

NATIONAL INSTITUTE OF TECHNOLOGY

WARANGAL 506 004

SCHEME OF INSTRUCTION AND EVALUATION**M.Tech. (Thermal Engineering)****I Year I Semester**

S. No.	Course No.	Course Name	L	T	P	C
1	ME5101	Incompressible and Compressible Flows	4	0	0	4
2	ME5102	Computational Methods in Thermal Engineering	4	0	0	4
3	ME5103	Advanced Heat and Mass Transfer	4	0	0	4
4	ME5104	Finite Element Method for Thermal Engineering	4	0	0	4
5		Elective - I	3	0	0	3
6		Elective - II	3	0	0	3
7	ME5105	Thermal Engineering Laboratory	0	0	3	2
8	ME5106	CFD Laboratory - I	0	0	3	2
TOTAL			22	0	6	26

I Year II Semester

S. No.	Course No.	Course Name	L	T	P	C
1	ME5151	Internal Combustion Engines	4	0	0	4
2	ME5152	Gas Turbines and Jet Propulsion	4	0	0	4
3	ME5153	Renewable Sources of Energy	4	0	0	4
4		Elective - III	3	0	0	3
5		Elective - IV	3	0	0	3
6		Elective - V	3	0	0	3
7	ME5154	Energy Systems Laboratory	0	0	3	2
8	ME5155	CFD Laboratory - II	0	0	3	2
9	ME5191	Seminar	0	0	3	2
TOTAL			21	0	9	27

II Year I Semester

S. No.	Course No.	Course Name	L	T	P	C
1	EE6142	Comprehensive Viva-voce	0	0	0	4
2	EE6149	Dissertation Part-A	0	0	0	8
TOTAL			0	0	0	12

II Year II Semester

S. No.	Course No.	Course Name	L	T	P	C
1	EE6199	Dissertation Part-B	0	0	0	18
TOTAL			0	0	0	18

Consolidated Credits

Category	I Sem	II Sem	III Sem	IV Sem	Total
Core courses	16	12	0	0	28
Electives	06	09	0	0	15
Lab Courses	04	04	0	0	08
Comprehensive Viva-Voce	00	00	4	0	04
Seminar	00	02	0	0	02
Dissertation	00	00	8	18	26
Total	26	27	12	18	83

ELECTIVE COURSES**I Semester**

ME5111	Combustion
ME5112	Power Plant Engineering
ME5113	Energy Systems and Management
ME5114	Advanced Refrigeration and Air-Conditioning
ME5418	Optimization Methods in Engineering
ME5419	Micro and Smart Systems
ME5421	Mechanical Vibrations

II Semester

ME5161	Cryogenics
ME5162	Alternate Fuels
ME5163	Design of Heat Transfer Equipment
ME5164	Advanced Computational Fluid Dynamics
ME5165	Convective Heat Transfer
ME5166	Jet and Rocket Propulsion
ME5167	Conjugate Heat Transfer
ME5168	Measurements in Thermal Engineering
ME5467	CAD for Thermal Engineering

SYLLABUS**M.Tech. (Thermal Engineering)**

ME5101 **INCOMPRESSIBLE AND COMPRESSIBLE FLOWS** (4-0-0) 4

Introduction, motion of viscous fluid, boundary layer theory, turbulent flow, drag, isentropic flow with variable area, flow in constant area ducts with friction and heat transfer, normal and oblique shock waves.

Reading:

1. Yuan, S. W., *Foundations of Fluid Mechanics*, Prentice Hall of India, 2000.
2. Yahya, S. M., *Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion*, 4th Edition, New Age Techno, 2010.
3. Schlichting, H., *Boundary Layer Theory*, 8th Edition, Springer, 2004.
4. White, F. M., *Viscous Fluid Flow*, 3rd Edition, Tata McGraw Hill, 2011.

ME5102 **COMPUTATIONAL METHODS IN THERMAL ENGINEERING** (4-0-0) 4

Philosophy of CFD, governing equations of CFD, mathematical behaviour of partial differential equations, discretization techniques, grid generation techniques, solution of elliptic, parabolic and hyperbolic equations, consistency and stability, error analysis, solution of incompressible and compressible flows with numerical examples.

Reading:

1. Hoffmann, K. A. and Chiang, S. T., *Computational Fluid Dynamics for Engineers*, Vol. I, II, and III, 2nd Edition, Engineering Education System, 2000.
2. Chung, T. J., *Computational Fluid Dynamics*, 2nd Edition, Cambridge University Press, 2010.
3. Anderson, J. D. (Jr.), *Computational Fluid Dynamics*, McGraw Hill, 2010.
4. Tannehill, J. C., Anderson, D. A. and Pletcher, R. H., *Computational Fluid Mechanics and Heat Transfer*, 2nd Edition, Taylor & Francis, 2002.

ME5103 **ADVANCED HEAT AND MASS TRANSFER** (4-0-0) 4

Conduction - steady and unsteady 1-D, 2-D and 3-D problems for various boundary conditions, extended surfaces, convection - various cases in laminar and turbulent flows, radiation - Prevost's theory, Stefan - Boltzmann law, radiation from real surfaces, Hottel's crossed string method, enclosure method of analysis, radiosity - irradiation formulation, mass transfer - isothermal equimolar counter diffusion.

Reading:

1. Sadik Kakac and Yaman Yener, *Heat Conduction*, 2nd Edition, Hemisphere, 2001.
2. Kays, W. M. and Crawford, M. E., *Convective Heat and Mass Transfer*, 4th Edition, Tata McGraw Hill, 2012.
3. Siegel, R. and Howell, J. R., *Thermal Radiation Heat Transfer*, 4th Edition, Taylor & Francis, 2002.
4. Incropera, F. P. and De Witt, D. P., *Fundamentals of Heat and Mass Transfer*, 5th Edition, John Wiley & Sons, New York, 2006.

ME5104 **FINITE ELEMENT METHOD FOR THERMAL ENGINEERING** (4-0-0) 4

Mathematical models, General concepts of Finite Element Method, 1-D, 2-D and 3-D problems, Assembly considerations, Boundary conditions, Iso-parametric, Sub parametric and Super parametric elements, Dynamic Analysis using FE, Introduction to Modal Analysis and Mode superposition, FE method for Heat Transfer problems.

Reading:

1. Rao, S. S., *The Finite Element Method in Engineering*, 5th Edition, Elsevier 2011.
2. Reddy, J. N. and Gartling D. K., *The Finite Element Method in Heat Transfer and Fluid Dynamics*, 3rd Edition, CRC Press, 2010.
3. Nithiarasu, P., Seetharamu, K. N. and Lewis, R. W., *The Finite Element Method for Heat Transfer Analysis*, John Wiley and Sons, 2004.

ME5105	THERMAL ENGINEERING LABORATORY	(0-0-3) 2
<p>Constant speed and variable speed performance tests on SI and CI engines and comparison of their performance parameters like specific fuel consumption, Motoring and Retardation tests on CI engine to determine friction power, Effect of spark advance on SI engine, Dual-fuel performance.</p>		
ME5106	CFD LABORATORY - I	(0-0-3) 2
<p>Writing programs using C++ and MATLAB for Solution of transcendental equations, solution of simultaneous algebraic equations, numerical differentiation and integration, solution of ordinary differential equations, Explicit and implicit methods of solving the fluid flow problems under various types of boundary conditions, methods of solving partial differential equations of elliptic, parabolic and hyperbolic types.</p>		
ME5151	INTERNAL COMBUSTION ENGINES	(4-0-0) 4
<p>Cycle analysis - equivalent air cycles, dimensionless representation, properties of fuel and Fuel-air mixtures, thermodynamics of combustion, unburned and burned product charts, engine characteristics - effects of operating and design parameters on engine performance, supercharging, SI, CI and multi-fuel engine combustion chambers, alternate fuels, exhaust pollution, design of two stroke and four stroke engines.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Obert, E. F., <i>Internal Combustion Engines and Air Pollution</i>, Harper and Row Publishers, New York, 1973. 2. Yadav, R., <i>I. C. Engines and Air Pollution</i>, Central Publishing House, 2002. 3. Maleev, V. L., <i>Internal Combustion Engines</i>, McGraw Hill Book Company, New York, 1987. 		
ME5152	GAS TURBINES AND JET PROPULSION	(4-0-0) 4
<p>Fundamentals of turbo machines, ideal and actual cycles for shaft power and propulsion, centrifugal compressors - slip, Stodola's Model, thin aerofoil theory, cascade mechanics, axial flow compressors, surge and stall, combustion chambers, gas turbine emissions, design of gas turbines, performance of turbo machines, matching of gas turbine components.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Sarvanamuttoo, H.I.H., Rogers, G. F. C. and Cohen, H., <i>Gas Turbine Theory</i>, 6th Edition, Pearson Prentice Hall, 2008. 2. Ganesan, V., <i>Gas Turbines</i>, 3rd Edition, Tata McGraw Hill, 2010. 3. Yahya, S. M., <i>Turbines, Compressors and Fans</i>, 4th Edition, Tata McGraw Hill, 2010. 		
ME5153	RENEWABLE SOURCES OF ENERGY	(4-0-0) 4
<p>Alternate sources of energy, solar energy, basic sun-earth relationships, coordinates of the sun, solar radiation measurement and prediction, solar thermal devices, photovoltaic power, fuel cells, wind energy, hydrogen energy, other forms of energy, nuclear, biomass, ocean and geothermal energy.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Sukhatme, S.P. and Nayak, J.K., <i>Solar Energy - Principles of Thermal Collection and Storage</i>, Tata McGraw Hill, New Delhi, 2008. 2. Khan, B.H., <i>Non-Conventional Energy Resources</i>, Tata McGraw Hill, New Delhi, 2006. 3. Duffie, J.A. and Beckman, W.A., <i>Solar Energy-Thermal Processes</i>, John Wiley, 2001. 		
ME5154	ENERGY SYSTEMS LABORATORY	(0-0-3) 2
<p>Heat transfer experiments: Measurement of thermal conductivity, Heat transfer coefficients, Stefan - Boltzmann constant, LMTD and effectiveness of parallel and counter-flow heat exchangers, Solar energy experiments.</p>		
ME5155	CFD LABORATORY - II	(0-0-3) 2
<p>Writing programs to solve problems related to parabolic partial differential Equations, Elliptic partial differential equations, and hyperbolic partial differential equations, Incompressible Navier-Stokes Equations, Grid Generation Techniques, 1-D and 2-D stress analysis, 1-D and 2-D heat conduction with convective boundaries, Inviscid incompressible fluid flows, Use of ANSYS package.</p>		

- ME5111 **COMBUSTION** (3-0-0) 3
- Chemical thermodynamics, gas mixture with variable compositions, chemical kinetics, ignition process, flame propagation, droplet combustion, basics of I.C. engine combustion.
- Reading:*
1. Sharma, S. P., *Fuels and Combustion*, Tata McGraw Hill, New Delhi, 2001.
 2. Benson, R. S. and Whitehouse, M. D., *Internal Combustion Engines*, Vol. I, Pergamon Press, 2002.
 3. Rao, Y. V. C., *An Introduction to Thermodynamics*, University Press, 2009.
 4. Stephen, R. T., *Combustion*, McGraw Hill, 1997.
- ME5112 **POWER PLANT ENGINEERING** (3-0-0) 3
- Introduction, steam power plant, steam boilers, steam nozzles, steam turbines, steam condensers, cooling towers, cogeneration and combined cycles, nuclear power plants, hydroelectric power plants, power plant economics.
- Reading:*
1. Arora, S. C. and Domkundwar, S., *Power Plant Engineering*, Dhanpat Rai & Sons, 2012.
 2. Glasstone, S. and Sesonske, A., *Nuclear Reactor Engineering: Reactor Design Basics*, Vol. I & II, CBS Publishers & Distributors Pvt. Ltd, 2004.
 3. Sharma, P.C., *Power Plant Engineering*, S. K. Kataria & Sons, 2010.
 4. Wakil, El., *Power Plant Technology*, McGraw Hill, 1985.
- ME5113 **ENERGY SYSTEMS AND MANAGEMENT** (3-0-0) 3
- Basic principles of Energy conservation, Energy analysis and application of laws of thermodynamics, energy consumption and rejection patterns for different processes, energy conservation potential for different processes, energy storage systems, energy demand estimation, pricing, energy management, energy audit, case studies.
- Reading:*
1. Turner, W. C., Doty, S. and Truner, W. C., *Energy Management Hand Book*, 7th edition, Fairmont Press, 2009.
 2. De, B. K., *Energy Management Audit and Conservation*, 2nd Edition, Vrinda Publication, 2010.
 3. Murphy, W. R., *Energy Management*, Elsevier, 2007.
 4. Smith, C. B., *Energy Management Principles*, Pergamon Press, 2007.
- ME5114 **ADVANCED REFRIGERATION AND AIR CONDITIONING** (3-0-0) 3
- Review of laws of thermodynamics, vapor compression refrigeration systems-single stage, multi stage and cascade systems, environmental aspects and alternate refrigerants, absorption refrigeration systems-refrigerant - absorbent combinations, non-conventional refrigeration systems, design of air-conditioning systems.
- Reading:*
1. Stoecker, W. F. and Jones, J. W., *Refrigeration and Air-Conditioning*, TMH Edition, 2001
 2. Arora, C. P., *Refrigeration and Air-conditioning*, TMH Edition, 2003.
 3. Roy J. Dossat, *Principles of Refrigeration*, 4th Edition, Prentice Hall of India (P) Ltd, 2004.
- ME5418 **OPTIMIZATION METHODS IN ENGINEERING** (3-0-0) 3
- Statement of an optimization problem, classification of optimization problems, classical optimization techniques, One dimensional minimization methods, unconstrained and constrained optimization, A brief treatment of linear programming, geometric programming, dynamic programming and integer programming.
- Reading:*
1. Rao, S. S., *Optimization Theory and Applications*, Wiley Eastern Ltd., 2nd Edition, 2004.
 2. Fox, R. L., *Optimization Methods for Engineering Design*, Addison Wesley, 2001.

- ME5419 **MICRO AND SMART SYSTEMS** (3-0-0) 3
- Introduction, Micro Sensors, Actuators, Systems and Smart Materials: An Overview, Micromachining Technologies, Modeling of Solids in Microsystems. Finite Element Method, Modeling of Coupled Electro-mechanical Systems, Electronics Circuits and Control for Micro and Smart Systems, Integration of Micro and Smart Systems, Scaling Effects in Microsystems.
- Reading:*
1. Ananthasuresh, G. K., *Micro and Smart Systems*, Wiley India Pvt. Ltd., 2010.
 2. Ananthasuresh, G. K., Vinoy, K. J., Gopalakrishnan, S., Bhat, K. N. and Kasudev Aatre, V., *Micro and Smart Systems: Technology and Modeling*, John Wiley & Sons, 2012.
 3. Tai-Ran Hsu, *MEMS and Microsystems: Design And Manufacture*, Tata McGraw Hill, 2002.
- ME5421 **MECHANICAL VIBRATIONS** (3-0-0) 3
- Review of free and forced vibrations of damped and undamped single degree freedom systems, impulse response technique, Laplace transformation technique, Two degree freedom systems, Eigen value problems, Modal analysis, Vibration control, Dynamic vibration absorbers, Vibration measuring devices, Introduction to continuous systems.
- Reading:*
1. Thomson, W. T., *Theory of Vibrations with Applications*, 5th Edition, Pearson Education, 2008.
 2. Rao, S. S., *Mechanical Vibrations*, 4th Edition. Pearson Education, 2003.
 3. Leonard Meirovitch, *Elements of Vibration Analysis*, 2nd Edition, Tata-McGraw Hill, 2006.
- ME5161 **CRYOGENICS** (3-0-0) 3
- Introduction, properties of solids for cryogenic systems, refrigeration and liquefaction - simple Linde cycle, precooled Joule-Thomson cycle, dual-pressure cycle, Simon helium liquefier, classical cascade cycle, mixed-refrigerant cascade cycle, ultra-low-temperature refrigerators, equipment associated with low-temperature systems, separation and purification systems, storage and transfer systems.
- Reading:*
1. Klaus, D. T. and Thomas, F. M., *Cryogenic Process Engineering*, Plenum Press, 2001.
 2. Arora, C. P., *Refrigeration and Air-conditioning*, 3rd Edition, Tata Mc Graw-Hill, 2008.
 3. Arora, S. C. and Domkundwar, S., *Refrigeration and Air-Conditioning*, Dhanpat Rai and Co., 2003.
- ME5162 **ALTERNATE FUELS** (3-0-0) 3
- Fossil fuels and their limitations, Engine requirements, potential alternative liquid and gaseous fuels, methods of production, properties, safety aspects, handling and distribution, use in engines, performance and emission characteristics, conversion of vegetable oils to their esters and effect on engine performance, use of gaseous fuels in engines, dual fuel combustion, surface ignition, additives, hybrid power plants and fuel cells.
- Reading:*
1. *CI Engine Performance for Use with Alternative Fuels*, Society of Automotive Engineers, 2009.
 2. Hordeski, M. F., *Alternative Fuels: The Future of Hydrogen*, CRC Press, 2006.
 3. Maxwell, T.T. and Jones, J., *Alternative Fuels: Emissions, Economics and Performance*, Society of Automotive Engineers, 2002.
 4. *Commercial Vehicle Alternative Fuels*, Society of Automotive Engineers, 2007.
- ME5163 **DESIGN OF HEAT TRANSFER EQUIPMENT** (3-0-0) 3
- Introduction, Various Methods of Classification of Heat Exchangers, LMTD and NTU Methods of Heat Exchangers, Counter flow double pipe (Hair-Pin) heat exchangers, shell and tube heat exchangers, boilers, condensers, cooling towers.
- Reading:*
1. Incropera, F. P. and De Witt, D. P., *Fundamentals of Heat and Mass Transfer*, 6th Edition, Wiley India, 2010.
 2. Nag, P. K., *Heat Transfer*, 1st Edition, Tata McGraw Hill, New Delhi, 2012.

3. Kern, D. Q., *Process Heat Transfer*, Tata McGraw Hill, New Delhi, 2001.
4. Kays, W. M. and London, A. K., *Compact Heat Exchangers*, 3rd Edition, Krieger Publishing Company, 1998.

ME5164 **ADVANCED COMPUTATIONAL FLUID DYNAMICS** (3-0-0) 3

Governing equations of fluid motion and boundary conditions, turbulence modeling, finite volume method for diffusion problems, convection-diffusion problems, pressure-velocity coupling, SIMPLE and SIMPLER algorithms, unsteady flows, errors and uncertainty in CFD modeling, unstructured grid generation.

Reading:

1. Versteeg, H. K. and Malalasekera, W., *An Introduction to Computational Fluid Dynamics: The Finite Volume Method*, 2nd Edition, Pearson, 2010.
2. Tannehill, J. C., Anderson, D. A. and Pletcher, R. H., *Computational Fluid Mechanics and Heat Transfer*, McGraw Hill, 2002.
3. Blazek, J., *Computational Fluid Dynamics: Principles and Applications*, 2nd Edition, Elsevier Science & Technology, 2006.
4. Chung, T. J., *Computational Fluid Dynamics*, Cambridge University Press, 2003.

ME5165 **CONVECTIVE HEAT TRANSFER** (3-0-0) 3

Fundamental principles, laminar forced convection in external flows, laminar forced convection in duct flows, external natural convection, internal natural convection, turbulent boundary layer flow, turbulent duct flow, mixed convection, conjugate mixed convection.

Reading:

1. Bejan, A., *Convection Heat Transfer*, 3rd Edition, Wiley India, 2006.
2. Louis, C. Burmeister, *Convective Heat Transfer*, John Wiley and Sons, New York, 2002.
3. Kays, W. M. and Crawford, M. E., *Convective Heat and Mass Transfer*, 4th Edition, Tata McGraw Hill, 2012.

ME5166 **JET AND ROCKET PROPULSION** (3-0-0) 3

Propulsion systems, choice of propulsion systems for missile and space launch vehicles, performance calculations, rocket propellants - performance of propellants, burning rate, erosive burning, liquid propellants, cryogenic bi-propellants, hyperbolic ignition and combustion, rocket propulsion technology - solid and liquid propellant rocket engines, solid ramjet systems, choice of propellants, choice of chamber pressure and mixture ratio, hybrid rocket engines.

Reading:

1. Barrere, M., *Rocket Propulsion*, Elsevier Pub. Co., 1990.
2. Sutton, G. P., *Rocket Propulsion Elements*, John Wiley, New York, 1993.
3. Feedesiev, V. I. and Siniarev, G. B., *Introduction to Rocket Technology*, Academic Press, New York, 2000.
4. Sarvanamuttoo, H.I.H., Rogers, G. F.C. and Cohen, H., *Gas Turbine Theory*, 6th Edition, Pearson Prentice Hall, 2008.

ME5167 **CONJUGATE HEAT TRANSFER** (3-0-0) 3

Review of fundamentals - energy balance approach, view factor calculations, Enclosure Analysis, Radiosity - irradiation methods, finite volume and finite difference methods, Principles and Applications, two-mode heat transfer problems - conjugate convection from different geometries without radiation, three-mode heat transfer problems - conjugate convection with radiation from various geometries, conjugate mixed convection problems.

Reading:

1. Sadik Kakac and Yaman Yener, *Heat Conduction*, 2nd Edition, Hemisphere, 2001.
2. Kays, W. M. and Crawford, M. E., *Convective Heat and Mass Transfer*, 4th Edition, Tata McGraw Hill, 2012.
3. Siegel, R. and Howell, J. R., *Thermal-Radiation Heat Transfer*, 4th Edition, Taylor & Francis, 2002.
4. Incropera, F. P. and De Witt, D. P., *Fundamentals of Heat and Mass Transfer*, 5th Edition, John Wiley & Sons, New York, 2006.

ME5168

MEASUREMENTS IN THERMAL ENGINEERING

(3-0-0) 3

Generalized configuration and functional description of measuring instruments, generalized performance characteristics of instruments - static characteristics, dynamic characteristics, Uncertainty analysis, pressure measurement, flow measurement, temperature and heat flux measurement.

Reading:

1. Holman, J. P., *Experimental Methods for Engineers*, Tata McGraw Hill Book Company, New Delhi, 2010.
2. Thomas G. Beckwith and Lewis Buck, *Mechanical Measurements*, Narosa Publishing House, 2009.
3. Ernest, O. D., *Measurement Systems - Applications and Design*, Tata McGraw Hill Book Company, New Delhi, 2011.

ME5467

CAD FOR THERMAL ENGINEERING

(3-0-0) 3

Hardware and software for CAD, Geometric modeling, Transformations, Curve representation: analytic and synthetic curves, Surface Modeling, Solid Modeling Techniques, CAD/CAM Exchange formats, Design Applications: Mechanical tolerances, Mass property calculations and Mechanical Assembly, Advanced Modeling Concepts: Feature Based Modeling, Assembling Modeling, Behavioral Modeling, Conceptual Design and Top Down Design, Collaborative Design.

Reading:

1. Ibrahim Zeid, *CAD / CAM Theory and Practice*, 2nd Edition, Tata-McGraw Hill, 2009.
2. Rogers, D. F. and Adams, J.A., *Mathematical Elements for Computer Graphics*, Tata-McGraw Hill, 2008.

M.Tech. (Manufacturing Engineering)**I Year I Semester**

S. No.	Course No.	Course Name	L	T	P	C
1	ME5201	Metal Cutting - Theory and Practice	4	0	0	4
2	ME5202	Design and Analysis of Machine Tools	4	0	0	4
3	ME5203	CNC Technology and Programming	4	0	0	4
4	ME5404	Advanced CAD	4	0	0	4
5		Elective - I	3	0	0	3
6		Elective - II	3	0	0	3
7	ME5205	Manufacturing Engineering Laboratory	0	0	3	2
8	ME5406	CAD Laboratory	0	0	3	2
TOTAL			22	0	6	26

I Year II Semester

S. No.	Course No.	Course Name	L	T	P	C
1	ME5251	Advanced Manufacturing Processes	4	0	0	4
2	ME5252	Metrology and Computer Aided Inspection	4	0	0	4
3	ME5253	Mechatronics and Robotics	4	0	0	4
4		Elective - III	3	0	0	3
5		Elective - IV	3	0	0	3
6		Elective - V	3	0	0	3
7	ME5254	Mechatronics Laboratory	0	0	3	2
8	ME5255	CNC Laboratory	0	0	3	2
9	ME5291	Seminar	0	0	3	2
TOTAL			21	0	9	27

II Year I Semester

S. No.	Course No.	Course Name	L	T	P	C
1	EE6242	Comprehensive Viva-voce	0	0	0	4
2	EE6249	Dissertation Part-A	0	0	0	8
TOTAL			0	0	0	12

II Year II Semester

S. No.	Course No.	Course Name	L	T	P	C
1	EE6199	Dissertation Part-B	0	0	0	18
TOTAL			0	0	0	18

Consolidated Credits

Category	I Sem	II Sem	III Sem	IV Sem	Total
Core courses	16	12	00	00	28
Electives	06	09	00	00	15
Lab Courses	04	04	00	00	08
Comprehensive Viva-Voce	00	00	04	00	04
Seminar	00	02	00	00	02
Dissertation	00	00	08	18	26
Total	26	27	12	18	83

ELECTIVE COURSES**I - Semester**

ME5211	Rapid Manufacturing Processes
ME5212	Micro and Nano Manufacturing
ME5213	Tribology
ME5314	Soft Computing Techniques
ME5316	Manufacturing Management
ME5421	Mechanical Vibrations

II - Semester

ME5261	Precision Engineering
ME5262	Product Design for Manufacturing and Assembly
ME5263	Tool Design
ME5264	Fluid Power Systems
ME5265	High Speed Machining
ME5361	Supply Chain Management
ME5362	Design and Analysis of Experiments
ME5363	Flexible Manufacturing Systems
ME5471	Finite Element Analysis

ME5406	CAD LABORATORY	(0-0-3) 2
Exercises using AutoCAD commands, script files, Auto LISP. Customi-zation of Auto CAD, Exercises on Modeling, Assembly and manufacturing using ProE, Exercises on Computer Graphics using Open GL.		
ME5251	ADVANCED MANUFACTURING PROCESSES	(4-0-0) 4
Advances in Casting: Stir Casting, Organic Processes, Fluid Sand Process, Graphite Moulding Process, Magnetic Moulding, Metal Injection Moulding, Centrifugal Casting. Advances in Welding: Introduction to Friction Stir Welding, Hybrid Welding Process. Preparation of Composites, Friction Stir Processing, Analysis of Composites. Advances in Forming: Hydro Forming, High Velocity Forming, Explosive Forming, Electro Magnetic Forming. Design Considerations for Forging, Casting and Welding.		
<i>Reading:</i>		
1. RS Mishra, <i>Friction Stir Welding and Processing</i> , ASM International, 2007.		
2. Heine, <i>Loper and Rosenthal, Principles of Metal Casting</i> , TMH, New Delhi, 1995.		
3. GR Nagpal, <i>Metal Forming Processes</i> , Khanna Publishers, New Delhi, 2000.		
4. V.K. Jain, <i>Advanced Machining Processes</i> , Allied Publishers, Mumbai, 2002.		
ME5252	METROLOGY AND COMPUTER AIDED INSPECTION	(4-0-0) 4
Metrology concepts: Standards for length measurement - Light interference - Method of coincidence - Slip gauge calibration. Tolerances, gauging principles, Angular measurements - Gear and Thread measurements. Surface and form metrology, Computer Aided Inspection: Laser Metrology - Applications of Lasers in precision measurements, Coordinate Measuring Machine - Non contact CMM - Non contact sensors for surface finish measurements. Image processing and its application in Metrology.		
<i>Reading:</i>		
1. Thomas. G. G, <i>Engineering Metrology</i> , Butterworth Pub.1974.		
2. Ulrich-Rembold, Armbruster and Ulzmann, <i>Interface Technology for Computer Controlled Manufacturing Processes</i> , Marcel Dekker Pub. New York,1993.		
ME5253	MECHATRONICS AND ROBOTICS	(4-0-0) 4
Mechatronics system Design, - Sensors and Actuators - Modeling, Analysis and Control of various physical systems - System Transfer Functions - Closed-loop Controllers - Digital design principles and applications - Microprocessors and Microcontrollers - System Interfaces - Logic System Design - Programmable Logic Controllers (PLCs) - Data Acquisition - Signal Conditioning - Robotics: Evolution and Classification - Structural designs - Drives for robots - Robot sensors - Programming methods.		
<i>Reading:</i>		
1. W. Bolton, <i>Mechatronics, Electronic Control Systems in Mechanical and Electrical Engineering</i> , 5th Edition, Pearson Education, 2011.		
2. David G. Alcaiatore and Michel B. Histan, <i>Introduction to Mechatronics and Measuring Systems</i> , 3rd Edition, McGraw Hill Int. Edition, 2006.		
3. John J Craig, <i>Introduction to Robotics: Mechanics and Control</i> , Pearson Education, 2010.		
ME5254	MECHATRONICS LABORATORY	(0-0-3) 2
Experiments on Instrumentation Tutor Kit, Servo Fundamentals Trainer, PLC, Mechatronics Training System, Pneumatic Trainer and Programming on Micro-controller based autonomous Robot.		
ME5255	CNC LABORATORY	(0-0-3) 2
CNC programming for turned and milled components using Denford, Sinutrain and Master CAM, Training on CNC machines.		

ME5211	RAPID MANUFACTURING PROCESSES	(3-0-0) 3
<p>Review of solid modeling techniques, Stereo lithography, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, 3D Printing and Ballistic Particle Modeling, Process Planning for Rapid Prototyping, STL file generation, Defects in STL files and repairing algorithms, Slicing, Accuracy issues in Rapid Prototyping, Strength of RP Parts, Surface Roughness problems in Rapid Prototyping, Part Deposition Orientation, Rapid Tooling techniques, Reverse Engineering and Integration of Reverse Engineering and RP.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Chua Chee Kai, Leong Kah Fai, Chu Sing Lim, <i>Rapid Prototyping: Principles and Applications in Manufacturing</i>, World Scientific, 2010. 2. Ian Gibson, David W Rosen, Brent Stucker, <i>Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing</i>, Springer, 2010. 3. Rafiq Noorani, <i>Rapid Prototyping: Principles and Applications in Manufacturing</i>, John Wiley & Sons, 2006. 		
ME5212	MICRO AND NANO MANUFACTURING	(3-0-0) 3
<p>Historical perspective of Micro and Nano manufacturing technology, advantages and applications of nanotechnology, Overview of Nano Fabrication Methods: Top-down and bottom-up approaches, lithography, deposition, CVD, PVD, etching, and material modification methods, processes and equipment, Application of Nano materials, Carbon Nano Tubes, Quantum dots, Organic compounds and bio-applications of nano materials, Characterization Tools, Optical microscopy, Profilometry, Ellipsometry, Spectrophotometer, Scanning Electron Microscope, AFM, FFM.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Mark James Jackson, <i>Microfabrication and Nanomanufacturing</i>, CRC Press, 2005. 2. Z. Cui, <i>Nanofabrication</i>, Springer, 2008. 3. Gabor L. Hornyak, H.F. Tibbals, Joydeep Dutta and John J. Moore, <i>Introduction to Nanoscience and Nanotechnology</i>, CRC Press, Boca Raton, 2009. 		
ME5213	TRIBOLOGY	(3-0-0) 3
<p>Contact of ideally smooth surfaces, contact of rough surfaces, types of wear and influence of operating conditions, corrosion, manufacturing methods improved wear resistance, lubrication, lubricants and additives, Friction and power losses in journal bearings, Bearing materials, Air lubricated bearing.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Paulo Davim, <i>Tribology for Engineers: A Practical Guide</i>, Woodhead Publishing, 2011. 2. Kragelski, Friction, <i>Wear and Lubrication</i>, Vol. I, II, III, MIR Publishers, 1983. 3. Basu, Sen Gupta and Ahuja, <i>Fundamentals of Tribology</i>, PHI, 2000. 		
ME5314	SOFT COMPUTING TECHNIQUES	(3-0-0) 3
<p>Problem Solving Methods and Tools, Evolutionary Computing Methods, Genetic Algorithm, Genetic Programming, Swarm Optimization, Ant Colony, Sheep Flock, Artificial Immune Algorithms, Advances in Soft Computing Tools, Introduction to Determining and Data mining tools, Artificial Neural Networks, Application of Soft Computing to Mechanical Engineering/Production Engineering Problems.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Tettamanzi Andrea, Tomassini and Marco, <i>Soft Computing Integrating Evolutionary, Neural and Fuzzy Systems</i>, Springer, 2001. 2. Elaine Rich, <i>Artificial Intelligence</i>, McGraw Hill, 2nd Edition, 1990. 3. Kalyanmoy Deb, <i>Multi-objective Optimization using Evolutionary Algorithms</i>, John Wiley and Sons, 2001. 		
ME5316	MANUFACTURING MANAGEMENT	(3-0-0) 3
<p>Competitive priorities and manufacturing strategy, Hierarchical production planning and control, Demand Forecasting, Facility Design: Product design and process selection, Capacity planning, Plant location and Plant layout, Inventory control: From EOQ to ROP, MRP crusade, JIT revolution, Production scheduling, Aggregate and workforce planning.</p>		

Reading:

1. Krajewski U and Ritzman LP, *Operations Management: Strategy and Analysis*, Pearson Education Pvt. Ltd., Singapore, 2002.
2. Gaither N and Frazier G, *Operations Management*, Thomson Asia Pvt. Ltd., Singapore, 2002.
3. Chase RB, Aquilano NJ and Jacobs RF, *Operations Management for Competitive Advantage*, McGraw-Hill Book Company, NY, 2001.

ME5421

MECHANICAL VIBRATIONS

(3-0-0) 3

Review of free and forced vibrations of damped and undamped single degree freedom systems, impulse response technique, Laplace transformation technique, Two degree freedom systems, Eigen value problems, Modal analysis, Vibration control, Dynamic vibration absorbers, Vibration measuring devices, Introduction to continuous systems.

Reading:

1. Thomson, W. T., *Theory of Vibrations with Applications*, 5th Edition, Pearson Education, 2008.
2. Rao, S. S., *Mechanical Vibrations*, 4th Edition, Pearson Education, 2003.
3. Leonard Meirovitch, *Elements of Vibration Analysis*, 2nd Edition, Tata-McGraw Hill, 2006.

ME5261

PRECISION ENGINEERING

(3-0-0) 3

Tolerances and fits, concept of selective assembly, calculation of fits in selective assembly, Concept of part and machine tool accuracy, alignment testing of machine tools, Theory of dimensional chains, Calculation of tolerances in dimensional chains, Errors during machining, Statistical methods of accuracy analysis, Surface roughness: Definition and measurement, surface roughness indicators (CLA, RMS etc) and their comparison, Calculation of machining allowances: In process dimensioning of work pieces with examples. Manufacturing methods of typical machine tool components: Spindles, lead screws and beds.

Reading:

1. David Dornfield and Dae Eun Lee, *Precision Manufacturing*, Springer Publishers, 2008.
2. VC Venkatesh, *Precision Engineering*, Tata McGraw Hill, 2007.
3. V. Kovan, *Fundamentals of Process Engineering*, Foreign Languages Publishing House, Moscow, 1975.
4. Murty, R. L., *Precision Engineering*, New Age Publications, 1996.

ME5262

PRODUCT DESIGN FOR MANUFACTURING AND ASSEMBLY

(3-0-0) 3

Introduction to DFM, DFMA, Design for Manual Assembly, High speed Automatic Assembly, Robot Assembly, Machining, Injection Moulding, Sheet Metal Working, Die-Casting, Automatic Feeding, Orientation Devices, Design for Assembly Automation.

Reading:

1. Geoffrey Boothroyd, *Assembly Automation and Product Design*, 3rd Edition, Marcel Dekker Inc., NY, 2010.
2. Geoffrey Boothroyd, *Hand Book of Product Design*, Marcel Dekker Inc., NY, 1992.

ME5263

TOOL DESIGN

(3-0-0) 3

Design of single point cutting tool, milling cutters, drill bits, carbide tools, gages and gauge design, locating and clamping methods, design of drill jigs, milling fixture, blanking and piercing dies, bending dies, drawing dies, NC fixture design, NC tool holding and changing methods, tooling for automatic screw machines.

Reading:

1. Wilson, F.W., *Fundamentals of Tool Design*, ASTME, Prentice Hall, India, 2010.
2. Donaldson, Lecain and Good, *Tool Design*, TMH, 2010.

ME5264

FLUID POWER SYSTEMS

(3-0-0) 3

Basic components: Pumps, Actuators, Valves, Hydraulic circuits: Regenerative, Sequence, Semi-automatic, automatic, Circuits for rotary and reciprocating motion, Speed control, Hydraulic power amplifiers, tracer control systems, Pneumatic and Pneumo-hydraulic systems, Fluidics, Servo control systems, fluid power system simulation.

Reading:

1. Esposito, *Fluid power with Applications*, 6/e, Pearson, 2011.
2. M. Galal Rabie, Rabie M., *Fluid Power Engineering*, McGraw-Hill Professional Publishing, 2009.
3. John J Pippenger and W. Hicks, *Industrial Hydraulics*, TMH, 1980.

ME5265

HIGH SPEED MACHINING

(3-0-0) 3

Advanced machining processes, the determinants of high speed high performance machining, characteristics of HSM, HSM support machine tool technology, advanced cutting tools, precision tooling interface, dry and near dry machining, the transition to high performance machining, Practical applications of HSM.

Reading:

1. Bert. P. Erdel, *High Speed Machining*, SME Publications, Michigan, 2003.
2. Dale Mickelson, *Hard Milling and High Speed Machining*, Industrial Press Inc., United States, 2007.

ME5361

SUPPLY CHAIN MANAGEMENT

(3-0-0) 3

Competitive and Supply Chain strategies, Drivers of supply chain performance, Managing demand and supply in supply chain: Managing inventories in supply chain, Bull Whip effect and Coordination, Distribution and Transportation Networks, Procurement and outsourcing strategies, Role and impact of E-business.

Reading:

1. Sunil Chopra and Peter Meindl, *Supply Chain Management - Strategy, Planning and Operation*, Pearson Education Asia, 2011.
2. David Simchi-Levi, Philp Kamintry and Edith Simchy Levy, *Designing and Managing the Supply Chain - Concepts Strategies and Case Studies*, Tata McGraw Hill, 2010.

ME5362

DESIGN AND ANALYSIS OF EXPERIMENTS

(3-0-0) 3

Fundamental of Experimentation, Simple comparative experiments, Experiments with single factor, ANOVA, Factorial and Fractional Factorial experiments, Orthogonal Arrays, Response Surface Methodology, Taguchi's Parameter Design.

Reading:

1. Ross P.J., *Taguchi Techniques for Quality Engineering*, McGraw-Hill Book Company, New York, 2008.
2. Montgomery D.C., *Design and Analysis of Experiments*, 7th Edition, John Wiley & Sons, New York, 2008.

ME5363

FLEXIBLE MANUFACTURING SYSTEMS

(3-0-0) 3

FMS planning, Flexibility issues, Flexibility assessment, Flexibility and productivity, Flexibility in pull and push type production ordering systems, FMS planning, FMS short term planning problems, Loading models in FMS, Production planning model for an FMS, FMS control, FMS planning and control, Models for performance evaluation and FMS configuration, Decision models for the design of a FMS, Working examples of FMS installations.

Reading:

1. William W Luggen, *Flexible Manufacturing Cells and Systems*, Prentice Hall Inc. New Jersey, 1991.
2. Reza A Maleki, *Flexible Manufacturing Systems*, Prentice Hall Inc.. New Jersey, 1991.
3. John E Lenz, *Flexible Manufacturing*, Marcel Dekker Inc., New York, 1989.
4. Mikell P Groover, *Automation, Production Systems and Computer Integrated Manufacturing*, 3rd Edition, Prentice Hall Inc., New Delhi, 2007.

ME5471

FINITE ELEMENT ANALYSIS

(3-0-0) 3

Identification of Physical problems, Mathematical Models, Philosophy of Finite Element method, Formulation of FE characteristics for 1-D structural elements, Assembly considerations, Boundary conditions and their incorporation, Case studies on bars, trusses, beams and frames, Formulation of FE characteristics Plane stress, Plane strain and Axi-symmetric elements. Overview of FE applications in Metal cutting, casting, forming and forging applications.

Reading:

1. S. S. Rao, *The Finite Element Method in Engineering*, 5th Edition, Elsevier, 2011.
2. Robert D.C, David S.M., Michel E Plesha, *Concepts and Applications of Finite Element Analysis*, 3rd Edition, John Wiley & Sons 2000.
3. Reddy, J. N., *Finite Element Method in Engineering*, Tata McGraw Hill, 2007.
4. O. C. Zienkiewicz, *The Finite Element Method: Its Basics and Fundamentals*, 6th Edition, Elsevier, 2007.

M.Tech. (Computer Integrated Manufacturing)**I Year I Semester**

S. No.	Course No.	Course Name	L	T	P	C
1	ME5301	CNC Systems and Programming	4	0	0	4
2	ME5302	Integrated Production Control System	4	0	0	4
3	ME5303	Mechatronics and MEMS	4	0	0	4
4	ME5404	Advanced CAD	4	0	0	4
5		Elective - I	3	0	0	3
6		Elective - II	3	0	0	3
7	ME5305	Mechatronics and Automation Laboratory	0	0	3	2
8	ME5305	CAD Laboratory	0	0	3	2
TOTAL			22	0	6	26

I Year II Semester

S. No.	Course No.	Course Name	L	T	P	C
1	ME5351	Computer Integrated Manufacturing	4	0	0	4
2	ME5352	Product Lifecycle Management	4	0	0	4
3	ME5353	Modeling and Simulation of Manufacturing Systems	4	0	0	4
4		Elective - III	3	0	0	3
5		Elective - IV	3	0	0	3
6		Elective - V	3	0	0	3
7	ME5354	Manufacturing Simulation Laboratory	0	0	3	2
8	ME5355	CNC Laboratory	0	0	3	2
9	ME5391	Seminar	0	0	3	2
TOTAL			21	0	9	27

II Year I Semester

S. No.	Course No.	Course Name	L	T	P	C
1	EE6342	Comprehensive Viva-voce	0	0	0	4
2	EE6349	Dissertation Part-A	0	0	0	8
TOTAL			0	0	0	12

II Year II Semester

S. No.	Course No.	Course Name	L	T	P	C
1	EE6399	Dissertation Part-B	0	0	0	18
TOTAL			0	0	0	18

Consolidated Credits

Category	I Sem	II Sem	III Sem	IV Sem	Total
Core courses	16	12	00	00	28
Electives	06	09	00	00	15
Lab Courses	04	04	00	00	08
Comprehensive Viva-Voce	00	00	04	00	04
Seminar	00	02	00	00	02
Dissertation	00	00	08	18	26
Total	26	27	12	18	83

ELECTIVE COURSES**I Semester**

ME5311	Business Intelligence
ME5312	Robotics
ME5313	Enterprise Resource Planning
ME5314	Soft Computing Techniques
ME5315	Computer Aided Inspection Systems
ME5211	Rapid Manufacturing Processes

II Semester

ME5361	Supply Chain Management
ME5362	Design and Analysis of Experiments
ME5363	Flexible Manufacturing Systems
ME5364	Lean Manufacturing Systems
ME5365	Concurrent Engineering
ME5366	Artificial Intelligence in CIM
ME5367	Computer Networks for Manufacturing
ME5262	Product Design for Manufacturing and Assembly
ME5471	Finite Element Analysis

M.Tech. (Computer Integrated Manufacturing)

ME5301 **CNC SYSTEMS AND PROGRAMMING** (4-0-0) 4

Numerical Control Machines, Classification, Design Considerations of NC machines, Tooling for CNC, NC programming, Computer aided programming, Drives and feedback drives, software and hardware interpolators, NC/CNC controller, DNC systems, adaptive control systems.

Reading:

1. James V. Valentino and Joseph Goldenberg, *Introduction to Computer Numerical Control*, 5th Edition, Prentice Hall, Englewood Cliff, New Jersey, 2012.
2. David Gibbs and Thomas Crandall, *CNC Machining and Programming: An Introduction*, Industrial Press Inc., 2003.
3. Yoram Koren, *Computer Control of Manufacturing Systems*, McGraw Hill International, Singapore, 2006.

ME5302 **INTEGRATED PRODUCTION CONTROL SYSTEMS** (4-0-0) 4

Competitive priorities and manufacturing strategy, Facility Design: Product design and process selection, Capacity planning, Plant location and Plant layout, Inventory control: From EOQ to ROP, MRP crusade, JIT revolution, Factory dynamics and variability, Push and pull production systems, Shop floor control, Production Scheduling, Aggregate and workforce planning, Integrated approach to production planning and control.

Reading:

1. Krajewski U and Ritzman LP, *Operations Management: Strategy and Analysis*, Pearson Education Pvt Ltd., Singapore, 2002.
2. Chase R B, Aquilano NJ and Jacobs RF, *Operations Management for Competitive Advantage*, McGraw-Hill Book Company, NY, 2005.
3. Hopp WJ and Spearman ML, *Factory Physics: Foundations of Manufacturing Management*, McGraw-Hill Book Company, NY, 2001.

ME5303 **MECHATRONICS AND MEMS** (4-0-0) 4

Mechatronics system Design, integrated design issues - Sensors and Actuators used in Mechatronics devices - Modeling, Analysis and Control of physical systems - Response of Dynamic Systems - System Transfer Functions - Closed-loop Controllers - Microprocessors and Micro-controllers, System Interfaces, Fault Analysis, Logic System Design - Programmable Logic Controllers (PLCs) - Data Acquisition- A/D and D/A Conversion - Signal Conditioning, Examples of Mechatronics systems. MEMS: History - Effect of scaling - Fabrication techniques: Oxidation, Sputter disposition, CVD, Lithography, Etching, Wafer bonding, LIGA, DRIE - Applications: Lab on chip.

Reading:

1. W. Bolton, Mechatronics, *Electronic Control Systems in Mechanical and Electrical Engineering*, Pearson Education, 2011.
2. David G. Alcaiatore and Michel B. Histan, *Introduction to Mechatronics and Measuring Systems*, McGraw Hill Int. Edition, 2006.
3. James J Allen, *Micro Electro Mechanical Systems Design*, CRC Press Taylor & Francis Group, 2010.

ME5404 **ADVANCED CAD** (4-0-0) 4

Hardware and software for CAD, Geometric modeling, Transformations, Curve representation: analytic and synthetic curves, Surface Modeling, Solid Modeling Techniques, CAD/CAM Exchange formats, Design Applications: Mechanical tolerances, Mass property calculations and Mechanical Assembly, Advanced Modeling Concepts: Feature Based Modeling, Assembling Modeling, Behavioral Modeling, Conceptual Design and Top Down Design. Collaborative Design.

Reading:

1. Ibrahim Zeid, *CAD / CAM Theory and Practice*, Tata McGraw Hill, 2010.
2. David F Rogers, J A Adams, *Mathematical Elements for Computer Graphics*, TMH, 2008

ME5304	MECHATRONICS AND AUTOMATION LABORATORY	(0-0-3) 2
Experiments on Instrumentation Tutor Kit, Servo Fundamentals Trainer, PLC, Mechatronics Training System, Pneumatic Trainer and Programming on Micro-controller based autonomous Robot, Simulation of automation systems using Automation studio.		
ME5406	CAD LABORATORY	(0-0-3) 2
Exercises using AutoCAD commands, script files, Auto LISP. Customization of AutoCAD, Exercises on Modeling, Assembly and manufacturing using ProE, Exercises on Computer Graphics using Open GL.		
ME5351	COMPUTER INTEGRATED MANUFACTURING	(4-0-0) 4
Manufacturing Automation, Automation strategies, Automated Flow lines, Line Balancing, Automated Assembly systems, Automatic Material Handling and Storage systems, Automated Inspection systems, Group Technology, Cell Design, Cellular Manufacturing Systems, Computer Aided Process Planning, Flexible Manufacturing Systems, Computer Integrated Manufacturing, Components of CIM, Data base For CIM, Planning, Scheduling and Analysis of CIM systems.		
<i>Reading:</i>		
1. Mikell P Groover, <i>Automation, Production Systems and Computer Integrated Manufacturing</i> , 3rd Edition, Prentice Hall Inc., New Delhi, 2007.		
2. Nanua Singh, <i>System Approach to Computer Integrated Manufacturing</i> , Wiley & Sons Inc., 1996.		
3. Andrew Kusiak, <i>Intelligent Manufacturing System</i> , Prentice Hall Inc., New Jersey, 1992.		
ME5352	PRODUCT LIFECYCLE MANAGEMENT	(4-0-0) 4
Fundamentals of PLM, Enterprise solution with PLM, Impact of Manufacturing with PLM, Standardized product data and materials data model, PLM service information model, PLM for e-manufacturing, Optimization of ERP for PLM, Implementing end to end business process management, Integration of PLM and CRM, PLM applications in process and product industries examples.		
<i>Reading:</i>		
1. Jaya Krishna S, <i>Product Lifecycle Management: Concepts and Cases</i> , ICFAI Publications, 2011.		
2. SOA Approach to Enterprise Integration for Product Lifecycle, IBM Red Books, 2011.		
ME5353	MODELING AND SIMULATION OF MANUFACTURING SYSTEMS	(4-0-0) 4
Introduction to System and simulation, Review of probability, Principles of modeling and simulation, Monte-Carlo simulation, Discrete event simulation, Steps in simulation, Random numbers generation, Test for random numbers, Random variate, Design of simulation experiment: analysis of input data, output data, Validation and verification etc., Over view of simulation languages, Modeling and analysis of manufacturing systems using Markov chains queuing networks and Game theory		
<i>Reading:</i>		
1. Jerry Banks, John S. Carson, Barry L. Nelson, David M. Nicol, and P. Shahabudeen, <i>Discrete Event System Simulation</i> , Prentice Hall of India, New Delhi, 2008.		
2. Averill M. Law and W. David Kelton, <i>Simulation Modeling and Analysis</i> , Tata McGraw Hill, New Delhi, 2006.		
ME5354	MANUFACTURING SIMULATION LABORATORY	(0-0-3) 2
Simulation experiments on automated manufacturing systems, JIT systems and FMS using Automod, ProModel, Awesim, Flexsim, Witness softwares.		
ME5255	CNC LABORATORY	(0-0-3) 2
CNC programming for turned and milled components using Denford, Sinutrain and Master CAM, Training on CNC machines.		

ME 5311	BUSINESS INTELLIGENCE	(3-0-0) 3
<p>Development Steps, Enterprise Infrastructure Evaluation, Project Planning, Project Requirements Definition, Data Analysis, Application Prototyping, Meta Data Repository Analysis, Database Design, Extract/ Transport/ Load Design, Meta Data Repository Design, , Extract/ Transport/ Load Development, Application Development, Data Mining, Meta Data Repository Development.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Larissa T Moss, <i>Business Intelligence Roadmap</i>, Addison-Wesley Information Technology Series, 2003. 2. Efraim Turban, Jay E. Aronson, Ting-Peng Liang, Ramesh Sharda, <i>Decision Support and Business Intelligence Systems</i>, 8th Edition, Prentice Hall, 2006. 		
ME5312	ROBOTICS	(3-0-0) 3
<p>Fundamentals of Robotics, Joints, Arm configurations, Wrists, design of end effectors, actuators, modular robots, Robot sensors and Machine vision. Forward Kinematics, Inverse kinematics, trajectory planning, manipulator dynamics-simple cases. Robot programming - overview of various programming languages, Robot Industrial and Non industrial applications.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Richard D. Klafter, Thomas A.Chmielewski and Michael Negin, <i>Robotic Engineering an Integrated Approach</i>, Prentice-Hall India Private Limited, 1994. 2. John J Craig, <i>Introduction to Robotics: Mechanics and Control</i>, Pearson Education, 2010. 3. Fu and Gonzales, <i>Industrial Robotics</i>, Tata McGraw Hill Book Co., 2008. 		
ME5313	ENTERPRISE RESOURCE PLANNING	(3-0-0) 3
<p>ERP checklist, Integrating the supply chain, strategic sourcing and procurement, Operations planning - Demand management, CRP, MRP; PLC Management, Manufacturing Execution system, Distribution Networks, ERP system Requirements, Selecting the right ERP system, Data Record Accuracy, Implementation- Repetitive, Process, Remanufacturing and Project Manufacturing, Customer Relationship and Service.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Alexis Leon, <i>ERP Demystified</i>, McGraw Hill, 2007. 2. Carol A Ptak, <i>ERP: Tools, Techniques, and Applications for Integrating the Supply Chain</i>, 2nd Edition, CRC Press, 2003. 		
ME5314	SOFT COMPUTING TECHNIQUES	(3-0-0) 3
<p>Problem Solving Methods and Tools, Evolutionary Computing Methods, Genetic Algorithm, Genetic Programming, Swarm Optimization, Ant Colony, Sheep Flock, Artificial Immure Algorithms, Advances in Soft Computing Tools, Introduction to Determining and D.M. tools, Artificial Neural Networks, Application of Soft Computing to Mechanical Engineering/Production Engineering Problems.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Tettamanzi Andrea, Tomassini and Marco, <i>Soft Computing Integrating Evolutionary, Neural and Fuzzy Systems</i>, Springer, 2001. 2. Elaine Rich, <i>Artificial Intelligence</i>, McGraw Hill, 2nd Edition, 1990. 3. Kalyanmoy Deb, <i>Multi-objective Optimization using Evolutionary Algorithms</i>, John Wiley and Sons, 2001. 		
ME5315	COMPUTER AIDED INSPECTION SYSTEMS	(3-0-0) 3
<p>Laser Metrology - Applications of Lasers in precision measurements - Laser interferometer, speckle measurements, Laser scanners. Coordinate Measuring Machine - Types of CMM - Probes used - Applications - Non contact CMM using Electro-optical sensors for dimensional metrology - Non contact sensors for surface finish measurements. Image processing and its application in Metrology.</p>		

Reading:

1. Thomas. G. G., *Engineering Metrology*, Butterworth Pub.1974.
2. Ulrich-Rembold, Armbruster and Ulzmann, *Interface Technology For Computer Controlled Manufacturing Processes*, Marcel Dekker Pub. New York,1993.

ME5211 **RAPID MANUFACTURING PROCESSES** (3-0-0) 3

Review of solid modeling techniques, Stereo lithography, Fused Deposition Modeling, Selective Laser Sintering, Laminated Object Manufacturing, 3D Printing, Ballistic Particle Modeling etc., Process Planning for Rapid Prototyping, STL file generation, Defects in STL files and repairing algorithms, Slicing, Accuracy issues in Rapid Prototyping, Strength of RP Parts, Surface Roughness problems in Rapid Prototyping, Part Deposition Orientation, Rapid Tooling techniques, Reverse Engineering and Integration of Reverse Engineering and RP.

Reading:

1. Chua Chee Kai., Leong Kah Fai., Chu Sing Lim, *Rapid Prototyping: Principles and Applications in Manufacturing*, World Scientific, 2010.
2. Ian Gibson., David W Rosen., Brent Stucker., *Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing*, Springer, 2010.
3. Rafiq Noorani., *Rapid Prototyping: Principles and Applications in Manufacturing*, John Wiley & Sons, 2006.

ME5361 **SUPPLY CHAIN MANAGEMENT** (3-0-0) 3

Competitive and Supply Chain strategies, Drivers of supply chain performance, Managing demand and supply in supply chain: Managing inventories in supply chain, Bull Whip effect and Coordination, Distribution and Transportation Networks, Procurement and outsourcing strategies, Role and impact of E-business.

Reading:

1. Sunil Chopra and Peter Meindl, *Supply Chain Management - Strategy, Planning and Operation*, Pearson Education Asia, 2011.
2. David Simchi-Levi, Philp Kamintry and Edith Simchy Levy, *Designing and Managing the Supply Chain - Concepts Strategies and Case Studies*, TMH, 2010.

ME5362 **DESIGN AND ANALYSIS OF EXPERIMENTS** (3-0-0) 3

Fundamental of Experimentation, Simple comparative experiments, Experiments with single factor, ANOVA, Factorial and Fractional Factorial experiments, Orthogonal Arrays, Response Surface Methodology, Taguchi's Parameter Design.

Reading:

1. Ross P.J., *Taguchi Techniques for Quality Engineering*, McGraw-Hill Book Company, New York, 2008.
2. Montgomery D.C, *Design and Analysis of Experiments*, 7th Edition, John Wiley & Sons, New York, 2008.

ME5363 **FLEXIBLE MANUFACTURING SYSTEMS** (3-0-0) 3

FMS, FMS planning, Flexibility issues, Flexibility assessment , Flexibility and productivity, Flexibility in pull and push type production ordering system, FMS planning, FMS short term planning problems, Loading models in flexible manufacturing systems, Production planning model for a flexible manufacturing system, FMS control, FMS planning and control, Models for performance evaluation and FMS configuration, Decision models for the design of a Flexible Manufacturing system, Working examples of FMS installations.

Reading:

1. William W Luggen, *Flexible Manufacturing Cells And Systems*, Prentice Hall Inc. New Jersey, 1991.
2. Reza A Maleki, *Flexible Manufacturing Systems*, Prentice Hall Inc, New Jersey, 1991.
3. John E Lenz, *Flexible Manufacturing*, Marcel Dekker Inc., New York, 1989.
4. Mikell P Groover, *Automation, Production Systems and Computer Integrated Manufacturing*, 3rd Edition, Prentice Hall Inc., New Delhi, 2007.

ME5364	LEAN MANUFACTURING SYSTEMS	(3-0-0) 3
<p>Introduction to Lean Manufacturing, Lean Manufacturing Concepts: Lean Manufacturing Tools and Methodologies: Value Stream Mapping: ONE-PIECE FLOW: Implementing Lean: Reconciling Lean With Other Systems: Toyota production system-lean six sigma-lean and ERP-lean with ISO9001:2000.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Askin R G and Goldberg J B, <i>Design and Analysis of Lean Production Systems</i>, John Wiley and Sons Inc., 2003. 2. Micheal Wader, <i>Lean Tools: A Pocket Guide to Implementing Lean Practices</i>, Productivity and Quality Publishing Pvt Ltd, 2002. 3. Richard B Chase F Robert Jacobs and Nicholas J Aquilano, <i>Operations Management for Competitive Advantage</i>, 10th Edition, McGraw Hill/Irwin, 2003. 		
ME5365	CONCURRENT ENGINEERING	(3-0-0) 3
<p>Introduction, Strategic approach and technical aspects of product design, Issues in manufacturing systems design, Assembly workstation design, design of automated fabrication systems, Case studies.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. James L Nevins and Daniel E Whitney, <i>Concurrent Design of Product and Processes</i>, McGraw Hill, 1989. 2. Andrew Kusiak, <i>Concurrent Engineering: Automation, Tools, and Techniques</i>, Wiley-Interscience, 1992. 		
ME5366	ARTIFICIAL INTELLIGENCE IN CIM	(3-0-0) 3
<p>Artificial Intelligence (A.I.), Learning and Problem Solving, Knowledge Acquisition and Representation, Learning Systems, Expert systems, Expert system applications for CIM, Knowledge based systems (KBS), Applications of KBS for Assembly, Process Planning and Scheduling. Artificial Neural Networks, Fuzzy Logic And Fuzzy Sets, Multi layered networks, Applications of Fuzzy systems and ANNS for selection of Robots, Fault Diagnostics.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Andrew Kusiak, <i>Intelligent Manufacturing Systems</i>, Prentice Hall Publications.2005 2. Simons, G. L., <i>Introducing Artificial Intelligence</i>, NCC Pub., 1990. 3. Andrew Kusiak, <i>Computational Intelligence in Design and Manufacturing</i>, John Wiley and Sons, 2000. 		
ME5367	COMPUTER NETWORKS FOR MANUFACTURING	(3-0-0) 3
<p>Introduction: Data communications, Networks, the internet, protocols and standards. Network models: Layered tasks, Internet model, OSI Model. Transmission media: Guided media, unguided media: wireless. Data link layer: Error detection and correction, data link control and protocols, PPP, Multi Access, LAN - Ethernet and Wireless. Network Layer: Host-to-host Delivery: Internetworking, Addressing and Routing, Network protocols. Transport layer: Process-to-process Delivery: UDP and TCP. Application layer: DNS, Electronic mail and FTP, HTTP and WWW.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Behrauz A. Forouzan, <i>Data Communication and Networking</i>, 4th Edition, Tata McGraw Hill Edition. 2003. 2. James F. Kurose, Keith W. Ross, <i>Computer Networking - A Top Down Approach Featuring the Internet</i>, Addison-Wesley Longman Pvt. Ltd, 2001. 		
ME5262	PRODUCT DESIGN FOR MANUFACTURING AND ASSEMBLY	(3-0-0) 3
<p>Introduction to DFM, DFMA, Design for Manual Assembly, High speed Automatic Assembly, Robot Assembly, Machining, Injection Moulding, Sheet Metal Working, Die-Casting, Automatic Feeding, Orientation Devices, Design for Assembly Automation.</p>		

Reading:

1. Geoffrey Boothroyd, *Assembly Automation and Product Design*, Marcel Dekker Inc., NY, 3rd Edition 2010.
2. Geoffrey Boothroyd, *Hand Book of Product Design*, Marcel Dekker Inc., NY, 1992.

ME5471

FINITE ELEMENT ANALYSIS

(3-0-0) 3

Identification of Physical problems, Mathematical Models, Philosophy of Finite Element method, Formulation of FE characteristics for 1-D structural elements, Assembly considerations, Boundary conditions and their incorporation. Case studies on involving bars, trusses, beams and frames, Formulation of FE characteristics Plane stress, Plane strain and Axi-symmetric elements. Overview of FE applications in Metal cutting, casting, forming and forging applications

Reading:

1. S. S. Rao, *The Finite Element Method in Engineering*, 5th Edition, Elsevier 2011.
2. Robert D.C, David S.M., Michel E Plesha, *Concepts and Applications of Finite Element Analysis*, 3rd Edition, John Willey & Sons 2000.
3. Reddy, J. N., *Finite Element Method in Engineering* Tata McGraw Hill, 2007.
4. O. C. Zienkiewicz, *The Finite Element Method*, 6th Edition, Elsevier, 2007.

M.Tech. (Product Design and Development)**I Year I Semester**

S. No.	Course No.	Course Name	L	T	P	C
1	ME5401	Engineering Design	4	0	0	4
2	ME5402	Advanced Mechanics of Solids	4	0	0	4
3	ME5403	Advanced Mechanical of Vibrations	4	0	0	4
4	ME5404	Advanced CAD	4	0	0	4
5		Elective - I	3	0	0	3
6		Elective - II	3	0	0	3
7	ME5405	Numerical Simulation Laboratory	0	0	3	2
8	ME5406	CAD Laboratory	0	0	3	2
TOTAL			22	0	6	26

I Year II Semester

S. No.	Course No.	Course Name	L	T	P	C
1	ME5451	Integrated Product Design and Development	4	0	0	4
2	ME5452	Finite Element Analysis in Design	4	0	0	4
3	ME5453	Rapid Manufacturing Techniques	4	0	0	4
4		Elective - III	3	0	0	3
5		Elective - IV	3	0	0	3
6		Elective - V	3	0	0	3
7	ME5454	Computer Aided Analysis Laboratory	0	0	3	2
8	ME5455	Rapid Prototyping Laboratory	0	0	3	2
9	ME5491	Seminar	0	0	3	2
TOTAL			21	0	9	27

II Year I Semester

S. No.	Course No.	Course Name	L	T	P	C
1	EE6442	Comprehensive Viva-voce	0	0	0	4
2	EE6449	Dissertation Part-A	0	0	0	8
TOTAL			0	0	0	12

II Year II Semester

S. No.	Course No.	Course Name	L	T	P	C
1	EE6499	Dissertation Part-B	0	0	0	18
TOTAL			0	0	0	18

Consolidated Credits

Category	I Sem	II Sem	III Sem	IV Sem	Total
Core courses	16	12	00	00	28
Electives	06	09	00	00	15
Lab Courses	04	04	00	00	08
Comprehensive Viva-Voce	00	00	04	00	04
Seminar	00	02	00	00	02
Dissertation	00	00	08	18	26
Total	26	27	12	18	83

ELECTIVE COURSES**I Semester**

ME5411	Mechanical Behavior of Materials
ME5412	Optimization Methods for Engineering
ME5413	Advanced Composites
ME5414	Condition Monitoring
ME5415	Robust Design
ME5416	Design for Manufacture and Assembly
ME5262	Product Lifecycle Management

II Semester

ME5461	Analysis and Design of Mechanical Systems
ME5462	Fatigue Fracture and Failure Analysis
ME5463	Tribology in Design
ME5464	Structural Health Monitoring
ME5465	Rotor Dynamics
ME5466	Reliability Engineering
ME5169	Computational Fluid Dynamics
ME5361	Supply Chain Management
ME5371	Mechatronics

M.Tech. (Product Design and Development)

ME5401 **ENGINEERING DESIGN** (4-0-0) 4

Historical perspective, Ethical Issues in Engineering Design (ED), ED Process, ED interfaces, ED systems, ED structure, Knowledge related to ED process, Basis of knowledge for rationalizing EDP, Design situation, procedural model support for design engineering, Methods and methodology, ED organizations their structure, team work and team dynamics. Need identification, problem definition, concept generation and evaluation and Embodiment design.

Reading:

1. Pahl, W Beitz J Feldhusun, K G Grote, *Engineering Design*, 3rd Edition, Springer, 2007.
2. George E Dieter, *Engineering Design*, 3rd Edition, McGraw Hill, 2001.
3. Ken Hurst, *Engineering Design Principles*, Elsevier, 1999.

ME5402 **ADVANCED MECHANICS OF SOLIDS** (4-0-0) 4

Analysis of stress and strain, Stress-strain relations for linearly elastic solids, Theories of failure, Energy methods, Bending of beams, Torsion, Axisymmetric problems, Thermal stresses, Introduction to inelastic deformations.

Reading:

1. Irving H. Shames, *Mechanics of Deformable Solids*, Krieger Pub Co, 2008.
2. L.S. Srinath, *Advanced Mechanics of Solids*, 3rd Edition, TMH, 2009.

ME5403 **ADVANCED MECHANICAL VIBRATIONS** (4-0-0) 4

Review of free and forced vibrations of single degree freedom systems, excitation due to unbalance, whirling of shafts and critical speeds, support motion, vibration isolation and transmissibility, forced vibrations under transient excitations, two degree freedom systems, dynamic vibration absorbers, multi degree freedom systems, Eigen value problems, modal analysis, introduction to experimental modal analysis, continuous systems- exact and approximate methods.

Reading:

1. Lenord Meirovitch, *Elements of Vibration Analysis*, McGraw Hill Ltd. 2004.
2. Rao, S.S., *Mechanical Vibrations*, 4th Edition. Pearson Education 2004.
3. Thomson, W.T., *Theory of Vibrations with Applications*, Prentice Hall of India, 1999.

ME5404 **ADVANCED CAD** (4-0-0) 4

Hardware and software for CAD, Geometric modeling, Transformations, Curve representation: analytic and synthetic curves, Surface Modeling, Solid Modeling Techniques, CAD/CAM Exchange formats, Design Applications: Mechanical tolerances, Mass property calculations and Mechanical Assembly, Advanced Modeling Concepts: Feature Based Modeling, Assembling Modeling, Behavioral Modeling, Conceptual Design and Top Down Design. Collaborative Design.

Reading:

1. Ibrahim Zeid, *CAD / CAM Theory and Practice*, TMH, 2010.
2. David F. Rogers, J. A. Adams, *Mathematical Elements for Computer Graphics*, TMH, 2008.

ME5405 **NUMERICAL SIMULATION LABORATORY** (0-0-3) 2

Developing software programs to solve the problems encountered in the theory courses using Programming languages such as FORTRAN, C++, developing programs in the MATLAB environment, Development of a comprehensive simulation program.

ME5406 **CAD LABORATORY** (0-0-3) 2

Exercises using AutoCAD commands, script files, Auto LISP. Customization of AutoCAD, Exercises on Modeling, Assembly and manufacturing using ProE, Exercises on Computer Graphics using Open GL.

ME5451	INTEGRATED PRODUCT DESIGN AND DEVELOPMENT	(4-0-0) 4
<p>Modern product developments, Design Theories, product development process tools, understanding customer needs, establishing product function, product tear down and experimentation, bench marking and establishing specification, product portfolios and architectures, modular design, generating concepts, concept embodiment, modeling of product metrics, Design for environment, analytical and numerical model solution, Design for robustness, Assessment of quality of industrial design, Life cycle concepts, project planning and execution, QFD.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Kevin N. Otto, Kristin L. Wood, <i>Product Design</i>, Pearson Education, 2004. 2. Gahl, W Beitz J Feldhusun, K. G. Grote, <i>Engineering Design</i>, 3rd Edition, Springer 2007. 3. W. Ernest Eder, S. Hosendl., <i>Design Engineering</i>, CRC Press, 2008. 		
ME5452	FINITE ELEMENT ANALYSIS IN DESIGN	(4-0-0) 4
<p>Identification of Physical problems, Differential formulation, Philosophy behind the approximate methods, FE formulation for a general problem in elasticity, Formulation of FE characteristics, case studies on 1-D and 2-D elements, Plane stress, Plane strain, Axisymmetric, Plate bending and Shell elements Isoparametric, Sub parametric and Super parametric elements, 3-D elements and their formulation, Dynamic Analysis, Modal Analysis and Mode superposition methods.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. S S Rao, <i>The Finite Element Method in Engineering</i>, 4th Edition, Elsevier 2007. 2. Reddy, J.N., <i>Finite Element Method in Engineering</i>, Tata McGraw Hill, 2007. 3. Zeinowicz, <i>The Finite Element Method for Solid and Structural Mechanics</i>, 4th Edition, Elsevier 2007. 4. Kenneth H H., Donald L D., and Byrom T G., <i>The Finite Element Method for Engineers</i>, 4th Edition, Wiley India, 2008. 		
ME5453	RAPID MANUFACTURING TECHNIQUES	(4-0-0) 4
<p>Traditional Prototyping Vs. Rapid Prototyping (RP). Need for time compression in product development. Data formats and softwares for RP. Classification of RP systems - liquid based, solid based, powder based. Materials for RP - polymers, metals, ceramics and composites. Introduction to Tooling. Conventional Tooling Vs. Rapid Tooling. Classification of Rapid Tooling - Indirect and Direct Tooling. Applications of Rapid Prototyping and Tooling. Virtual Prototyping and Virtual Reality in Product Development. Reverse Engineering - Methodologies and techniques - Hardware and software - selection of Reverse Engineering System. Rapid Manufacturing/Research issues of Rapid Prototyping.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Vinesh Raja, Kiran J Fernandes, <i>Reverse Engineering Industrial Perspectives</i>, Springer, 2008. 2. Chua Chee kai, Leong Kah Fai, <i>Rapid Prototyping: Principles and Applications in Manufacturing</i>, World Scientific, 2003. 3. Pham, D.T, Dimov, S.S, <i>Rapid Manufacturing</i>, Springer, 2001. 		
ME5454	COMPUTER AIDED ANALYSIS LABORATORY	(0-0-3) 2
<p>Finite element analysis of mechanical structures using ANSYS, development of programs in MATLAB environment for the analysis of simple structures.</p>		
ME5455	RAPID PROTOTYPING LABORATORY	(0-0-3) 2
<p>Converting CAD models into STL files, Simulation of Process Parameters using Catalyst Software and fabrication of CAD Model using FDM RP Machine, Converting CT/ MRI scan data using MIMIC Software.</p>		

ME5411	MECHANICAL BEHAVIOR OF MATERIALS	(3-0-0) 3
<p>Tensile testing, other tests of plastic behavior, strain hardening of metals, strain rate and temperature dependence, slip, Hardening mechanisms in metals, dynamic strain aging; ductility and fracture, fracture mechanics theories, Creep mechanisms, Fatigue Analysis, cyclic stress-strain behavior, fatigue of polymers, design considerations. Mechanical behavior of ceramics and glasses; polymers, composites, Material characterization using optical microscopy and SEM.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. George E. Dieter, <i>Mechanical Metallurgy</i>, McGraw Hill, 2nd Edition, 2005. 2. Hellan K, <i>Introduction to Fracture Mechanics</i>, McGraw Hill, 2002 3. J.E.Dorn, <i>Mechanical Behavior of Materials at Elevated Temperatures</i>, McGraw Hill, 2000. 		
ME5412	OPTIMIZATION METHODS FOR ENGINEERING	(3-0-0) 3
<p>Statement of an optimization problem, classification of optimization problems, classical optimization techniques. One dimensional minimization methods, unconstrained and constrained optimization, A brief treatment of linear programming, geometric programming, dynamic programming and integer programming.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Rao, S. S., <i>Engineering Optimization Theory and Practice</i>, 3rd Edition, New Age International, 2010. 2. Fox, R. L., <i>Optimization Methods for Engineering Design</i>, Addison Wesley, 1971. 		
ME5413	ADVANCED COMPOSITES	(3-0-0) 3
<p>Introduction to composites, Constituent materials, Engineering mechanics analysis and design, Fabrication Techniques, Properties and performance, Failure analysis, Applications.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. D.B. Miracle and Steven L. Donaldson, <i>ASM Handbook Composites Volume 21</i>, ASM International, 2001. 2. Krishan K. Chawla, <i>Composite Materials, Science and Engineering</i>, Springer, 2001. 3. Suresh G. Advani, E. Murat Sozer, <i>Process Modeling in Composites Manufacturing</i>, 2nd Edition, CRC Press, 2009. 		
ME5414	CONDITION MONITORING	(3-0-0) 3
<p>Condition Monitoring applications and benefits, online and off-line techniques, vibration monitoring and analysis, Shock pulse method, oil analysis - wear debris, temperature analysis, non-destructive techniques, case studies.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Isermann R., <i>Fault Diagnosis Applications</i>, Springer-Verlag Berlin, 2011. 2. Rao, J S., <i>Vibration Condition Monitoring</i>, 2nd Edition, Narosa Publishing House, 2000. 3. Alan Davies, <i>Handbook of Condition Monitoring</i>, Chapman & Hall, 2000. 		
ME5415	ROBUST DESIGN	(3-0-0) 3
<p>Concept of robustness, Stages in Engineering Design: System Design, Parameter Design and Tolerance Design, Loss functions and Signal-to-noise ratios, Control Factors and Noise Factors, Factorial experiments and experimental designs for robust parameter design, Tolerance design and allocation.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Jeff Wu, <i>Experiments: Planning, Analysis and Parameter Design</i>, John Wiley, 2000. 2. Ross PJ, <i>Taguchi Techniques for Quality Engineering</i>, TMH, 2005. 		
ME5416	DESIGN FOR MANUFACTURE AND ASSEMBLY	(3-0-0) 3
<p>Application of Design for manufacture and assembly with selection of materials and ranking of processes like casting, injection moulding, sheet metal working, die casting, powder metal process, investment casting and hot forging, Design for assembly and automation.</p>		

Reading:

1. George E. Dieter, *Engineering Design - A Material Processing Approach*, 2nd Edition, McGraw Hill International, 2001.
2. Geoffrey Boothroyd, Peter Dewhurst, *Product Design for Manufacture and Assembly*, 3rd Edition, CRC Press, 2010.

ME5262

PRODUCT LIFECYCLE MANAGEMENT

(3-0-0) 3

Fundamentals of PLM, Enterprise solution with PLM, Impact of Manufacturing with PLM, Standardized product data and materials data model, PLM service information model, PLM for e-manufacturing, Optimization of ERP for PLM, Implementing end to end business process management, Integration of PLM and CRM, PLM applications in process and product industries examples.

Reading:

1. Jaya Krishna S, *Product Lifecycle Management Concepts and Cases*, ICFAI Publications 2011.
2. *SOA Approach to Enterprise Integration for Product Lifecycle*, IBM Red Books, 2011.

ME5461

ANALYSIS AND DESIGN OF MECHANICAL SYSTEMS

(3-0-0) 3

Analysis vs Design, Characteristics of Mechanical Design and considerations, Formulation of Design problem, Modeling of mechanical systems: Physical models, Mathematical models, Identification of Variables and Parameters, Numerical simulation, Analysis and design of mechanisms, Machine tool components, IC engine components, Introduction to complete system design.

Reading:

1. R L Norton., *Kinematics and Dynamics of Machinery*, TMH, 3rd Edition, 2009.
2. RL Norton., *Machine Design An Integrated Approach*, Pearson Education, 2nd Edition, 2009.
3. Shigley, Budynas and Nisbett., *Mechanical Engineering Design*, 9th Edition, TMH, 2011.

ME5462

FATIGUE FRACTURE AND FAILURE ANALYSIS

(3-0-0) 3

Review of elastic and plastic deformation, dislocations and their properties. Creep and stress rupture, creep under combined stresses, deformation mechanism maps, super plasticity, environmental effects, life assessment. Fatigue, process of fatigue fracture, cyclic stress/strain response of materials, fracture mechanics, fracture toughness and design, Kic plane, strain toughness testing, plasticity corrections, COD-J Integral, R curve, probabilistic aspects of fracture mechanics, fractography.

Reading:

1. George E Diter, *Mechanical Metallurgy*, McGraw Hill, 2001.
2. Joseph Marin, *Mechanical Behavior of Engineering Materials*, Prentice Hall, 2002

ME5463

TRIBOLOGY IN DESIGN

(3-0-0) 3

Friction wear and lubrication, Properties of lubricants, hydrodynamic, hydrostatic, Elastohydrodynamic lubrication, Selection of bearings, Bearing characteristics, Wear of bearings, wear of non metallic bearing materials, bearing vibration measurements.

Reading:

1. Stachowaik, G.W., Batchelor, A.W., *Engineering Tribology*, 3rd Edition, Elsevier, 2010.
2. Neale MJ, *Tribology Hand Book*, CBS Publications, 2012.
3. Williams JA, *Engineering Tribology*, Oxford Univ. Press, 2001.
4. Cameron A, *Basic Lubrication Theory*, Ellis Horwood Ltd., 2002.

ME5464

STRUCTURAL HEALTH MONITORING

(3-0-0) 3

Definition and Significance of SHM, Applications, Stages of SHM: Operational evaluation, Data acquisition and cleansing procedures, Feature extraction methods to identify damage sensitive properties, Development of statistical models. SHM based Flaw detection in mechanical structures - Integrity and damage recognition in plates and pipes, defect identification in weld joints, Wear monitoring in cutting tools.

Reading:

1. Daniel Balageas, Claus-Peter Fritzen and Alfredo Guemes, *Structural Health Monitoring*, John Wiley & Sons, 2006.
2. Victor Giurgiutiu, *Structural Health Monitoring with Piezoelectric Wafer Active Sensors*, Academic Press, 2008.

ME5465

ROTOR DYNAMICS

(3-0-0) 3

Review of Discrete and Continuous system, stiffness and damping forces - rolling element bearings, Critical speeds, Unbalance response and orbit analysis, Gyroscopic effect, Rotor balancing, Torsional vibration analysis, analysis of rotating machines response to steady state and transient excitations Effect of support non-linearity, Rotor instability.

Reading:

1. Rao, J S., *Rotor Dynamics*, 3rd Edition, New Age International, 2003.
2. Muszynka and Agnieszka, *Rotor Dynamics*, CRC Press, 2005.
3. Chen W J and Guntur E J, *Introduction to Dynamics of Rotor-bearing Systems*, McGraw Hill, 2005.

ME5466

RELIABILITY ENGINEERING

(3-0-0) 3

Basic concepts and Terminology, Component reliability models, System reliability models, Reliability Block Diagrams, Repairable and non-repairable systems, Life testing and reliability assessment, Reliability allocation, Tools for reliability analysis, Mechanical reliability, Maintainability analysis.

Reading:

1. Ebeling CE, *An Introduction to Reliability and Maintainability Engineering*, TMH, New Delhi, 2004.
2. O'Connor P and Kleymer A, *Practical Reliability Engineering*, Eastern Wiley, 2012.

ME5169

COMPUTATIONAL FLUID DYNAMICS

(3-0-0) 3

Review of Numerical Methods, algorithm for CFD problems, governing equations of fluid dynamic equations, applications of CFD in various engineering fields, grid generations, panel methods, solutions of Laplace's equation, Burger's equation, Heat transfer equation, boundary layer equations, introduction to turbulence modeling, shock capturing methods.

Reading:

1. Tannehill, J.C., Anderson, D.A., and Pletcher, R.H., *Computational Fluid Mechanics and Heat Transfer*, McGraw Hill, 2002.
2. Hoffman, K.A. and Chiang, S.T., *Computational Fluid Dynamics For Engineers*, Vol. I, II and III, Engineering Education System, 2000.
3. Chung, T.J., *Computational Fluid Dynamics*, Cambridge, University Press, 2003.

ME5361

SUPPLY CHAIN MANAGEMENT

(3-0-0) 3

Competitive and Supply Chain strategies, Drivers of supply chain performance, Managing demand and supply in supply chain: Managing inventories in supply chain, Bull Whip effect and Coordination, Distribution and Transportation Networks, Procurement and outsourcing strategies, Role and impact of E-business.

Reading:

1. Sunil Chopra and Peter Meindl, *Supply Chain Management-Strategy, Planning and Operation*, Pearson Education Asia, 2011.
2. David Simchi-Levi, Philp Kamintry and Edith Simchy Levy, *Designing and Managing the Supply Chain - Concepts Strategies and Case Studies*, TMH, 2010.

ME5371

MECHATRONICS

(3-0-0) 3

Mechatronics system Design, Modeling and simulation, Sensors and transducers, Actuators, digital design principles and applications, signal conditioning, Programmable logic controllers. P, D, PD, PID and adaptive controllers, real time interfacing. Applications of Mechatronics, case studies.

Reading:

1. Devdas Shetty and Rochand A. Kolk, *Mechatronics System Design*, PWS Publishing Company, 2000.
2. Michel B. Histan and David G. Alcaiatore, *Introduction to Mechatronics and Measuring Systems*, Int. Edition, Mc. Graw Hill, 2001.
3. W. Bolton, *Mechatronics*, Pearson Education, New Delhi, 2002.

M.Tech. (Automobile Engineering)**I Year I Semester**

S. No.	Course No.	Course Name	L	T	P	C
1	ME5501	Automotive Engineering	4	0	0	4
2	ME5502	Prime Movers for Automobiles	4	0	0	4
3	ME5403	Advanced Mechanical Vibrations	4	0	0	4
4	ME5504	Advanced CAD	4	0	0	4
5		Elective - I	3	0	0	3
6		Elective - II	3	0	0	3
7	ME5406	CAD Laboratory	0	0	3	2
8	ME5503	Computational Laboratory	0	0	3	2
TOTAL			22	0	6	26

I Year II Semester

S. No.	Course No.	Course Name	L	T	P	C
1	ME5551	Automotive Body Structures	4	0	0	4
2	ME5452	Finite Element Analysis in Design	4	0	0	4
3	ME5456	Vehicle Dynamics	4	0	0	4
4		Elective - III	3	0	0	3
5		Elective - IV	3	0	0	3
6		Elective - V	3	0	0	3
7	ME5553	Automotive Engines Laboratory	0	0	3	2
8	ME5554	Simulation Laboratory	0	0	3	2
9	ME5591	Seminar	0	0	3	2
TOTAL			21	0	9	27

II Year I Semester

S. No.	Course No.	Course Name	L	T	P	C
1	EE6542	Comprehensive Viva-voce	0	0	0	4
2	EE6549	Dissertation Part-A	0	0	0	8
TOTAL			0	0	0	12

II Year II Semester

S. No.	Course No.	Course Name	L	T	P	C
1	EE6599	Dissertation Part-B	0	0	0	18
TOTAL			0	0	0	18

Consolidated Credits

Category	I Sem	II Sem	III Sem	IV Sem	Total
Core courses	16	12	00	00	28
Electives	06	09	00	00	15
Lab Courses	04	04	00	00	08
Comprehensive Viva-Voce	00	00	04	00	04
Seminar	00	02	00	00	02
Dissertation	00	00	08	18	26
Total	26	27	12	18	83

ELECTIVE COURSES**I Semester**

ME5511	Alternate Fuels and Emissions
ME5316	Manufacturing Management
ME5411	Mechanical Behavior of Materials
ME5412	Optimization Methods for Engineering
ME5415	Condition Monitoring
ME5416	Robust Design

II Semester

ME5561	Vehicle Testing and Instrumentation
ME5563	Automotive Electronics
ME5564	Advanced Materials and Sensors for Automobiles
ME5169	Computational Fluid Dynamics
ME5361	Supply Chain Management
ME5371	Mechatronics
ME5463	Tribology in Design
ME5466	Reliability Engineering
ME5469	Automotive Component Design

M.Tech. (Automobile Engineering)

ME5501 **AUTOMOTIVE ENGINEERING** (4-0-0) 4

Layout of different kinds of vehicles, Engine cooling, lubrication and ignition (including electronic ignition) systems, Clutch: function, components, fluid couplings, torque converters, Gear Box and types, automatic transmission systems. Hotchkiss and torque tube drives. Rear axle and final drive differential, front axle construction and steering systems, Suspension systems, Brakes, tyres, lighting and accessories.

Reading:

1. Srinivasan.S, *Automotive Mechanics*, 2nd Edition, Tata McGraw-Hill, 2003
2. Crouse and Anglin, *Automotive Mechanism*, 9th Edition. Tata McGraw-Hill, 2003.
3. Jack Erjavec, *A Systems Approach to Automotive Technology*, Cengage Learning Pub., 2009
4. Kirpal Singh, *Automobile Engineering*, Vol.1 and 2, Standard Publishers, New Delhi, 2003.

ME5502 **PRIME MOVERS FOR AUTOMOBILES** (4-0-0) 4

I.C. Engines, design and operating parameters, cycle analysis, Two-stroke cycle engines-scavenging systems, Gas Exchange processes-Inlet and exhaust processes, flow through valves, supercharging and turbo charging, Spark-ignition engines-Mixture preparation, carburetion and fuel injection systems, fuel requirement, combustion and analysis, combustion chambers, Engine operating characteristics- operating variables that affect SI and CI engine performance, efficiency and emissions, I C Engine modeling.

Reading:

1. John B. Heywood, *IC Engine Fundamentals*, McGraw Hill, 2000.
2. Edward F. Obert, *IC Engines and Air Pollution*, Harper and Row Publishers, 2001.
3. CF Taylor and Taylor: *IC Engines and Theory and Practice*, Vol I and II, Oxford, 2002

ME5403 **ADVANCED MECHANICAL VIBRATIONS** (4-0-0) 4

Review of free and forced vibrations of damped and undamped single degree freedom systems, impulse response technique, Laplace transformation technique, two and multi degree freedom systems, eigen value problems, model analysis free and forced vibrations, vibration control, dynamic vibration absorbers, vibration measuring devices, introduction to experimental modal analysis, continuous systems.

Reading:

1. Lenord Meirovitch, *Elements of Vibration Analysis*, McGraw Hill, 2004
2. Rao, S.S., *Mechanical Vibrations*, 4th Edition, Pearson Education, 2004.
3. Thomson, W.T., *Theory of Vibrations with Applications*, Prentice Hall of India, 1999.

ME5404 **ADVANCED CAD** (4-0-0) 4

Hardware and software for CAD, Geometric modeling, Transformations, Curve representation: analytic and synthetic curves, Surface Modeling, Solid Modeling Techniques, CAD/CAM Exchange formats, Design Applications: Mechanical tolerances, Mass property calculations and Mechanical Assembly, Advanced Modeling Concepts: Feature Based Modeling, Assembling Modeling, Behavioral Modeling, Conceptual Design and Top Down Design, Collaborative Design.

Reading:

1. Ibrahim Zeid, *CAD / CAM Theory and Practice*, Tata McGraw Hill, 2010.
2. David F Rogers, J A Adams, *Mathematical Elements for Computer Graphics*, TMH, 2008.

ME5406 **CAD LABORATORY** (0-0-3) 2

Exercises using AutoCAD commands, script files, Auto LISP. Customization of AutoCAD, Exercises on Modeling, Assembly and manufacturing using ProE, Exercises on Computer Graphics using Open GL.

ME5503	COMPUTATIONAL LABORATORY	(0-0-3) 2
<p>Programming for numerical solutions of transcendental equations, Simultaneous algebraic equations, Numerical integration, Numerical differentiation, Numerical methods for ordinary and partial differential equations using C++ and MATLAB.</p>		
ME5551	AUTOMOTIVE BODY STRUCTURES	(4-0-0) 4
<p>Introduction to SSS method, scope and limitations of SSS method, fundamental vehicle loads and estimation, overview of vehicle structures, standard sedan (saloon) - baseline load paths, construction of body subassemblies and model variants, structural surfaces and floor grillages, applications of SSS method, fundamentals and preliminary sizing of sections and joints, case studies on positioning and sizing of major car components, Safety and crash analysis.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Jason C Brown, <i>Motor Vehicle Structures</i>, Butterworth Heinemann, 2002. 2. Matthew Huang, <i>Vehicle Crash Mechanics</i>, CRC Press, June 19, 2002. 		
ME5452	FINITE ELEMENT ANALYSIS IN DESIGN	(4-0-0) 4
<p>Identification of Physical problems- A continuum Approach. Establishing the Mathematical Models, Approximate methods for the solution of the mathematical models. Need for FE modeling, FE formulation for a general problem in elasticity: 1-D and 2-D problems, Case studies on 2-D elements, 3-D elements and their formulation, Dynamic Analysis using FE, Modal Analysis and Mode superposition methods, FE softwares, Algorithmic approach for developing the code by the individuals.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. SS Rao, <i>The Finite Element Method in Engineering</i>, 4th Edition, Elsevier, 2007. 2. Reddy, J.N., <i>Finite Element Method in Engineering</i>, Tata-McGraw Hill, 2007. 3. O. C. Zienkiewicz, <i>The Finite Element Method for Solid and Structural Mechanics</i>, Butterworth Heinemann, 2007. 		
ME5456	VEHICLE DYNAMICS	(4-0-0) 4
<p>Static and Dynamic loads, lift, drag, Aerodynamic forces, spoilers - Acceleration Performance - Braking Performance - Ride - Steering systems - Steady State cornering - Suspension mechanics.</p> <p><i>Reading:</i></p> <ol style="list-style-type: none"> 1. Hans B Pacejka, <i>Tire and Vehicle Dynamics</i>, 3rd Edition, Elsevier Ltd., 2012. 2. Amitosh D, <i>Vehicle Dynamics</i>, Galgotia Book Ltd., 2010. 3. Rao V Dukkipati, <i>Road Vehicle Dynamics</i>, Springer 2008. 4. Werner and Karl, <i>Ground Vehicle Dynamics</i>, Springer Berlin Heidelberg, 2008. 		
ME5553	AUTOMOTIVE ENGINES LABORATORY	(0-0-3) 2
<p>Constant speed and variable speed performance tests on SI and CI engines and comparison of their performance parameters like specific fuel consumption, Motoring and Retardation tests on CI engine to determine friction power, Effect of spark advance on SI engine, Duel-fuel performance.</p>		
ME5554	SIMULATION LABORATORY	(0-0-3) 2
<ul style="list-style-type: none"> ✓ Training on software packages such as ANSYS and Pro-E ✓ Crash analysis using LS DYNA package ✓ Training to develop comprehensive simulation programs. 		
ME5511	ALTERNATE FUELS AND EMISSIONS	(4-0-0) 4
<p>Need for alternate fuels, ASTM standards, Alcohols- performance in SI and CI engines, Vegetable oils, natural gas, LPG, Hydrogen, Fuel cell Biogas, Electric and solar power vehicles, Automobile emission and control, EURO standards, Indian standards.</p>		

Reading:

1. Michael Frank Hordoski, *Alternative fuels: The future of Hydrogen*, CRC Press, Llc, 2006.
2. Maxwell, Timothy.T, and Jesseco Jones, *Alternative Fuels: Emissions, Economics, and Performance*, Society of Automotive Engineers, 2002.

ME5316

MANUFACTURING MANAGEMENT

(3-0-0) 3

Competitive priorities and manufacturing strategy, Hierarchical production planning and control, Demand Forecasting, Facility Design: Product design and process selection, Capacity planning, Plant location and Plant layout, Inventory control: From EOQ to ROP, MRP crusade, JIT revolution, Production scheduling, Aggregate and workforce planning.

Reading:

1. Krajewski U and Ritzman LP, *Operations Management: Strategy and Analysis*, Pearson Education Pvt. Ltd., Singapore, 2002.
2. Gaither N and Frazier G, *Operations Management*, Thomson Asia Pvt. Ltd., Singapore, 2002.
3. Chase RB, Aquilano NJ and Jacobs RF, *Operations Management for Competitive Advantage*, McGraw-Hill Book Company, NY, 2001.

ME5411

MECHANICAL BEHAVIOR OF MATERIALS

(3-0-0) 3

Tensile testing, other tests of plastic behavior, strain hardening of metals, strain rate and temperature dependence, slip, Hardening mechanisms in metals, dynamic strain aging; ductility and fracture, fracture mechanics theories, Creep mechanisms, Fatigue Analysis, cyclic stress-strain behavior, fatigue of polymers, design considerations. Mechanical behavior of ceramics and glasses; polymers, composites, Material characterization using optical microscopy and SEM.

Reading:

1. George E. Dieter, *Mechanical Metallurgy*, McGraw Hill, 2005
2. Hellan K, *Introduction to Fracture Mechanics*, McGraw Hill, 2002
3. J.E.Dorn, *Mechanical Behavior of Materials at Elevated Temperatures*, McGraw Hill, 2000

ME5412

OPTIMIZATION METHODS FOR ENGINEERING

(3-0-0) 3

Statement of an optimization problem, classification of optimization problems, classical optimization techniques. One dimensional minimization methods, unconstrained and constrained optimization. A brief treatment of linear programming, geometric programming, dynamic programming and integer programming.

Reading:

1. Rao, S. S., *Engineering Optimization Theory and Practice*, 3rd Edition, New Age International, 2010.
2. Fox, R. L., *Optimization Methods for Engineering Design*, Addison Wesley, 1971.

ME5415

CONDITION MONITORING

(3-0-0) 3

Condition Monitoring application and benefits, online and off-line techniques, vibration monitoring and analysis, Shock pulse method, oil analysis - wear debris, temperature analysis, non-destructive techniques, case studies.

Reading:

1. Isermann R., *Fault Diagnosis Applications*, Springer-Verlag Berlin, 2011.
2. Rao, J S., *Vibration Condition Monitoring*, 2nd Edition, Narosa Publishing House, 2000.
3. Alan Davies, *Handbook of Condition Monitoring*, Chapman and Hall, 2000.

ME5416

ROBUST DESIGN

(3-0-0) 3

Causes of performance variation, control factors and noise factors, Concept of robust design, Stages in product/process design, QFD, Over view of design of experiments, Selection of performance characteristics, S/N ratios, inner-array and outer-array designs, data analysis, Robust parameter selection, Tolerance design.

Reading:

1. Taguchi G, Chowdhury S and Taguchi S, *Robust Engineering*, TMH, 2000.
2. Ross PJ, *Taguchi Techniques for Quality Engineering*, TMH, 2005.

ME5561	VEHICLE TESTING AND INSTRUMENTATION	(3-0-0) 3
Introduction-vehicle testing and instrumentation, Basics of measurement techniques, Engine testing, combustion process and combustion analysis, Fuel injection systems, Flow visualization techniques, Vehicle emissions, vehicle performance and testing techniques, vehicle drag and aerodynamics, vehicle certification.		
<i>Reading:</i>		
1. John. B. Heywood, <i>Internal Combustion Engine Fundamentals</i> , McGraw Hill Co., 1988.		
2. Heinz Heisler, <i>Advance Vehicle Technology</i> , Butterworth-Heinemann, 2002		
3. Martyr and Plint, <i>Engine testing-theory and Practice</i> , Butterworth-Heinemann, 2002.		
4. J.P. Holeman, <i>Experimental Methods for Engineers</i> , Tata McGraw Hill Co. 2007.		
ME5563	AUTOMOTIVE ELECTRONICS	(3-0-0) 3
Safety and communication, Circuit fundamentals and basic test equipment, Vehicle circuits, Digital Storage oscilloscope, Electronic fundamentals, wiring diagrams, batteries, starting systems, charging systems, ignition systems, auxiliaries.		
<i>Reading:</i>		
1. Al Santini, <i>Automotive Technology, Electricity and Electronics</i> , Cengage Publishers, 2011.		
2. William Ribbens, <i>Understanding Automotive Electronics</i> , 6th Edition, Elsevier, 2011.		
ME5564	ADVANCED MATERIALS AND SENSORS FOR AUTOMOBILES	(3-0-0) 3
Characteristics and fabrication of plastically deformed bodies-cold rolled steel-super plasticity -foam materials-materials for safety-bearing materials-coating techniques for wear, heat and environment- corrosion phenomenon with special reference to automobile bodies - advanced materials for automobile, power sources-materials for super capacitors and electrolytic cells for automobiles, Sensors.		
<i>Reading:</i>		
1. Black, J.T., Ronald, A.K. <i>Materials and Processes in Manufacturing</i> , 10th Edition, John Wiley Publication, 2007.		
2. George S. Brady, Henry R. Clanser, <i>Materials: Theory Properties and Uses</i> , McGraw-Hill, 2006.		
ME5169	COMPUTATIONAL FLUID DYNAMICS	(3-0-0) 3
Review of Numerical Methods, algorithm for CFD problems, governing equations of fluid dynamic equations, applications of CFD in various engineering fields, grid generations, panel methods, solutions of - Laplace's equation, Burger's equation, Heat transfer equation, boundary layer equations, introduction to turbulence modeling, shock capturing methods.		
<i>Reading:</i>		
1. Tannehill, J.C., Anderson, D.A. and Pletcher, R.H., <i>Computational Fluid Mechanics, and Heat Transfer</i> , McGraw Hill, 2002.		
2. Hoffman, K.A. and Chiang, S.T., <i>Computational Fluid Dynamics for Engineers</i> , Vol. I,II and III, Engineering Education System, 2000.		
3. Chung, T.J., <i>Computational Fluid Dynamics</i> , Cambridge University Press, 2003.		
ME5361	SUPPLY CHAIN MANAGEMENT	(3-0-0) 3
Competitive and Supply Chain strategies, Drivers of supply chain performance, Managing demand and supply in supply chain: Managing inventories in supply chain, Bull Whip effect and Coordination, Distribution and Transportation Networks, Procurement and outsourcing strategies, Role and impact of E-business.		
<i>Reading:</i>		
1. Sunil Chopra and Peter Meindl, <i>Supply Chain Management - Strategy, Planning and Operation</i> , Pearson Education Asia, 2011.		
2. David Simchi-Levi, Philp Kamintry and Edith Simchy Levy, <i>Designing and Managing the Supply Chain - Concepts Strategies and Case Studies</i> , Tata McGraw Hill, 2010.		

ME5371 **MECHATRONICS** (3-0-0) 3

Mechatronics system Design, integrated design issues, Modeling and simulation of electrical, mechanical and electromechanical systems. Sensors and transducers used in Mechatronics devices, Actuators, digital design principles and applications, signal conditioning, Programmable logic controllers. P, D, PD, PID and adaptive controllers, real time interfacing. Applications of Mechatronics, case studies, introduction to MEMS.

Reading:

1. Devdas Shetty and Rochand A. Kolk, *Mechatronics System Design*, PWS Publishing Company, 2000.
2. Michel B. Histan and David G. Alcaiatore, *Introduction to Mechatronics and Measuring Systems*, McGraw Hill, 2001.
3. W. Bolton, *Mechatronics*, Pearson Education, New Delhi, 2002.

ME5463 **TRIBOLOGY IN DESIGN** (3-0-0) 3

Friction wear and lubrication, Properties of lubricants, hydrodynamic, hydrostatic, Elastohydrodynamic lubrication, Selection of bearings, Bearing characteristics, Wear of bearings, wear of non metallic bearing materials, bearing vibration measurements.

Reading:

1. Stachowaik, G.W., Batchelor, A.W., *Engineering Tribology*, 3rd Edition, Elsevier, 2010.
2. Neale MJ, *Tribology Hand Book*, CBS Publications, 2012.
3. Williams JA, *Engineering Tribology*, Oxford Univ. Press, 2001.
4. Cameron A, *Basic Lubrication Theory*, Ellis Horwood Ltd., 2002.

ME5466 **RELIABILITY ENGINEERING** (3-0-0) 3

Basic concepts and Terminology, Component reliability models, System reliability models, Reliability Block Diagrams, Repairable and non-repairable systems, Life testing and reliability assessment, Reliability allocation, Tools for reliability analysis, Mechanical reliability, Maintainability analysis.

Reading:

1. Ebeling CE, *An Introduction to Reliability and Maintainability Engineering*, TMH, New Delhi, 2004.
2. O'Connor P and Kleymer A, *Practical Reliability Engineering*, Wiley, 2012.

ME5469 **AUTOMOTIVE COMPONENT DESIGN** (3-0-0) 3

Suspension system - types of front and rear suspensions. Design and analysis using multibody dynamics. Characteristics of dampers and active damping. Suspension testing. Steering - layout. Design of Steering systems. Design principles for differentials and constant velocity joints. Drive line vibrations. Selection/design of gear box, clutch, drivelines, axles and its integration. Braking system design - principles, standards and testing. Design of automatic braking system. Principles of body and frame design.

Reading:

1. Smith J.H., *An Introduction to Modern Vehicle Design*, 2nd Edition, Butterworth-Heinemann, 2001.
2. Limpert, R., *Brake Design and Safety*, SAE, 1999.
3. Matschinsky, W., *Road Vehicle Suspensions*, PEP, 2000.
4. Wong, J.Y., *Theory of Ground Vehicles*, 2nd Edition, John Wiley, 1993.