs. 2nd edition 1993, Prentice Hall*
2. *Nonlinear Systems, H. K. Khalil, Englewood Cliffs, N.J ,3rd edition, 2001 Prentice Hall*
3. *Nonlinear Control of Engineering Systems: W. E. Dixon, A. Behal, D.M. Dawson, and S. Nagarkatti A Lyapunov-Based Approach, Birkhäuser, Boston, 2003*

EI4036 POWER PLANT INSTRUMENTATION Cr-3

Overview of Power Generation: **(6 Hrs)**
Introduction, Basic overview of power generation in thermal power plants, P& I diagram, Cogeneration of power, Importance of instrumentation and control in power generation.

Instrumentation and Control in Water Circuit: **(12 Hrs)**
Introduction, Measurements in water circuit: water flow, steam flow, water and steam pressure, water and steam temperature, boiler drum water level, Measurement of impurities in water and steam, Controls in water circuit: boiler drum level, superheated steam temperature, steam pressure.

Instrumentation and Control in Air-Fuel Circuit: **(10 Hrs)**
Introduction, Measurements in air-fuel circuit: flow, pressures, temperatures and level. Controls in air-fuel circuit: combustion and furnace draft. Analytical measurements in air-fuel circuit: oxygen and carbon dioxide in flue gas, combustibles analyser, and infrared flue gas analyser, smoke detector, dust monitor, fuel analysers and chromatography, Pollution monitoring instruments.

Turbine–Monitoring and Control: **(8 Hrs)**
Introduction, Turbine measurements: electrical, mechanical and process parameters. Turbine control systems: safety and process, Lubrication system for Turbo Alternator and its control, Turbo Alternator cooling system.

Text books:
1. *Power Plant Instrumentation – K.Krishnaswamy, M.Ponnibala, 2nd Edition, PHI publications.*
2. Power Plant Engineering - P.K Nag, 3rd Edition, Tata McGraw-Hill.

References:

1. *Standard Boiler Operations - S.M. Elonka and A.L Kohal, Tata McGraw-Hill.*
2. Mechanical and Industrial Measurements - R.K Jain, 2008, Khanna Publishers.
3. Power Plant Engineering – EL. Wakil, Tata McGraw-Hill.

EI4038 INSTRUMENTATION FOR OIL & GAS INDUSTRIES Cr-3

Overview of petrochemical processes: (8 Hrs)

Introduction, Petroleum Feedstocks: exploration, recovery, composition, Oil and Gas separation, Refining of crude oil, Processes, Products from crude oil: Methane, Acetylene, Ethylene, Propylene – derivatives etc., Unit operations: Distillation etc.

Measurements: (12 Hrs)

Pressure, Temperature, Flow, Level sensors; Analytical Instruments: Chromatography, Gas analyzer etc.; Special types of sensors: Soft-sensors in distillation columns, magnetostrictive and magnetic float for level measurement etc.

Control of refinery processes: (16 Hrs)

Process control in refinery and petrochemical industry: Control of distillation column, Control of catalytic crackers and pyrolysis unit, Automatic control of polyethylene production, Control of vinyl chloride and PVC production; Controls for Safety.

Text books:

1. *Chemicals from Petroleum, L. Waddams,2nd edition, Chemical Publishing Company*
2. *Process Control Structures and Applications, Balchan.J.G., and Mumme K.I., Van 1988, Nostrand Reinhold Company, New York*

Reference books:

1. *The Refinery of the Future, James G. Speight, 2010. William Andrew Publishing*
2. *Instrumentation in Process Industries, B. G. Liptak 2005, CRC Press*

MECHANICAL ENGINEERING COURSES

ME1001 ENGINEERING MECHANICS Cr-4

Concurrent Forces in a Plane: Introduction to Engineering Mechanics, Free-body diagrams, Composition and resolution of forces, Equilibrium of concurrent forces in a plane, Methods of projections, Methods of moments **(10 Hrs)**

Friction: Static friction, Laws of dry friction, Applied of friction in inclined plane, Wedge friction, Belt friction **(4 Hrs)**

Parallel Forces in a Plane: Parallel forces acting in the same and opposite directions, General case of parallel forces in a plane, Centre of parallel forces, Centroid and Centre of gravity, Theorem of Pappus, Centre of composite plane figures and Curves, Distributed forces in a plane. **(8 Hrs)**

Moment of Inertia: M I of plane figures, Parallel Axis Theorem, Perpendicular axis theorem and MI of composite figures. **(3 Hrs)**

Force analysis of Plane Trusses and Frames: Methods of joints, Method of Sections and Method of members. **(6 Hrs)**

Principle of Virtual work: Equilibrium of Ideal Systems, Virtual work. **(2 Hrs)**

Kinematics of Rectilinear Motion: Differential equations of rectilinear motion, Force proportional to displacement, Free vibration, D' Alembert's Principle, Momentum and Impulse, Work & Energy, Conservation of energy, Impact. **(7 Hrs)**

Kinematics of Curvilinear Motion: Normal and Tangential acceleration, Motion of a Projectile, Work and Energy in curvilinear motion. **(4 Hrs)**

Rotation of a rigid body: Kinematic s of rotation, Rotation under the action of a constant moment. **(4 Hrs)**

Text Book

2. *Engineering Mechanics* – S Timoshenko, D. H Young & J.V. Rao-TMH

Reference Books

1. *Engineering Mechanics (Statics and Dynamics)* - Bear and Johnson, TMH
2. *Engineering Mechanics* –S.S. Bhavikatti, New Age International

ME2001 ENGINEERING THERMODYNAMICS Cr-4

Basic concepts and definitions: Scope of thermodynamics, Macroscopic and microscopic approaches, Definition of fixed mass (closed system) and control volume (open system), Properties (extensive and intensive), State and representation on a property diagram, process and its representation, cyclic process (or cycle) and its representation, Characteristics of properties (point and path function), Reversible and irreversible processes, Thermal, mechanical and chemical equilibrium, thermodynamic equilibrium, Zeroth law of thermodynamics, Forms of energy, energy transfer by heat, forms of work (electrical and mechanical), energy transfer by work, conservation of mass in a control volume. **(10 Hrs)**

First law of thermodynamics: Moving boundary work (PdV work), PdV work for different processes, First law for closed systems (for cyclic and non-cyclic processes), introduction of internal energy as a thermodynamic property, flow work and energy of a flowing fluid, first law for control volumes (open systems) and introduction of enthalpy as a thermodynamic property, Application of first law to different processes of fixed masses (closed systems) and control volumes. **(10 Hrs)**

Second law of thermodynamics: Kelvin-Planck and Clausius statements of second law, Reversible and irreversible processes, Irreversibilities, Carnot principles, Clausius inequality, definition of entropy and its evaluation for various processes of pure substances, principle of increase of entropy, Entropy generation. **(8 Hrs)**

Pure substances: Definition of pure substance, p-V and T-v diagrams for pure substances, specific volumes of saturated liquid, wet vapor and superheated vapor. Use of steam tables in finding internal energy and enthalpy of steam at different conditions. **(8 Hrs)**

Thermodynamic property relations: Ideal gases and their p-V-T relation, The Maxwell relations, The Clapeyron's equation, Change in internal energy, Change in internal enthalpy, the T-ds relations, Relation between specific heats, isothermal compressibility and volume expansivity, the Joule-Thomson coefficient. **(6 Hrs)**

Exergy: Available energy or Exergy, Useful work, availability for closed systems, flow availability, irreversibility, Second law efficiency. **(6 Hrs)**

Text Books:

1. *Thermodynamics, An Engineering Approach,* Yunus A Cengel and Michael A. Boles, Mc Graw Hill Education, 7th Edition, 2011 (reprint 2013)

Reference Books:

1. *Fundamentals of Classical Thermodynamics,* Gordon J. Van Wylen , Richard E. Sonntag, Claus Borgnakke, John Wiley, Fifth Edition
2. *Engineering thermodynamics,* P. K. Nag, McGraw Hill Education, Fifth Edition

ME2002 MACHINE DYNAMICS Cr-3

Force analysis: Analytical method of finding acceleration of a piston and connecting rod. Inertia force, Torque. Inertia forces in the Reciprocating Engines, Turning Moment diagrams, Flywheel. **(5 Hrs)**

Gyroscope: Gyroscopic couple of plane disc. Analysis of the forces on bearings due to the forced processing of rotating disc mounted on shafts. Gyroscopic effects on a two wheel and four wheel vehicle. Gyroscopic stabilization with reference to practical application. **(5 Hrs)**

Governors: Centrifugal Governor: Watt and Porter Governors, Spring loaded Governor-Hartnell Governor,Sensitiveness,Stability,Isochronous,Hunting,Governor Effort and Power, curves of Controlling force, Effects of frictions. **(5 Hrs)**

Balancing: Balancing of revolving masses in the same planes and different planes. Partial balance of Locomotives. Variation of tractive efforts, swaying couple. Primary and Secondary balance of multicylinder engines. **(5 Hrs)**

Free Vibration: Free vibration of single degree system without and with damping, Equilibrium Method, Energy method, stiffness of spring elements, viscous damping, Logarithmic decrement. **(4 Hrs)**

Forced Vibration: Equation of motion, Dynamic amplifier, Vibration isolation and transmissibility, transverse vibration of shafts carrying a point load, uniformly distributed load and several loads. Dunkerly's method and energy method, whirling of shafts, Two rotor systems. **(5 Hrs)**

Toothed Gears: Theory of shape and action of tooth properties and methods of generation of standard tooth profiles, Standard proportions, Interference and under cutting, methods of elimination of interference, minimum number of teeth to avoid interference. **(4 Hrs)**

Lower Pairs: Hook's joint, Davis and Ackerman Steering gears. **(3 Hrs)**

Text Books:

1. *Theory of Machines,* Sadhu Singh, Pearson

Reference Books:

1. *Theory of Machines,* Shigley J, TMH
2. *Mechanism and Machine Theory,* J.S.Rao and R.V.Dukkipati, New Age
3. *Theory of Mechanism and machines,* Sharma & Purohit, PHI

ME2003 FLUID MECHANICS Cr-3

Fundamental Concepts: Definition of a fluid, Macroscopic and Microscopic view points, the concept of continuum, concept of pressure and stress in a fluid, Properties of a fluid. (**3 Hrs)**

Fluids under Rest: Fundamental equation and its solution (constant density and constant temperature solutions), Units and scales of pressure measurement, Manometers, Hydrostatic thrusts on submerged surfaces (plane and curved), Buoyancy, Stability of unconstrained bodies in fluids, Fluids under relative equilibrium. **(6 Hrs)**

Kinematics of Fluid Flow: Scalar and vector fields, Description of fluid motion, variation of flow parameters in time and space, Material derivative and acceleration, Stream lines, path lines and streak lines, Translation, Rate of deformation and Rotation. Derivation of Continuity Equation in Cartesian coordinates (Control mass system approach and Control volume approach). Stream function, constancy of stream function on a streamline, physical significance, Velocity Potential, Relationship between velocity potential and stream function. **(9 Hrs)**

Dynamics of Invicid Flows: Equation of motion for invicid flow in Cartesian coordinates, Pressure differential between two points (steady, unsteady along a streamline and irrotational flow). Euler's equation o motion in streamline coordinates. Mechanical energy conservation and its application to vortex flow (free and force vortex flow), pressure distribution in free and forced vortex flow, Derivation of Bernoulli' equation from Euler's equation, Applications of Bernoulli's equation for measurement of flow rate through venturimeter, orificemeter, and flow nozzles, concept of static and stagnation pressures and application of pitot tube in flow measurements. **(9 Hrs)**

Dynamics of Viscous Flows: Conservation of linear momentum in differential form, viscous flows through pipes: concept of friction factor in a pipe flow, variation of friction factor, losses due to geometric changes (sudden enlargement, exit loss, sudden contraction, and entry loss), concept of flow potential and flow resistance, flow through branched pipes (pipes in series and parallel), losses in pipe bends, losses in pipe fittings, power transmission by a pipeline.

(9 Hrs)

Text Books:

1. *Introduction to Fluid Mechanics and Fluid Machines*, S. K. Som, G. Biswas & S. Chakraborty, McGraw Hill Education (India) Pvt. Ltd, New Delhi, 3rd Edition, 2014.

Reference Books:

1. *A Text Book of Fluid Mechanics*, R. K. Rajput, S. Chand Limited, 2008.
2. *Hydraulics and Fluid Mechanics Including Hydraulics Machines*, P.N. Modi, Standard Publishers Distributors, 19th Edition, 2013.
3. *Fluid Mechanics*, A. K. Mohanty, PHI Learning Pvt. Ltd., 2001.
4. *Engineering Fluid Mechanics*, K. L. Kumar, S. Chand Limited, 2008.
5. *Fluid Mechanics*, Y. Cengel and J. Cimbala, McGraw Hill Education (India) Pvt. Ltd, New Delhi, 2rd Edition, 2010.

ME2004 HEAT TRANSFER Cr-4

Introduction: Scope of the subject, the three modes of heat transfer-conduction, convection and radiation. Fourier conduction equation, Newton's law of cooling and Stefan- Boltzmann equation for black body radiation. Simultaneous heat transfer mechanisms. **(2 Hrs)**

Conduction:

a. Mechanism of conduction: Derivation of the generalized heat conduction equation in Cartesian coordinates, polar cylindrical and polar spherical coordinates. Different types of boundary conditions encountered in heat conduction problems. **(4 Hrs)**

b. Solution of the one dimensional steady state heat conduction equation with constant thermal conductivity and without internal heat generation in Cartesian coordinates. Extension of the solution to composite walls by electrical analogy. Thermal contact resistance, Effect of variable thermal conductivity on temperature distribution in plane wall. **(4 Hrs)**

c. Solution of the one dimensional steady state heat conduction equation with constant thermal conductivity and without internal heat generation in Cylindrical and Spherical coordinates. Extension of the solution to composite cylinders/spheres by electrical analogy. Critical thickness of insulation. **(4 Hrs)**

d. Heat transfer from fins (only longitudinal fins with constant cross sectional area), Fin efficiency and effectiveness. **(3 Hrs)**

Convection:

a. Mechanism of convection and basic concepts: Dimensional analysis for forced and free convection, Nusselt number. **(3 Hrs)**

b. Thermal boundary layer, Prandtl number, Boundary layer equations: Conservation equations for mass, momentum and energy for two dimensional steady state flow in Cartesian coordinates. Non dimensionalization of the conservation equations. **(4 Hrs)**

c. Solution of convection equations for a flat plate: energy integral equations for boundary layer flow over a flat plate. Solution of the integral equations to derive expressions for heat transfer coefficients. Average values of heat transfer coefficients. **(4 Hrs)**

d. Experimental correlations for forced and free convection for various geometries. **(2 Hrs)**

Fundamentals of Thermal Radiation: Blackbody radiation, Planck's law, Spectral and total emissive power, Wein's displacement law, Spectral and total intensity of radiation, Radiation properties: emissivity, absorptivity, reflectivity and transmissivity, Kirchoff's law. **(6 Hrs)**

Radiant heat transfer: Radiation shape factor, Relation for shape factor and shape factor algebra. Heat exchange between black bodies through non-absorbing medium. Gray bodies and real bodies. Heat exchange between gray bodies. Radiosity and irradiation. Electrical analogy and radiation network for a 2-surface and 3-surface enclosures in non-absorbing medium, radiation shields. **(8 Hrs)**

Heat exchangers: Types of heat exchangers and heat exchanger configurations. The overall heat transfer coefficient and fouling factor. LMTD and effectiveness-NTU analysis of heat exchangers. Heat exchanger selection considerations. **(4 Hrs)**

Text Books:

1. *Heat and Mass Transfer*, R. K. Rajput, S. Chand & Company, 5th Edition

Reference Books:

1. *Heat transfer*, J P Holman and S. Bhattacharya, McGraw Hill Education, 10th Edition.
2. *Introduction to Heat Transfer*, S. K. Som, PHI Learning Private Ltd, 2013.
3. *Engineering Heat Transfer,* M. M. Rathore, Jones & Bartlett Learning, 2011.
4. *Heat and Mass Transfer*, Y. A. Cengel and A. J. Ghajar, McGraw Hill Education, 4th Edition

ME2005 MECHANICS OF SOLIDS Cr-4

Simple stress and strain: Concept of stress: Definition, Reason of stress phenomenon, normal stress and shear stress; Concept of strain: Types, Stress strain diagram and its features. Stress strain diagram for ductile and brittle materials, Stress and strain in composite rods, Stress and strain in bolt and nut assembly, Stress due to self weight of members, Stress in nuts and bolts, Thermal stress. **(7 Hrs)**

Compound stress and strain: Two-dimensional stresses, principal stress, principal planes, Mohr's circle for the stresses, strain analysis, principal strains. **(4 Hrs)**

Shear force and bending moment: Types of support and beams, Shear force (SF), Bending Moment (BM), Relation between load, SF and BM. Shear force diagram and Bending Moment diagram of beams subject to concentrated and distributed load. Beams with overhangs, Beams subjected to couples. **(5 Hrs)**

Bending and shear stress: Theory of simple bending of initially straight beams. Distribution of normal and shear stresses in different sections. Composite beams, carriage springs. **(4 Hrs)**

Strain Energy: Strain Energy, Resilience and Strain Energy due to Axial load, Bending Moment and Twisting Moment. **(3 Hrs)**

Slope and deflection: Slope and deflection of beams by double integration method, Macaulay's method and moment area method, Principle of Virtual Work, Unit load and Unit couple method for determining slope and deflection of beams, Castigliano's theorem, Maxwell's theorem of Reciprocal Relations. **(5 Hrs)**

Theories of Failure: Maximum principal stress theory, Maximum Shearing stress Theory, Maximum Strain Theory, Total strain energy Theory, Maximum Distortion Energy Theory, Octahedral Shearing Stress Theory, Graphical representation of theories of failure. **(5 Hrs)**

Torsion: Torsion in solid and hollow circular shafts, Torque and Horse Power transmitted by solid and hollow shafts, combined bending and Torsion, close coiled helical springs, strain energy in Torsion, Combined bending and torsion. **(5 Hrs)**

Stresses in cylindrical and spherical shells: Stresses in thin cylinders and thin spherical shell under internal pressure, Thick cylinders subjected to internal and external pressures, compound cylinders, Membrane stress in shells, Application to cylindrical, spherical and conical shells. **(5 Hrs)**

Columns: Definition of a column, types of failure in a column, definition of the critical load of a column, Slenderness ratio of a column, Influence of end conditions and effective length, Design of eccentrically loaded columns. **(5 Hrs)**

Text Book:

1. *Strength of Materials,* S.S. Rattan, TMH

Reference Books*:*

1. *Strength of Materials,* Lehri & Lehri, Kataria,

2. *Mechanics of Materials*, R.C. Hibler
3. *Mechanics of solids,* S.H. Crandall & Dahl,TMH

ME2006 BASIC MANUFACTURING PROCESSES Cr-3

Foundry Process: Pattern making, pattern materials, allowances, types of pattern, sand casting types, sand cast, moulding procedure, types of sand, gates and riser (basic design considerations) essential properties of moulding sand, core making, types of cores. Essential qualities, core mixtures and binder sand testing, Mould and core hardness test, fineness test, clay content test, permeability test, moisture content test, sand conditioning. Basic idea about cupolas and other melting furnaces. Melting and pouring procedures for cast Iron, Steel and nonferrous castings. Cleaning of casting and defects in casting, die casting. Precision investment casting, shell moulds, centrifugal casting processes, permanent moulds casting, dies casting.

(12 Hrs)

Metal Working Process: Hot and cold working of Metals: Basic Principles of hot and cold working of metals.

Rolling: Types of Rolling, Rolling equipments hot and cold rolling, General deformation pattern, Pressure and forces in rolling. Distribution of roll pressure, angle of bite, effect of rolling on microstructure, Rolling defects, Numericals on rolling load and power required for reduction.

Forgings: Smith forging, Drop forging, press forging & Machine forging, Description of Presses and hammers, forging defects.

Extrusion: Direct, Indirect and impact extrusion and their applications, Extrusion defects. Determination of extrusion force.

Drawing: Wire and rod drawing, Tube drawing, Process variables in drawing process. Deep drawing. Determination of drawing force. **(9 Hrs)**

Powder Metallurgy: Preparation of powder, properties of powder, fabrication methods & procedure, applications, advantages. **(5 Hrs)**

Fabrication Processes: Classification, types of welding joints, Gas welding principles, types of flames, equipment, techniques of gas cutting. Electric Arc Welding: Principles of electric welding equipments and electrodes (in brief), principles of Inert Gas Welding. TIG, MIG, sub-merged arc welding. Atomic hydrogen welding, plasma are welding. Resistance Welding: Principle of forge welding, spot-seam, Projection, Upset-butt welding, flash welding. Thermit -welding, electro-slag welding, friction welding Brazing, Soldering. Welding defects and inspection.

(10 Hrs)

Text Book:

1. *Manufacturing Technolog,* P.N. Rao (Tata Mc-Graw Hill, Publication. Co.Ltd.)

Reference Books:

1. *Manufacturing Processes:* J. Kausish , PHI
2. *Principle of Manufacturing Materials and Processes:* J.S. Cambell, TMH
3. *Welding & Welding Technology* - R. Little, TMH, 43rd reprint, 2014
4. *Manufacturing Science:* A. Ghosh & A.K. Mallick, EWP

ME2007 MATERIAL SCIENCE AND ENGINEERING Cr-3

Introduction of Engineering Materials: Materials Classification, Engineering requirements of materials, recent development in metallic and non metallic materials. **(3 Hrs)**

Structure of Materials: Fundamental concepts, bonding forces and energies, unit cells, crystal structures, crystal systems, Crystallographic plane and directions, single and poly-crystalline materials, non-crystalline materials.

(5 Hrs)

Structure property relationship: Defects in crystals – point defects, line defects (dislocations), surface defects and volume defects, mechanical properties of materials (tensile, hardness, creep and fatigue), strengthening mechanism of metals, electrical properties, thermal properties, magnetic properties and optical properties. **(8 Hrs)**

Phase Diagram and Phase transformation of metals and alloys: Basics of phase diagram, Gibb's phase rule, Lever rule, Isomorphous, Eutectic and Peritectic alloy system, Iron-carbon equilibrium diagram, Isothermal decomposition of austenite (TTT curve), transformation of austenite upon continuous cooling, Principles of heat treatment, basics of heat treatment furnaces, Annealing, Normalizing, Hardening, Tempering, Martempering, Age hardening, Surface hardening, Case hardening, Hardenability of steel and Jominey end quench test. **(8 Hrs)**

Metallic and non-metallic Materials: Alumium, Magnesium and Titanium alloys and their application, Structural classes of alloy steels, Ordinary, improved and quality carbon structural steels, alloy structural steels, tool steels, wear-resistant steels, stainless and acid resistant steels, corrosion resistant steels, Magnetic steels. Pig iron, Grey cast iron, White cast iron, malleable cast iron, SG (spheroidal graphite) iron, ceramics, polymers and composites. **(6 Hrs)**

Materials Selection and Design Considerations: Introduction, case studies to select material for Torsionally-stressed cylindrical shaft, Automotive valve spring, Anatomy of Hip joint, Integrated circuit and etc. **(3 Hrs)**

Economic, Environmental, and societal issues in materials Science and Engineering: Corrosion & its Prevention, Component design, materials, manufacturing techniques, recycling issues. **(3 Hrs)**

Text Book:

1. *Materials Science and Engineering,* Willium D. Callister, Jr. John Wiley & Sons publications

OR

Callister's Materials Science and Engineering Adapted By R. Balasubramaniam, Wiley India, Edition -2010

Reference Books:

1. *Material Science and Engineering*, V. Ragvan, Prentice Hall of India, 4th Edition.
2. *Engineering Metallurgy: Applied Physical Metallurgy*, R. A. Higgins, 6th Edition

ME2009 KINEMATIC AND KINETICS OF MACHINES Cr-3

Simple Mechanisms: Classification of links and pairs, kinematics chains, degrees of freedom, Grashof's law, Grubler's criterion for plane mechanism. Four bar mechanism and its inversions. Single slider crank chain and its inversions. Double slider crank chain and its inversions. **(5 Hrs)**

Velocity Analysis: Velocity of a point in a link by relative velocity methods and instantaneous center method, Numbers and types of instantaneous centers in a mechanism. Location of instantaneous centers. Kennedy's theorem, Velocities of four-bar and slider crank mechanisms. **(5 Hrs)**

Acceleration Analysis: Acceleration of point on a link, Acceleration diagram of a link, Acceleration in the slider crank and four bar mechanism .Klein's construction, Coriolis' components of acceleration. **(5 Hrs)**

Friction: Friction of a square threaded screw and V-threads, Friction of journal, pivot and collar bearings, single plate, multi plate , conical clutches ,Centrifugal clutch. **(5 Hrs)**

Brakes and Dynamometer: Block, internally expanding and Disc Brakes, Absorption and Transmission Dynamometers, Pony Brakes, Rope Brake, Belt Transmission and torsional Dynamometer. **(5 Hrs)**

Belt and Rope and Chain Drive: Velocity ratio, Effect of belt thickness and slip on velocity ratio, Length of belt, Ratio of driving tensions, Power transmitted by belt ,Centrifugal tension .Maximum power transmitted by belts, Creep and initial tension, V-belt. Ratio of tensions in rope drive. Chain length, angular speed ratio and Classification of chains. **(6 Hrs)**

Gear Trains: Simple, compound, Riveted and Epicyclic Gear Trains, Calculation of velocity ratio.

Cams: Types of cams and followers, Displacement velocity and acceleration-time curves for uniform velocity, uniform acceleration and deceleration, simple harmonic motion and cycloid motion, Graphical construction of cam profiles for different types of followers, Cams with specified contours. **(5 Hrs)**

Text Book:

1. *Theory of Machines*, S. Ratan, TMH, 4th Edition

Reference Book:

1. *Theory of Machines,* J. Shigley, TMH
2. *Machines and Mechanisms: Applied Kinematics Analysis,* David H Myszka, PHI
3. *Kinematics of Machinery through Hyper Works,* J.S.Rao, Springer, 1st Edition

ME2016 THERMAL ENGINEERING APPLICATIONS Cr-4

Thermodynamics: First law of thermodynamics, internal energy, enthalpy, different thermodynamic processes, Second law of thermodynamics, entropy, carnot cycle, properties of steam, use of steam table and Mollier chart, Rankine cycle, reheat and regeneration. **(8 Hrs)**

Steam turbine: Types, working principle of impulse and reaction turbines, work done and efficiencies.

(5 Hrs)

Gas turbine: Classification, working principle of gas turbine, Brayton cycle, gas turbine cycle with intercooling, reheat and regeneration. **(5 Hrs)**

IC engines: Otto, Diesel & Dual cycle, S. I. and C. I. engines, 2 stroke & 4 stroke engines, indicator diagram and power measurement. **(8 Hrs)**

Fluid dynamics: Introduction, Euler's equation, Bernoulli's equation. Practical applications of Bernoulli's equation- Venturimeter, Orificemeter, Pitot tube. **(4 Hrs)**

Hydraulic turbines: Types, working principle of Pelton, Francis, Kaplan and Propeller turbines, different heads and efficiencies, work done & efficiency of turbines. Specific speed equation and specific discharge equation. **(6 Hrs)**

Centrifugal pump: Classification, construction, work done, efficiencies, cavitation. **(6 Hrs)**

Reciprocating pump: Classification, construction, working, work done, slip and coefficient discharge. **(6 Hrs)**

***Text Books*:**

1. *Thermal Engineering,* A. S. Sarao, Satya Prakashan, New Delhi, Eighth Edition.

Reference Books:

1. *Engineering thermodynamics,* P K Nag, McGraw Hill Education, Fifth Edition

2. *Hydraulics and Fluid Machines:* P. N. Modi and S. M. Seth

ME3001 FLUID DYNAMICS AND HYDRAULIC MACHINES Cr-4

Boundary Layer Theory: Boundary layer growth over a flat plate, Boundary layer thickness, displacement thickness, Momentum thickness, and energy thickness, Laminar and Turbulent boundary layer, Momentum integral equation, Separation of boundary layer. **(8 Hrs)**

Drag and Lift: Drag and Lift coefficient, pressure drag and friction drag on stream lined and bluff bodies, Drag over flat plate, Local and average skin friction drag coefficient. Profile drag, Drag characteristics of sphere, cylinder and disc and drag function, Circulation, Lift and Magnus effect. **(8 Hrs)**

Dimensional Analysis and Model study: Dimensional homogeneity, dimensional analysis, Raleigh's method and Buckingham theorem. Superfluous and Omitted Variables, Similarity laws and model studies, Distorted models. **(6 Hrs)**

Forces on vanes: Dynamic pressure on fixed and moving flat plates and curved vanes, work done and efficiency. **(4 Hrs)**

Turbines: Classification, Impulse and reaction type, Outward and inward flow, mixed and axial flow turbines, Study of Pelton, Francis and Kaplan turbines Blade angle, velocity triangle efficiency of Pelton, Francis, Kaplan turbines. Specific speed, and unit quantities, performance of turbines, Governing of turbines, Draft tubes, Cavitations in reaction turbines, Principles of similarity applied to turbines. **(8 Hrs)**

Centrifugal Pump :Principles, classifications, Blade angle, velocity triangle, efficiency of centrifugal pump, specific speed, Characteristics, curves, Multistage pumps- pumps in sires and parallel, Principle of similarity applied to pumps , cavitations in pumps, NPSH. **(6 Hrs)**

Reciprocating pump: Principle of working, slip, work done effect of acceleration and frictional resistance, separation, air vessels. **(4 Hrs)**

Miscellaneous Machine: Rotary and air injection pumps, Hydraulic ram, Hydraulic accumulator, intensifier, crane, Lift, fluid drives, its specific features and applications. **(4 Hrs)**

Text Book:

1. *A Text Book of Fluid Mechanics and Hydraulic Machines,* R. K. Bansal . Laxmi Publications(p) Ltd. 2010, 9th Edition.

Reference Books:

1. *Hydraulics and Fluid Mechanics (including Hydraulic Machines in SI Units)*, P. N. Modi, S. M. Seth., Standard Book House, 1991, 10th Edition
2. *Fluid Mechanics and Hydraulics(Including Fluidics)*, Jagdish Lal, MPP (Metropolitan Book co. Pvt .Ltd, New Delhi.), 1994, 9th Edition
3. *Fluid Mechanics*, A. K. Mohanty, Prentice-Hall of India Private Limited, New Delhi, 2006, 2nd Edition(10th Printing)

ME3002 REFRIGERATION AND AIR CONDITIONING CR-3

Introduction to Refrigeration: Reversed Carnot Cycle, Reversed Brayton Cycle, Vapour compression cycle, Units of refrigeration, Coefficient of performance. **(4 Hrs)**

Refrigerants: Classification of refrigerants: Halocarbon compounds, Azeotrope, Hydrocarbons, Inorganic compounds, Properties of refrigerants, Comparison of common refrigerants, uses of important refrigerants. **(3 Hrs)**

Air Refrigeration system: Open Air refrigeration cycle, Closed or dense Air refrigeration cycle, Air refrigerator working on Reversed Carnot cycle, Air refrigerator working on Bell-Coleman cycle, Methods of Air refrigeration systems, Simple Air cooling system, Simple Air Evaporative cooling system, Boot-strap Air cooling system, Boot-strap Air Evaporative cooling system, Regenerative Air cooling system. **(4 Hrs)**

Vapour Compression system: Types of Vapour Compression Cycle, Actual vapour compression cycle, T-s and P-h diagram simple saturation cycle, super heated and sub-cooled cycle, Effect of suction pressure and discharge pressure on performance. **(4 Hrs)**

Multistage compression and multi-evaporator system: Different arrangements of compressors and intercooling, multistage compression with intercooling, Multi-evaporation system, dual compression system. **(4 Hrs)**

Vapour Absorption system: Simple Ammonia Absorption system, improved vapour absorption system, Electrolux system, Comparison of vapour absorption system with vapour compression system. **(3 Hrs)**

Psychometrics: Properties of air-vapour mixtures, Psychometric chart, Law of air-water vapour mixture, Enthalpy of mixture, simple heating and cooling, Humidification, Dehumidification mixture of air streams**.** **(3 Hrs)**

Requirements of comfort Air conditioning: Oxygen supply, Heat removal, Moisture removal, Air-motion purity of air, Thermodynamics of human body, Comfort and comfort chart, Effective temperature, factors governing optimum effective temperature. **(4 Hrs)**

Air conditioning system: Processes in air conditioning, summer air conditioning, winter air conditioning and year round air conditioning, cooling load calculation. **(4 Hrs)**

Refrigerant Compressor: Classification of Compressor, Reciprocating Compressor, Work done by a single stage reciprocating Compressor, Hermetic Sealed Compressor, Rotary compressor, Centrifugal Compressor. **(3 Hrs)**

Text Books:

1. *Refrigeration and Air Conditioning*, C. P. Arora, McGraw Hill Education, 3rd Edition, 2013.
2. *Refrigeration and Air Conditioning*, R. S. Khurmi, and J. K. Gupta, S. Chand Ltd, 2013

Reference books:

1. *Refrigeration and Air Conditioning*, R. C. Arora, PHI Learning Pvt. Ltd., 2013.
2. *A course in Refrigeration and Air Conditioning*, S.C. Arora and S. Domkundwar, Dhanpat Rai & Co (P) Ltd, 2013.
3. *Refrigeration and Air Conditioning*, Manohar Prasad, New Age International, 2003.

ME3003 INTERNAL COMBUSTION ENGINES & GAS TURBINES Cr-3

Introductions: Classification of I.C. Engines. Fundamental difference between SI and CI engines, Comparison of two stroke and four stroke engines. Otto, Diesel and Dual cycle. Valve timing diagram, Properties and rating of IC engine, fuels, Additives and non-petroleum fuels. **(4 Hrs)**

Carburetion and Fuel injection: Function of carburetors, Description and principle of simple carburetor and its drawback, petrol injections. Requirements of diesel injections system. Types of injection systems, Fuel pumps and nozzles, types of fuel injections, Spray formation, penetration and direction. **(3 Hrs)**

Combustion of Fuels: Stages of SI engine combustion, Effect of engine variables on ignition lag and flame propagation, fuel knock, control of knock. SI engine combustion chamber stage of diesel combustion, variables affecting delay period. Diesel knock and methods of control. CI engine combustion chambers. **(4 Hrs)**

Supercharging: Thermodynamic cycle with supercharging and its effect. Efficiency of supercharging engines Methods of supercharging and scavenging of two stoke engines. **(4 Hrs)**

Test and Performance: Fuel air and power measurement methods. Performance of SI and CI engines, Characteristic curves, Governing of speed. **(4 Hrs)**

Engine Emission and Control: Engine Emissions and its harmful effects. Gasoline and Diesel emission. Methods of measuring pollutants controlling of engine emission. **(4 Hrs)**

Cooling Lubrication and ignition systems: (a) Air cooling and water cooling systems effects of cooling on power output and efficiency.(b) Properties of lubricants additives lubricating systems.(c) Battery, Magnet ignition systems ignition timing. **(3 Hrs)**

Gas Turbines: Gas turbine Shaft Power cycle: Introduction open cycle single shaft and twin shaft arrangements. Multi-spool arrangement ideal cycle. Methods of accounting component losses. Comparative performance, of practical cycles. GOGAS cycles and co-generations schemes. Closed cycle gas turbines. **(4 Hrs)**

Gas Turbine cycles for Aircraft Propulsion: Criteria of performance, Intake and propelling nozzle efficiencies, simple turbojet cycle, turbofan and turboprop engine. **(4 Hrs)**

Introduction to Alternative Fuels: LPG, LNG, CNG, Alcohol, Hydrogen, Vegetable oils and Biogas. **(2 Hrs)**

Text Books:

1. *IC Engines,* V Ganeshan, TMH, 4th edition
2. *Gas Turbines,* V Ganeshan, TMH, 3rd edition

Reference:

1. *IC Engines,* Mathur and Sharma, Dhanpat Rai & Sons
2. *IC Engines,* S.P. Sen, Khanna Publishers
3. *IC Engines,* Gill and Smith, OXFORD & IBH
4. *An introduction to energy Conversion (Vol. II),* Kadambi & Prasad, Wiley Eastern.
5. *Gas Turbine Theory,* Cohen, Rogers and Saravanamutto, Pearson Education

ME3004 METAL CUTTING AND CUTTING TOOL DESIGN Cr-4

Introduction to machining

Place of machining in manufacturing industries, Manufacturing: need and concept, Broad classification of manufacturing processes, Cycle of manufacturing, Machining: Classification, purpose, principle and definition, Machining requirements, Aims & objective of machining & manufacturing industries, Constraints in fulfilling the machining objectives and control over the machining constraints. **(3 Hrs)**

Geometry of cutting tools

General configuration of cutting edges of tools, concept of rake and clearance angles, Systems of description of tool geometry (Tool in hand system, ASA, ORS, NRS Systems), Geometry of multiple-point cutting tools, Conversion of tool angles. **(7 Hrs)**

Mechanism of machining

Mechanism of chip formation in machining ductile and brittle materials, classification of machining chips, geometry & characteristics of continuous chip formation, chip reduction coefficient and cutting ratio, shear angle, cutting strain, velocity relationship and Kronenberg relationship, effect of cutting variables on chip reduction co-efficient, Built-up-edge (BUE) formation, orthogonal cutting and oblique cutting, causes of chip flow deviation and angle of deviation, effective rake angle, effects of oblique cutting, chip-tool contact length. **(10 Hrs)**

Mechanics of metal cutting

Needs & purposes of determining cutting forces, force system during turning & their significances, Merchant circle diagram & its use, advantages & limitations of MCD, development of mathematical expressions for cutting forces using MCD, stress in conventional shear plane, energy of cutting process, Ernst-Merchant angle relationship, Lee-shaffer's relationship, chip breaking effect, turning dynamometer, drill dynamometer. **(8 Hrs)**

Failure, wear, tool life and cutting tool materials

Major causes and modes of Failure of cutting tools, Mechanism & pattern of cutting tool wear, Form stability, Criteria of wear, Flank and crater wear, Tool life-definition in R&D & shop floor, evaluation of tool life, Taylor's tool life equation, role of different machining parameters on tool life and surface finish, economics of machining, Gilbert's model, concept, definition & criteria of judgment of machinability, Factors affecting machinability, tool Materials & chronological development, location and causes of heat generation in machining, cutting fluid & its effect.

(10 Hrs)

Cutting Tool design

Design of single point cutting tool, Design of broach, Form tools, Boring tools, Reamers, Twist drill and Milling cutters. **(10 Hrs)**

Text Books:

1. *Metal Cutting Theory and Practice*: A. Bhattacharyya, Jamini Kanta Sen of Central Book Pub, 1984.
2. *A Text. Book of Production Engineering*: P.C. Sharma, S.Chand & Co., 2008.

Reference Books:

1. *Machining and Machine Tools*: A. B. Chattopadhyay, Wiley-India Pub, 2012.
2. *Fundamentals of Metal Cutting and Machine Tools*: B.L. Juneja, G.S. Sekhon, & Nitin Seth, New Age International Pub, 2005.
3. *Metal Cutting Principles*: M. C. Shaw, Oxford Pub, 2002.
4. *Fundamentals of Machining & Machine Tools*: Boothroy & Knight, CRC press, 1988.
5. *Tool Design*: Cyril Donaldson, V. C. Goold, Tata McGraw-Hill, 1976.

ME3005 MECHANICAL MEASUREMENTS & CONTROL Cr-3

Introduction to Generalized Mechanical Measurement System: The significance of mechanical measurements.

(2 Hrs)

Basic detector transducer elements: Electrical transducer, Sliding Contact devices, Variable- Inductance transducer elements. The differential transformer, Variable- reluctance transducers. Capacitive transducers. The piezoelectric effect, photo-electric transducers, Electronic Transducer element. **(4 Hrs)**

Signal Processing: Electrical Intermediate modifying devices, input circuitry, the simple current sensing circuit, the ballast circuit, the voltage-dividing potentiometer circuit. The voltage balancing potentiometer circuit. Resistance bridges. **(4 Hrs)**

Measurement of Strain: The Electrical resistance strain gauge. The metallic resistance strain gage, Selection and installation factors for metallic strain gages, Circuitry, Metallic strain gage, The strain gage ballast circuit, the strain gage bridge circuit, Temperature compensation. **(5 Hrs)**

Measurement of Pressure: Pressure measurement systems, Pressure measuring transducers, Gravitations transducers, Elastic transducers, Elastic diaphragms, Secondary transducers used with diaphragms, strain gage pressure cells, Measurement of high pressure, Measurement of low pressures. Dynamic characteristic of pressure measuring systems. Calibration method. **(4 Hrs)**

Temperature Measurement: Use of bimetals pressure thermometers. Thermocouples, Pyrometer, calibration of temperature measuring devices. **(2 Hrs)**

Vibration and Shock: Measurement and test methods- Vibrometers and accelerometers, Elementary vibrometers and vibration defectors. **(1 Hrs)**

Measurement system modeling: Description of open and closed loop control systems and their block diagrams. Use of block diagrams and signal flow graph to find the overall transfer function. **(4 Hrs)**

Basic characteristics of feedback control systems: Stability, steady-state accuracy, transient accuracy, disturbance rejection, insensitivity and robustness. Basic modes of feedback control: proportional, integral and derivative. Feed-

forward and multi-loop control configurations, stability concept, relative stability, Routh stability criterion. Time response of second-order systems, steady-state errors and error constants. Performance specifications in time-domain. Root locus method of design. Lead and lag compensation. **(6 Hrs)**

Frequency-response analysis: Relationship between time & frequency response, Polar plots, Bode's plot, stability in frequency domain, Nyquist plots. Nyquist stability criterion. Performance specifications in frequency-domain. Frequency-domain methods of design, Compensation & their realization in time & frequency domain. Lead and Lag compensation. Tuning of process controllers. State variable formulation and solution. **(4 Hrs)**

Text Books:

1. *Mechanical Measurements:* Thomas G. Beckwith, Roy D. Marangoni, John H. Lienhard V, Prentice Hall; 6 edition (August 17, 2006)
2. *Control systems Engineering:* I. J. Nagpal and M. Gopal, New Age International Publishers,

Reference Books:

1. *A course in mechanical measurement and instrumentation: A K Sawhney, P Sawhney, DR Co*

ME3006 METROLOGY, QUALITY CONTROL & RELIABILITY CR-3

Metrology & Needs of Inspection: Needs of inspection, Principle and methods of measurements, Sources of error, precision and accuracy. Standards of measurement: - Line, End and Wave length standards. **(4 Hrs)**
Limits, Fits and Tolerances: Interchangeability, selective assembly, limits, tolerances and fits (Indian standard), Fundamental deviation, Hole & Shaft basis systems, limit gauges, Taylor's principles of designs of limit gauges. **(6 Hrs)**
Comparators: Needs of comparator, Basic principle, use, classification and characteristics of comparators, Mechanical, electrical & electronic comparator, pneumatic comparator and comparator sensitivity. **(4 Hrs)**
Angle Measurements: Sine bar; its use, limitations, errors. Slip gauges and its use. Auto-collimator: - principle, construction and application. Measurement of taper angle. **(3 Hrs)**
Inspection of Screw Thread Elements: measurement of effective diameter using 2- wire and 3- wire methods of measurement. **(2 Hrs)**
Geometric Shapes: Measurement of straightness, flatness, parallelism, squareness and roundness (circularity) testing. **(2 Hrs)**
Surface Texture: Elements of surface texture, order of surface irregularity, methods of measurement of surface finish. **(3 Hrs)**
Statistical Quality Control: Frequency distribution, process capability, control charts, X charts, R Charts, P-charts, C-chart. Acceptance sampling, O. C. curves, Sampling plan & acceptability, Design of Experiment. **(6 Hrs)**
Reliability: Definitions & field data analysis, Hazard models: Constant hazard & linearly increasing hazard models, Bath-Tub Curve, System reliability and reliability improvement, Availability, Maintainability. **(6 Hrs)**
Text Books:
1. *Engineering Metrology,* R K Jain, Khanna Publishers.

Reference Books:

1. *Reliability Engineering,* L. S. Srinath, East West Press.
2. *Statistical Quality Control,* M Mahajan, Dhanpat Rai & Co, 2010

ME3007 MANUFACTURING PROCESSES & DESIGN Cr-3

Conventional Machine Tools & Machining Processes: Types, Specification, Operations, Tools, Accessories and attachments, Estimation of cutting time of conventional machining processes. Turning; Taper turning and thread cutting, Shaping; Quick return Mechanisms. Milling; Up milling, Down milling and indexing. Grinding; Surface grinding, Centreless grinding, grinding wheel specification, wheel truing and dressing. Finishing Processes: Reaming and boring, Lapping, Honing, Super finishing. **(15 Hrs)**
Production Machine Tools: Turret & Capstan lathe, multi spindle automatic lathe, Gear Machining & Transfer machines. **(5 Hrs)**

Jigs and Fixtures: Principles of design and construction. Principles of Location and Clamping. Design of simple Jigs for drilling operations, simple fixtures for milling and broaching operation. **(4 Hrs)**

Press Tool Design: Press working equipment and operations, Press selection, Principle of cutting and cutting forces, methods of reducing cutting forces, Blanking and Piercing die design, design procedure for progressive dies, materials and manufacture of sheet metal working dies. **(4 Hrs)**

Forging Die Design: Forging equipments, Drop forging & Press forging, Die design for machine forging, Selection of sizes of forging equipments, Materials and manufacture of forging dies **(4 Hrs)**

Process Planning: Contents of process plan, process operations, steps in process planning, planning and tooling for low cost processing. **(4 Hrs)**

Text Books:

1. *Manufacturing Processes,* J.P. Kaushish, PHI
2. *Tool Design,* C. Donaldson, G.H. LeCain, V C Goold, J. Ghosh, McGraw Hill, 4th edition, 2012

Reference Books:

1. *A Text Book of production Engineering,* P C Sharma, S. Chand Publicatio, 2010
2. *Fundamental of Tool design,* F. W. Wilson, ASTM

ME3008 INDUSTRIAL ENGINEERING & MANAGEMENT Cr-3

Production, Planning and Control: Introduction, Types of Production processes (Project/Job, Batch, Mass/Line, Continuous), Production, Planning & Control (PPC) and its functions, Aggregate Production Planning (Chase, Level, and Mixed Strategy). **(5 Hrs)**

Forecasting and Its Techniques: Introduction, Errors in forecasting, Simple Moving Average, Weighted Moving Average, Exponential Smoothening, Linear Regression Techniques. **(4 Hrs)**

Inventory Control: Inventory Control: Relevant Costs, P & Q Systems of Inventory, Deterministic and probabilistic models of Inventory control, Safety Stock, Reorder Point, ABC Analysis, Material Requirement Planning I & II **(5 Hrs)**

Scheduling: Operations scheduling, Job shop scheduling, Priority dispatching rules, Johnson's rule, n jobs with 2&3 machines. Queuing theory, JIT **(4 Hrs)**

Plant Location and Layout: Factors affecting plant location, Facilities Layout, Process layout, Product layout, Combination Layout. Assembly line balancing, **(4 Hrs)**

Work Study: Work study, Method Study procedure, Principles of motion economy, and Time study procedure, PMTS. **(3 Hrs)**

Network Design:, Project Management-CPM and PERT, Critical path, Crashing, New Product Development **(6 Hrs)**

Productivity & Quality Tools: Productivity Concepts: Factors affecting productivity, Quality Circle, Kaizen, Total Quality management, Six sigma, Break down, Preventive and Predictive maintenance. **(5 Hrs)**

Text Books:

1. *Production and Operation Management*, R. Paneerselvam, Prentice Hall of India, 3rd edition,

Reference Books:

1. *Operations Management:Processes and Supply Chains,* Larry P. Ritzman, Manoj K. Malhotra, Lee J. Krajewski, PHI, 10th, 2012.
2. *Industrial Engineering and Management*, S.Tripathy, PHI, 2014.
3. *Modern Production/Operations Management*, Sarin Buffa, Wiley India Pvt Ltd, 8th,2011.
4. *Industrial Engineering and Production management*, Telsang Mertand, S.Chand, 2002.

ME3009 FUNDAMENTALS OF MACHINE DESIGN Cr-3

***Standard Design Data Books are allowed during examinations**

Introduction: Basic requirement for machine elements and machines, Design procedure, Design Synthesis, Use of standards in design, Selection of engineering materials, Selection of factor of safety, Manufacturing considerations in design, Various stresses in machine elements. **(5 Hrs)**

Design of fastening elements: Design of riveted joints (Methods of riveting, Application to Boiler Drum), Design of welded joints (strength of butt, transverse and parallel fillet weld, circular fillet weld subjected to torsion and bending, axially loaded unsymmetrical, eccentrically loaded welded joint), Design of bolted joints (types of screw fastening/locking devices, bolts of uniform strength, eccentrically loaded (in-plane, out-plane) bolted joints. Design of cotter joints, Design of knuckle joints. **(15 Hrs)**

Design of transmission elements: Design of shafts (types of shaft, shafts subjected to torsion, bending and combined loading, design consideration/application as per ASME code), Design of keys (types of keys, design of sunk key), Design of couplings (types of couplings, protected type rigid and bushed-pin- type flexible coupling), Design of belt (selection of flat/ V-belt from manufactures catalogue). **(10 Hrs)**

Design of springs: Closed coil helical springs of circular section, spiral spring, Leaf springs. **(3 Hrs)**

Design of levers & brackets: Hand lever, foot lever, bell crank lever, rocker arm, wall brackets. **(3 Hrs)**

Text Books:

1. *Design of Machine Elements* - VB Bhandari (TMH), 3rd Ed.
2. *Design Data Hand Book,* S. Md. Jallaludeen (Anuradha Pub.)

Reference Books:

1. *Machine Design* - Sharma/Agarwal (katson publishing House)
2. *Machines Design Data Book* - P.S.G. College of Technology, Coimbatore.
3. *Mechanical Engineering Design* - Shigley J E, Mischiee C. R.; TMH
4. *Mechanical Design - of Machines*, Maleev/Hartman (CBS)

ME3012 DESIGN OF MACHINE ELEMENTS Cr-3

Design against fatigue load: Stress concentration and factors, methods for reduction of stress conc., endurance strength and limit stress, notch sensitivity, LCF and HCF. Design for finite life of components and cumulative damage. Design for infinite life, Soderberg and Goodman lines, and modified Goodman's lines. Design of springs against fatigue load. Bolted joint under fluctuating load. Evaluation of fatigue life in machine components using *ANSYS/ MATLAB* (*optional*). **(10 Hrs)**

Design of IC Engine Components: Cylinder liners & Piston, Connecting rod, Crankshaft, Valve mechanism, Demonstration of temperature and stress/strain distribution in IC Engine components using *ANSYS* (*optional*). **(8 Hrs)**

Design of Gear Drives: Design of spur gear (gear materials, gear failures, gear design using Hertz and Belayev equations), Design of Helical gear (equivalent spur gear and virtual number of teeth, force analysis and design of helical gear by AGMA method), Design of bevel gear. **(7 Hrs)**

Sliding and Rolling contact bearings: Basic modes of lubrication, viscosity index, Petroff's & McKee's Equation, Selection of Lubricants, Theory of film (Stribeck's Equation), Static and dynamic load carrying capacity, equivalent bearing load, selection of bearing life from manufacturer's catalogue. Demonstration of a typical bearing failure. **(7 Hrs)**

Strategies in design of machine elements: Design optimization for functional life and cost using *ANSYS/ MATLAB/ NASTRAN/ DOE***.** **(4 Hrs)**

Text Books:

1. *Design of Machine Elements: VB Bhandari (TMH)*
2. *Machine Design-An Integrated Approach* , Robert L. Norton (Pearson)

Reference Books:

1. *Mechanical Engineering Design*, Shigley J E, Mischiee C R (TMH)
2. *Machine Design data book* - P.S.G.College of Technology, Coimbatore.
3. *Design Data Hand Book* - K. Mahadevan & K.B.Reddy(CBS)

ME3013 THERMODYNAMICS & FLUID MECHANICS Cr-4

Thermodynamics

Preliminary Concept: Laws of perfect gas in Engineering Units. Relationship between CP, CV, R and J, Constant Pressure, Constant Volume, isothermal and adiabatic process. Second law of thermodynamics: Entropy, Work done, heat added and entropy changes in simple processes. **(5 Hrs)**

Steam: Constant pressure formation of steam, Enthalpy and specific volume of dry, wet and super heated steam. Use of Mollier chart. **(5 Hrs)**

I.C. Engines & Gas Turbine: Compression and Spark ignition engines, 4-stroke and 2-stroke cycles, valve timing, Fuel supply system, Governing, Air standard efficiency of Otto, Diesel and Dual cycle combustion cycles. **(7 Hrs)**

Gas Turbines: Principle of operation, simple open and closed cycles **(5 Hrs)**

Fluid Mechanics

Introduction: Physical properties of fluids, Types of fluid, Hydrostatic Law, Measurement of pressure by manometers. Total pressure and centre of pressure on horizontal, vertical and inclined surfaces submerged in liquid

Buoyancy and Floatation: Centre of buoyancy, Meta center & meta-centric height, Analytical method for metacentric height, Stability of floating and submerged bodies, Oscillation of a floating body. **(6 Hrs)**

Dimensional Analysis and Model study: Dimensional homogeneity, dimensional analysis, Raleigh's method and Buckingham theorem. Superfluous and Omitted Variables, Similarity laws and model studies, Distorted models

(7 Hrs)

Turbines: Classification, Impulse and reaction type, Outward and inward flow, mixed and axial flow turbines, study of Pelton, Francis and Kaplan turbines Blade angle, velocity triangle efficiency of Pelton, Francis, Kaplan turbines. Specific speed, and unit quantities, performance of turbines, Governing of turbines, Draft tubes, Cavitations in reaction turbines, Principles of similarity applied to turbines. **(8 Hrs)**

Centrifugal Pump :Principles, classifications, Blade angle, velocity triangle, efficiency of centrifugal pump, specific speed, Characteristics, curves, Multistage pumps- pumps in sires and parallel, Principle of similarity applied to pumps , cavitations in pumps, NPSH. **(5 Hrs)**

Text Book:

1. *Thermodynamics and Heat Power Engineering-Mathur and Meheta., Jain Brothers, 5th Edition*
2. *Thermal Engineering- P. L. Ballaney, Khanna Publisher 20th edition*
3. *Hydraulic Machines- By: Dr. J. Lal, Metropolitan Book co. Pvt .Ltd, New Delhi*

.

Reference Books*:*

1. *Fluid Mechanics- & Fluid power Engineering, Dr. D.S Kumar*
2. *Fluid Mechanics and Hydraulic Machines, Modi and Seth*
3. *IC Engines: Mathur and Sharma, Dhanpat Rai & Sons,*
4. *Gas Turbines: V Ganeshan, TMGH*

ME4001 ADVANCED MANUFACTURING PROCESSES Cr-3

Non-conventional Machining: Classification of non-conventional machining processes, Basic Principles, features of equipment, process variables and application of AJM, USM, ECM, EDM, PAM, LBM, and EBM**.** **(12 Hrs)**

Micro manufacturing: Scopes of micro manufacturing, size effect and tooling issues in micro manufacturing. Micro turning, micro grinding, Ultrasonic assisted micromachining, Abrasive jet micromachining. **(12 Hrs)**

Metal Forming processes: Hydro forming, Electromagnetic forming and hydroelectric forming. Micro forming– micro bending, micro extrusion, micro molding. **(6 Hrs)**

Micro Fabrication processes: Electron Beam Welding, Laser Beam Welding, Fabrication of MEMS-Chemical Vapor Deposition (CVD), Physical Vapor Deposition (PVD), Epitaxy, Sputtering, Lithography, Etching.

(6 Hrs)

Text Books:

1. *Modern Machining Process,* P.C. Pandey, H.S. Shan , TMH,3rd Edition
2. *Introduction to Micromachining,* V.K. Jain, Narosa Publishing house , 2010

Reference Books:

1. *Manufacturing Technology, Part –II,* P.N. Rao , TMH, 3rd Edition, 2014
2. *High Velocity Forming of Metals,* ASTM
3. *An Introduction to Microelectromechanical Systems Engineering,* Maluf, Nadim, Norwood, Massachusetts, U.S.A.: Artech House, 1999, ISBN 10: 0890065810 / ISBN 13: 9780890065815

ME 4002 INDUSTRIAL AUTOMATION Cr-3

Introduction: Introduction to Industrial Automation and Control, Automations; basic laws and principles, level of automation Introductions to sensors and measurement systems; pressure measurement, temperature measurement, velocity measurement, force and torque measurements, response of measuring systems **(7 Hrs)**

Laws and principles of hydraulics and pneumatics: Components of basic Pneumatic and Hydraulic systems; Characteristics and properties pumps and compressors used in industry; Pneumatic and Hydraulic accessories like filters, lubricators, air dryers, pipelines, connectors; Pneumatic and Hydraulic actuators and their classifications; Proportional and Servo Valves, Construction and working of various Pneumatics and Hydraulics valves; Pneumatic and hydraulic circuits. **(8 Hrs)**

Industrial Control systems: Continuous and discrete control, Control requirements, Programmable Logic Controllers (PLCs), Sensors and Actuators. Introduction to Process Control, PID Control, Implementation of PID Controllers, Logic circuits: Pneumatic logic circuits, Electric and electronic controls used in automation. **(7 Hrs)**

NC & CNC: NC co-ordinate systems and machine motions, types of NC systems, components of NC systems, machine tool application, NC part programming, APT language, computer automated part programming, DNC, CNC and adaptive control. **(4 Hrs)**

Industrial Robotics: Industrial robot applications, Robot anatomy, Coordinate system, work envelope, Robotic Grippers, Sensors in robotics. Robot Programming, Robot application in machining, Welding and assembly, Hostile and remote environment. **(5 Hrs)**

Automation in material handling and storage system: Automated guided vehicle systems (AGV), Monorails and other rail guided vehicles, Conveyor systems, Automated storage systems, Engineering analysis of storage system.

(5 Hrs)

Text Books

1. *Industrial Automation and Robotics,* A. K. Gupta and S. K. Arora, Lakshmi Publication, New Delhi, ISBN-8131805921, 2009

2. *Mechatronics Principles, Concepts and Application*, N. P. Mahalik, TMH, ISBN-0-07-048374-4, 2003

Reference Books

1. *Automation, Production Systems, and Computer-Integrated Manufacturing*, Mikell P. Groover, Pearson Education, ISBN 81-7808-511-9. 3rd Edition, 2007

2. *Overview of Industrial Process Automation* (1st Edition), K. L. S. Sharma, Elsevier, ISBN-978-012-415779-8

3. *Industrial Robotics-Technology, Programming and Applications*, M. P. Groover, McGraw Hill, 2001.

ME4003 POWER PLANT ENGINEERING Cr-3

Sources of energy: Fuel, water, wind and nuclear reactors, principal types of power plants and choice of power plants, power plant layouts. **(2 Hrs)**

Analysis of steam cycles: Introduction, Classification of power plant cycles, Carnot cycle, Rankine cycle, Modified Rankine cycle, Reheat cycle, Regenerative cycle, Binary vapour cycle, Its engineering applications. **(4 Hrs)**

Generation of steam: Boilers and its mountings and accessories, combustion equipment, Air supply systems for combustion, fuel and ash handling systems, dust collectors. **(4 Hrs)**

Flow of steam through nozzles: Continuity, energy and momentum equations, nozzle shape for different applications, Outer velocity, throat and exit areas for flow without and with friction, choked flow and critical pressure ratio, effect of variations in nozzle back pressures, super saturated flow in nozzles. **T**ypes of steam turbines, axial variation of pressure and velocity through various types of turbines. **(8 Hrs)**

Performance characteristics: Power, efficiency and other related calculations for simple impulse, pressure compounded impulse and velocity compounded impulse turbines using velocity triangles. Reaction turbines and degree of reaction. Parsons' turbines, Power, efficiency and other related calculations for reaction turbine. Internal losses in steam turbines and reheat factor. Governing of steam turbines. **(8 Hrs)**

Steam condensers and cooling tower for power plant application: Surface condensers, condenser vacuum and vacuum efficiency, maintaining vacuum by air pumps, sources of air leakage into the condenser, Dalton's law of partial pressures applied to steam and air mixtures, Air pump capacity for wet and dry air pumps, Cooling water requirements, Cooling towers. **(6 Hrs)**

Introduction to Nuclear power plants: Nuclear fuels, Chain reaction, Neutron balance, coolants, Reflectors, Moderators, control rods, types of reactors, Boiling water reactors, pressurized water reactors. **(4 Hrs)**

Text Book:

1. *Power Plant Engineering,* P. K. Nag Tata McGraw-Hill Education, 2002

References:

1. *Power Plant Engineering,* R. K. Rajput Laxmi Publications (P) Ltd., Fourth Edition.
2. *Power Plant Engineering,* M. K. Gupta, PHI Learning, 2012.
3. *Power Plant Engineering,* P.C. Sharma, S. K. Kataria & Sons, 2009.

ME4021 AUTOMOBILE ENGINEERING Cr-3

Introduction: Main units of automobile chassis and body, different systems of the automobile, description of the main parts of the engine, motor vehicle act. **(4 Hrs)**

Suspension System: Function, types, leaf spring suspension system, coil spring suspension system, torsion bar, telescopic type shock absorber. **(4 Hrs)**

Transmission System: clutch : single plate, multi plate, centrifugal clutch, their functions; gear box: Sliding mesh, constant mesh and synchromesh gearbox, design of 3 speed and 4 speed gear box, over drive, torque converter, semi and fully automatic transmission.; Hooks Joint: Hooks Joint, propeller, shaft, transmission system for two wheel and four wheel drives, Hotchkiss and torque tube drives; Differential and rear axle: differential, rear axles, types of rear axles, semi floating, three quarter floating and full floating types. **(6 Hrs)**

Braking System: Hydraulic braking system, braking of vehicles when applied to rear, front and ill four wheels, theory of internal shoe brake, design of brake lining and brake drum different arrangement of brake shoes, servo and power brakes. **(5 Hrs)**

Front wheel Geometry and Steering System: Camber, castor, Kingpin inclination, toe-in, center point steering condition for true rolling components of steering mechanism. power steering system. **(6 Hrs)**

Electrical systems of an automobile: Starting system, starting drive, generation system, ignition system other electrical system. **(6 Hrs)**

Power for propulsion: Types of resistance, traction, tractive effort, power required for propulsion for vehicle.

(5 Hrs)

Text Books:

1. *Automobile Engineering* – R B Gupta, Satya Prakasan, New Delhi

Reference Books:

1. *Automobile Engineering* - G.B.S.Narang.
2. *Automobile Mechanics - J.Heitner.*
3. *Automobile Engineering* - K.M.Gupta. Vol I & II (Umesh Publications)

ME4022 SUPPLY CHAIN MANAGEMENT Cr-3

Introduction: Understanding the supply chain, decision phases in supply chain, process view of supply chain, supply chain flows. **(5 Hrs)**

Drivers & Obstacles of Supply Chain Performance : Supply chain performance: Strategic fit and scope; Supply chain drivers, Obstacles to Achieving Strategic fit. **(5 Hrs)**

Design the Distribution Network: Designing the distribution network, role of distribution, factors influencing distribution, design option for distribution. **(5 Hrs)**

Network Design: Network design in the SC, factors influencing network design, models for facility location. **(5 Hrs)**

Transportation in Supply Chain: Transportation in the supply chain, factors affecting transportation decisions, modes of transportation and their performance. **(5 Hrs)**

Pricing in Supply Chain: Pricing and revenue management in the SC, Sourcing decision in SC, supplier selection, supplier assessment. **(5 Hrs)**

Coordination in Supply Chain: Coordination in the SC, Lack of coordination and the bullwhip effect, Supply chain information system, E-business and supply chain. **(6 Hrs)**

Text Books:

1. *Supply Chain Management: Strategy, Planning, and Operation*, Chopra Sunil and Meindl Peter, PHI, 5thEdition, 2013.

Reference Books:

1. *Supply Chain Management: Text and Cases,* Janat Saha, Pearson Education, First Edition, 2009.
2. *Logistics and Supply Chain Management,* Martin Christoper, Pearson Education, 1998.
3. *Designing and Managing the Supply Chain*, David Semchi-Levi, Philip Kaminsy, TMH, 3rd Edition, 2007.

ME4023 GAS DYNAMICS AND JET PROPULSION Cr-3

Introduction: Energy equation for a flow process, stagnation value, various regions of flow, critical velocity of sounds, Rocco number, effect of Mach number on compressibility, rate equation of momentum, energy and entropy. **(4 Hrs)**

Isotropic flow with variable area: Mach number variation ,stagnation critical state, area ratio as function of mach number, impulse functions, mass flow rate, flow through nozzles and diffusers, use of gas tables. **(5 Hrs)**

Wave motion: wave propagation in elastic solid medium, propagation sound waves, pressure field due to a moving source of disturbance, mach angle. **(4 Hrs)**

Flow with normal shock waves: governing equations, variation of Mach number, static pressure, temperature and density across the shock. Strength of shock waves, moving shock waves. **(5 Hrs)**

Flow in constant area ducts with friction: The fanno curve, fanno flow equation and solutions variations of flow properties, table and charts for fanno flow. **(5 Hrs)**

Flow in constant area ducts with heat transfer: The Rayleigh's line, fundamental equation, Rayleigh flow equations variation of flow properties, maximum heat transfer, tables and charts of Rayleigh flow. **(5 Hrs)**

Jet propulsion: Thrust equation, maximum thrust relationship, engine performance parameters, ramjet engine, ideal ramjet, ideal and actual turbo jet engine. **(4 Hrs)**

Rocket propulsion: Operation principle, thrust equations, specific characteristics velocities, impulse weight ratio. **(4 Hrs)**

Text Books:

1. *Fundamentals of compressible flow,* SM Yahya, New Age International, 4th edition

References:

1. *Compressible fluid flow,* MA Saad, Prentice Hall
2. *Elements of Gas Dynamics,* Leipmann and Rosko, Willey
3. *Air craft and Missile propulsion,* M. J. Zucrow, John Willey

ME4024 INNOVATIONS AND NEW PRODUCT DEVELOPMENT Cr-3

Introduction: A project-based course in which each student team comprising students from different universities/courses will be responsible for development of a product for the global market. Teams will use collaboration technology tools extensively. Several case studies on global product development will be presented and follow-up lectures will focus on the issues highlighted. **(4 Hrs)**

Product Design: Definition of Design – Industrial Product vs Consumer Products – Asthetic vs Functional design – Various techniques reducing product development cycle time – Product planning – Product life cycle – Cost of development. **(5 Hrs)**

Product Development Processes: Concepts of product development processes – Concurrent Engineering – Reverse Engineering – ethics – Competition intellectual rights – Patents – Product safety, liability and compensation, Advance Product Quality Planning (APQP). **(5 Hrs)**

Product Features: – Identifying customer needs – Concept generation – Techniques for identifying product features – Quality function deployment (QFD) – Concern for manufacturability, Serviceability, Maintainability, disposal problem – Ergonomical factors. **(5 Hrs)**

Design and Process FMEA: Design for Failure Mode Effects Analysis (DFMEA), Design Review, Vehicle Review. **(4 Hrs)**

Quality Assurance and Design for Manufacturing: Design for quality. Process behavior over time. Concept of statistical process control (SPC). Process capability study. Tolerance. Measurement system analysis. Implication of customer satisfaction and profitability. Including Applications of probability and statistics in design reliability and quality control. **(4 Hrs)**

Design Synthesis: Integration of ideas, concepts, and fundamentals of science and engineering into preliminary design; synthesis of technical, human, and economic factors. Mathematical modeling and design optimization. **(4 Hrs)**

Fatigue in Mechanical Design: A broad treatment of stress, strain, and strength with reference to engineering design and analysis. Major emphasis is placed on the analytical and experimental determination of stresses in relationship to the fatigue strength properties of machine and structural components. Also considered are deflection, post-yield behavior, residual stresses, temperature and corrosion effects. **(5 Hrs)**

Text Books:

1. *The Mechanical Design Process,* David G. Ullman, McGraw Hill, 1997.

Reference Books:

1. *Proceedings, 3 Day Certificate Course on Quality Function Deployment*, May 2007. ARAI & SAE INDIA W.S.
2. *ARAI & SAEINDIA W.S. Proceedings, 3 Day Certificate Course on Design Failure Mode & Effect* Analysis, May 2007.
3. *Design of Devices and Systems,* William H. Middendroff, Maecell Dekker Inc, New York, 1998.

ME4025 COMPUTATIONAL FLUID DYNAMICS Cr-3

Basic Equations of Fluid Dynamics: Types of second order partial differential equations, linear and non linear equations. **(3 Hrs)**

Finite Difference Formulation: One dimensional steady state heat conduction in Cartesian coordinates, Conditions of stability, boundary conditions: prescribed temperature, prescribed heat flux, convection boundary condition, radiation boundary condition, combined convection and radiation boundary condition. **(6 Hrs)**

Methods of Solving Simultaneous Algebraic Equations: Gaussian elimination method, matrix inversion method, iterative method, SOR method, Runge-Kutta method, 4^{th} Order RK Method. **(6 Hrs)**

One Dimensional Transient Heat Conduction: Explicit and implicit methods, stability and convergence, Crank-Nicholson implicit method. **(6 Hrs)**

Two Dimensional Heat Conduction: Steady state conduction equations in Cartesian coordinates. Difference equation for boundary nodes. **(6 Hrs)**

One and Two dimensional convection-diffusion equation: Application of convection schemes like first order upwind, second order upwind, QUICK and other hybrid schemes for convection term. **(6 Hrs)**

Finite Volume Method: Application of finite volume method in heat transfer problems. **(3 Hrs)**

Text Books:

1. *An introduction to computational fluid dynamics, the finite volume method,* H K Versteeg and W Malalakekera, Prentice Hall; 2^{nd} Edition, 2007.
2. *Computational fluid dynamics, the basics with applications,* John D Anderson, Jr; McGraw-Hill Science/Engineering/Math, 1^{st} Edition, 1995.

Reference Books:

1. *Introduction to Computational fluid dynamics,* P. Niyogi, S. K. Chakraborty and M. K. Laha, Pearson Education India, 2013.
2. *Numerical Heat Transfer and Fluid Flow*, S. Patankar, CRC Press, 1980.

ME4026 TOTAL QUALITY MANAGEMENT Cr-3

Introduction to Quality: Defining Quality, Quality as a Management Framework, Quality and Competitive Advantage, Quality cost, Quality losses, link between Quality and productivity. **(3 Hrs)**

Tools for Quality Control: Basic tools of quality (the stem and leaf plot, histogram, box plot etc.), ISO 9000:2000, Six Sigma, Total quality management, introduction to total quality management, the evolution of total quality, Statistical methods for Quality control and improvement. **(4 Hrs)**

Statistical Process Control: Statistical Process Control, Specification & Limits, Charts for variables & attributes, Process Control (X, R & P chart), Summary of Control Chart Construction, Designing Control Charts. **(6 Hrs)**

Sampling Plan: Design of single sampling plan. Double, multiple and sequential sampling plans, O.C. curve, AOQ, AOQL. **(5 Hrs)**

Reliability: Reliability analysis and predictions, Bath-Tub Curve, Exponential and Weibull distribution in modelling reliability, System reliability. **(6 Hrs)**

Experimental Design: Experimental designs and factorial experiments: Concepts of randomization, Blocking and Confounding Single factor randomized design, ANOVA, 2^k factorial experiments Taguchi philosophy; Loss function; Signal to noise ratio, Orthogonal arrays for parameter and tolerance design. **(6 Hrs)**

Process Capability: Process capability analysis using histogram, use and interpretation of Cp, normality and process capability ratio, process capability analysis using designed experiment. **(6 Hrs)**

Text Books:

1. *Fundamentals of Quality Control and Improvement*, Amitava Mitra , Wiley , 3^{rd} Edition, 2008.

Reference Books:

1. *Quality Planning and Analysis*, Frank Gryna, TMH, 2001.
2. *Total Quality Management*, J.R. Evans – South-Western; 3rd Revised edition, 2002.
3. *Total Quality Management*, L. Suganthi, PHI, 1st Edition, 2004.

ME4027 MICRO AND NANO FLUIDICS Cr-3

Microfluidics: Definition, Microchannel flow theory, Microfluidic system components, integration and challenges, Scaling laws, fluid properties and surface tension effects, wall slip velocity and temperature jump, electrokinetic phenomena (electroosmosis, electrostatics, electrophoresis, Nernst-Plank equation), magneto hydrodynamics.

(9 Hrs)

Applications in Microfluidics: Micropumps and Microchannel flow (liquid flow and gas flow through microchannel), micromixing, laboratory-on-a chip devices (LoC processing steps and LoC applications). **(9 Hrs)**

Nanofluidics: Definition, nanofluids flow in nanoconduits, nanostructures, nano-thermodynamics, nanoscale phenomena and descriptive equations, liquid flow in nanoconduits, rarefied gas flow in microchannel, nanochannel flow examples. **(9 Hrs)**

Applications in Nanofluidics: Nanoparticle fabrication (metal and metal oxides for cooling), forced convection cooling with nanofluids (nanofluids properties, thermal nanofluids flow, and friction factor and pressure drop).

(9 Hrs)

Text Book:

1. *Microfluidics and Nanofluidics- Theory and Selected Applications*, Clement Kleinstreuer, John Wiley & Sons, Inc., 2014.

Reference Books:

1. *Electrokinetically driven microfluidics and nanofluidics*, Alexander Oron, Cambridge University Press, 2010.
2. *Nanofluidics,* P. Abgrall and N. T. Nguyen, Artech House; 1st Edition, 2009.
3. *Theoretical Microfluidics*, H. Bruus, Oxford University Press, 2007.

ME4028 INDUSTRIAL SAFETY Cr-3

Introduction to Industrial Safety: History and development of safety movement, Need for safety, Safety legislation: Acts and rules, Safety standards and codes, Safety policy: safety organization and responsibilities and authorities of different levels. (**4 Hrs)**

Types of industries: Light, heavy, high tech – manufacturing (iron and steel), process (oil refinery), service (hospital); Overview of a typical modern industry: activity flow, machineries, operations, parameters which could lead to accidents; ranges of temperatures and pressures, working media like fluids and gases, safety concerns (over pressure, gas leaks, etc.) (**5 Hrs)**

Areas of industrial safety: Process safety, personnel safety, instrument safety, facility safety, environmental safety. (**4 Hrs)**

Accidents: Accident sequence theory, Causes of accidents, Accident prevention and control techniques, Plant safety inspections, Job safety Analysis and investigation of accidents, First aid. (**3 Hrs)**

Financial costs: Direct and indirect social costs of accidents. Compilation procedure for financial costs. Cost data, quality and its limitations-Budgeting. (**4 Hrs)**

Hazard Identification: Identification of hazard, Categorization methods for elimination of hazard, Mechanical hazards; machine guarding, safety with hand tools/ portable power tools, Pressure vessel hazards and their control, Safety in material handling: hazards and safe Practices, safety with storage of materials, Electrical hazards: classification, safe work practices, Chemical hazards: laboratory safety, bulk handling of chemicals, Fire and explosion hazards, Fire detection, Prevention ,control, and extinguishments, Industrial layout, Industrial waste management.

(**8 Hrs)**

Hazard analysis: Checklist procedure, Preliminary hazard analysis, What if analysis, Failure mode effect analysis, Hazard and operability (HAZOP) studies, Hazard analysis techniques: Fault tree analysis, Event tree analysis, General outline of DOW index, Risk estimation and management, Major hazard control, On-site and Off-site emergency preparedness. (**8Hrs)**

Text Book:

1. *Industrial Safety, Health and Environment Management Systems*, R.K. Jain and Sunil S. Rao, Khanna publishers, 2006.

Reference Books:

1. *Check list for work place inspection for improving safety, " health and working condition ",* Intl. Labour Organisation Geneva, 1987.
2. *Safety and failure of components, "Proceedings of Mechanical Engineering ",* London, Vol. 184, Part 38, 1974.
3. *Industrial Safety Management,* L M Deshmukh, TMH, 1st Edition, 2005.

ME4029 ALTERNATIVE FUELS AND RENEWABLE ENERGY Cr-3

Introduction to Renewable Energy: Forms of energy, Fossil fuels and climate change, Renewable energy sources (direct and indirect uses of solar energy and non-solar energy), Importance of energy storage and distribution, Biological storage, Chemical storage, Heat storage, Electrical storage, Mechanical storage, Distribution of energy.

Solar Power Generation: The nature and availability of solar radiation, Low temperature solar energy applications, Active solar heating, Passive solar heating, Solar thermal engines and electricity generation, Economics, potential and environmental impact. **(8 Hrs)**

Bio Power Generation: Bioenergy past and present, Biomass as a solar energy store, Biomass as a fuel, Primary biomass energy sources: plant materials, Secondary biomass sources: wastes, residues, and co-products, Physical processing of biomass, Thermochemical processing, Biochemical processing, Vegetable oils and biodiesel, Environmental benefits and impacts, Economics, Future prospects for bioenergy. **(8 Hrs)**

Tidal and Wave Power Generation: Nature of tidal source, Physics of tidal energy, Power generation from barrages, Environmental considerations for tidal barrages, Integration of electrical power from tidal barrages, Economics of tidal barrages, Tidal lagoons, Tidal streams/currents, Tidal current projects, Tidal current assessment, Physical principles of wave energy, Wave energy sources, Wave energy technology, Integration (wave energy for isolated communities and large electricity grids). **(8 Hrs)**

Wind Power Generation: Energy and power in the wind, Characteristics of wind, Wind turbines (types, horizontal and vertical axis wind turbines), Linear momentum and basic theory, Dynamic matching, Blade element theory, Aerodynamics of wind turbines, Power extraction by a turbine, Electricity generation, Power from wind turbines, Environmental impact, Economics of energy generation, Commercial development and wind energy potential, Offshore wind energy. **(8 Hrs)**

Geothermal Power Generation: The mining of geothermal heat, Source of heat, Physics of deep geothermal resources, Technologies for exploiting high enthalpy steam fields, Technologies for direct use of geothermal energy, Harnessing geothermal resources, Environmental implications, Economics and world potential. **(4 Hrs)**

Text Book:

1. Renewable Energy- Power for a Sustainable Future, Godfrey Boyle, Oxford University Press, 3rd Edition, 2012.

Reference Books:

1. Renewable Energy Resources, John Twidell and Tony Weir, Taylor & Francis Group, 3rd Indian Edition, Vikash Publications, 2010.

ME4031 NOISE, VIBRATION AND HARSHNESS Cr-3

NVH in the Automotive Industry: Sources of noise and vibration. Design features. Common problems. Marque values. Noise quality. Pass-by noise requirements. Target vehicles and objective targets. Development stages in a new vehicle programme and the altering role of NVH engineers. **(7 Hrs)**

Sound and Vibration Theory: Sound measurement. Human sensitivity and weighting factors. Combining sound sources. Acoustical resonances. Properties of acoustic materials. Transient and steady state response of one degree of freedom system applied to vehicle systems. Transmissibility. Modes of vibration. **(7 Hrs)**

Test Facilities and Instrumentation: Laboratory simulation: rolling roads (dynamometers), road simulators, semi-anechoic rooms, wind tunnels, etc. Transducers, signal conditioning and recording systems. Binaural head recordings. Sound Intensity technique, Acoustic Holography, Statistical Energy Analysis. **(7 Hrs)**

Signal Processing: Sampling, aliasing and resolution. Statistical analysis. Frequency analysis. Campbell's plots, cascade diagrams, coherence and correlation functions. **(7 Hrs)**

NVH Control Strategies & Comfort Source ranking. Noise path analysis. Modal analysis. Design of Experiments, Optimization of dynamic characteristics. Vibration absorbers and Helmholtz resonators. Active control techniques. **(8 Hrs)**

Text Books:

1. *Noise Control of Internal Combustion Engine*,Baxa,, John Wiley, 1984.
2. *Fundamental of Noise and Vibration,* Norton M. P., Cambridge University Press, 1989.

Reference Books:

1. *Theory and Practice,* Ewins D. J., Model Testing :, John Wiley,1995.
2. *Dynamic Vibration Absorbers,* Boris and Kornev, John Wiley, 1993.
3. *Vibration Testing Theory and Practice,* McConnell K, , John Wiley, 1995.
4. *Vehicle Refinement Controlling Noise and Vibration in Road Vehicles*, M. Harrison, Elsevier.

ME4032 FLEXIBLE AND SUSTAINABLE MANUFACTURING Cr-3

Introduction: FMS definition and classification of manufacturing systems, Automated production cycle, Need of flexibility, Concept of flexibility, Types of flexibilities and its measurement. **(4 Hrs)**

FMS Equipment: Why FMS, Factors responsible for the growth of FMS, FMS types and applications, Economic justification for FMS, Functional requirements for FMS equipments, FMS processing and QA equipment, e.g., turning and machining centers, Co-ordinate measuring machines, Cleaning and deburring machines, FMS system support equipment, Automated material handling and storage equipment, cutting tool and tool management, Work holding considerations, Fixture considerations in FMS environment. **(12 Hrs)**

Group Technology: GT concepts, Advantages of GT, Part family formation-coding and classification systems; Part machine group analysis, Methods for cell formation, Use of different algorithms, mathematical programming and graph theoretic model approach for part grouping, Cellular vs FMS production. **(8 Hrs)**

Sustainable Manufacturing: Introduction, importance and scope in the present scenario, green manufacturing, intelligent manufacturing, web based manufacturing, virtual manufacturing, lean and agile manufacturing. **(12 Hrs)**

Text Books:

1. *Automation, Production Systems, and Computer-Integrated Manufacturing*, Mikell P. Groover, Pearson Education, ISBN 81-7808-511-9. 3rd Edition, 2007

Reference Books:

1. *Flexible Manufacturing Cells and systems,* W.W. Luggen Prentice Hall India
2. *Green Manufacturing: Fundamentals and Applications,* David A. Dornfeld, Springer, 2013
3. *Virtual Manufacturing,* Prashant Banerjee, Dan Zetu, Wiley; 1 edition (March 9, 2001), ISBN-10: 0471354430, ISBN-13: 978-0471354437.
4. *Performance Modeling of Automated Manufacturing Systems,* Vishwanathan & Narahari, Prentice Hall India, ISBN: 978-81-203-0870-1.

ME4033 AUTOMOTIVE SAFETY AND LIGHTING Cr-3

Automotive Safety: Active and passive safety, Driver assistance systems in automobiles, Definitions and terminology, Balance of stiffness and toughness characteristics and energy absorption characteristics of vehicle structures, Design of crash crumple zones, Modeling and simulation studies, Optimization of vehicle structures for crash worthiness, Types of impacts, and Impact with rebound, movable barrier tests, Analysis and simulation of vehicle in barrier impacts, Roll over crash tests, Behavior of specific body structures in crash testing, Photographic analysis of impact tests, Regulatory requirements for crash testing. **(8 Hrs)**

Ergonomics and Human response to Impact: Importance of Ergonomics in Automotive safety, Locations of controls, Anthropomerty, Human impact tolerance, Determination of Injury thresholds, Severity Index, Study of comparative tolerance, Application of Trauma for analysis of crash injuries. Injury criteria's and relation with crash and modeling and simulation studies in dummy. **(4 Hrs)**

Vehicle safety systems: Survival space requirements, Restraints systems used automobiles, Types of safety belts, Head restraints, Air bags used in automobiles, Use of energy absorbing systems in automobiles, Impact protection from steering controls, Design of seats for safety, types of seats used in automobiles. Importance of Bumpers in automobiles, Damageability criteria in bumper designs. Introduction to the types of safety glass and their requirements and rearward field of vision in automobiles, Types of rear view mirrors and their assessment. Warning devices, indicators, hinges, latches, wipers, horns, etc. **(7 Hrs)**

Fundamentals of light, vision and colour: Electromagnetic radiation and light, Propagation of light, Spectral sensitivity of light,Measures of radiation and light, Standard elements for optical control. Illuminant calculations, Derivation of luminous flux from luminous intensity, flux transfer and inter reflection, luminance calculations, discomfort glare, eyes as an optical system, visual processing, lighting
for results, modes of appearance, Pointers for lighting devices. Nature of the colour, Tri-chromatic Colorimetry, Surface colour, colour spaces and colour solids,, colour rendering. **(5 Hrs)**

Light Measurements, Testing equipment, calibration and photometric practice: Basics of standards and detectors, spectral measurements and Colorimetry, illuminant meters and luminance meters, colorimeters. Fundamentals of equipment used for light measurement in Automotive field; Gonio-Photometer, Reflecto-meter, Colorimeter, Integrating sphere, types, application, coordinates system, Types of sensors and working principle, construction, characteristics etc. used in different equipment. National and international Regulations, test requirements and testing procedure.
(6 Hrs)

New Technology in Automotive lighting: Technology progress in automotive lighting, Gas Discharges lamps, LED, adoptive front lighting system, Daylight running lamps. **(6 Hrs)**

Text Books:

1. *Low speed Automobile Accidents,* Watts, A. J., et al Lawyers and Judges 1996.

Reference Books:

1. *An Introduction to Modern Vehicle Design,* Jullian Happian-Smith SAE, 2002
2. *Crashworthiness of Vehicles,* Johnson, W., and Mamalis, A.G., MEP, London, 1995

Lamps and Lighting, Edward .A, Hodder & Stoughton, London, 1993.

ME4034 VEHICLE DYNAMICS Cr-3

Introduction: Fundamental of vibration, Mechanical vibrating systems. Modelling and Simulation - Model of an automobile, Single, two, multi degrees of freedom systems, Free, forced and damped vibrations. Magnification factor - Transmissibility **(7 Hrs)**

Multi-degree of freedom systems: Vibration absorber, Closed coupled system, Eigen value problems, Far coupled Systems, Orthogonality of mode shapes, Modal analysis, and Forced vibration by matrix inversion. Approximate methods for fundamental frequency, Dunkerley's lower bound, Rayleigh's upper bound, Hozler method for close coupled systems and branched systems. **(6 Hrs)**

Suspension and Tyers: Requirements. Sprung mass frequency. Wheel hop, wheel wobble, wheel shimmy. Choice of suspension spring rate. Calculation of effective spring rate. Vehicle suspension in fore and apt directions. Ride characteristics of tyre, Effect of driving and braking torque, Gough's tyre characteristics. **(8 Hrs)**

Vehicle Handling: Oversteer, under steer, steady state cornering. Effect of braking, driving torques on steering. Effect of camber, transient effects in cornering. **(7 Hrs)**

Stability of Vehicles: Directional stability of vehicles. Load distribution. Calculation of Tractive effort and reactions for different drives - Stability of a vehicle on a slope, on a curve and a banked road. **(8 Hrs)**

Text Book:

1. *Vehicle handling Dynamics Theory and Application,* Masato Abe, Elsevier.

Reference Books:

1. *Vehicle Dynamics Theory and Application*, *Theory and Application, Reza N. Jazar, Springer.*
2. *Automotive Chassis,* Heldt.P.M., Chilton Co., New York, 1992.
3. *Vehicle Dynamics,* Ellis.J.R., Business Books Ltd., London, 1991.
4. *Suspension and Tyres*, Giles.J.G. Steering, llliffe Books Ltd, London, 1998.

ME4035 AUTOMOTIVE CHASSIS, SUSPENSION AND TRANSMISSION SYSTEM Cr-3

Introduction: Types of chassis layout with reference to power plant locations and drive. Vehicle frames. Various types of frames. Constructional details. Materials. Testing of vehicles frames. Unitised frame body construction, Loads acting on vehicle frame. **(2 Hrs)**

Transmission: Layout of power transmission system, requirement of transmission system Clutch Need of clutch. Types of clutches, principle, construction, torque capacity, clutch operating system. Performance curve. **(4 Hrs)**

Gear Box: Requirement of gearbox, different types of gear box viz sliding, constant mesh and synchromesh gear box. Construction details of gear boxes. Gear ratios of vehicle Gear box operation principle. **(4 Hrs)**

Hydro dynamic drive: Fluid coupling, Principle and operation Torque capacity Performance characterictic. Torque converter Construction, principle of operation, Torque capacity multistage torque converter Performance behaviour. **(2 Hrs)**

Automatic transmission: Construction and operating principle, 4 forward and reverse & 3 forward and reverse. Over drive unit and its operation. **(2 Hrs)**

Electrical drive: Construction and operation Electric drive Ward Leonard control system, construction and operation, advantages and disadvantages. **(1 Hr)**

Front axle and Steering System: Types of front axle. Constructions details. Materials. Front wheel geometry viz. Castor, Camber, King pin inclination, Toe-in. Conditions for true rolling motion of wheels during steering. Steering geometry. Ackerman and Davis steering system. Constructional details of steering linkages. Different types of steering gear boxes. Steering linkages and layouts. Power and Power assisted Steering. **(4 Hrs)**

Drive Line: Effect of driving thrust and torque reactions. Hotch Kiss drive, torque tube drive and radius rods. Propeller shaft. Universal joints. Constants velocity universal joints. Front wheel drive. Final Drive Differential: Different types of final drive. Worm and worm wheel, Straight bevel gear, Sprial bevel gear and hypoid gear final drives. Differential principles. Construction details of differential unit.Differential locks. Differential housings. **(4 Hrs)**

Rear Axles: Construction of rear axles. Types of loads acting on rear axles. Full floating. Three quarter floating and semi floating rear axles. Rear axle housing. Construction of different types of axle housings. **(3 Hrs)**

Suspension System: Need of suspension system, types of suspension, suspension springs, constructional details and characteristics of leaf, coil and torsion bar springs. Independent suspension, Rubber suspension, Pneumatic suspension, Shock absorbers. **(4 Hrs)**

Braking System: Classification of brakes, drum brake & disc brakes. Constructional details-Theory of braking. Mechanical hydraulic and Pneumatic brakes. Servo brake. Power and power assisted brakes different types of retarders like eddy current and hydraulic retarder. Anti lock braking systems. **(6 Hrs)**

Text Book:

1. *Automobile Engineering Vol-I*, Kripal Singh, Standard Publisher Distributor.

Reference Books:

1. *A Text book of Automobile Engineering*, Volume-II. P.S.Gill, S.K. Kataria & Sons Publisher of ngineering & Computer Books.
2. *Basic automobile Engineering*, Nakra C P , , Dhanpat Rai Publication co. Ltd 7th edition, 2005
3. *Automobile Engineering*, De A, Galgotia Publication Pvt. Ltd. 2004.

ME4036 MARKETING MANAGEMENT Cr-3

Marketing Concepts: Approaches to Marketing –Core concepts of marketing - Marketing Process – Functions of Marketing. **(4 Hrs)**

Marketing Environment: The changing marketing environment – Analyzing needs and trends in Macro Environment and Micro Environment. **(5 Hrs)**

Market Segmentation: Bases for market segmentation of consumer goods, industrial goods and services – Market Targeting and positioning strategies. **(5 Hrs)**

New Product Decision Process: Types of new products – Test Marketing of a new product, Packaging – Purpose, Types and New Trends in packaging. **(5 Hrs)**

Marketing Mix: Four P's – Its significance in the competitive environment – Product and Product Line – Product Mix – Product Life Cycle – Managing the product in Product Life Cycle. **(4 Hrs)**

Physical Distribution: Importance and role of distribution in marketing – Introduction to the various channels of distribution –Promotion Tools – Sales Promotion, Advertising, Personal Selling, Direct Marketing and Online Marketing as promotion tools. **(4 Hrs)**

Pricing: –importance – methods – objectives –factors. **(4 Hrs)**

Market Evaluation and Controls: Types, processes, obstacles to marketing control – Marketing Audit – Marketing Ethics. **(5 Hrs)**

Text Books:

1. *Principles of Marketing* 9th Edition - Philip Kotler and Gary Armstrong.

Referance Books:

2. *Marketing* - Stanton,,Michael Etzel,Walker(Tata)
3. *Marketing Management* - V.S.Ramaswamy and S.Namakumari
4. *Marketing Special Indian Edition*- Dhruv Grewal, Michael Levy

ME4037 AUTOMOTIVE MATERIALS Cr-3

High strength steels – Bake hardening (BH) grades, Isotropic steels, Interstitial free (IF) grade steels, Rephosphorized steels, High strength micro alloy steels, Dual phase steels, TRIP steels, Boron steels, Multiphase steels, AHSS grades – Austenitic SS, L-IP, TWIP; Hydroforming process. **(8 Hrs)**

Natural fiber composites – Why natural fiber composites? Natural fiber classification – Bast fibers, Leaf fibers, Sead fibers, Fruit fibers, Wood fibers; Fiber properties; TS & TP composites with NFs and their properties; Automotive applications. **(8 Hrs)**

Smart Materials – What are Smart Materials? Functional properties that lead to their consideration; Piezoelectric materials, Electoactive materials, Shape memory alloys (SMA), Optical fibers, Nano-composites. What are MEMS? Uses as sensors, actuators and signaling devices in vehicles. **(9 Hrs)**

Nano-composites – Defination, Types, Mechanisms, Structure=property relationship, Basic classes – TP, TS, Elastomers and blends; Forms – Fibers, Foams, Film, Membranes and Paints; Geometric forms – Nanospheres (clay), Nanotubes (Single & multi wall) & Nano fibers, and Nanoplatelets; Importance of interface between matrix and nanophase; Functionalization; Production of Nano-composites – Melt processes, Solution processes, In-situ processes and other processes; Structural characterization of Nano-composites – X-ray Diffraction, Electron microscope (SEM, TEM), Scanning probe microscopy (SPM, AFM), Spectroscopic methods (EDS, FTIR); Mechanical behaviors, Thermal response, Fire retardancy, Chemical resistance and Electrical-Magnetic-Optical properties of ploymer nano-composites; Applications and future trends – Automobiles, Coatings, Adhesives, Fire retardants, Micro-electronic packages, Optical integrated circuits, Sensors, Membranes, etc. **(11 Hrs)**

Text books:

1. *Materials for Engineers and Technicians*, 4th edition, Higgins, Elsevier.

2. *Polymer Nanocomposites and their Applications*, Ray & Bousmania, , ASP, 2006

Reference Books:

1. *Experimental Stress Analysis*, L. S. Srinath, Tata McGraw Hill, 1998
2. *Automotive Engineering Light Weight, Functional and Novel Materials*, Cartor, Taylor & Francis Group.

ME4038 TOTAL LIFE CYCLE MANAGEMENT Cr-3

Definition of total life cycle (TLC)-Concept of TLC-Life cycle impacts-Integrating life cycle technologies-Products and processes within TLC-TLC methodology-TLC assessment data to complex products-Results Improvement for product. **(9 Hrs)**

Vehicle End Life: Design for end of old vehicle management –Problems of old vehicles in emerging markets-recovery and economic feasibility of materials such as Plastics, rubber aluminum, steel, etc. **(9 Hrs)**

Trade offs: Applying life cycle thinking to define tradeoffs along the supply, manufacture-use and end of life chain-Effect on the customer- Expectation of the customer-Evaluate product cost on fuel consumption, emissions, durability, environment and health. **(9 Hrs)**

Sustainability: What is sustainability-Use of renewable resources-View to design horizon. Harmonization of Environmental Goals: TLC for emerging vs. developed markets-Rules and regulations to guide designers-International common practices for end of life vehicles. **(9 Hrs)**

Text Books:

1. *Total Quality Managemen,* K. C. Arora,. S.K. Kataria & Sons, 2007-08.

ME4041 MECHANICAL VIBRATION AND NOISE ENGINEERING Cr-3

Two Degree of Freedom Systems: Generalized Derivation of Equation of motion, Static and dynamic coupling, Langrange's equations. Undamped dynamic vibration observers. **(5 Hrs)**

Multi-Degree of freedom system: Derivation of Equations, Influence coefficients, Eigen values and Eigen vectors, Calculation of Natural Frequencies by Rayleigh, Stodala, Matrix iteration and Holzer-Methods. **(5 Hrs)**

Torsional Vibration: Multi-rotor systems, geared system and branched system **(5 Hrs)**

Vibration of continuous system: Vibration of strings, free longitudinal vibration of prismatic bars, Lateral vibrations of uniform beams. **(7 Hrs)**

Introduction to acoustics: Propagation of acoustic disturbances, the decibel scale for the measurement of sound pressure, Acoustic energy density and intensity, the wave equations, acoustic impedance. **(5 Hrs)**

Human Response to sound: Noise effects, auditory response, Ratings and Regulations**.** **(4 Hrs)**

Noise control: Principles of passive noise control, Acoustic enclosures, Acoustic barriers, Sound-absorbing materials, Vibration isolations materials and Damping materials. **(5 Hrs)**

Text Books:

1. *Mechanical Vibrations and Noise Engineering*, Ashok G. Ambekar, PHI.

Reference Books:

1. *Theory of Vibration and Application*, William T. Thomson, CBS
2. *Textbook of Mechanical Vibrations,* Rao.V. Dukkipati, PHI
3. *Noise and vibration control*, L. Beranek, McGraw-Hill

ME4042 MACHINE MAINTENANCE AND CONDITION MONITORING Cr-3

Maintenance strategies: Breakdown, Preventive, Predictive and Proactive maintenance. Plant machinery classification, Condition based maintenance. **(2 Hrs)**

Transducers for condition monitoring: Principles and application of accelerometers, velocity pickups, eddy current probes, stroboscopes, proximity probes, spike energy detector, laser vibrometer, condenser microphones, thermocouples, optical pyrometer, ultrasonic thickness detector, acoustic emission transducer. **(2 Hrs)**

Fundamentals of Signal processing: Fast Fourier Transform (FFT) analysis, Sampling rate, Nyquist sampling theorem, aliasing, filters, A/D converter, Windowing. **(2 Hrs)**

Vibration Monitoring: Measuring vibration: Signal forms, phase, overall and spectral vibration, Measurement point location, Transducer mountings.
Rotating machinery fault analysis: Imbalance, Misalignments, Looseness, Oil whirl, Bent shafts, Coupling problem, Bearing defects, Gear defects.
Vibration level classification: ISO standards, Peak and RMS levels, Time domain averaging, Trending fault data. Case studies based on vibration data and signature of machines. **(8 Hrs)**

Wear and Debris Analysis: Principle of Tribology, Industrial and Automotive Lubricants, Lubricants Properties, Lubricants Contamination and Prevention, Lubricants Mechanism and Failures, Sampling of Lubricants, Wear particle size, Ferrography, Particle Counting, Magnetic Plugs, Spectrometric metals analysis and Types of Wear Particles. Case studies based on oil analysis data of machines. (**6 Hrs**)

Temperature Monitoring: Infra-red Thermograghy, Principles, Instruments, Thermal imaging, Locating hot spots for maintenance intervention, Ascertaining condition of refractory lining, Identifying faults in cooling system and in electrical Equipments, Plant Heat audit .Case studies based on thermal images. (**4 Hrs**)

Non Destructive Testing: Faults that can be detected by NDT, Ultrasonic, Radiography Methods, Eddy Current Method, Acoustic Emission Method, Dye penetrant Method. Case studies based on available NDT data. **(6 Hrs)**

Advance Maintenance Practices: Total Productive Maintenance (TPM), Reliability Centered Maintenance (RCM), Computerized Maintenance Management Systems (CMMS), Five Zero Maintenance Concept. Maintenance Planning and Scheduling, Budgeting, Costing. **(6 Hrs)**

Text Book:

1. *Maintenance Engineering and Management*, Sushil Kumar Srivastava, S.CHAND,

Reference Books:

1. *Maintenance Engineering and Management,* K.Venkataraman, PHI, 1st Edition
2. *Plant Maintenance and Reliability Engineering,* N.V.S. Raju, CENGAGE, 1st Edition

ME4043 INTRODUCTION TO COMPOSITE MATERIALS Cr-3

Introduction: An overview of composites, Classification & characteristics of composite materials, Application and advantages of composites. **(5 Hrs)**

Fibers, Matrices and Fabrication of Composites: Advanced fibers, Fiber properties, Matrix materials, Fillers, Fabrication of polymer, metal, ceramic matrix composites. (**7 Hrs)**

Elastic behavior of composite lamina-Microanalysis: Longitudinal behavior of unidirectional composites, Transverse stiffness and strength, Failure modes, expansion coefficients and transport properties. **(10 Hrs)**

Analysis of Laminated Composites-Macromechanics: Stress-strain relations and engineering constants, Hooke's law and stiffness and compliance matrices, Strength of an orthotropic lamina, Fracture mechanics of fiber composites, factors influencing fatigue behavior of composites. **(8 Hrs)**

Test methods: Measurement of physical properties, Measurement of Mechanical properties, Flexural properties, Fracture toughness and Impact properties. **(6 Hrs)**

Text Book:

1. *Engineering Mechanics of Composite Materials, I.M. Daniel and Ori Ishai, Oxford University Press (Indian 2nd Ed.)*

Reference Books:

1. *Composite Materials, K.K. Chawala, Springer-Verlag.*
2. *Mechanics of Composite Materials R.M. Jones, 2nd Ed., Taylor and Francis.*

ME4044 RAPID PROTOTYPING Cr-3

Introduction: Need & Development of RP systems, RP process chain, Impact of Rapid prototyping and Tooling on Product Development, Benefits, Applications, Digital prototyping, Virtual prototyping. **(5 Hrs)**

Liquid and Solid Based Rapid Prototyping Systems: Stereo lithography Apparatus, Fused deposition Modeling, Laminated object manufacturing, 3D printing: Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies. **(6 Hrs)**

Powder Based Rapid Prototyping Systems: Selective Laser Sintering, Direct Metal Laser Sintering, 3D Printing, Laser Engineered Net Shaping, Selective Laser Melting, Electron Beam Melting: Processes, materials, products, advantages, applications and limitations. **(4 Hrs)**

Data Processing for Rapid Prototyping: Process planning for rapid prototyping, CAD model preparation, Data Requirements & geometric modeling techniques: Wire frame, surface and solid modeling data formats - Data interfacing, Tessellation of surfaces, STL file generation Defects in STL files and repairing algorithms, Part orientation and support generation, Support structure design, Model Slicing and contour data organization, direct and adaptive slicing, Tool path generation. **(8 Hrs)**

Issues of Prototype: Accuracy issues in Rapid Prototyping, Strength of RP Parts, Surface roughness problem in Rapid Prototyping, Part deposition orientation and issues like accuracy, surface finish, build time, support structure, cost etc. **(3 Hrs)**

Rapid Tooling: Classification: Soft tooling, Production tooling, Bridge tooling; direct and indirect, Fabrication processes, Applications, Rapid tooling techniques such as laminated metallic tooling, direct metal laser sintering, vacuum casting. **(5 Hrs)**

Reverse Engineering: Introduction to reverse engineering, Integration of reverse engineering and rapid prototyping. **(5 Hrs)**

Text Books:

1. *Rapid Prototyping: Principle and Applications*, Rafiq I Noorani, Wiley & Sons, 2006

References Books:

1. *Rapid prototyping: Principles and applications*, Chua C.K., Leong K.F., and Lim C.S., Yes Dee Publishing Pvt.Ltd, Third edition,2010.
2. *Rapid Prototyping And Engineering Applications*, Frank W. Liou, CRC Press, Special Indian Edition, 2007.
3. *Journey from Rapid Prototyping to Rapid Manufacturing* , Somnath Chattopadhyaya, LAP Lambert Academic Publishing,,2011.
4. *Rapid Prototyping Technology: Selection and Application*, Kenneth G. Cooper, Cooper Cooper, Marcel Dekker Inc, 1st Edition, 2001.

ME4045 INTRODUCTION TO FINITE ELEMENT METHOD Cr-3

Introduction: Overview of FEM, General description of FEM, Engineering Application of FEM. **(5 Hrs)**

Basic Procedure: Discritization of domain, interpolation models, simplex, complex and multiplex elements, selection of the order of the interpolation, convergence requirements, linear interpolation polynomialsin Global and local co-ordinate system. **(8 Hrs)**

Higher Order and Isoparametric Elements: Higher order elements in terms of Natural co-ordinate system, one dimensional elements using classical interpolation polynomials, two dimensional elements using classical interpolation polynomials, Isoparametric elements, numerical integration. **(6 Hrs)**

Derivation of Element Matrices and Vectors: Direct Approach, Variatonal approach, derivation of Finite Element equations using Rayleigh-Ritz and Galerkin Method, Solution of eigenvalue problems using weighted Residual approach. **(7 Hrs)**

Assembly of Element Matrices and Derivation of System Equations: Co-ordinate transformations, Assemblage of Element equations, Incorporation of boundary conditions. **(5 Hrs)**

Application to Solid Mechanics and Heat Transfer Problems: Formulation of solid and structural mechanics, formulation of FE equations(Static Analysis), application to (Truss Elements, Beam Elements, Triangular Elements, Tetrahedral Elements). **(5 Hrs)**

Text Books:

1. *The Finite Element Method in Engineering,* S S Rao, Elsevier Publications

Reference Books:

1. *Concept and Application of FEM,* R D Cook, D S Malkus (Wiley edition)
2. *Fundamentals of Finite Element Analysis,* D.V. Hutton, McGraw Hill.

ME4046 ARTIFICIAL INTELIGENCE TECHNIQUES Cr-3

Introduction to Soft Computing & AI: Introduction to Soft Computing: Soft computing constituents and conventional Artificial Intelligence, Neuro-Fuzzy and soft computing characteristics, Areas of application of artificial intelligence, Taxonomy of artificial intelligence techniques. **(4 Hrs)**

Genetic Algorithms: Definitions, concepts, and areas of application, General structure of a genetic algorithm, Main components of a genetic algorithm (genetic representation, individual and population, evaluation function, genetic operators), Encoding, Fitness functions and Reproduction, Example application: Parameter optimization for a complex engineering design problem. **(7 Hrs)**

Genetic Modeling: Crossover, Inversion and deletion, Mutation Operators, Bitwise operators used in GA, Convergence of Genetic Algorithm, Applications. **(3 Hrs)**

Fuzzy Logic: Definitions, concepts, and areas of application of fuzzy logic and fuzzy sets, General structure of a fuzzy logic-based controller, Design of main components of a fuzzy logic-based controller (linguistic variables and values, membership functions, inference rules), Crisp sets, Fuzzy sets, Crisp relations, Fuzzy relations, Operations on Crisp and Fuzzy sets. **(6 Hrs)**

Artificial Neural Networks: Biological neuron versus artificial neuron, Definitions, concepts, and areas of application of artificial neural networks, artificial neural network topology, Learning process, Feed forward and feedback artificial neural networks, Design of an artificial neural network, Examples of applications. **(7 Hrs)**

Decision Modeling: Different methodology of optimization and decision making like Data Envelopment Analysis (DEA), Analytical Hierarchy Process (AHP); Statistical Decision Trees and its applications. **(4 Hrs)**

Nature Inspired Optimization Techniques: Concepts of heuristic approaches with introduction to Genetic Algorithm (GA), Tabu Search (TS), Artificial Immune System (AIS), Particle Swarm Optimization (PSO), Ant Colony Optimization (ACO) and Simulated Annealing (SA) **(5 Hrs)**

Text Books:

1. *Neural Networks, Fuzzy Logic and Genetic Algorithms*, S. Rajasekaran, G.A. Vijaylakshmi Pai, PHI, 2003.

Reference Books:

1. *Fuzzy Logic with Engineering Applications*, T. J. Ross, TMH, New York, 1997.
2. *Neuro-fuzzy and soft Computing,* J S R Jng, C T Sun and E. Mizutani, Pearson Education, New Delhi , 2004.

ME4047 TRIBOLOGY Cr-3

Study of various parameters: Viscosity, flow of fluids, viscosity and its variation -absolute and kinematic viscosity, temperature variation, viscosity index determination of viscosity, different viscometers used. **(5 Hrs)**

Hydrostatic lubrication: Hydrostatic step bearing, application to pivoted pad thrust bearing and other applications, hydrostatic lifts, hydrostatic squeeze films and its application to journal bearing. **(5 Hrs)**

Hydrodynamic theory of lubrication: Various theories of lubrication, petroffs equation, Reynold's equation in two dimensions -Effects of side leakage - Reynolds equation in three dimensions, Friction in sliding bearing, hydro dynamic theory applied to journal bearing, minimum oil film thickness, oil whip and whirl anti -friction bearing.

(7 Hrs)

Friction and power losses in journal bearings : Calibration of friction loss friction in concentric bearings, bearing moduIus, Sommerfield number, heat balance, practical consideration of journal bearing design considerations.

(4 Hrs)

Air lubricated bearing: Advantages and disadvantages application to Hydrodynamic journal bearings, hydrodynamic thrust bearings. Hydrostatic thrust bearings. Hydrostatic bearing Analysis including compressibility effect.

(3 Hrs)

Study of current concepts of boundary friction and dry friction. **(4 Hrs)**

Types of bearing oil pads: Hydrostatic bearing wick oiled bearings, oil rings, pressure feed bearing, partial bearings - externally pressurized bearings. **(4 Hrs)**

Bearing materials: General requirements of bearing materials, types of bearing materials. **(4 Hrs)**

Text Books :

1. Fundamentals of Tribology, Basu, Sen Gupta and Ahuja, PHI

Reference Books:

1. Tribology in Industry : Sushil Kumar Srivatsava, S. Chand &Co.

2. Tribilogy, Friction and Wear of Engineering Materials, I.M. Hutchings, Elsevier Limited.

ME4048 INTELLECTUAL PROPERTY RIGHTS Cr-3

Introduction: Invention and Creativity – Intellectual Property (IP) – Importance – Protection of IPR – Basic types of property (i) Movable Property (ii) Immovable Property and (iii) Intellectual Property. **(5 Hrs)**

Patents, Copyrights and Trademarks IP: Patents – Copyrights and related rights – Trade Marks and rights arising from Trademark registration – Definitions – Industrial Designs and Integrated circuits – Protection of Geographical Indications at national and International levels – Application Procedures. **(8 Hrs)**

International Standardization: International convention relating to Intellectual Property – Establishment of WIPO – Mission and Activities – History – General Agreement on Trade and Tariff (GATT). **(8 Hrs)**

Indian Strategies: Indian Position Vs WTO and Strategies – Indian IPR legislations – commitments to WTO-Patent Ordinance and the Bill, Draft of a national Intellectual Property Policy – Present against unfair competition.

(8 Hrs)

Case Studies: Case Studies on – Patents (Basumati rice, turmeric, Neem, etc.) – Copyright and related rights – Trade Marks – Industrial design and Integrated circuits – Geographic indications – Protection against unfair competition.

(7 Hrs)

Text Book:

1. *Handbook of Indian Patent Law and Practice*, Subbaram N.R., S. Viswanathan, Printers and Publishers Pvt. Ltd., 1998.

Reference Books:

1. *Intellectual Property Law (3rd Edition)*, P. Narayana, Eastern Law House, 2002.
2. *United States Patent Number: 72X*, Eli Whitney, Cotton Gin, March 14, 1794.
3. *Law of Intellectual Property (2nd Edition),* Dr. S. R. Myneni, Asian Law House, 2003

ME4049 ADVANCED MECHANICS OF SOLIDS Cr-3

Fixed and continuous beams: Fixed and continuous beams. **(6 Hrs)**

Curved Beams: Bending of Beams with small initial curvature, strain energy of beam with small initial Curvature, Deflection of beam with small initial curvature, curved beam with large initial curvature. **(5 Hrs)**

Shear Centre: Shear centre for sections symmetrical about both axes, shear centre for section symmetrical about one axis. **(5 Hrs)**

Unsymmetrical Bending: Unsymmetrical Bending stress at any point in cross-section, sign convention, Direction of neutral axis, Determining stress and deflection in Beams with unsymmetrical bending. **(4 Hrs)**

Basic concepts in theory of Elasticity: Basic concepts in theory of Elasticity (Theoretical approach in Cartesian co-ordinates only), stress at a point. Notation for stress, sign convention for stress. Differential equations of equilibrium, strain components, compatibility equations. **(8 Hrs)**

Engineering Stress Analysis: Two-dimensional photo elastic method of Stress analysis, Stress optic law, Light and dark field in polariscope. Iso-chromatic fringe pattern: stress determination by Brittle Coating method. **(8 Hrs)**

Text Books:

1. *Advanced mechanics of materials,* A. P Boresi.; R.J Schimdt.; Wiley

Reference Books:

1. *Strength of Materials*: G.H. Ryder.
2. *Strength of Materials:* Dr Sadhu Singh
3. *Strength of materials*, Beer and Johnson TMGH.

ME4051 ASSEMBLY LINE AUTOMATION Cr-3

Fundamental of Manufacturing and automation: Types of production, functions in manufacturing, production concepts and mathematical models, automation strategies. **(6 Hrs)**

PLC (Programmable Logic controller): Over view and architecture, PLC programming, Application examples. **(6 Hrs)**

Pneumatics and Hydraulics: Pneumatic components: Properties of air compressors-filter, regulators, Unit- Air control Valves, Quick Exhaust valves, Pneumatic actuators- Fluid Power, Circuit design, speed control circuits. Hydraulic system- sources of hydraulic power, Fluid power actuators, Pumping theory, Direction control valves, pressure control valves, Types of hydraulic cylinders. **(6 Hrs)**

Robotics and Robot applications: Robot introduction- definition –classification and specification. Mechanism: Kinematic parameters and modeling- Direct and inverse kinematic differential motion and jacobians. Introduction to Dynamics path planning, trajectory planning and control –skew, joint interpolation and straight line motion. Offline programming and simulation. **(6 Hrs)**

Computer Networks for manufacturing: Hierarchy of computers in manufacturing, local area networking, manufacturing automation protocol. **(6 Hrs)**

The Future automated Factory: Trends in manufacturing, The future automated factory. **(6 Hrs)**

Text Book:

1. *Industrial Automation and Robotics,* A. K. Gupta and S. K. Arora, Laxmi Publications, New Delhi
2. *Computer-Based Industrial Control",* Krishna Kant, Prentice Hall of India Ltd, 1997.
3. *Chemical Process Control – Theory and Practice",* Stephanopoulous, Prentice Hall of India Ltd, 1984.
4. *Fundamentals of Industrial Instrumentation and Process Control",* William C. Dunn, TataMcGrawHill, 2009.

Reference Books:

1. *Oil Hydraulics,* Majumdar S.R., Tata McGraw- Hill, 2000.
2. *Fluid power with application,* Anthony Esposito. Pearson education, 2000.

ME4052 NANO TECHNOLOGY Cr-3

General properties of Nano materials-mechanical properties **(7 Hrs)**

Fullerenes and CNT's-Synthesis, physical properties **(7 Hrs)**

Investigation and manipulating materials in the Nano scale – SAM's and clusters; **(10 Hrs)**

Semi conducting Quantum Dots – Nanobiology-Nanosensors –Nanomedicines. **(12 Hrs)**

Text Book:

1. *Textbook of Nano Science and Nanotechnology*, B.S. Murthy, Universities Press, 2012.

Reference Books:

1. *Nano: The Essentials,* T. Pradeep, Ta Ta McGraw-Hill, 2008.
2. *Nanotechnology and Nanoelectronics,* W.R.Fahrner, Springer,2006
3. *Nanotechnology*, Rechard Booker and Earl Boysen, Willey, 2006.

ME4053 DESIGN OF EXPERIMENTS AND OPTIMIZATION TECHNIQUES Cr-3

Analysis of Variance and its meaning: One-way classification- two-way classification. Basic principles of design of experiments (replication, randomization and local control)- CRD- RBD- LSD. **(6 Hrs)**

Factorial experiments and their need: and Factorial Experimental Designs with out confounding (Theory and Problem only, no derivation expected). **(3 Hrs)**

Taguchi Approach: Parameter Design, Robust Design **(3 Hrs)**

Optimal problem formulation: Boundary phase method – Fibonacci search method **(3 Hrs)**

Golden section search method: Powell's conjugate direction method – Conjugate gradient method – Variable-metric method. **(3 Hrs)**

Kuhn-Trucker conditions: Penalty function method – Frank-Wolfe method – Generalized reduced gradient method – Generalized projection method. **(6 Hrs)**

Genetic algorithms (GAs): working principle – difference between GAs and the traditional methods – GAs for constrained optimization – Simulated annealing – Global optimization: using steepest descent method and GA. **(6 Hrs)**

Quantitative Techniques: Assignment, Transportation problem, Network analysis (CPM/PERT), Job sequencing, LPP (graphical & simplex), Artificial variables, dual problems, Integer programming problems**.** **(6 Hrs)**

Text Books:

1. *Design of Experiments,* D.C.Montogomary, McGraw-Hill, 7th Edition.
2. *Optimization in Engg.* Design, K. Deb, McGraw-Hill. 1957.

Reference Books:

1. *Experimental Designs,* Cochran, W.G. and Cox, G.M., 2nd Edition, John Wiley & Sons, Inc,
2. *Quality Engineering using robust design,* Phadke, M. S:, Prentice Hall, 1989.
3. *Taguchi Techniques for quality engineering,* Philip, R. J.:, McGraw Hill, 1989.
4. *Optimization theory and applications,* Rao, S.S., Wiley Eastern, 1984.
   Operations research, S.D. Sharma, Kedar nath Publications

ME4054 TRACTOR AND FARM EQUIPMENTS Cr-3

General Design of Tractors: Classification of Tractors-Main components of Tractor-Safety Rules. **(5 Hrs)**

Control of the Tractor and Fundamentals of Engine Operation: Tractor controls and the starting of the tractor engines-Basic notions and definition-Engine cycles-Operation of multicylinder engines-General engine design - Basic engine performance characteristics. **(7 Hrs)**

Engine Frame Work and Valve Mechanism of Tractor: Cylinder and pistons-Connecting rods and crankshafts Engine balancing – Construction and operation of the valve mechanism-Valve mechanism components – Valve mechanism troubles. **(8 Hrs)**

Cooling system, Lubrication System and Fuel System of a Tractor: Cooling system – Classification –Liquid cooling system – Components, Lubricating system servicing and troubles – Air cleaner and turbocharger – Fuel tanks and filters – Fuel pumps. **(8 Hrs)**

Farm Equipments: Working attachment of tractors-Farm equipment – Classification – Auxiliary equipment – Trailers and body tipping mechanism. **(8 Hrs)**

Text Book:
1. Farm Tractor-Maintenance and Repair, Jain, McGraw-Hill Education.

Reference Books:
1 Tractor and Automobiles, Rodichev and G. Rodicheva, MIR Publishers, 1987.
2 Design of Automotive engines for tractor, Kolchin. A., and V. Demidov, MIR Publishers, 1972.

ME4055 AUTOMOTIVE ELECTRICAL SYSTEMS AND ELECTRONICS Cr-3

Starting System: Condition at starting, Behavior of starter during starting, and its characteristics, Principle & construction of starter motor, working of different starter drive units, care and maintenance of starter motor. Starter Switches. Three point starter-basic construction and working principle. **(4 Hrs)**

Lighting System & Accessories: Insulated & earth return systems, Positive & negative earth systems, Details of head light & side light, Headlight dazzling & preventive methods, Electrical fuel-pump, Speedometer, Fuel, oil & temperature gauges, Horn, Wiper system, Trafficator. **(5 Hrs)**

Automotive Electronics: Current trends in modern automobiles Open and close loop systems- Components for electronic engine management, Electronic management of chassis system, Vehicle motion control. **(5 Hrs)**

Transducer: Introduction, Mechanical spring devices, Pressure sensing primary devices, Basic requirements of transducer, Classification of transducer, Resistive transducer, Capacitive Transducer, Strain gauges, Thermistors, Thermocouples, R.V.D.T, Magnetoresistors, Magnetostrictive Transducers, Photoelectric transducer, Digital displacement transducer. **(4 Hrs)**

Sensors and Actuators: Hall Effect, hot wire, thermistor, piezo electric, piezoresistive, based sensors. Introduction, basic sensor arrangement, types of sensors, oxygen concentration sensor, lambda sensor, crankshaft angular position sensor, cam position sensor, Mass air flow (MAF) rate, Manifold absolute pressure (MAP), Throttle plate angular position, engine oil pressure sensor, vehicle speed sensor, stepper motors, relays, detonation sensor, emission sensors.
(5 Hrs)

Electronic Fuel Injection and Ignition Systems: Introduction, feed back carburetor systems. Throttle body injection and multi port or point fuel injection, fuel injection systems, Injection system controls. Advantages of electronic ignition systems: Types of solid-state ignition systems and their principle of operation, Contact less electronic ignition system, and electronic spark timing control. **(5 Hrs)**

Digital Engine Control System: Open loop and closed loop control systems-Engine cranking and warm up control-Acceleration enrichment-Deceleration leaning and idle speed control. Distributor less ignition-Integrated engine control systems, Exhaust emission control engineering. **(5 Hrs)**

Electronic Dashboard Instruments: Onboard diagnosis system, security and warning system. **(3 Hr)**

Text Books:
1. *Automotive Electrical Equipment,* P.L. Kohli, McGraw-Hill Education
2. *Electronics Engine Controls,* Steve V. Hatch, CENGAGE Learning

Reference Books:
1. *Modern Electrical Equipment of Automobiles,* Judge. A.W., , Chapman & Hall, London, 1992.
2. *Understanding Automotive Electronics,* 6th edition, Ribbers, Elsevier.
3. *Storage Batteries ,* Vinal. G.W., John Wiley & Sons Inc., New York, 1985.
4. *Automobile Electrical Equipment,* Crouse. W.H. , McGraw Hill Book Co Inc., New York, 1980

ME4056 COMBUSTION ENGINEERING Cr-3

Thermodynamics of Combustion Premixed and diffusion combustion process in IC engines and gas turbines. First and Second Law of Thermodynamics applied to combustion- combustion Stoichiometry chemical equilibrium, spray formation and droplet combustion. **(8 Hrs)**

Chemical Kinetics of Combustion Fundamentals of combustion kinetics, rate of reaction, equation of Arrhenius activation energy. Chemical thermodynamic model for Normal Combustion. **(9 Hrs)**
Flames Laminar premixed – flame speed correlations- quenching, flammability, and ignition, flame stabilization, laminar diffusion flames, turbulent premixed flames-Damkohler number. **(9 Hrs)**
Burning of Fuels: spray formation & droplet behavior, gas turbine spray combustion, direct injection engine combustion, detonation of liquid – gaseous mixture, combustion of solid fuels, **(10 Hrs)**

Text Book:
1. *An Introduction to Combustion Concepts and Application*, Stefan R. Turns, McGraw-Hill.

Reference Books:
1. *Combustion Engineering,* Gary L. Borman, Kenneth W. Ragland, Mc Graw Hill
2. *Some fundamental of Combustion*, Spalding. D.B., Butterworth Science Publications, London, 1985.
3. *Combustion Process High Speed Gas Dynamics and Jet Propulsion Series,* Lewis. B., Pease. R.N. and Taylor. H.S., Princeton University Press, Princeton, New Jersey, 1976.

ME4057 THEORY AND DESIGN OF JIGS AND FIXTURES Cr-3

Introduction: Definitions of Jigs and Fixtures, Principles of Jigs and Fixtures design, preliminary analysis and planning of Jigs and fixture parts and their materials, Basic steps in the design of jigs and fixtures and Advantages of Jigs & Fixtures. **(5 Hrs)**

Location and Clamping: Degrees of freedom-3-2-1 location principle, Radial location and diamond pin location, Principle of pin location, Location from pin surfaces, location from a profile, location from a cylinder, Circular location, Jamming and remedies. Location Adjustable locators, redundant locators, fool proofing; Adjustable supports and centralizes Strap clamps, cam clamps , screw clamping, latch clamps, wedge clamps, pivoted clamps, eccentric operator clamp, power clamps, quick acting clamps, equalizers. **(8 Hrs)**

Loading and unloading problems: Loading, Entering, locating and clamping, symmetric consideration. Unloading, Bur clearance, ejectors, receivers, chip problems, relief and projection, shields and seals. **(7 Hrs)**

Cutter Guidance: Various types of setting blocks, Press fit bushes, Renewable bushes, Slip bushes, Threaded bushes, Special bushes, Drills with attached bushing for small holes. **(7 Hrs)**

Design of Jigs and Fixtures: Three construction principles, Built-up type, casting and weldment. Practicing the various types of jigs, practicing the various types of milling fixtures, broaching fixtures, function of broaching fixtures-internal and external broaching fixtures. **(9 Hrs)**

Text Books:
1. *Jigs and fixtures,* Joshi. P.H. Tata McGraw-Hill, 1988

References Books:

1. *Jigs and Fixtures,* Design Manual Industrial Henriksen, Erik.K., Press Inc., Madison Avenue, New York, 1983.
2. *Tool design* Donaldson G.H., Lecain, Gould. V.V., , TMH Edition, 1990
3. *Fundamentals of Tool design* ASTME, Prentice Hall, 1989.

ME4058 TWO AND THREE WHEELERS Cr-3

Power Unit: Two stroke and four stroke SI engine, merits and demerits. Symmetrical and unsymmetrical port timing diagrams. Types of scavenging processes merits and demerits, scavenging efficiency. Scavenging pumps. Rotary valve engine.Fuel system. Lubrication system. Magneto coil and battery coil spark ignition system. electronic Ignition system. Starting system. Kick starter system. **(5 Hrs)**

Chassis and Sub-Systems: Mainframe, its types. Chassis and shaft drive. Single, multiple plates and centrifugal clutches. Gear box and gear controls. Front and rear suspension- systems. Shock absorbers. Panel meters and controls on handle bar. **(7 Hrs)**

Brake and Wheels: Drum brakes, Disc brakes, front and rear brake links layouts. Spoked wheel, Cast wheel. Disc wheel. Disc types. Tyres & tubes. **(4 Hrs)**

Two wheeler dynamics: Stability of two wheelers on straight and curved path. **(4 Hrs)**

Two Wheelers: Case study of major Indian models of motorcycles, SCOOTERS AND MOPEDS. Bajaj,Vespa, Lambretta scooters. Enfield, TVS-Suzuki, Hero-Honda, Yamaha RX-100, Kawasaki Bajaj Motor cycle. Kinetic Spark, Hero Majestic, TVS mopeds. Servicing and maintenance. **(8 Hrs)**

Three Wheelers: Case study of Indian Models. Front engine and rear engine. Auto rickshaws. Pickup van. Delivery Van and Trailer, stability of three wheelers. **(8 Hrs)**

Text Books:

1. *Two Wheelers*, K. K. Ramlingam, SCITECH

Reference Books:

1. *Automobile Engineering vol I & II,* Gupta H M 1st edition Reprint 2006.
2. *Automobile Engineering,* Gupta R B, Satya Prakashan 2004.

ME4061 OPERATIONS RESEARCH Cr-3

Assignment and Routing Problem **(4 Hrs)**

Mathematical formulation of assignment problem and its algorithm, unbalanced assignment problem, Routing problems, Traveling Salesman problem.

Transportation problem **(4 Hrs)**

The Transportation table. Loops in transportation Table Initial basic feasible solutions, Test for optimality, Transportation algorithm, Degeneracy in transportation problem, unbalanced T.P.

Linear Programming Problem **(2 Hrs)**

Formulations of the LPP, General formulation, canonical and standard forms. Graphical solution of problems, Applications, Advantages & Limitations.

Simplex Method **(4 Hrs)**

Fundamental properties of solution to L.P.P. Computational procedure. Artificial variable technique, problem of Degeneracy.

Duality in Linear Programming **(4 Hrs)**

Concept of Dualities fundamental properties of duality. Fundamental theorem of Duality and simplex Method, Dual Simplex Method, Dual Simplex algorithm.

Post Optimality Analysis **(2 Hrs)**

Sensitivities Analysis, Discrete changes in cost vector and requirement vector.

Integer Programming Problem **(3 Hrs)**

All and Mixed I.P.P. Gomory all I.P.P method, Cutting plane all I.P.P algorithm, Branch and Bound Technique.

Network Analysis **(5 Hrs)**

CPM, PERT, Fulkersons rule, Determination of critical path, Crashing & updating.

Game Theory **(3 Hrs)**

Two person zero sum games. The Maximin and Minimax principle, Mixed strategies, Graphical solutions of (2 x n) and (m x 2) games, Dominance property.

Job Sequencing & Queuing Theory **(5 Hrs)**

Principal assumptions, Processing 2 jobs through m machines, Processing 'n' jobs through 2 machines, 'n' jobs through 3 machines, 2 jobs through 'm' machines and 'n' jobs through 'm' machines, Probability distributions in queueing systems.

Text Books:

1. *Operations Research*- Kanti Swarup, P. K. Gupta, Man Mohan, Sultan Chand & Sons Pub, 1978.

Reference Books:

1. *Operations Research*-Prem Kumar Gupta, D.S. Hira, S. Chand & Co, 2009.
2. *Operations Research*-S. D. Sharma, Kedar Nath Ram Nath Pub.

ME4062 VEHICLE MAINTENANCE Cr-3

Maintenance records and Schedules: Importance of maintenance. Scheduled and unscheduled maintenance. Preparation of check lists. Chassis lubrication. Cost effectiveness. Pre-trip. Inspection forms. Log books. Trip sheets. Other maintenance record forms. **(6 Hrs)**

Maintenance, Repair and Overhauling of engine: Dismantling of engine components. Cleaning methods. Visual inspection and dimensional check of various engine components. Minor and Major tune up Reconditioning, repairing methods of engine components. Assembly procedure. Special tools used for maintenance, repair and overhauling. **(6 Hrs)**

Maintenance, Repair and Overhauling of Chassis, Drive Line components:
Clutch - Mechanical, Automatic types Gear box - Mechanical Automatic types. Final reduction. Propeller shaft. Front and rear suspension systems. Rigid and independent types. Brakes systems - Hydraulic, Servo, Air. Air bleading. Steering system. Wheel alighment - Tyres. **(6 Hrs)**

Maintenance, Repair and Servicing of Electrical System: Battery - Testing methods. Starter motor. Charging system - DC Generator, AC Alternator, Regulator, Ignition systems - Coil ignition, Transistor assisted ignition, Capacitor discharge ignition. Eletric Horn, Wiper, Flasher, Electric fuel pump, Gauges. Lighting system Head lights focussing. Wiring system. **(6 Hrs)**

Maintenance, Repair and Servicing of Cooling System: Cooling system - types, water pump, radiator, thermostat valve. anti corrosion and anti freezing solutions. **(6 Hrs)**

Lubrication system, Fuel system and Body: Lubricating system - Oil analysis, oil topping up, oil change, oil filters, oil relief valve. Fuel system - Petrol, diesel fuel feed system components. Body repair tools, minor body panel beating, tinkering, and soldering, polishing, painting. Door locks mechanism. Window glass actuating mechanism. **(6 Hrs)**

Text Books:

1. *Fleet Management,* JOHN Doke, McGraw Hill Co, 1984.

Reference Books:

1. *Motor vehicle engine servicing,* Judge. A.N., 3rd, Edition, Pitman Paperpack, London, 69.
2. *Maintenance of High speed diesel engines,* Judge. A.W., Chapman Hall Ltd., London,'56.
3. *Diesel Engine operation and Maintenance,* Maleev V.L., Maintenance, McGrawHill Book Co., New York, 1954.

ME4063 METAL FORMING PROCESSES Cr-3

Introduction: Fundamentals of plasticity, stress and strain, stress-strain relationship, yield criteria and flow rules, instability. **(4 Hrs)**

Fundamentals of Metal Forming: Classification of forming processes, mechanisms of metal forming-slab method, limit analysis, upper bound and lower bound theorem, slip line solution, temperature of metal working, hot working, cold working; Friction and lubricants in metal forming **(8 Hrs)**

Rolling of Metals: Rolling processes, forces and geometrical relationship in rolling, simplified analysis of cold and hot rolling, rolling load, rolling process variables, defects in rolling, torque and power calculations, friction hill. **(6 Hrs)**

Forging: Classification of forging process, forging of plates and circular discs, forging load calculation, open-die and closed-die forging, stress and strain distribution in forging process, friction and lubrication in forging process. **(6 Hrs)**

Extrusion: Classification of extrusion process, Analysis of Extrusion process, Extrusion load estimation, extrusion process parameters, extrusion of tubes and production of seamless pipes. **(4 Hrs)**

Drawing of tubes, rods and wires: Wire drawing dies, tube drawing process, analysis of wire drawing, deep drawing and tube drawing, drawing force calculation. **(4 Hrs)**

Sheet Metal forming: Forming methods, bending, stretch forming, spinning, hydraulic forming, forming limit criteria, defect in formed parts. **(4 Hrs)**

Text Books:

1. *Fundamentals of Metal Forming Processes*, B. L. Juneja, New Age International Publishers, 2nd Edition, 2010

References Books:

1. *Principles of Metal Working Processes*, G.W. Rowe, CBS Publishers, 2005, ISBN-10: 8123904282 ISBN-13: 978-8123904283.
2. *Metal Forming Hand book*, ASM

ME4065 MODELLING AND SIMULATION Cr-3

System and System Environment: Component of a system, Continuous and discrete systems, Models of a system modeling. **(6 Hrs)**

Random Number Generation: Mid-square & mid-product method, Constant multiplier method, Additive congruential method , Test for random numbers: the Chi-square test, Koimogrov Smimov test, Run test & Gap test. **(7 Hrs)**

Random Variable Generation: Inverse transform technique, Exponential distribution, Poisson distribution, Uniform distribution, Weibull distribution, Empirical distribution, Normal distribution, Building and empirical distribution, Rejection method. **(10 Hrs)**

System Modelling: Simulation of continuous system, Simulation of discrete system, Simulation of an event occurrence using random number table. Simulation of component failures using Exponential and weibull models. Simulation of single server queue and a two server queue. Simulation of inventory system, Simulation of a network problem, Simulation using languages/ packages. **(13 Hrs)**

Text Books:

1. *Discrete Event System Simulation,* Bankds J., Carson. J.S., and Nelson B.L., Prentice Hall of India, New Delhi, 1996.

References Books:

1. *System Simulation,* Geoffrey Gordon, Prentice Hall of India, 1984.
2. *System simulation with Digital Computer*, Narsingh Deo., Prentice Hall of India, 1979.
3. *Elements of Stochastic Process Simulation,* Gottfried B.S., Prentice Hall, London, 1984.

ME4067 MACHINE TOOL TECHNOLOGY Cr-3

General classification of machine tools **(3 Hrs)**

Working and auxiliary motions, Hydraulic transmission and its elements Mechanical transmission and is elements, General requirement of machine tools.

Kinematics of Machine Tools **(6 Hrs)**

Stepped and stepless drive, basic consideration on the design of drives, Variable speed range in machine tools, Graphical representation of speed and structure diagram, selection of optimum ray diagram, design of speed and feed gear boxes, Step less regulation of speed and feed rates

Machine Tool structure **(5Hrs)**

Design criteria, materials static and dynamic stiffness, basic design procedure, design of beds and columns, Model technique in design of machine tool structure

Guideways and powers Screws **(6 Hrs)**

Classification of guideways, materials and lubrication. Design criteria and calculations for slideways, Design of guides under hydrostatic lubrication. Aerostatics slideways, Antifriction guideways combination guideways, Classifications of power screws, Design principle of powers screws, re-circulating powers screw assemblies, elimination of backlash.

Machine tool spindles and its bearings **(5 Hrs)**

Materials of spindles, effect of machine tools, compliance on machining accuracy, design principles of spindles, antifriction and sliding bearings

Controlling system in machine tools **(5 Hrs)**

Classifications, control systems for changing speeds and feeds, ergonomics consideration applied to design of control members, principle of automatic and adaptive control

Vibration in machine tools **(3 Hrs)**

Forced vibration, self excited vibration, stick -slip vibration and its minimization, vibration isolation.

Numerical control of machine tool Fundamental concepts and its classifications, Components of NC machines and their description, elements of part programming. **(3 Hrs)**

Text books:

1. *Machine Tool Design:* N K Mehta, Tata McGraw-Hill, 2012

Reference Books:

1. *Design of Machine Tools:* S K Basu & D K Pal, OIBH
2. *Principles of Machine Tools:* Amitabha Bhattacharyya, Gopal Chandra Sen, New Central book Agency

ME4069 COMPUTER INTEGRATED MANUFACTURING Cr-3

Fundamental of Manufacturing and automation: Types of production, functions in manufacturing, production concepts and mathematical models, automation strategies. **(5 Hrs)**

Process planning: Introduction, process plan development, CAPP, CAPP benefits, CAPP approaches, Variant CAPP, Generative CAPP, Hybrid CAPP. **(5 Hrs)**

Numerical Control production System: Numerical control, coordinate system and machine motion, Types of NC system, machine tool applications, problems of conventional NC, CNC, DNC. **(10Hrs)**

Part Programming: Basics of NC programming, mathematics of tool paths, machining forces, Tool offsets, programming steps, NC programming Languages, G-Code and M-Code, APT Programming, CAD/CAM NC programming. **(8 Hrs)**

Computer Networks for manufacturing: Hierarchy of computers in manufacturing, Local area networking, manufacturing automation protocol. **(5 Hrs)**

The Future automated Factory: Trends in manufacturing, The future automated factory. **(3Hrs)**

Text Books:

1. Automation, Production Systems, and Computer-Integrated Manufacturing, Mikell P. Groover, Pearson Education, ISBN 81-7808-511-9. 3rd Edition, 2007

2. CAD/CAM, Ibrahim Zeid, TMH

Reference Books:
1. *Computer Integrated Manufacturing,* Paul Ranky Prentice Hall of India
2. *Computer Integrated Manufacturing System,* Yorem Koren, McGraw-Hill, 1983

ME4071 FUELS AND EMISSIONS Cr-3

Introduction: General Scenario on automotive Pollution, Pollutants-sources-formation-effects-transient operational effects on pollution. **(5 Hrs)**

Engine Combustion and Pollutant Formation: HC, CO, NOx, Particulate Matters, Aldehyde emissions, Effect of operating variables on emission formation. **(5 Hrs)**

Emission Control Efforts: Supply of fuel – establishment of national test centers, construction of road networks. **(5 Hrs)**

Alternate Fuels: Estimation of petroleum reserve – need for alternate fuels – Merits & Demerits and uses of CNG, LPG, Alcohols, Hydrogen, Bio-fuels, Electric Energy, Solar Energy. **(5 Hrs)**

Emission Standards : Evaluation of Emission Standards – Mandatory Tests for Emission measurement – Type Approval & Production Conformity Tests – Driving Cycles, Bharat Stages & Euro emission standards. **(5 Hrs)**

Control Techniques for SI and CI: Design changes, optimization of operating factors, Control of Crankcase emission, Evaporative emission, Exhaust emission - exhaust gas recirculation, air injector PCV system, thermal reactors, catalytic converters. **(5 Hrs)**

Test Procedure & Instrumentation for Emission Measurement: Test procedures- Measurements of invisible emissions -ORSAT apparatus, NDIR analyzer, Flame ionization detectors, Chemiluminescent analyzer, Gas analyzer, Measurements of visible emissions – Comparison methods & Obscure methods - Smoke meters, Emission standards. **(6 Hrs)**

Text book:
1. *Automotive Engineering Fuels and Emissions* (Classroom & Shop Manual), Ollembeak, CENGAGE Learning

Reference Books:
1. *Engine Emissions*, B.P. Pundir, Narosa Publishing House, 2007.
2. *Internal Combustion Engines*, V. Ganesan, Tata McGraw Hill Co., 2004.
3. *Automobile Engineering*, K.K. Ramalingam, Scitech Publications Pvt. Ltd., 2005

ME4073 TOTAL QUALITY MANAGEMENT Cr-3

Definition of Quality, Dimensions of Quality, Quality Planning, Quality Costs - Analysis Techniques for Quality Costs, Basic Concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership - Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation **(9 Hrs)**

TQM Principles - Customer satisfaction - Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement - Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement - Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership - Partnering, Sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures - Basic Concepts, Strategy, Performance Measure. **(9 Hrs)**

Statistical Quality Control, The Seven Tools of Quality, Measures of Central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and Attributes, Process Capability, Concept of Six Sigma, New Seven Management Tools. **(9 Hrs)**

TQM Tools, Benchmarking, Reasons to Benchmark, Benchmarking Process, Quality Function. Deployment (QFD), House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM), ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System, Implementation of Quality System, Documentation, Quality Auditing. **(9 Hrs)**

Text Books:

1. *Quality Management: Concepts and Tasks,* V. Narayana and N.S. Sreenivasan, New Age International, 1996

Reference Books:

1. *Total Quality Management,* Dale H. Besterfiled, Pearson Education, 2003 (Indian reprint - 2004)
2. *The Management and Control of Quality*, James R. Evans & William M. Lidsay, 5th Edition, South-Western (Thomson Learning), 2002
3. *Total Quality Management for Engineers,* M. Zeiri, Wood Head Publishers, 1991

ME4075 ENGINE TRIBOLOGY Cr-3

Surface, Friction and Wear: Topography Of The Surfaces - Surface Features Of Metal And Composites – Surface Interaction –Definition of Friction- Laws of Friction - Friction Properties Of Metallic, Ceramic, Polymer and lamellar solid materials– Wear- Types of Wear – Archard Wear Equation - Wear of brass-unlubricated wear of metals-wear regime maps for metals- Mechanism of Adhesive – Abrasive wear equation- Mechanism of Abrasive wear – particles properties: hardness, shape and size- Wear Resistance Materials – Wear testing methods.

(8 Hrs)

Lubrication Theory: Lubricants and Their Physical Properties - Lubricants Standards - Lubrication Regimes Hydrodynamic Lubrication - Reynolds Equation, Thermal, Inertia And Turbulent Effects - Elasto Hydrodynamic and Plasto Hydrodynamic And Magneto Hydrodynamic Lubrication - Hydro Static Lubrication - Gas Lubrication. – Stirbeck Diagram.Design And Performance Analysis Of Thrust And Journal Bearings – Slide Bearing -Full, Partial, Fixed And Pivoted Journal Bearings Design - Lubricant Flow And Delivery- Power Loss, Heat And Temperature Rotating Loads And Dynamic Loads In Journal Bearings - Special Bearings - Hydrostatic Bearing Design.

(9 Hrs)

Rolling Element Bearings: Geometry And Kinematics - Materials And Manufacturing Processes - Contact Stresses - Hertzian Stress Equation - Load Divisions - Stresses And Deflection - Axial Loads And Rotational Effects, Bearing Life Capacity And Variable Loads - ISO Standards – Oil Films And Their Effects - Rolling Bearings Failures, Needle bearing.

(6 Hrs)

Tribo Measurement and Instrumentation: Surface Topography Measurements –Assessment Statically Methods –Stylus Profilometers - Optical Microscopy - Scanning Electron Microscope – Transmission Electron Microscopy – AFM – XPS – EDX – XRD – hardness measurement – micro hardness – nano indentation - Instrumentation – Wear Measurements – Wear Debris Analysis - Bearings Performance Measurements. **(7 Hrs)**

Engine Tribology: Introduction – Modified Stribeck Curve for Engine Components – Fuel Energy Distribution of Engine Components – Tribological Engine Components: Friction and wear - Piston Assemblies: Surface topography, wear prediction – Valve Train: Surface Roughness, wear prediction, waviness – Engine Bearings: Asperity Interaction, journal waviness, bearing with microgrooves, wear prediction – Design modification of Engine components.

(6 Hrs)

Text Books:

1. *Introduction to Tribology of Bearing,* B.C. Majumdar, S. Chand, 2nd Edition, 2012.

Reference Books:

1. *Friction And Wear Of Materials,* Ernest Rabinowie z, Inter science Publishers,1995
2. *Tribology – Hand Book,* Neale, M.J., , Butterworth, 1995.
3. *Theory And Practice Of Lubrication Of Engineers,* Fuller D.D., John Wiley Sons,198.
4. *Friction And Lubrication Of Solids,* Bowden, F.P. & Tabor, D., Oxford University Press 1986

ME4077 OFF-ROAD VEHICLES Cr-3

Introduction: Classification of off road vehicles and their application Excavator: Different types of Shovel and Dragline, their construction, operating principles, operating cycles. Production capacity and cost of production. **(7 Hrs)**

Transport Equipment: Various types of Dumpers, Main system, components and Carrying capacity of Dumper. **(7 Hrs)**

Road making and maintenance Machines: Different types of Dozer, Grader, and their onstruction. Operating principles, Production capacity and application mechanism. **(8 Hrs)**

Other equipment: Scraper and front end loader, their construction and operation. **(7 Hrs)**

Maintenance: Maintenance aspect of Off Road vehicles. **(7 Hrs)**

Text Books:

1. *Latest Development of Heavy Earth Moving Machinery,* De, A., Annapurna Publishers, Dhanbad 1995

Reference Books:

1. *Road Making Machinery,* Abrosimov, K. Bran berg, A and Katayer, K. M I R. Publishers Moscow.1971
2. *Moving the Earth,* Nichols, Herber L (Jr.), Galgotia Publishing House, New Delhi,1962.
3. *Digging of soils by earthmover with Power Parts*, Rudnev, V. K., Oxanian Press Pvt.Ltd., New Delhi, 1985