HINDUSTAN UNIVERSITY

HINDUSTAN INSTITUTE OF TECHNOLOGY & SCIENCE

SCHOOL OF AERONAUTICAL SCIENCES

B.Tech. AEROSPACE ENGINEERING

CURRICULUM & SYLLABUS

ACADEMIC REGULATIONS (B.Tech)

(Full /Part Time) (Effective 2012-13)

1. Vision, Mission and Objectives

1.1 The Vision of the Institute is "To make every man a success and no man a failure".

In order to progress towards the vision, the Institute has identified itself with a mission to provide every individual with a conducive environment suitable to achieve his / her career goals, with a strong emphasis on personality development, and to offer quality education in all spheres of engineering, technology, applied sciences and manage-ment, without compromising on the quality and code of ethics.

1.2 Further, the Institute always strives

- To train our students with the latest and the best in the rapidly changing fields of Engineering, Technology, Management, Science & Humanities.
- To develop the students with a global outlook possessing, state of the art skills, capable of taking up challenging responsibilities in the respective fields.
- To mould our students as citizens with moral, ethical and social values so as to fulfill their obligations to the nation and the society.
- To promote research in the field of Science, Humanities, Engineering, Technology and allied branches.

1.3 Aims and Objectives of the Institute are focused on

- Providing world class education in engineering, technology, applied sciences and management.
- Keeping pace with the ever changing technological scenario to help the students to gain proper direction to emerge as competent professionals fully aware of their commitment to the society and nation.
- To inculcate a flair for research, development and entrepreneurship.

2. Admission

2.1. The admission policy and procedure shall be decided from time to time by the Board of Management (BOM) of the Institute, following guidelines issued by Ministry of Human Resource Development (MHRD), Government of India. The number of seats in each branch of the B.Tech programme will be decided by BOM as per the directives from MHRD, Government of India and taking into account the market demands. Some seats for Non Resident Indians and a few seats for foreign nationals shall be made available.

2.2.(i) Full-Time :

At the time of applying for admission, the candidates should have passed / appeared and be awaiting results of the final examination of the 10+2 system or its equivalent with Mathematics, Physics and Chemistry as subjects of study.

(ii) Part -Time:

At the time of applying for admission, the candidates should have a Diploma in Engineering/Technology in the relevant branch of specialization awarded by the State Board of Technical Education, Tamil Nadu or any other authority accepted by the Board of Management of the University as equivalent thereto and a minimum of one year practical experience.

2.3. The selected candidates will be admitted to the B.Tech. programme after he/she fulfills all the admission requirements set by the Institute and after the payment of the prescribed fees.

2.4. In all matters relating to admission to the B.E. / B.Tech. programme, the decision of the Institute and its interpretation given by the Chancellor of the Institute shall be final.

2.5. If at any time after admission, it is found that a candidate has not fulfilled any of the requirements stipulated by the Institute, the Institute may revoke the admission of the candidate with information to the Academic Council.

3. Structure of the programme

3.1. The programme of instruction will have the following structure:

i) A general (common) core programme comprising basic sciences, engineering sciences, humanities, technical arts and mathematics.

ii) An engineering core programme introducing the student to the foundations of engineering in the respective branch.

iii) An elective programme enabling the student to opt and undergo a set of courses of interest to him/ her.

iv) Professional practice including project, seminar and industrial training .

v) General elective courses, such as, Environmental Studies, Physical Education, Professional ethics, and National Service Scheme.

The distribution of total credits required for the degree programme into the above five categories will nominally be 20%, 50%, 15%, 5%, and 10% respectively.

3.2.(i) Full-Time:

The duration of the programme will be a minimum of 8 semesters. Every branch of the B.E. / B.Tech. programme will have a curriculum and syllabi for the courses approved by the Academic Council.

ii) Part – Time:

The duration of the programme will be a minimum of 7 semesters. Every branch of the B.Tech. programme will have a curriculum and syllabi for the courses approved by the Academic Council

3.3 The academic programmes of the Institute follow the credit system. The general pattern is:

- One credit for each lecture hour per week per semester;
- One credit for each tutorial hour per week per semester;
- One credit for each laboratory practical (drawing) of three (two) hours per week per semester.
- One credit for 4 weeks of industrial training and
- One credit for 4 hours of project per week per semester

3.4. (i) Full-Time:

For the award of degree, a student has to earn certain minimum total number of credits specified in the curriculum of the relevant branch of study. The curriculum of the different programs shall be so designed that the minimum prescribed credits required for the award of the degree shall be within the limits of 180-190.

(ii) Part-Time:

For the award of degree, a student has to earn certain minimum total number of credits specified in the curriculum of the relevant branch of study. The curriculum of the different programs shall be so designed that the minimum prescribed credits required for the award of the degree shall be within the limits of 110-120.

3.5. The medium of instruction, examination and the language of the project reports will be English.

4. Faculty Advisor

4.1. To help the students in planning their courses of study and for getting general advice on the academic programme, the concerned Department will assign a certain number of students to a Faculty member who will be called their Faculty Advisor.

5. Class Committee

5.1 A Class Committee consisting of the following will be constituted by the Head of the Department for each class:

(i) A Chairman, who is not teaching the class.

(ii) All subject teachers of the class.

(iii) Two students nominated by the department in consultation with the class.

The Class Committee will meet as often as necessary, but not less than three times during a semester.

The functions of the Class Committee will include:

(i) Addressing problems experienced by students in the classroom and the laboratories.

(ii) Analyzing the performance of the students of the class after each test and finding ways and means of addressing problems, if any.

(iv) During the meetings, the student members shall express the opinions and suggestions of the class students to improve the teaching / learning process.

6. Grading

6.1 A grading system as below will be adhered to.

6.2 GPA and CGPA

GPA is the ratio of the sum of the product of the number of credits C_i of course "i " and the grade points P_i earned for that course taken over all courses "i" registered by the student to the sum of C_i for all "i ". That is,

$$GPA = \frac{\sum_i C_i P_i}{\sum_i C_i}$$

CGPA will be calculated in a similar manner, at any semester, considering all the courses enrolled from the first semester onwards.

Range of Marks	Letter Grade	Grade points
95-100	S	10
85 - 94	A	09
75- 84	B	08
65-74	C	07
55-64	D	06
50-54	E	05
< 50	U	00
	I (Incomplete)	--

6.3. For the students with letter grade I in certain subjects, the same will not be included in the computation of GPA and CGPA until after those grades are converted to the regular grades.

6.4 Raw marks will be moderated by a moderation board appointed by the Vice Chancellor of the University. The final marks will be graded using an absolute grading system. The Constitution and composition of the moderation board will be dealt with separately.

7. Registration and Enrolment

7.1 Except for the first semester, registration and enrollment will be done in the beginning of the semester as per the schedule announced by the University.

7.2 A student will be eligible for enrollment only if he/she satisfies regulation 10 (maximum duration of the programme) and will be permitted to enroll if (i) he/she has cleared all dues in the Institute, Hostel and Library up to the end of the previous semester and (ii) he/she is not debarred from enrollment by a disciplinary action of the University.

7.3. Students are required to submit registration form duly filled in.

8. Registration requirement

8.1.(i). Full -Time:

A full time student shall not register for less than 16 credits or more than 30 credits in any given semester.

(ii). Part -Time:

A part time student shall not register for less than 10 credits or more than 20 credits in any given semester

8.2 If a student finds his/her load heavy in any semester, or for any other valid reason, he/she may withdraw from the courses within three weeks of the commencement of the semester with the written approval of his/her Faculty Advisor and HOD. However the student should ensure that the total number of credits registered for in any semester should enable him/her to earn the minimum number of credits per semester for the completed semesters.

9. Continuation of the programme

9.1 For those students who have not earned the minimum required credit prescribed for that particular semester examination, a warning letter to the concerned student and also to his/her parents regarding the shortage of his/her credit will be sent by the HOD after the announcement of the results of the university examinations.

10. Maximum duration of the programme

10.1.(i) Full - Time

The normal duration of the programme is eight semesters. However a student may complete the programme at a slower pace by taking more time, but in any case not more than 14 semesters excluding the semesters withdrawn on medical grounds or other valid reasons.

(ii) Part - Time

The normal duration of the programme is seven semesters. However a student may complete the programme at a slower pace by taking more time, but in any case not more than 12 semesters excluding the semesters withdrawn on medical grounds or other valid reasons

11. Temporary discontinuation

11.1. A student may be permitted by the Director (Academic) to discontinue temporarily from the programme for a semester or a longer period for reasons of ill health or other valid reasons. Normally a student will be permitted to discontinue from the programme only for a maximum duration of two semesters.

12. Discipline

12.1. Every student is required to observe discipline and decorous behavior both in-side and outside the campus and not to indulge in any activity which will tend to bring down the prestige of the University.

12.2. Any act of indiscipline of a student reported to the Director (Academic) will be referred to a Discipline Committee so constituted. The Committee will enquire into the charges and decide on a suitable punishment if the charges are substantiated. The committee will also authorize the Director (Academic) to recommend to the Vice Chancellor the implementation of the decision. The student concerned may appeal to the Vice Chancellor whose decision will be final. The Director (Academic) will report the action taken at the next meeting of the Council.

12.3. Ragging and harassment of women are strictly prohibited in the University campus and hostels.

13. Attendance

13.1. A student whose attendance is less than 75% in a semester is not eligible to appear for the end – semester examination for that semester. The details of all students who have less than 75% attendance in a course will be announced by the teacher in the class. These details will be sent to the concerned HODs and Director (Academic).

13.2. Those who have less than 75% attendance will be considered for condonation of shortage of attendance.However, a condonation of 10% in attendance will be given on medical reasons. Application for condonation recommended by the Faculty Advisor, concerned faculty member and the HOD is to be submitted to the Director (Academic) who, depending on the merits of the case, may permit the student to appear for the end semester examination. A student will be eligible for this concession at most in two semesters during the entire degree programme. Application for medical leave, supported by medical certificate with endorsement by a Registered Medical Officer, should reach the HOD within seven days after returning from leave or, on or before the last instructional day of the semester, whichever is earlier.

13.3 As an incentive to those students who are involved in extra curricular activities such as representing the University in Sports and Games, Cultural Festivals, and Technical Festivals, NCC/ NSS events, a relaxation of up to 10% attendance will be given subject to the condition that these students take prior approval from the officer – in-charge. All such applications should be recommended by the concerned HOD and forwarded to Director (Academic) within seven instructional days after the programme / activity.

14. Assessment Procedure

14.1. The Academic Council will decide from time to time the system of tests and examinations in each subject in each semester.

14.2 For each theory course, the assessment will be done on a continuous basis as follows:

Test / Exam	Weigh - tage	Duration of Test / Exam
First Periodical Test	10%	2 Periods
Second Periodical Test	10%	2 Periods
Third Periodical Test/Model Exam	20%	3 Periods
Seminar/ Assignments/Quiz	10%	-
Attendance	10%	
End – semester examination	50%	3 Hours

*Best out of the two test will be considered.

14.3 For practical courses, the assessment will be done by the subject teachers as below:

(i) Weekly assignment/Observation note book / lab records – weightage 60%.

(ii) End semester examination of 3 hours duration including viva – weightage 40%.

14.4 For courses on Physical Education, NSS, etc the assessment will be as satisfactory/not satisfactory only.

15. Make up Examination/Periodical Test

15.1. Students who miss the end-semester examinations / periodical test for valid reasons are eligible for make-up examination /periodical test. Those who miss the end-semester examination / periodical test should apply to the Head of the Department concerned within five days after he / she missed examination, giving reasons for absence.

15.2. Permission to appear for make-up examination / model exam will be given under exceptional circumstances such as admission to a hospital due to illness. Students should produce a medical certificate issued by a Registered Medical Practitioner certifying that he/she was admitted to hospital during the period of examination / model exam and the same should be duly endorsed by parent / guardian and also by a medical officer of the University within 5 days.

16. Project evaluation

16.1 For Project work, the assessment will be done on a continuous basis as follows:

Review / Examination	Weightage
First Review	10 %
Second Review	20 %
Third Review	20 %
End-semester Examination	50 %

For end – semester examination, the student will submit a Project Report in a format specified by the Director (Academic). The first three reviews will be conducted by a Committee constituted by the Head of the Department. The end – semester examination will be conducted by a Committee constituted by the Registrar / Controller of examination. This will include an external expert.

17. Declaration of results

17.1.(i) A candidate who secures not less than 50% of total marks prescribed for a course with a minimum of 50% of the marks prescribed for the end semester examination shall be declared to have passed the course and earned the specified credits for the course.

(ii) To be Eligible to appear for the end semester examinations for a particular course, a candidate will have to secure a minimum of 40% marks in the sessional for that course.

(iii). Candidates are required to obtain all credits assigned to the first two semesters of the programme within the first four semesters of the programme. Candidates failing to satisfy this requirement will not be allowed to proceed to the fifth semester until the condition is satisfied. Further, candidates will not allowed to proceed to seventh semester if they have not cleared all the courses assigned during third & fourth semesters.

17.2 After the valuation of the answer scripts, the tabulated results are to be scrutinized by the Result Passing Boards

of UG programmes constituted by the Vice-Chancellor. The recommendations of the Result Passing Boards will be placed before the Standing Sub Committee of the Academic Council constituted by the Chancellor for scrutiny. The minutes of the Standing Sub Committee along with the results are to be placed before the Vice-Chancellor for approval. After getting the approval of the Vice-Chancellor, the results will be published by the Controller of Examination/Registrar.

17.3 If a candidate fails to secure a pass in a course due to not satisfying the minimum requirement in the end semester examination, he/she shall register and re-appear for the end semester examination during the following semester. However, the sessional marks secured by the candidate will be retained for all such attempts.

17.4 If a candidate fails to secure a pass in a course due to insufficient sessional marks though meeting the minimum requirements of the end semester examination, and wishes to improve on his/her sessional marks, he/she will have to register for the particular course and attend the course with permission of the HOD concerned and Director(Academic) with a copy marked to the Registrar. The sessional and external marks obtained by the candidate in this case will replace the earlier result.

17.5 A candidate can apply for the revaluation of his/her end semester examination answer paper in a theory course within 2 weeks from the declaration of the results, on payment of a prescribed fee through proper application to the Registrar/Controller of Examinations through the Head of the Department. The Registrar/ Controller of Examination will arrange for the revaluation and the results will be intimated to the candidate concerned through the Head of the Department. Revaluation is not permitted for practical courses and for project work.

18. Grade Card

18.1 After results are declared, grade sheet will be issued to each student which will contain the following details:

(i) Program and branch for which the student has enrolled.
(ii) Semester of registration.
(iii) List of courses registered during the semester and the grade scored.
(iv) Semester Grade Point Average (GPA)
(v) Cumulative Grade Point Average (CGPA).

19. Class/Division

19.1 Classification is based on CGPA and is as follows:

CGPA ≥ 8.0 : **First Class with distinction**

6.5 ≤ CGPA < 8.0 : **First Class**

5.0 ≤ CGPA < 6.5 : **Second Class.**

19.2 (i) Further, the award of 'First class with distinction' is subject to the candidate becoming eligible for the award of the degree having passed the examination in all the courses in his/her first appearance within the minimum duration of the programme.

(ii) The award of 'First Class' is further subject to the candidate becoming eligible for the award of the degree having passed the examination in all the courses **within 10 semesters.**

(iii) The period of authorized discontinuation of the programme (vide clause 11.1 will not be counted for the purpose of the above classification.

20. Transfer of credits

20.1. Within the broad framework of these regulations, the Academic Council, based on the recommendation of the transfer of credits committee so consulted by the Chancellor may permit students to earn part of the credit requirement in other approved institutions of repute and status in the country or abroad.

20.2 The Academic Council may also approve admission of lateral entry (who hold a diploma in Engineering/ technology) candidates with advance credit based on the recommendation of the transfer of credits committee on a case to case basis.

21. Eligibility for the award of B.Tech. Degree

21.1. A student will be declared to be eligible for the award of the B.Tech. Degree if he/she has

i) registered and successfully acquired the credits for the core courses;

ii) successfully acquired the credits in the different categories as specified in the curriculum corresponding to the discipline (branch) of his/her study within the stipulated time;

iii) has no dues to all sections of the Institute including Hostels, and

iv) has no disciplinary action pending against him/her.

The award of the degree must be recommended by the Academic Council and approved by the Board of Management of the University.

22. Change of Branch

22.1 If the number of students in any branch of B.Tech. class as on the last instructional day of the First Semester is less than the sanctioned strength, then the vacancies in the said branches can be filled by transferring students from other branches. All such transfers will be allowed on the basis of merit of the students. The decision of the Chancellor shall be final while considering such requests.

22.2 All students who have successfully completed the first semester of the course will be eligible for consideration for change of branch subject to the availability of vacancies.

23. Power to modify

23.1. Notwithstanding all that has been stated above, the Academic Council shall modify any of the above regulations from time to time subject to approval by the Board of Management.

SCHOOL OF AERONAUTICAL ENGINEERING

Semester I

SEMESTER I (Common to All Branches)

Sl. No.	Course Code	Course Title	L	T	P	Credit	TCH
1	EL 1101	English – I	3	0	1	3	4
2	MA1101	Engineering Mathematics – I	3	1	0	4	4
3	PH1101	Engineering Physics – I	3	1	0	4	4
4	CY1101	Engineering Chemistry – I	3	1	0	4	4
5	ME1101	Engineering Graphics	3	0	3	4	6
6	CS1101	Computer Programming	3	1	0	4	4
Practical							
7	CS1131	Computer Programming Laboratory	0	0	3	1	3
8#	GE1101	Engineering Practices Laboratory (OR)	0	0	3	1	3
	GE1102	Physical Sciences Laboratory	0	0	3	1	3
9	GE1103	NSS/NCC/NSO/YRC	0	0	2	0	2
Total						26	37

SEMESTER II

Sl. No.	Course Code	Course Title	L	T	P	Credit	TCH
1	EL1102	English – II*	3	1	0	4	4
2	MA1102	Engineering Mathematics – II*	3	1	0	4	4
3	PH1102	Engineering Physics – II**	3	1	0	4	4
4	CY1102	Engineering Chemistry - II	3	1	0	4	4
5	EE1105	Basic Electrical and Electronics Engineering	3	1	0	4	4
6	ME1102	Engineering Mechanics***	3	1	0	4	4
Practical							
7#	GE1101	Engineering Practices Laboratory (OR)	0	0	3	1	3
	GE1102	Physical Sciences Laboratory	0	0	3	1	3
8	AE1101	Computer Aided Drafting &Modelling Laboratory****	0	0	3	1	3
Total						27	33

**Decided by the Department**

***** **Common to All Branches**

****** **Common to All Branches except IT**

******* **Common to AERONAUTICAL, AUTO, CIVIL, EEE & EIE**

****** Common to AERONAUTICAL**

SEMESTER III

Sl. No.	Course Code	Course Title	L	T	P	Credit	TCH
1	MA1203	Engineering Mathematics - III*	3	1	0	4	4
2	ME1202	Fluid Mechanics and Machinery	3	1	0	4	4
3	CY1203	Environment Science and Engineering	3	0	0	3	3
4	AE1202	Aero Engineering Thermodynamics****	3	1	0	4	4
5	AE1203	Solid Mechanics **** (NEW)	3	1	0	4	4
6	AS1201	Introduction to Aero Space Engineering	3	0	0	3	3
Practical							
7	AE1205	Strength of Materials Lab****	0	0	3	1	3
8	CS 1233	Computer Programming Lab II	0	0	3	1	3
9	AE1207	Thermodynamics Lab****	0	0	3	1	3
Total						25	31

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SEMESTER IV

Sl. No.	Course Code	Course Title	L	T	P	Credit	TCH
1	MA1204	Numerical Methods	3	1	0	4	4
2	AS1202	Aero Space Structures – I (NEW)	3	1	0	4	4
3	AE1208	Aerodynamics – I****	3	1	0	4	4
4	AS1203	Propulsion – I	3	1	0	4	4
5	AE1211	Control Engineering ****	3	0	0	3	3
6	AS1204	Elements of Avionics	3	0	0	3	3
Practical							
7	AS1205	Aerospace Structures Lab -I	0	0	3	1	3
8	AE1213	Fluid Mechanics & Machinery Lab ****	0	0	3	1	3
9	AS1206	Aerodynamics Lab-I	0	0	3	1	3
						25	31

****** Common to AERONAUTICAL**

SEMESTER V

Sl. No.	Course Code	Course Title	L	T	P	Credit	TCH
1	AS 1301	Aerospace Structures II	3	1	0	4	4
2	AS 1302	Flight Mechanics – I	3	1	0	4	4
3	AE 1304	Aerodynamics-II	3	1	0	4	4
4	AS 1303	Propulsion – II	3	1	0	4	4
5	AS 1304	Aircraft Maintenance Practices	3	0	1	3	4
6	AS 1305	Elements of Vibration	3	0	0	3	3
Practical							
7	AS 1306	Propulsion Lab - I	0	0	3	1	3
8	AS 1307	Aerodynamics Lab - II	0	0	3	1	3
9	AS 1308	Flight Dynamics Lab	0	0	3	1	3
Total						25	32

SEMESTER VI

Sl. No.	Course Code	Course Title	L	T	P	Credit	TCH
1	AS 1310	Propulsion – III	3	1	0	4	4
2	AS 1311	Flight Mechanics II	3	1	0	4	4
3	AS 1312	Advanced Materials and Performance	3	0	0	3	3
4	-	Elective – I	3	0	0	3	3
5	-	Elective – II	3	0	0	3	3
6	-	Elective – III	3	0	0	3	3
Practical							
7	AS 1313	Propulsion Lab- II	0	0	3	1	3
8	AS 1314	Aerodynamics Design Lab	1	0	3	1	4
9	AS 1315	Experimental Stress Analysis Laboratory	0	0	3	1	3
10	EL1331	Communication skills lab*	2	0	2	3	4
Total						26	34

SEMESTER VII

Sl. No.	Course Code	Course Title	L	T	P	Credit	TCH
1	AS 1401	Flight Mechanics III	3	1	0	4	4
2	AS 1402	Introduction to Composite Materials and Structures	3	1	0	4	4
3	AS 1403	Satellites and Space System Design	3	1	0	4	4
4	AE1407	Rockets and Missiles****	3	0	0	3	3
5	MG1401	Total Quality Management *	3	0	0	3	3
6	GE 1401	Professional Ethics / Humanities	3	0	0	3	3
Practical							
7	AS 1404	Structural Design Lab	1	0	3	1	3
8	AS 1405	Space Propulsion Laboratory	0	0	3	1	3
9	AS 1406	Identification of Project Work**	0	0	2	-	2
Total						23	29

SEMESTER VIII

Sl. No.	Course Code	Course Title	L	T	P	Credit	TCH
1	-	Elective – IV	3	0	0	3	3
2	-	Elective – V	3	0	0	3	3
Practical							
3	AS1407	Project Work	0	0	24	6	24
Total						12	30

Total No. of Credit = 187

ELECTIVE COURSES

SEMESTER VI

COURSE CODE	COURSE TITLE	L	T	P	C	TCH
AS 1351	Advanced Aerodynamics	3	0	0	3	3
AS 1352	Advanced Strength of Materials	3	0	0	3	3
AS 1353	Turbo Machinery and Dynamics	3	0	0	3	3
AS 1354	FEM in Aerospace	3	0	0	3	3
AS 1355	Aero elasticity	3	0	0	3	3
AS 1356	Transport Process in Reacting Flows	3	0	0	3	3
AS 1357	Theory of Combustion	3	0	0	3	3
AS 1358	Experimental Stress Analysis	3	0	0	3	3
AS 1359	High Temperature Materials	3	0	0	3	3

SEMESTER VIII

COURSE CODE	COURSE TITLE	L	T	P	C	TCH
AE1418****	Computational Fluid Dynamics	3	0	0	3	3
AS 1408	Flight Testing	3	0	0	3	3
AS 1409	Design of Gas Turbines	3	0	0	3	3
AS 1410	Fundamentals of space vehicle design	3	0	0	3	3
AS 1411	Avionics and Instrumentation	3	0	0	3	3
AS 1412	Reliability Engineering	3	0	0	3	3
AS 1413	Cryogenic Propulsion	3	0	0	3	3
AS 1414	Product Design & Development	3	0	0	3	3
AS 1415	Ceramic Technology	3	0	0	3	3
AS 1416	Introduction to NDT	3	0	0	3	3
AS 1417	Optimization Techniques	3	0	0	3	3

****** Common to AERONAUTICAL**

SEMESTER I

EL 1101	ENGLISH –I	L T P C 3 0 1 3
Goal	The goal of the programme is to provide a theoretical input towards nurturing accomplished learners who can function effectively in the English language skills; to cultivate in them the ability to indulge in rational thinking, independent decision-making and lifelong learning; to help them become responsible members or leaders of the society in and around their workplace or living space; to communicate successfully at the individual or group level on engineering activities with the engineering community in particular, and on multi-disciplinary activities in general, with the world at large.	

Objectives	**Outcome**
1. To widen the capacity of the learners to listen to English language at the basic level and understand its meaning. 2. To enable learners to communicate in an intelligible English accent and pronunciation. 3. To assist the learners in reading and grasping a passage in English. 4. To learn the art of writing simple English with correct spelling, grammar and punctuation. 5. To **c**ultivate the ability of the learners to think and indulge in divergent and lateral thoughts.	1. The learners will have the self-confidence to improve upon their informative listening skills by an enhanced acquisition of the English language. **2.** The learners will be able to speak English at the formal and informal levels and use itfor daily conversation, presentation, group discussion and debate. 3. The learners will be able to read, comprehend and answer questions based on literary, scientific and technological texts. 4. The learners will be able to write instructions, recommendations, checklists, process-description, letter-writing and report writing. **5.** The learners will have the confidence to develop thinking skills and participate in brainstorming, mind-mapping, audiovisual activities, creative thinking and also answer tests in the job-selection processes.

Unit I: Listening Skill **9**

Topics: Listening to the sounds, silent letters & stress in English words & sentences – Listening to conversation & telephonic conversation -- Listening for general meaning & specific information -- Listening for positive & negative comments – Listening to technical topics – Listening to prose & poetry reading -- Listening exercises.

Embedded language learning: Sentence definition -- Spelling & punctuation -- Imperative form – Sequencing of sentences -- Gerunds -- Infinitives -- 'Wh-'questions.

Unit II: Speaking Skill **9**

Topics: Self-introduction – Expressing personal opinion – Dialogue – Conversation – Simple oral interaction -- Speaking on a topic -- Expressing views for & against -- Speaking on personal topics like hobbies, topics of interest, present & past experiences, future plans – Participating in group discussions, role plays, debates, presentations, power-point presentations & job-interviews.

Embedded language learning: Adverbs –Adjectives – Comparative and Numerical adjectives -- Nouns & compound nouns -- Prefixes and suffixes.

Unit III: Reading Skill **9**

Topics: Reading anecdotes, short stories, poems, parts of a novel, notices, message, time tables, advertisements, leaflets, itinerary, content page – Reading pie chart & bar chart -- Skimming and scanning -- Reading for contextual meaning – Scanning for specific information -- Reading newspaper & magazine articles – Critical reading -- Reading-comprehension exercises.

Embedded language learning: Tenses – Active and passive voice -- Impersonal passive -- Words and their function -- Different grammatical forms of the same word.

Unit IV: Writing Skill **9**

Topics: Writing emails, notes, messages, memos, notices, agendas, advertisements, leaflets, brochures, instructions, recommendations & checklists -- Writing paragraphs -- Comparisons & contrasts – Process description of Flow charts – Interpretation of Bar charts & Pie charts – Writing the minutes of a meeting -- Report writing -- Industrial accident reports -- Letter-writing -- Letter to the editors – Letter inviting & accepting or declining the invitation – Placing orders – Complaints -- Letter requesting permission for industrial visits or implant training, enclosing an introduction to the educational institution -- Letters of application for a job, enclosing a CV or Resume – Covering letter.

Embedded language learning: Correction of errors – Subject-verb Concord -- Articles – Prepositions -- Direct and indirect speech.

Unit V: Thinking Skill **9**

Topics: Eliciting & imparting the knowledge of English using thinking blocks – Developing thinking skills along with critical interpretation side by side with the acquisition of English -- Decoding diagrams & pictorial representations into English words, expressions, idioms and proverbs.

Embedded language learning: General vocabulary -- Using expressions of cause and effect -- Comparison & contrast -- If-conditionals -- Expressions of purpose and means.

TOTAL=45

Reference Books

1. Norman Whitby. *Business Benchmark: Pre-Intermediate to Intermediate* – BEC Preliminary. New Delhi: Cambridge University Press, 2008 (Latest South Asian edition).
2. Norman Whitby. *Business Benchmark: Pre-Intermediate to Intermediate* – Preliminary—Personal Study Book. New Delhi: Cambridge University Press, 2008 (Latest South Asian edition).
3. *Cambridge BEC Preliminary: Self-study Edition* – Practice Tests. New Delhi: Cambridge University Press, 2008 or latest South Asian edition.
4. Devaki Reddy & Shreesh Chaudhary. *Technical English***.** New Delhi: Macmillan, 2009.
5. Rutherford, Andrea J. *Basic Communication Skills for Technology*. 2nd edition. New Delhi: Pearson Education, 2006.

MA1101	ENGINEERING MATHEMATICS - I	L T P C 3 1 0 4
Goal	To create the awareness and comprehensive knowledge in engineering mathematics.	

Objectives	Outcome
The course should enable the students to: • Find the inverse of the matrix by using Cayley Hamilton Theorem and Diagonalisation of matrix using transformation. • Understand the Evolutes and Envelope of the curve. • Learn the solutions of second order linear differential equations of standard types and Legendre's linear differential equation. • Learn partial differentiations involving two and three variables and expansions of functions using Taylor series. • Learn the expansions of trigonometric, hyperbolic functions and their relations.	The students should be able to: • Identify Eigen value problems from practical areas and obtain its solutions and using transformation diagonalising the matrix which would render Eigen values. • Find out effectively the geometrical aspects of curvature and appreciates mathematical skills in constructing evolutes and envelopes in mechanics and engineering drawing. • Recognize and to model mathematically and solving, the differential equations arising in science and engineering. • Understand and model the practical problems and solve it using maxima and minima as elegant applications of partial differentiation. • Acquire skills in using trigonometric and hyperbolic and inverse hyperbolic functions.

UNIT I MATRICES 12

Review: Basic concepts of matrices-addition, subtraction, multiplication of matrices – adjoint – inverse – solving cubic equations.

Characteristic equation – Properties of Eigen values – Eigen values and Eigen vectors –Cayley Hamilton theorem (without proof) – Verification and inverse using Cayley Hamilton theorem.Diagonalisation of matrices – Orthogonal matrices– Quadratic form – Reduction of symmetric matrices to a Canonical form using orthogonal transformation – Nature of quadratic form.

UNIT II DIFFERENTIAL CALCULUS 12

Review: Basic concepts of differentiation – function of function, product and quotient rules.

Methods of differentiation of functions - Cartesian form – Parametric form – Curvature – Radius of curvature – Centre of curvature – Circle of curvature. Evolutes of parabola, circle, ellipse, hyperbola and cycloid –Envelope.

III ORDINARY DIFFERENTIAL EQUATIONS 12

Review: Definition, formation and solutions of differential equations.

Second order differential equations with constant coefficients – Particular integrals – $e^{ax}Sinbx$ or $e^{ax}Cosbx$, $e^{ax}Cosbx$, $e^{ax}Sinbx$. Euler's homogeneous linear differential equations – Legendre's linear differential equation - Variation of parameters.

UNIT IV PARTIAL DIFFERENTIATION 12

Partial differentiation – differentiation involving two and three variables – Total differentiation – Simple problems. Jacobian – verification of properties of Jacobians – Simple problems. Taylor's series – Maxima and minima of functions of two and three variables.

UNIT V TRIGONOMETRY 12

Review: Basic results in trigonometry and complex numbers - De Moivre's theorem.Expansions of $\sin n\theta$, $\cos n\theta$, $\tan n\theta$ where n is apositive integer. Expansions of $\sin^m\theta\cos^n\theta$ interms of sines and cosines of multiples of θ where m and n are positive integers.Hyperbolic and inverse hyperbolic functions – Logarithms of complex numbers – Separation of complex functions into real and imaginary parts – Simple problems.

Note: Questions need not be asked from review part.

TOTAL: 60

TEXT BOOKS

1. Erwin Kreyzig, *A Text book of Engineering Mathematics*, John Wiley, 1999.
2. Grewal B.S, *Higher Engineering Mathematics*, Thirty Eighth Editions, Khanna Publisher, Delhi, 2004.
3. Chandrasekaran A, *A Text book of Engineering Mathematics I*, Dhanam Publications, Chennai, 2010.

REFERENCES

1. Venkataraman M.K, *Engineering Mathematics, Volume I*, The National Publishing Company, Chennai, 1985.
2. Kandaswamy P, Thilagavathy K and Gunavath K, *Engineering Mathematics, Volume I & II*, S.Chand and Company, New Delhi, 2005.
3. Bali N.P, Narayana Iyengar. N.Ch., *Engineering Mathematics*, Laxmi Publications Pvt. Ltd, New Delhi, 2003.
4. Veerarajan T, *Engineering Mathematics (*for first year), Fourth Edition,Tata McGraw – Hill Publishing Company Limited, New Delhi, 2005.

PH1101	ENGINEERING PHYSICS-I	L T P C 3 1 0 4
Goal	To impart fundamental knowledge in various fields of Physics and its applications.	
OBJECTIVES	**OUTCOMES**	
➢ To develop strong fundamentals of properties and behaviour of the materials ➢ To enhance theoretical and modern technological aspects in acoustics and ultrasonic's. ➢ To enable the students to correlate the theoretical principles with application oriented study of optics. ➢ To provide a strong foundation in the understanding of solids and materials testing. ➢ To enrich the knowledge of students in modern engineering materials.	The student will ➢ Be able to understand the properties and behaviour of materials. ➢ Have a fundamental knowledge of acoustics which would facilitate in acoustical design of buildings and on ultrasonic's and be able to employ it as an engineering tool. ➢ Understand the concept, working and application of lasers and fiber optics. ➢ Know the fundamentals of crystal physics and non destructive testing methods. ➢ Have an understanding of the production, characteristics and application of the new engineering materials. This would aid them in the material selection stage.	

UNIT I – PROPERTIES OF MATTER 9

Elasticity – types of moduli of elasticity – Stress-Strain diagram – Young's modulus of elasticity – Rigidity modulus – Bulk modulus – Factors affecting elasticity – twisting couple on a wire – Torsional pendulum – determination of rigidity modulus of a wire – depression of a cantilever – Young's modulus by cantilever – uniform and non-uniform bending - viscosity – Ostwald's viscometer – comparison of viscosities.

UNIT II – ACOUSTICS AND ULTRASONICS 9

Classification of sound – characteristics of musical sound – intensity - loudness – Weber Fechner law – Decibel – Reverberation – Reverberation time, derivation of Sabine's formula for reverberation time(Jaeger's method) – absorption coefficient and its determination – factors affecting acoustics of building (Optimum reverberation time, loudness, focusing, echo, echelon effect, resonance and noise) and their remedies. Ultrasonics - production – Magnetostriction and Piezoelectric methods – properties – applications of ultrasonics with particular reference to detection of flaws in metal (Non – Destructive testing NDT) – SONAR.

UNIT III - LASER AND FIBRE OPTICS 9

Principle of lasers – Stimulated absorption – Spontaneous emission, stimulated emission – population inversion – pumping action – active medium – laser characteristics – Nd-Yag laser – CO_2 laser – Semiconductor laser – applications - optical fiber – principle and propagation of light in optical fibers – Numerical aperture and acceptance angle – types of optical fibers – single and multimode, step index and graded index fibers – applications – fiber optic communication system.

UNIT IV – CRYSTAL PHYSICS AND NON- DESTRUCTIVE TESTING 9

Crystal Physics: Lattice – Unit cell - Bravais lattice – Lattice planes – Miller indices – 'd' spacing in cubic lattice – Calculation of number of atoms per unit cell – Atomic radius – coordination number – Packing factor for SC, BCC, FCC and HCP structures.

Non Destructive Testing: Liquid penetrate method – Ultrasonic flaw detection – ultrasonic flaw detector (block diagram) – X-ray Radiography – Merits and Demerits of each method.

UNIT V –MODERN ENGINEERING MATERIALS AND SUPERCONDUCTING MATERIALS 9

Modern Engineering Materials: Metallic glasses: Preparation properties and applications. Shape memory alloys (SMA): Characteristics, applications, advantages and disadvantages of SMA. Nano Materials: Synthesis –Properties and applications.

Superconducting Materials: Superconducting phenomena – Properties of superconductors – Meissner effect – Type I and Type II superconductors – High Tc superconductors (qualitative) – uses of superconductors.

TOTAL = 45

TEXT BOOKS:

1. Gaur R.K. and Gupta S.L., "*Engineering Physics* ", 8th edition, Dhanpat rai publications (P) Ltd., New Delhi 2010.
2. P.Mani, "*Engineering Physics* ", Vol-I, Dhanam Publications, Chennai 2011.
3. Rajendran V. an Marikani A., "*Applied Physics for engineers*" , 3rd edition, Tata Mc Graw –Hill publishing company Ltd., New Delhi,2003.

REFERENCES:

1. Uma Mukherji, "*Engineering Physics* ", Narosa publishing house, New Delhi, 2003.
2. Arumugam M., "*Engineering Physics* ", Anuradha agencies, 2007.
3. Palanisamy P.K., "*Engineering Physics* ", SciTech Publications, Chennai 2007.
4. Arthur Beiser, "*Concepts of Modern Physics",* Tata Mc Graw –Hill Publications, 2007.
5. P.Charles, Poople and Frank J. Owens, "Introduction to Nanotechnology", Wiley India, 2007

CY1101	ENGINEERING CHEMISTRY-I	L T P C 3 1 0 4
Goal	To impart basic principles of chemistry for engineers.	
OBJECTIVES	OUTCOME	
The objective of the course is • To make the students conversant with the basics of (a) Water technology and (b) Polymer science	Upon successful completion of the course, the outcomes are as follows: • The students will gain basic knowledge in water analysis and suitable water treatment method. • The study of polymer chemistry will give an idea on the type of polymers to be used in engineering applications.	
• To provide knowledge on the requirements and properties of a few important engineering materials.	• Exposure of the students to the common engineering materials will create awareness among the students to search for new materials.	
• To educate the students on the fundamentals of corrosion and its control.	• Knowledge on the effects of corrosion and protection methods will help the young minds to choose proper metal / alloys and also to create a design that has good corrosion control.	
• To give a sound knowledge on the basics of a few significant terminologies and concepts in thermodynamics.	• Students with good exposure on the important aspects of basic thermodynamics will be able to understand the advanced level thermodynamics in engineering applications.	
• To create an awareness among the present generation about the various conventional energy sources.	• A good background on the various aspects of energy sources will create awareness on the need to utilize the fuel sources effectively and also for exploring new alternate energy resources.	

UNIT I: WATER TECHNOLOGY AND POLYMER CHEMISTRY 9

Hardness (Definition, Types, Units) – problems - Estimation of Hardness (EDTA Method) – Water softening - Carbonate conditioning and Calgon conditioning - Demineralization (Ion-Exchange Method) - Water Quality Parameters - Municipal Water Treatment- Desalination - Reverse Osmosis.

Classification of Polymers - PVC, Bakelite - preparation, properties and applications - Effect of Polymer Structure on Properties - Compounding of Plastics- Polymer Blends and Polymer Alloys – Definition, Examples.

UNIT II: ENGINEERING MATERIALS 9

Properties of Alloys – Heat Treatment of Steel – Polymer Composites – types and applications.- Lubricants – Classification, properties and applications - Mechanism of Lubrication – MoS_2 And Graphite – Adhesives – classification and properties – Epoxy resin (Preparation, properties and applications) – Refractories – Classification, Properties and General Manufacture – Abrasives – Classification , Properties and Uses – Carbon nano tubes – preparation, properties and applications.

UNIT III: ELECTROCHEMISTRY AND CORROSION 9

Conductometric Titration – HCl vs NaOH and mixture of acids vs NaOH - Electrochemical Series and its applications - Nernst Equation – problems - Polarization, Decomposition Potential, Over-voltage (definitions only) - Galvanic series -Corrosion (Definition, Examples, effects) – Mechanism of Dry Corrosion and Wet Corrosion – Differential aeration Corrosion , examples – Factors Influencing Corrosion – Metal and Environment – Corrosion Control – Design –Cathodic Protection methods – Protective Coatings – Galvanising - Anodising – Electroplating (Cu and Ni) and Electroless plating (Cu and Ni) – Constituents of Paints and varnish.

UNIT IV: CHEMICAL THERMODYNAMICS 9

Thermodynamic terminology- First Law of Thermodynamics-Internal energy- enthalpy - heat capacity – work done in isothermal expansion of an ideal gas –problems - second law of thermodynamics – entropy change – phase transformations and entropy change – problems - Work Function &Free Energy Function- Maxwell's Relations-Gibbs Helmholtz equation- van't Hoff Isotherm- van't Hoff Isochore – Problems.

UNIT V: FUELS ANDENERGY SOURCES 9

Fuels – classification - Calorific Value – Dulong's Formula – Problems - Determination of Calorific Value by Bomb Calorimeter – Coal – Proximate Analysis – problems - Octane Number – Cetane Number – Diesel Index (Definitions only) – Bio Gas – Producer Gas –Water Gas – Preparation, Properties and Uses – Batteries – Primary Cells – Leclanche Cell –Secondary Cell – Nickel Cadmium Battery – Fuel Cells – Hydrogen –Oxygen Fuel Cell – Solar Battery – Lead Acid Storage Cell – Nuclear Energy – Light water nuclear power plant.

Total 45

Text Books

1.S. S. Dara, *Text Book of Engineering Chemistry*, S. Chand &Company Ltd., New Delhi, 2003
2. Murthy, Agarwal &Naidu, *Text Book of Engineering Chemistry*, BSP, 2003.
3. S.Sumathi, *Engineering Chemistry*, Dhanam Publications, 2008.
4.S.Sumathi and P.S.Raghavan, *Engineering Chemistry II*, Dhanam Publications, 2008.

References

1. B. K. Sharma, *Engineering chemistry*, Krishna Prakasam Media (P) Ltd., 2003
2. A 1. Vogel, *A text book of Qualitative Inorganic Analysis*, ELBS, London, 2004
3. A. Gowarikar, *Text Book of Polymer Science*, 2002
4. Kuriacose &Rajaram, Vols. 1 &2, *Chemistry in Engineering and Technology*, 2004
5. Puri, Sharma and Pathania, *Principles of Physical Chemistry*, Vishal Publishing Co. Jalandar, 2004.

ME 1101	ENGINEERING GRAPHICS	L T P C 3 0 3 4
Goal	To develop graphical skills for communicating concepts, ideas and designs of engineering products and to give exposure to national standards relating to technical drawings.	

Objectives	Outcome
The course should enable the students to 1. Introduce drawing standards and use of drawing instruments. 2. Introduce first angle projection. 3. Practice of engineering hand sketching and introduce to computer aided drafting 4. Familiarize the students with different type of projections. 5. Introduce the process of design from sketching to parametric 3D CAD and 2D orthographic drawings to BIS	The students should be able to 1. Develop Parametric design and the conventions of formal engineering drawing 2. Produce and interpret 2D & 3D drawings 3. Communicate a design idea/concept graphically 4. Examine a design critically and with understanding of CAD – The student learn to interpret drawings, and to produce designs using a combination of 2D and 3D software. 5. Get a Detailed study of an engineering artifact

Note: Only first angle projection is to be followed

BASICS OF ENGINEERING GRAPHICS 2

Importance of graphics Use of drawing instruments - BIS conventions and specifications – drawing sheet sizes, layout and folding - lettering - Dimensioning - Geometrical constructions - Scales. Construction of curves like ellipse, parabola, cycloids and involutes.

UNIT I PROJECTION OF POINTS, LINES AND SURFACES 15

General principles of presentation of technical drawings as per BIS - Introduction to Orthographic projection - Naming views as per BIS - First angle projection. Projection of points. Projection of straight lines located in first quadrant (using rotating line method only). Projection of plane surfaces like polygonal lamina and circular lamina. Drawing views when the surface of the lamina is inclined to one reference plane.

UNIT II PROJECTION OF SOLIDS 10

Projections of simple solids like prism, pyramid, cylinder and cone - Drawing views when the axis of the solid is inclined to one reference plane.

UNIT III DEVELOPMENT OF SURFACES 10

Introduction to sectioning of solids. Development of lateral surfaces of truncated prisms, pyramids, cylinders and cones.

UNIT IV ORTHOGRAPHIC PROJECTIONS 10

Orthographic projections - Conversion of orthographic views from given pictorial views of objects, including dimensioning. Free hand sketching of Orthographic views from Pictorial views.

UNIT V PICTORIAL PROJECTIONS 10

Isometric projection - Isometric scale - Isometric views of simple solids like prisms, pyramids, cylinders and cones. Introduction to perspective Projections.

COMPUTER AIDED DRAFTING (Demonstration Only) 3

Introduction to computer aided drafting and dimensioning using appropriate software. 2D drawing commands Zoom, Picture editing commands, Dimensioning, Isometric drawing, Iso-Planes and 3D drafting. Plotting of drawing. Practice includes drawing the projection of lines and solids. Prepare isometric view of simple solids like prisms, pyramids, cylinders and cones.

TOTAL : 60

TEXT BOOKS:

1. Jeyapoovan T, "*Engineering Drawing and Graphics Using AutoCAD*", Vikas Publishing House Pvt. Ltd., New Delhi, 2010.

2. Warren J. Luzadder and Jon. M.Duff, "*Fundamentals of Engineering Drawing*", Prentice Hall of India Pvt. Ltd., Eleventh Edition, 2003.

REFERENCE BOOKS

1. Bhatt N.D and Panchal V.M, *"Engineering Drawing: Plane and Solid Geometry*", Charotar Publishing House, Anand-3001, 2007.

2. Thomas E. French, Charles J.Vierck and Robert J.Foster, " Engineering *Drawing and Graphic Technology,* McGraw- Hill Book company 13th Edition.1987.

3. Venugopal K., "*Engineering Graphics*", New Age International (P) Limited, New Delhi, 2008.

CS1101	COMPUTER PROGRAMMING	L T P C 3 1 0 4
Goal	To introduce computers and programming and to produce an awareness of the power of computational techniques that are currently used by engineers and scientists and to develop programming skills to a level such that problems of reasonable complexity can be tackled successfully.	

Objectives	Outcome
The course should enable the students to: (i) Learn the major components of a Computer system. (ii) Learn the problem solving techniques. (iii) Develop skills in programming using C language.	The student should be able to: (i) Understand the interaction between different components of Computer system and number system. (ii) Devise computational strategies for developing applications. (iii) Develop applications (Simple to Complex) using C programming language.

UNIT - I COMPUTER FUNDAMENTALS 9

Introduction – Evolution of Computers – Generations of Computer – Classification of Computers – Application of Computers - Components of a Computer System – Hardware - Software - Starting a Computer (Booting) – Number Systems.

UNIT- II COMPUTER PROGRMMING AND LANGUAGES 9

Introduction - Problem-Solving Techniques: Algorithms, Flowchart, Pseudocode - Program Control Structures – Programming Paradigms – Programming languages – Generations of Programming Languages – Language Translators – Features of a Good ProgrammingLanguages.

UNIT - III PROGRAMMING WITH C 9

Introduction to C - The C Declaration - Operators and Expressions – Input and Output in C – Decision Statements – Loop Control Statements.

UNIT- IV FUNCTIONS, ARRAYS AND STRINGS 9

Functions – Storage Class – Arrays – Working with strings and standard functions.

UNIT - V POINTERS, STRUCTURES AND UNION 9

Pointers – Dynamic Memory allocation – Structure and Union – Files.

TOTAL = 45

TEXT BOOK:

ITL Education Solution Limited, Ashok Kamthane, “Computer Programming”, Pearson Education Inc 2007 (Unit: I to V).

REFERNCES:

1. Byron S. Gottfried, “Programming with C”, Second Edition, Tata McGraw Hill 2006.
2. Yashvant Kanetkar, “Let us C”, Eighth edition, BPP publication 2007.
3. Stephen G.Kochan, “Programming in C - A Complete introduction to the C programming langu
4. T.JeyaPoovan, “Computer Programming Theory and Practice”, Vikas Pub, New Delhi.

CS1131	COMPUTER PROGRAMMING LABORATORY	L T P C 0 0 3 1
Goal	To provide an awareness develop the programming skills using computer languages.	

Objectives	Outcome
The course should enable the students to: (i) To gain knowledge about Microsoft office, Spread Sheet. (ii)To learn a programming concept in C. .	The student should be able to: (i) Use MS Word to create document, table, text formatting and Mail merge options. (ii) Use Excel for small calculations using formula editor, creating different types of charts and including pictures etc, (iii) Write and execute the C programs for small applications.

LIST OF EXPERIMENTS:

a) Word Processing 15

1. Document creation, Text manipulation with Scientific notations
2. Table creation, Table formatting and Conversion
3. Mail merge and Letter preparation
4. Drawing - flow Chart

b) Spread Sheet 15

5. Chart - Line, XY, Bar and Pie
6. Formula - formula editor
7. Spread sheet - inclusion of object, Picture and graphics, protecting the document

c) Programming in C :

8. To write a C program to prepare the electricity bill
9. Functions:
   (a) Call by value (b) Call by reference
10. To write a C program to print the Fibonacci series for the given number
11. To write a C program to find the factorial of number using recursion
12. To write a C program to implement the basic arithmetic operations using Switch Case Statement
13. To write a C program to check whether the given number is an Armstrong number
14. To write a C program to check whether the given string is a Palindrome
15. To write a C program to create students details using Structures
16. To write a C program to demonstrate the Command Line Arguments
17. To write a C program to implement the Random Access in Files
18. To write C programs to solve some of the Engineering applications

TOTAL = 45

GE 1101	ENGINEERING PRACTICE LABORATORY – I	L T P C 0 0 3 1
Goal	To provide the students with hands on experience on various basic engineering practices in Civil and Mechanical Engineering.	

Objectives	Outcomes
The course should enable the students to 1. Relate theory and practice of basic Civil and Mechanical Engineering 2. Learn concepts of welding and machining practice 3. Learn concepts of plumbing and carpentry practice	The students should be able to 1. Indentify and use of tools, Types of joints used in welding, carpentry and plumbing operations. 2. Have hands on experience on basic fabrication techniques such as carpentry and plumbing practices. 3. Have hands on experience on basic fabrication techniques of different types of welding and basic machining practices.

LIST OF EXPERIMENTS

1. Mechanical Engineering

1. Welding

Arc welding - butt joints, lap joints and T joints.

2. Basic Machining

Facing, Turning, Threading and Drilling practice.

3. Machine assembly practice

Study of centrifugal pump

4. Study on

a. Smithy operations- Production of hexagonal headed bolt.

b. Foundry operations – mould preparation for gear and step cone pulley.

2. Civil Engineering

1. Basic pipe connection using valves, couplings, unions, reducers, elbows in household fitting.
2. Practice in mixed pipe connections: Metal, plastic and flexible pipes used in household appliances.
3. Wood work: Sawing, Planning and making common joints.
4. Study of joints in door panels, wooden furniture.

Text Book:

T. Jeyapoovan, M.Saravanapandian and S. Pranitha, "*Engineering Practices Lab Manual*", 3rd Edition 2006, Vikas Publishing house (P) Ltd., New Delhi.

GE 1102 PH 2031	PHYSICAL SCIENCES LABORATORY PHYSICS LABORATORY	L T P C 0 0 3 1
Goal	To provide the students with hands on experience on various basic physics experiments	

Objectives	**Outcomes**
The course should enable the students to estimate 1. Rigidity modulus of the material 2. Young's modulus 3. Viscosity of liquid 4. Thermal conductivity 5. Refractive Index 6. Wavelength	The students should be able to Understand the basics and estimation of the parameters of the materials (solid and liquid) through performing different experiments .

List of Experiments

1. Torsional Pendulum - Determination of rigidity modulus of the material of a wire.
2. Non Uniform Bending - Determination of Young's Modulus.
3. Viscosity -Determination of co-efficient of Viscosity of a liquid by Poiseuille's flow.
4. Lee's Disc - Determination of thermal conductivity of a bad conductor.
5. Air Wedge - Determination of thickness of a thin wire.
6. Spectrometer - Refractive index of a prism.
7. Semiconductor laser - Determination of wavelength of Laser using Grating.

REFERENCES:

7. P.Mani, Engineering Physics Practicals, Dhanam Publications, Chennai, 2005.

GE1102 CY 2301	PHYSICAL SCIENCES LABORATORY CHEMISTRY LABORATORY	L T P C 0 0 3 1
Goal	To provide the students with hands on experience on various basic chemical experiments.	

Objectives	Outcomes
The course should enable the students to	The students should be able to Estimate volumetric , potentiometric, conductometric analysis for different materials. Understanding of titration. Viscosity and polyimerisation process by performing different hands on experiments

List of Experiments

1. Estimation of Commercial soda by acid-base titration
2. Determination of Percentage of nickel in an alloy
3. Determination of Temporary, permanent and total hardness of water by EDTA method
4. Determination of Chloride content in a water sample
5. Potentiometric Estimation of iron
6. Conductometric Titration of a strong acid with a strong base
7. Conductometric Titration of mixture of acids.
8. Determination of Degree of polymerization of a polymer by Viscometry

References:

1. J.Mendham, R.C. Denney, J.D. Barnes and N.J.K. Thomas, Vogel's Textbook of Quantative Chemical Analysis, 6th Edition, Pearson Education, 2004.
2. C. W. Garland, J. W. Nibler, D. P. Shoemaker, ;"Experiments in Physical Chemistry, 8th ed.," McGraw-Hill, New York, 2009.
3. S. Sumathi, Engineering Chemistry Practicals, Dhanam Publications, 2011.

Semester-II

EL1102	ENGLISH- II	L T P C 3 1 0 4
Goal	To provide practice in realizing the meaning potential of a text and to make the learners become familiar with different reading strategies and to train learners in organized academic and professional writing.	

Objectives	**Outcome**
The course should enable the students to: 1) To develop the vocabulary using reference words cohesion, adjectives using various tenses 2) To enable learners to express suggestions, explanations and forming questions with appropriate tenses. 3) To enable the learners to design advertisement, job application with perfect resume and making notes by listening to the lecture. 4) To develop the art of describing the scenery, writing memos, circulars and reports with appropriate phrases idioms and tenses. 5) To cultivate the learners to use conditionals and understand about direct indirect speech.	The students should be able to: 1) The learners will able to form any kind of letters by using appropriate punctuations, tenses with perfect vocabulary 2) The learners will able to scan and study reading and can easily describe answers for the questions with appropriate tenses. 3) The learners will able come out with an innovative ideas regarding advertisement and can able to follow the lecture and can make their own hint notes. 4) The learners will able to explain about the situation by looking the scenery and listening to the talks. 5) The learners will have the confidence to speak with better vocabulary and can express their thoughts with better language.

UNIT I **12**

Vocabulary Development – Use of reference words, cohesion and coherence – Adjectives – Using present participle and past participle – Punctuation – Antonyms – Single line definition and extended definition – Listening for specific information – non-verbal presentation of ideas – preposition – Expressing suggestions – Informal letters – formal and social letters.

Activities Suggested:

Guessing meaning for contexts while reading

Pick out reference words from paragraphs

Order jumbled sentences

Order jumbled paragraphs

Punctuating passages

Fill in blanks using prepositions

Writing letters expressing thanks

Writing complement letters to editor of a newspaper

Writing one sentence definition

Writing extended definition

UNIT II **12**

Vocabulary Development – scanning and study reading – Use of numerical expressions as adjectives – Expressing suggestions – Expressing explanation – Yes/no question formations and discussion – Listening comprehension - Description of things and events.

Activities Suggested:

Matching words with meanings

Formation of words using prefixes and suffixes

Read and answer comprehension questions

Hold short group discussions

Expand numerical expression

Write description of objects and events

Write letters expressing suggestions

Role-plays

UNIT III **12**

Expression of cause and effect – Prepositional phrases – Describing a process – Giving instructions – Design advertisements – Job application with resume – Arguments – Stating a problem and expressing solutions – Listening and making notes – Summary writing.

Activities Suggested:

Making summary of a passage

Listen to instructions and write a description

Combine sentences using connectives to show cause and effect (eg., so as to, because of, as result of etc…)

Design an advertisement for promotion of sale of a particular item

Write an application letter

Prepare a resume

Writing an argument for a cause

Stating solution for a problem

UNIT IV **12**

Present perfect continuous – Use of 'should', 'ought' – Listening to a talk to know the gist - Describing a scenery – Use of as soon as, no sooner than, though, in spite of – Expressing certainty, probability, possibility, impossibility – Use of modal verbs – Use of phrases and idioms – simple past and past perfect – Use of infinitives – Writing memos and circulars- Report writing.

Activities Suggested:

Changing instructions to suggestions

Listening to a talk and write summary

Preparing a travel itinerary

Writing a travelogue

Rewriting sentences using modal verbs

Rewrite sentences using as soon as, no sooner than, though, in spite of etc…

Prepare memos and circulars

Hold discussions and write reports based on the discussions

UNIT V **12**

Meanings of words – Use of conditionals – Expressing futurity – Direct and Indirect speech – Essay writing.

Activities Suggested:

Holding interviews

Role-plays

Complete sentences using conditionals

Expressing fears and hopes

Write short essays for given topics

TOTAL: 60

TEXT BOOK:

1. Learning to Communicate, " A Resource book for Scientists and Technologists "– Dr. V. Chellamal., Allied Publishers.

Units 5 to 10

Extensive Reading:

The Monk Who Sold His Ferrari, Robin Sharma., Jaico Publishers.

Note:

Extensive reading is not for testing. Regular assignments have to be submitted by the students.

REFERENCES:

1. Farhatullah. T.M. English Practice Book for Engineering Student's. Chennai, Emerald Publishers 2000.
2. Joseph KV. A Text Book of English Grammar and Usage. Chennai; Vijay Nickole Imprints Pvt Ltd 2006.

MA1102	ENGINEERING MATHEMATICS II	L T P C 3 1 0 4
Goal	To create the awareness and comprehensive knowledge in engineering mathematics.	

Objectives	Outcome
The course should enable the students to:	The students should be able to:
6) Understand the evaluation of the double and triple integrals in Cartesian and polar forms.	6) Find area as double integrals and volume as triple integrals in engineering applications.
7) Know the basics of Vector calculus.	7) Evaluate the gradient, divergence, curl, line, surface and volume integrals along with the verification of classical theorems involving them.
8) Know Cauchy - Riemann equations, Milne – Thomson method and Conformal mapping	8) Applies analytic functions and their interesting properties inscience and engineering.
9) Grasp the concept of Cauchy's integral formula, Cauchy's residue theorem and contour integration.	9) Evaluate the basics of complex integration and the concept of contour integration which is important for evaluation of certain integrals encountered in practice.
10) Know Laplace transform and inverse Laplace transform and their properties.	10) Have a sound knowledge of Laplace transform and its properties and their applications in solving initial and boundary value problems.

UNIT I MULTIPLE INTEGRALS 12

Review: Basic concepts of integration- Standard results – Substitution methods – Integration by parts - Simple problems.

Double integrals: Cartesian and polar co-ordinates –Change of variables – simple problems - Area as a double integral. Triple integrals: Cartesian co ordinates – Volume as a triple integral– simple problems.

UNIT II VECTOR CALCULUS 12

Review: Definition – vector, scalar – basic concepts of vector algebra - dot and cross products-properties.

Gradient, Divergence and Curl –Unit normal vector, Directional derivative – angle between surfaces-Irrotational and solenoidal vector fields.Verification and evaluation of Green's theorem-Gauss divergence theorem and Stoke's theorem.Simple applications to regions such as square, rectangle, triangle, cuboids and rectangular parallelopipeds.

UNIT III ANALYTIC FUNCTIONS 12

Review: Basic results in complex numbers - Cartesian and polar forms - Demoivre's theorem.

Functions of a complex variable – Analytic function – Necessary and sufficient conditions (without proof) – Cauchy - Riemann equations – Properties of analytic function – Harmonic function – Harmonic conjugate - Construction of Analytic functions by Milne – Thomson method.Conformal mapping: w = z + a, az, 1/z and bilinear transformation.

UNIT IV COMPLEX INTEGRATION 12

Statement and application of Cauchy's integral theorem and Integral formula– Evaluation of integrals using the above theorems –Taylor and Laurent series expansions–Singularities – Classification. Residues – Cauchy's residue theorem (without proof)– Contour integration over unit circle and semicircular contours (excluding poles on boundaries).

UNIT V LAPLACE TRANSFORM 12

Laplace transform – Conditions of existence – Transform of elementary functions – properties– Transforms of derivatives and integrals – Derivatives and integrals of transforms - Initial and final value theorems – Transforms of unit step function and impulse function – Transform of periodic functions. Inverse Laplace transform – Convolution theorem – Solution of linear ODE of second order with constant coefficients.

TOTAL: 60

Note: Questions need not be asked from review part.

TEXT BOOKS

1. VenkatramanM.K, *Mathematics, Volume II*, National Publishing Company, Chennai, 1985.
2. Grewal B.S, *Higher Engineering Mathematics*, Thirty Eighth Editions, Khanna Publisher, Delhi, 2004.
3. Chandrasekaran A, *Engineering Mathematics, Volume – II*, Dhanam Publication, 2008.

REFERENCE:

1. Kandasamy P, *Engineering Mathematics Volume II*, S. Chand & Co., New Delhi, 1987.
2. GrewalB.S, "*Engineering Maths – II*", Sultan Chand, New Delhi, 1993.
3. Bali N.P, Manish Goyal, *Text book of Engineering Mathematics*, 3rd Edition, Lakshmi Publications, 2003.

PH1102	ENGINEERING PHYSICS-II	L T P C 3 1 0 4
Goal	To impart fundamental knowledge in various fields of Physics and its applications.	

OBJECTIVES	OUTCOME
➢ To develop strong fundamentals of properties and behavior of the materials ➢ To enhance theoretical and modern technological aspects in acoustics and ultrasonics. ➢ To enable the students to correlate the theoretical principles with application oriented study of optics. ➢ To provide a strong foundation in the understanding of solids and materials testing. ➢ To enrich the knowledge of students in modern engineering materials.	The student will ➢ Be able to understand the properties and behavior of materials. ➢ Have a fundamental knowledge of acoustics which would facilitate in acoustical design of buildings and on ultrasonics and be able to employ it as an engineering tool. ➢ Understand the concept, working and application of lasers and fiber optics. ➢ Know the fundamentals of crystal physics and non destructive testing methods. ➢ Have an understanding of the production, characteristics and application of the new engineering materials. This would aid them in the material selection stage.

UNIT I – PROPERTIES OF MATTER **9**

Elasticity – types of moduli of elasticity – Stress-Strain diagram – Young's modulus of elasticity – Rigidity modulus – Bulk modulus – Factors affecting elasticity – twisting couple on a wire – Torsional pendulum – determination of rigidity modulus of a wire – depression of a cantilever – Young's modulus by cantilever – uniform and non-uniform bending - viscosity – Ostwald's viscometer – comparison of viscosities.

UNIT II – ACOUSTICS AND ULTRASONICS **9**

Classification of sound – characteristics of musical sound – intensity - loudness – Weber Fechner law – Decibel – Reverberation – Reverberation time, derivation of Sabine's formula for reverberation time(Jaeger's method) – absorption coefficient and its determination – factors affecting acoustics of building (Optimum reverberation time, loudness, focusing, echo, echelon effect, resonance and noise) and their remedies. Ultrasonics - production – Magnetostriction and Piezoelectric methods – properties – applications of ultrasonics with particular reference to detection of flaws in metal (Non – Destructive testing NDT) – SONAR.

UNIT III - LASER AND FIBRE OPTICS **9**

Principle of lasers – Stimulated absorption – Spontaneous emission, stimulated emission – population inversion – pumping action – active medium – laser characteristics – Nd-Yag laser – CO_2 laser – Semiconductor laser – applications - optical fiber – principle and propagation of light in optical fibers – Numerical aperture and acceptance angle – types of optical fibers – single and multimode, step index and graded index fibers – applications – fiber optic communication system.

UNIT IV – CRYSTAL PHYSICS AND NON- DESTRUCTIVE TESTING 9

Crystal Physics: Lattice – Unit cell - Bravais lattice – Lattice planes – Miller indices – 'd' spacing in cubic lattice – Calculation of number of atoms per unit cell – Atomic radius – coordination number – Packing factor for SC, BCC, FCC and HCP structures.

Non Destructive Testing: Liquid penetrate method – Ultrasonic flaw detection – ultrasonic flaw detector (block diagram) – X-ray Radiography – Merits and Demerits of each method.

UNIT V –MODERN ENGINEERING MATERIALS AND SUPERCONDUCTING MATERIALS 9

Modern Engineering Materials: Metallic glasses: Preparation properties and applications. Shape memory alloys (SMA): Characteristics, applications, advantages and disadvantages of SMA. Nano Materials: Synthesis –Properties and applications.

Superconducting Materials: Superconducting phenomena – Properties of superconductors – Meissner effect – Type I and Type II superconductors – High Tc superconductors (qualitative) – uses of superconductors.

TOTAL 45

TEXT BOOKS:

1. Gaur R.K. and Gupta S.L., "*Engineering Physics* ", 8th edition, Dhanpat rai publications (P) Ltd., New Delhi 2010.
2. P.Mani, "*Engineering Physics* ", *Vol-I*, Dhanam Publications, Chennai 2011.
3.Rajendran V. an Marikani A., "*Applied Physics for engineers*" , 3rd edition, Tata Mc Graw –Hill publishing company Ltd., New Delhi,2003.

REFERENCES:

1.Uma Mukherji, "*Engineering Physics* ", Narosa publishing house, New Delhi, 2003.
2.Arumugam M., "*Engineering Physics* ", Anuradha agencies, 2007.
3.Palanisamy P.K., "*Engineering Physics* ", SciTech Publications, Chennai 2007.
4.Arthur Beiser, "*Concepts of Modern Physics*", Tata Mc Graw –Hill Publications, 2007.
5.P.Charles, Poople and Frank J. Owens, "*Introduction to Nanotechnology*", Wiley India, 2007

CY1102	ENGINEERING CHEMISTRY-II	L T P C 3 1 0 4
Goal	To impart basic principles of chemistry for engineers.	
OBJECTIVES	**OUTCOME**	
The objective of the course is • To make the students conversant with the basics of a) Water technology and b) Polymer science	Upon successful completion of the course, the outcomes are as follows: • The students will gain basic knowledge in water analysis and suitable water treatment method. • The study of polymer chemistry will give an idea on the type of polymers to be used in engineering applications.	
• To provide knowledge on the requirements and properties of a few important engineering materials.	• Exposure of the students to the common engineering materials will create awareness among the students to search for new materials.	
• To educate the students on the fundamentals of corrosion and its control.	• Knowledge on the effects of corrosion and protection methods will help the young minds to choose proper metal / alloys and also to create a design that has good corrosion control.	
• To give a sound knowledge on the basics of a few significant terminologies and concepts in thermodynamics.	• Students with good exposure on the important aspects of basic thermodynamics will be able to understand the advanced level thermodynamics in engineering applications.	
• To create an awareness among the present generation about the various conventional energy sources.	• A good background on the various aspects of energy sources will create awareness on the need to utilize the fuel sources effectively and also for exploring new alternate energy resources.	

UNIT I:WATER TECHNOLOGY AND POLYMER CHEMISTRY 9

Hardness (Definition, Types, Units) – problems - Estimation of Hardness (EDTA Method) – Water softening - Carbonate conditioning and Calgon conditioning - Demineralization (Ion-Exchange Method) - Water Quality Parameters - Municipal Water Treatment- Desalination - Reverse Osmosis.

Classification of Polymers - PVC, Bakelite - preparation, properties and applications - Effect of Polymer Structure on Properties - Compounding of Plastics- Polymer Blends and Polymer Alloys – Definition, Examples.

UNIT II: ENGINEERING MATERIALS 9

Properties of Alloys – Heat Treatment of Steel – Polymer Composites – types and applications.- Lubricants – Classification, properties and applications - Mechanism of Lubrication – MoS_2 And Graphite – Adhesives – classification and properties – Epoxy resin (Preparation, properties and applications) – Refractories – Classification, Properties and General Manufacture – Abrasives – Classification , Properties and Uses – Carbon nano tubes – preparation, properties and applications.

UNIT III: ELECTROCHEMISTRY AND CORROSION 9

Conductometric Titration – HCl vs NaOH and mixture of acids vs NaOH - Electrochemical Series and its applications - Nernst Equation – problems - Polarization, Decomposition Potential, Over-voltage (definitions only) - Galvanic series -Corrosion (Definition, Examples, effects) – Mechanism of Dry Corrosion and Wet Corrosion – Differential aeration Corrosion , examples – Factors Influencing Corrosion – Metal and Environment – Corrosion Control – Design –Cathodic Protection methods – Protective Coatings – Galvanising - Anodising – Electroplating (Cu and Ni) and Electroless plating (Cu and Ni) – Constituents of Paints and varnish.

UNIT IV: CHEMICAL THERMODYNAMICS 9

Thermodynamic terminology- First Law of Thermodynamics-Internal energy- enthalpy - heat capacity – work done in isothermal expansion of an ideal gas –problems - second law of thermodynamics – entropy change – phase transformations and entropy change – problems - Work Function &Free Energy Function- Maxwell's Relations-Gibbs Helmholtz equation- van't Hoff Isotherm- van't Hoff Isochore – Problems.

UNIT V: FUELS ANDENERGY SOURCES 9

Fuels – classification - Calorific Value – Dulong's Formula – Problems - Determination of Calorific Value by Bomb Calorimeter – Coal – Proximate Analysis – problems - Octane Number – Cetane Number – Diesel Index (Definitions only) – Bio Gas – Producer Gas –Water Gas – Preparation, Properties and Uses – Batteries – Primary Cells – Leclanche Cell –Secondary Cell – Nickel Cadmium Battery – Fuel Cells – Hydrogen –Oxygen Fuel Cell – Solar Battery – Lead Acid Storage Cell – Nuclear Energy – Light water nuclear power plant.

Total 45

Text Books

1. S. S. Dara, Text Book of *Engineering Chemistry*, S. Chand &Company Ltd., New Delhi, 2003
2. Murthy, Agarwal &Naidu, Text Book of *Engineering Chemistry*, BSP, 2003.
3. S.Sumathi, *Engineering Chemistry*, Dhanam Publications, 2008.
4. S.Sumathi and P.S.Raghavan, *Engineering Chemistry II*, Dhanam Publications, 2008.

References

1. B. K. Sharma, *Engineering chemistry*, Krishna Prakasam Media (P) Ltd., 2003
2. A 1. Vogel, A text book of *Qualitative Inorganic Analysis*, ELBS, London, 2004
3. A. Gowarikar, Text Book of *Polymer Science*, 2002
4. Kuriacose &Rajaram, Vols. 1 &2, *Chemistry in Engineering and Technology*, 2004
5. Puri, Sharma and Pathania, Principles of Physical Chemistry, Vishal Publishing Co. Jalandar, 2004.

EE1105	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	L T P C 3 1 0 4
Goal	To impart basic principles of electrical circuits and its applications. To understand about digital electronics, its devices and application in aerospace industry.	

OBJECTIVES	OUTCOME
1) To explain basic laws, circuits, principles and theories of electrical instruments like ammeter, voltmeter etc 2) To enable the learners about principle and applications of major electrical equipments like generators, motors, transformers etc. 3) To enable the learners about the concept of semiconducting and device like diodes, rectifiers and transistors. 4) To enable the learners to understand about binary number system, logic gates and other electronic devices. 5) To enable learners about the fundamentals of communication systems and signals	1) The learners will able to understand the basic concepts of electrical circuits and measurements 2) The learners can understand the mechanism of electrical equipments and basic equations to calculate their performance. 3) The learners can understand about the semiconducting devices, its circuits and applications 4) The learners can understand about binary number system, counters and its usage. 5) The learners can understand about basic concepts of communication system and working of various basic communication equipments like radio, television, fax and the basic principle of satellites

UNIT I ELECTRICAL CIRCUITS & MEASURMENTS 12

Ohm's Law – Kirchoff's Laws – Steady State Solution of DC Circuits – Introduction to AC Circuits – Waveforms and RMS Value – Power and Power factor – Single Phase and Three Phase Balanced Circuits.

Operating Principles of Moving Coil and Moving Iron Instruments (Ammeters and Voltmeters), Dynamometer type Watt meters and Energy meters.

UNIT II ELECTRICAL MECHANICS
12

Construction, Principle of Operation, Basic Equations and Applications of DC Generators, DC Motors, Single Phase Transformer, single phase induction Motor.

UNIT III SEMICONDUCTOR DEVICES AND APPLICATIONS 12

Characteristics of PN Junction Diode – Zener Effect – Zener Diode and its Characteristics – Half wave and Full wave Rectifiers – Voltage Regulation.

Bipolar Junction Transistor – CB, CE, CC Configurations and Characteristics – Elementary Treatment of Small Signal Amplifier.

UNIT IV DIGITAL ELECTRONICS 12

Binary Number System – Logic Gates – Boolean Algebra – Half and Full Adders – Flip-Flops – Registers and Counters – A/D and D/A Conversion (single concepts)

UNIT V: FUNDAMENTALS OF COMMUNICATION ENGINEERING 12

Types of Signals: Analog and Digital Signals – Modulation and Demodulation: Principles of Amplitude and Frequency Modulations.

Communication Systems: Radio, TV, Fax, Microwave, Satellite and Optical Fibre (Block Diagram Approach only).

TOTAL: 60

TEXT BOOKS:

1. V.N. Mittle “Basic Electrical Engineering”,Tata McGraw Hill Edition, New Delhi, 1990.

2. R.S. Sedha, “Applied Electronics” S. Chand & Co., 2006.

REFERENCES:

1. Muthusubramanian R, Salivahanan S and Muraleedharan K A, “Basic Electrical, Electronics and Computer Engineering”,Tata McGraw Hill, Second Edition, (2006).

2. Nagsarkar T K and Sukhija M S, “Basics of Electrical Engineering”, Oxford press (2005).

3. Mehta V K, “Principles of Electronics”, S.Chand & Company Ltd, (1994).

4. Mahmood Nahvi and Joseph A. Edminister, “Electric Circuits”, Schaum’ Outline Series, McGraw Hill, (2002).

5. Premkumar N, “Basic Electrical Engineering”, Anuradha Publications

ME 1102	ENGINEERING MECHANICS	L T P C 3 1 0 4
OBJECTIVES		**OUTCOME**
The course should enable the student to : Understand the Basics & Statics of particles Study the Equilibrium of rigid bodies and resolution of forces Understand the basics of properties of surfaces & solids Study the Dynamics of particles Study the friction and elements of rigid body dynamics		The student should be able to understand : The Vectorial representation of forces & Moment And principle of transmissibility The types of supports & Reactions and Equilibrium of Rigid bodies in two & Three dimensions First moment of area and the Centroid of various shapes & sections The Relative motion particles and Impact of elastic bodies The frictional force & types of friction and Translation and Rotation of Rigid Bodies

UNIT I BASICS & STATICS OF PARTICLES 12

Introduction – Units and Dimensions – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Vectors – Vectorial representation of forces and moments – Vector operations: additions, subtraction, dot product, cross product – Coplanar Forces – Resolution and Composition of forces – Equilibrium of a particle – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility – Single equivalent force.

UNIT II EQUILIBRIUM OF RIGID BODIES 12

Free body diagram – Types of supports and their reactions – requirements of stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions – Examples

UNIT III PROPERTIES OF SURFACES AND SOLIDS 12

Determination of Areas and Volumes – First moment of area and the Centroid of sections – Rectangle, circle, triangle from integration – T section, I section, - Angle section, Hollow section by using standard formula – second and product moments of plane area – Rectangle, triangle, circle from integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Polar moment of inertia – Principal moments of inertia of plane areas – Principal axes of inertia – Mass moment of inertia – Derivation of mass moment of inertia for rectangular section, prism, sphere from first principle – Relation to area moments of inertia.

UNIT IV DYNAMICS OF PARTICLES 12

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion – Newton's law – Work Energy Equation of particles – Impulse and Momentum – Impact of elastic bodies.

UNIT V FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS 12

Frictional force – Laws of Coulomb friction – simple contact friction – Rolling resistance – Belt friction. Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion.

TOTAL : 60

TEXT BOOK

1. Beer, F.P and Johnson Jr. E.R. "*Vector Mechanics for Engineers"*, Vol. 1 Statics and Vol. 2 Dynamics, McGraw-Hill International Edition, (1997).

REFERENCES

1. Rajasekaran, S, Sankarasubramanian, G., "*Fundamentals of Engineering Mechanics"*, Vikas Publishing House Pvt. Ltd., (2000).
2. Hibbeller, R.C., "*Engineering Mechanics*", Vol. 1 Statics, Vol. 2 Dynamics, Pearson Education Asia Pvt. Ltd., (2000).
3. Palanichamy, M.S., Nagam, S., "*Engineering Mechanics* – Statics & Dynamics", Tata McGraw-Hill, (2001).
4. Irving H. Shames, "*Engineering Mechanics* – Statics and Dynamics", IV Edition – Pearson Education Asia Pvt. Ltd., (2003).
5. Ashok Gupta, "*Interactive Engineering Mechanics* – Statics – A Virtual Tutor (CDROM)", Pearson Education Asia Pvt., Ltd., (2002).

GE 1101	ENGINEERING PRACTICE LABORATORY – I	L T P C 0 0 3 1
Goal	To provide the students with hands on experience on various basic engineering practices in Civil and Mechanical Engineering.	

Objectives	Outcomes
The course should enable the students to 4. Relate theory and practice of basic Civil and Mechanical Engineering 5. Learn concepts of welding and machining practice 6. Learn concepts of plumbing and carpentry practice	The students should be able to 4. Indentify and use of tools, Types of joints used in welding, carpentry and plumbing operations. 5. Have hands on experience on basic fabrication techniques such as carpentry and plumbing practices. 6. Have hands on experience on basic fabrication techniques of different types of welding and basic machining practices.

LIST OF EXPERIMENTS

1. Mechanical Engineering

1. Welding

Arc welding - butt joints, lap joints and T joints.

2. Basic Machining

Facing, Turning, Threading and Drilling practice.

3. Machine assembly practice

Study of centrifugal pump

4. Study on

a. Smithy operations- Production of hexagonal headed bolt.

b. Foundry operations – mould preparation for gear and step cone pulley.

2. Civil Engineering

5. Basic pipe connection using valves, couplings, unions, reducers, elbows in household fitting.
6. Practice in mixed pipe connections: Metal, plastic and flexible pipes used in household appliances.
7. Wood work: Sawing, Planning and making common joints.
8. Study of joints in door panels, wooden furniture.

Text Book:

T. Jeyapoovan, M.Saravanapandian and S. Pranitha, "*Engineering Practices Lab Manual*", 3rd Edition 2006, Vikas Publishing house (P) Ltd., New Delhi.

GE1102 PH 2031	PHYSICAL SCIENCES LABORATORY PHYSICS LABORATORY	L T P C 1 0 3 3
Goal	To provide the students with hands on experience on various basic physics experiments	

Objectives	**Outcomes**
The course should enable the students to estimate 1. Rigidity modulus of the material 2. Young's modulus 3. Viscosity of liquid 4. Thermal conductivity 5. Refractive Index 6. Wavelength	The students should be able to Understand the basics and estimation of the material (solid and liquid) properties through performing different experiments .

List of Experiments

8. Torsional Pendulum - Determination of rigidity modulus of the material of a wire.
9. Non Uniform Bending - Determination of Young's Modulus.
10. Viscosity -Determination of co-efficient of Viscosity of a liquid by Poiseuille's flow.
11. Lee's Disc - Determination of thermal conductivity of a bad conductor.
12. Air Wedge - Determination of thickness of a thin wire.
13. Spectrometer - Refractive index of a prism.
14. Semiconductor laser - Determination of wavelength of Laser using Grating.

REFERENCES:

8. P.Mani, Engineering Physics Practicals, Dhanam Publications, Chennai, 2005.

GE1102 CY 2301	PHYSICAL SCIENCES LABORATORY CHEMISTRY LABORATORY	L T P C 1 0 3 3
Goal	To provide the students with hands on experience on various basic chemical experiments.	

Objectives	Outcomes
The course should enable the students to Give wider exposure on titration methods for different mixtures of acids, viscosity and degree of polymerisation	The students should be able to Estimate volumetric, potentiometric, conductometric analysis for different materials. Understanding of titration. Viscosity and polyimerisation process by performing different experiments

List of Experiments

9. Estimation of Commercial soda by acid-base titration
10. Determination of Percentage of nickel in an alloy
11. Determination of Temporary, permanent and total hardness of water by EDTA method
12. Determination of Chloride content in a water sample
13. Potentiometric Estimation of iron
14. Conductometric Titration of a strong acid with a strong base
15. Conductometric Titration of mixture of acids.
16. Determination of Degree of polymerization of a polymer by Viscometry

References:

4. J.Mendham, R.C. Denney, J.D. Barnes and N.J.K. Thomas, Vogel's Textbook of Quantative Chemical Analysis, 6th Edition, Pearson Education, 2004.
5. C. W. Garland, J. W. Nibler, D. P. Shoemaker, ;"Experiments in Physical Chemistry, 8th ed.," McGraw-Hill, New York, 2009.
6. S. Sumathi, Engineering Chemistry Practicals, Dhanam Publications, 2011.

AE 1101	COMPUTER AIDED DRAFTING AND MODELING LAB	L T P C 0 0 3 1
GOAL	To develop the knowledge computer based design and development using AUTOCAD.	

S.No	OBJECTIVE	OUTCOME
1	To study the capabilities of software for Drafting and Modeling	Simple figures like polygon and multi-line figures can be generated
2	To draw a Title block with necessary text and projection symbol.	Basic details about title block an d projection symbol can be made.
3	To draw curves like parabola, spiral, involute using Bspline or cubic spline.	Basic knowledge about drawing parabola, spiral, involute using Bspline or cubic spline is imparted
4	To draw front view and top view of simple solids like prism, pyramid, cylinder, cone, etc, and dimensioning.	Basic knowledge about front view and top view of simple solids like prism, pyramid, cylinder, cone is imparted
5	To draw front view, top view and side view of objects from the given pictorial views.	Basic knowledge about front view and top view of objects from the given pictorial views is imparted.
6	To draw a plan of residential building.	Basic knowledge about plan of residential building is imparted.
7	To Draw a simple steel truss	The learners will able draw a steel truss.
8	To draw the sectional views of prism, pyramid, cylinder, cone, etc,	The sectional view of prism, pyramid, cylinder, and cone are made.
9	To draw the isometric projection of simple objects.	The isometric projection of simple objects are made.
10.	To Create 3-D models of simple objects and obtaining 2-D multi-view drawings from 3-D model.	The 3-D models of simple objects and 2D multi-view drawings are made.

List of Exercises using software capable of Drafting and Modelling

1. Study of capabilities of software for Drafting and Modelling – Coordinate systems (absolute, relative, polar, etc.) – Creation of simple figures like polygon and general multi-line figures.
2. Drawing of a Title Block with necessary text and projection symbol.
3. Drawing of curves like parabola, spiral, involute using Bspline or cubic spline.
4. Drawing of front view and top view of simple solids like prism, pyramid, cylinder, cone, etc, and dimensioning.
5. Drawing front view, top view and side view of objects from the given pictorial views (eg. V-block, Base of a mixie, Simple stool, Objects with hole and curves).
6. Drawing of a plan of residential building (Two bed rooms, kitchen, hall, etc.)
7. Drawing of a simple steel truss.
8. Drawing sectional views of prism, pyramid, cylinder, cone, etc,
9. Drawing isometric projection of simple objects.
10. Creation of 3-D models of simple objects and obtaining 2-D multi-view drawings from 3-D model.

Note: Plotting of drawings must be made for each exercise and attached to the records written by students.

List of Equipments for a batch of 30 students:

1. Pentium IV computer or better hardware, with suitable graphics facility -30 No.
2. Licensed software for Drafting and Modeling. – 30 Licenses
3. Laser Printer or Plotter to print / plot drawings – 2 No.

SEMESTER-III

MA 1203	ENGINEERING MATHEMATICS III	L T P C 3 1 0 4
Goal	To create the awareness and comprehensive knowledge in engineering mathematics	

Objectives	Outcome
The course should enable the students to: 1) Learn techniques of solving the standard types of first and second partial differential equations. 2) Grasp the Fourier series expansions for the given periodic function in the specific intervals and their different forms. 3) Learn solving one dimensional wave equation, One and two dimensional heat equation using Fourier series. 4) Understand the problems using Fourier transform and learns their properties. 5) Understand the problems using Z – transform and learns their properties.	The students should be able to: 1) Formulate mathematically certain practical problems in terms of partial differential equations, solve them and physically interpret the results. 2) Use the knowledge of Fourier series, their different possible forms and the frequently needed practical harmonic analysis that an engineer may have to make from discrete data. 3) Formulate and identify certain boundary and initial value problems encountered in engineering practices, decide on applicability of the Fourier series method of solution, solve the vibration and heat flow problems and then interpret the results. 4) Apply Fourier transform pair, their properties, with the possible special cases with attention to their applications 5) Apply the basics of Z – transform in its applicability to discretely varying functions, gained the skill to formulate certain problems in terms of difference equations and solve them using the Z – transform technique bringing out the elegance of the procedure involved.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 12

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Solution of standard types of first order non linear partial differential equations-simple problems – Lagrange's linear equation – Linear partial differential equations of second and higher order with constant coefficients.

UNIT II FOURIER SERIES **12**

Dirichlet's conditions – General Fourier series – Odd and even functions – Half range sine series – Half range cosine series – Complex form of Fourier Series – Parseval's identity – Harmonic Analysis.

UNIT III BOUNDARY VALUE PROBLEMS **12**

Classification of second order quasi linear partial differential equations – Solutions of one dimensional wave equation – One dimensional heat equation – Steady state solution of two-dimensional heat equation (Insulated edges excluded) – Fourier series solutions in Cartesian coordinates.

UNIT IV FOURIER TRANSFORM **12**

Fourier integral theorem (without proof) – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of simple functions – Convolution theorem – simple problems.

UNIT V Z -TRANSFORM AND DIFFERENCE EQUATIONS **12**

Z-transform - Elementary properties – Inverse Z – transform – Convolution theorem -Formation of difference equations – Solution of difference equations using Z - transform.

TOTAL: 60

TEXT BOOKS

1. Grewal, B.S., "*Higher Engineering Mathematics*", Thirty Sixth Edition, Khanna Publishers, Delhi, 2001.
2. Kandasamy, P., Thilagavathy, K., and Gunavathy, K., "*Engineering Mathematics Volume III"*, S. Chand & Company ltd., New Delhi, 1996.
3. Wylie C. Ray and Barrett Louis, C., "*Advanced Engineering Mathematics*", Sixth Edition, McGraw-Hill, Inc., New York, 1995.

REFERENCES

1. Andrews, L.A., and Shivamoggi B.K., "*Integral Transforms for Engineers and Applied Mathematicians,"* MacMillan, New York, 1988.
2. Narayanan, S., Manikavasagom Pillai, T.K. and Ramaniah, G., *"Advanced Mathematics for Engineering Students", Volumes II and III,* S. Viswanathan (Printers and Publishers) Pvt. Ltd. Chennai, 2002.
3. Churchill, R.V. and Brown, J.W., "*Fourier Series and Boundary Value Problems"*, Fourth Edition, McGraw-Hill Book Co., Singapore, 1987.

ME 1202	FLUID MECHANICS AND MACHINERY	L T P C 3 1 0 4
GOAL	To introduce the behaviour of fluids, kinematics and dynamics of fluids and hydraulic Machines	

OBJECTIVES	OUTCOME
The course should enable the student to :	The student should be able to understand :
1. Understand the principles of Basic concepts and properties of Fluid	1. The basic terms like Pressure , Density, Surface Tension & Fluid Statics
2. Understand the Fluid Kinematics and its Dynamics	2. The types of flows , stream functions, Velocity Potential & familiarize in equations of Fluid Motion
3. Study the basic concepts of Incompressible Flows	3. The Laminar Flows , Flow through Pipes , Boundary Layers
4. Study the basic concepts of Fluid Machines and Hydraulic turbines	4. The working Principles of Various Turbines like Keplon , Pelton , Francis
5. To study the Hydraulic pumps & its applications	5. The working Principles of Pumps like Centrifugal & Reciprocating Pumps

UNIT I BASIC CONCEPTS AND PROPERTIES 6

Fluid – definition, distinction between solid and fluid - Units and dimensions - Properties of fluids - density, specific weight, specific volume, specific gravity, temperature, viscosity, compressibility, vapour pressure, capillary and surface tension - Fluid statics: concept of fluid static pressure, absolute and gauge pressures - pressure measurements by manometers and pressure gauges.

UNIT II FLIUD KINEMATICS AND FLUID DYNAMICS 12

Fluid Kinematics - Flow visualization - lines of flow - types of flow - velocity field and acceleration - continuity equation (one and three dimensional differential forms). Equation of streamline - stream function - velocity potential function - circulation - flow net. Fluid dynamics - equations of motion - Euler's equation along a streamline - Bernoulli's equation – applications - Venturi meter, Orifice meter, Pitot tube - dimensional analysis - Buckingham's π theorem- applications - similarity laws and models.

UNIT III INCOMPRESSIBLE FLUID FLOW 12

Viscous flow - Navier-Stoke's equation (Statement only) - Shear stress, pressure gradient relationship - laminar flow between parallel plates - Laminar flow through circular tubes (Hagen poiseulle's) - Hydraulic and energy gradient - flow through pipes - Darcy -weisback's equation - pipe roughness -friction factor- Moody's diagram-minor losses - flow through pipes in series and in parallel - power transmission - Boundary layer flows, boundary layer thickness, boundary layer separation - drag and lift coefficients.

UNIT IV HYDRAULIC TURBINES 8

Fluid machines: definition and classification - exchange of energy - Euler's equation for turbo machines - Construction of velocity vector diagram's - head and specific work - components of energy transfer - degree of reaction.

Hydro turbines: definition and classifications - Pelton turbine - Francis turbine - propeller turbine - Kaplan turbine - working principles - velocity triangles - work done - specific speed - efficiencies - performance curve for turbines.

UNIT V HYDRAULIC PUMPS 7

Pumps: definition and classifications - Centrifugal pump: Classifications, working principles, velocity triangles, specific speed, efficiency and performance curves. Reciprocating pump: classification, working principles, indicator diagram, work saved by air vessels and performance curves - cavitations in pumps - rotary pumps, working principles of gear and vane pumps

TOTAL: 45

TEXT BOOKS

1. Anderson, J.D., *"Fundamentals of Aerodynamics"*, McGraw-Hill Book Co., New York, 1985.

REFERENCES

1.Houghton, E.L., and Carruthers, N.B., *"Aerodynamics for Engineering students"*, Edward Arnold PublishersLtd., London, 1989.

2. Milne Thomson, L.H., "*Theoretical aerodynamics*", Macmillan, 1985.

3. Clancey, L.J., *"Aerodynamics"*, Pitman, 1986

CY 1203	ENVIRONMENTAL SCIENCE AND ENGINEERING	L T P C 3 0 0 3
Goal	To impart basic knowledge on the significance of environmental science for engineers.	

OBJECTIVES	OUTCOME
The objective of the course is • To make the students aware of the existing natural resources such as forest water resources etc. and to educate them to understand the need for preserving the resources.	Upon successful completion of the course, the outcomes are as follows: • The students would have understood the effects of over exploitation of water resources, forest resources etc. and their impact on day to day life on earth.
• To educate the students about the functions of various ecosystems and biodiversity.	• Knowledge on the functions of several of ecosystems will help the students to design the processes that are eco friendly.
• To provide knowledge on the various aspects of different types of pollution such as air pollution, water pollution, soil pollution etc.	• Knowledge on the different types of pollution will help the young minds to device effective control measures to reduce rate of pollution.
• To give a basic knowledge on the social issues such as global warming, acid rain, ozone layer depletion, nuclear hazards etc. and to	• Exposure on the issues such as global warming, acid rain, ozone layer depletion, and nuclear hazards will make the students understand the significances of sustainable

educate them about the various Environmental Protection Acts.	development and the need to enforce Environmental Acts.
• To create an awareness among the present generation about the various aspects of human population and their effect on environment.	• Educating on the various aspects of population explosion will create awareness on population control for effective utilization of the resources and the need to explore new alternate energy resources for a healthy environment.

UNIT I INTRODUCTION TO ENVIRONMENTAL STUDIES AND NATURAL RESOURCE

(10)

Definition, scope and importance – Need for public awareness – Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – Role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.

Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT II ECOSYSTEMS AND BIODIVERSITY 14

Concept of an ecosystem – Structure and function of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to Biodiversity – Definition: genetic, species and ecosystem diversity – Biogeographical classification of India – Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-spots of biodiversity – Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – Endangered and endemic species of India – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

Field study of common plants, insects, birds

Field study of simple ecosystems – pond, river, and hill slopes, etc.

UNIT III ENVIRONMENTAL POLLUTION 8

Definition – Causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – Soil waste Management: Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: floods, earthquake, cyclone and landslides.

Field Study of local polluted site – Urban / Rural / Industrial / Agricultural

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, rain water harvesting, watershed management – Resettlement and rehabilitation of people; its problems and concerns, case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – Wasteland reclamation – Consumerism and waste products – Environment Production Act – Air (Prevention and Control of Pollution) Act – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Issues involved in enforcement of environmental legislation – Public awareness

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – Population explosion – Family Welfare Programme – Environment and human health – Human Rights – Value Education – HIV / AIDS – Women and Child Welfare – Role of Information Technology in Environment and human health – Case studies.

TOTAL : 45

TEXT BOOKS

1. Gilbert M.Masters, Introduction to Environmental Engineering and Science, Pearson Education Pvt., Ltd., Second Edition, ISBN 81-297-0277-0, 2004.
2. Miller T.G. Jr., Environmental Science, Wadsworth Publishing Co., 1971.
3. Townsend C., Harper J and Michael Begon, Essentials of Ecology, Blackwell Science, 1999.
4. Trivedi R.K. and P.K. Goel, Introduction to Air Pollution, Techno-Science Publications, 1998.

REFERENCES

1. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad India, 2004.
2. Trivedi R.K., Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards, Vol. I and II, Enviro Media.

3. Cunningham, W.P.Cooper, T.H.Gorhani, Environmental Encyclopedia, Jaico Publ., House, Mumbai, 2001.
4. Wager K.D., Environmental Management, W.B. Saunders Co., Philadelphia, USA, 1998.

AE 1202	AERO ENGINEERING THERMODYNAMICS	L T P C 3 1 0 4

GOAL:	To give a brief background of application of various laws of thermodynamics and its application in heat transfer, refrigeration and air-conditioning, jet propulsion system.

OBJECTIVES	OUTCOME
1. The subject should enable the students to have a basic idea about Thermodynamic Systems, and processes.	1.The student should be able to understand the basic thermodynamic systems.
2. The student should understand the air cycles like (**Otto**, Diesel, Dual combustion and Brayton combustion cycles) ,They should understand PV diagrams of four stroke and two stroke IC Engines.	2.Understanding about the air cycles, and understanding about the plot of the PV diagrams of four stroke and two stroke IC Engines
3.To understand the thermodynamics of One Dimensional fluid flow and the application of Continuity and energy equations Properties of steam .To understand the Simple jet propulsion system and Thrust rocket motor	3.Understand about the One Dimensional fluid flow and the applications of the Continuity equation and understand about the simple jet propulsion systems.
4.To understand about the refrigeration and Principles of Air conditioning and understand the Coefficient of performance and Properties of refrigerants.	4.Understand about the Principles of refrigeration and Air conditioning and understand the Coefficient of performance and Properties of refrigerants.

UNIT I BASIC THERMODYNAMICS 12

Systems, Zeroth Law, First Law - Heat and work transfer in flow and non-flow processes, Second law, Kelvin- Planck statement - Clausius statement - concept of entropy - Clausius inequality - entropy change in non-flow processes.

UNIT II AIR CYCLES 12

Otto, Diesel, Dual combustion and Brayton combustion cycles – Air standard efficiency - Mean effective pressure – Actual and theoretical PV diagrams of four stroke and two stroke IC Engines.

UNIT III THERMODYNAMICS OF ONE DIMENSIONAL FLUID FLOW 12

Application of Continuity and energy equations- Properties of steam - Rankine cycle - Isentropic flow of ideal gases through nozzles - Simple jet propulsion system - Thrust rocket motor – Specific impulse.

UNIT IV REFRIGERATION AND AIR CONDITIONING 12

Principles of refrigeration, Air conditioning - Heat pumps - Vapour compression - Vapour absorption types - Coefficient of performance, Properties of refrigerants.

UNIT V AIR COMPRESSORS 12

Classification and working principle, work of compression with and without clearance, Isothermal and Isentropic efficiency of reciprocating air compressors, multistage compression and intercooling. Various types of compressors (Descriptive treatment only.

Total 60

TEXT BOOKS

1. Rathakrishnan, E, *"Fundamentals of Engineering Thermodynamics"*, Prentice – Hall, India, 2000

2. Nag. P.K., "Engineering Thermodynamics", Tata McGraw-Hills Co., Ltd., Seventh Edn., 1993

3.Yunus A.Cengal. *"Thermodynamics an Engineering Approach"*, Tata McGraw-Hill Co. Ltd., 3rd Edition, 2002.

REFERENCES

1. Mayhew, A. and Rogers, B., *"Engineering Thermodynamics"*, Longman Green & Co. Ltd., London, E.L.B.S. Edition, 1990.

2. Van Wylen, G.J. and Sonntag, R.E., *"Fundamentals of Classical Thermodynamics* (S.I.Version)", Second Edition, 1986.

3. Bacon, D.H., *"Engineering Thermodynamics*", Butterworth & Co., London, 1989.

4. Saad, M.A., *"Thermodynamics for Engineers*", Prentice-Hall of India Pvt. Ltd., 1989.

5. Reynolds, *"Thermodynamics*", Int. Student Edn., McGraw-Hill Book Co., Ltd., 1990

AE 1203	SOLID MECHANICS	L T P C 3 1 0 4
Goal	Understanding effects of loads on structures --- loads could be tension, compression, bending, twisting --- arriving at the stresses & strains and establish factors of safety	

Objectives	Outcome
The course should enable the student : 1. Stress and Strain – Hooke's Law – Elastic constants and their relationship– Statically determinate cases - bar with uniform and varying section statically indeterminate cases –composite bar. Thermal Stresses – stresses due to freely falling weight. 2. Shear force and bending moment diagrams for simply supported and cantilever beams – Bending stresses in straight beams – Shear Stresses in bending of beams with various cross sections – beams of uniform strength 3. Beam Deflections though various methods 4. Torsion of circular shafts - shear stresses and twist in solid and hollow circular shafts – closely coiled helical springs. 5. Stresses in thin circular cylinder and spherical shell under intl pressure, volumetric Strain. Combined loading,	The students should be able to: 1. Proportional Limit, Elastic Limit, Elastic Constants and relations. Determinacy and indeterminacy. Elongation of bars with uniform varying section. Elongation of compound bars and thermal stresses 2. Calculation of reaction forces. Differentiate between cantilever and simple support beams. Draw the shear force and bending moment diagrams for various load cases. Establish the relation between Moment, Moment of Inertia, Radius of curvature, Young's modulus. Understand shear stresses and obtain shear stress for various cross sections. 3. Double integration method – McCauley's method - Area moment method – Conjugate beam method. 4. Distinguish difference between bending moment & twisting moment and effects of twisting moment. Find out shear stresses for solid & hollow shafts and study of helical springs 5. Understand Hoops stress, Meridonal stress for thin cylinders and obtain pressure for spherical shell. Calulate principal planes and find principal stresses. Represent as Mohor's circles in graphical form

Principal and maximum Shear Stresses - Analytical and Graphical methods.	

UNIT I - BASICS AND AXIAL LOADING **12**

- Stress and Strain – Hooke's Law – Elastic constants and their relationship– Statically determinate cases - bar with uniform and varying section statically indeterminate cases – composite bar. Thermal Stresses – stresses due to freely falling weight.

UNIT II - STRESSES IN BEAMS **12**

- Shear force and bending moment diagrams for simply supported and cantilever beams – Bending stresses in straight beams – Shear Stresses in bending of beams with various cross sections – beams of uniform strength

UNIT III - DEFLECTION OF BEAMS **12**

- Double integration method – McCauley's method - Area moment method – Conjugate beam method.

UNIT IV – TORSION **12**

- Torsion of circular shafts - shear stresses and twist in solid and hollow circular shafts – closely coiled helical springs.

UNIT V - BI AXIAL STRESSES **12**

- Stresses in thin circular cylinder and spherical shell under internal pressure, volumetric Strain. Combined loading, Principal Stresses and maximum Shear Stresses - Analytical and Graphical methods.

Total **60**

TEXT BOOKS

Nash William – "*Strength of Materials"*, TMH, 1991

Timoshenko.S. and Young D.H. – "*Elements of strength materials* Vol. I and Vol. II"., T. Van Nostrand Co-Inc Princeton-N.J. 1990.

REFERENCES

1. Dym C.L. and Shames I.H. – "*Solid Mechanics*", 1990.

AS1201	INTRODUCTION TO AEROSPACE ENGINEERING	L T P C 3 0 0 3
GOAL	To introduce the basic concepts of aerospace engineering and the current developments in the field.	

OBJECTIVES	OUTCOME
The course should enable the student to : 1. Understand the Historical evaluation of Airplanes 2. Study the different component systems and functions 3. Understand the basic principles behind propulsion of flight 4. Study the different structures & construction 5. Study the various types of instruments and navigation systems	The student should be able to understand : 1. The history of aircraft & developments over the years 2. The types & classifications of components and configurations. 3. The basic concepts of propulsion and power plants 4. The types of fuselage, constructions and materials 5. Different types of navigation and instruments for flight

AS 1201 INTRODUCTION TO AEROSPACE ENGINEERING 3 0 0 3

OBJECTIVE:

To introduce the basic concepts of aerospace engineering and the current developments in the field.

UNIT I HISTORICAL EVALUATION 9

History of aviation, early development of airplanes, biplanes and monoplanes, history of spaceflight, development of space vehicle, classification of duct jet propulsion, rocket propulsion, advance propulsion and applications.

UNIT II CONFIGURATIONS 9

Anatomy of flight vehicles, components of an airplanes and their function, configuration of space vehicle, earth's atmosphere and gravitational field, bluff bodies v/s streamlined body, airfoil. lift generation, significance of L/D ratio, aerodynamic forces.

UNIT III PROPULSION 9

Classification and essential features of propulsion, jet propulsion, general characteristics of rocket engines, theory of propulsion, elementary gas dynamics, spacecrafts and aircraft performance.

UNIT IV AEROSPACE STRUCTURES AND MATERIALS 9

General types of construction and structural layout, flight envelope and V-n diagrams, monocoque, semimonocoque, corrugated, sandwich structure, reinforced and honeycomb structures, geodesic construction, aerospace materials, metallic and non metallic materials, use of aluminum alloy, titanium, stainless steel, composite and ceramic materials.

UNIT V INSTRUMENTS AND NAVIGATION 9

Basic instrumentation electronics (dc electronics, ac electronics, semiconductors, electro-optics and digital electronics), sensing devices, bridge circuits, optical devices and introduction to computer based data acquisition, measurements in aerodynamics, flight structures, and flight control, principles of navigation, celestial, radio, and inertial navigation schemes, navigational and guidance requirements for orbital, planetary, and atmospheric entry missions.

TOTAL: 45

TEXT BOOKS:

1. Shevel, “Fundamentals of Flight”, Prentice Hall, 1989.
2. Merrill, G., “Principle of Guided Missile Design”, D. Van Nostrand Co., INC., 1977

REFERENCES:

1. Anderson, J. D., “Introduction to Flight”, McGraw-Hill, 2000.
2. Kermode, A. C., “Flight without Formulae”, Pitman, 1970

AE 1205	STRENGTH OF MATERIALS LABORATORY	L T P C 0 0 3 2
GOAL	To develop the knowledge in testing the materials for hardness, fatigue, impact, tension and torsion.	

S.No	OBJECTIVE	OUTCOME
1	To test a specimen using Brinell hardness testing machine.	The hardness of the material is found out and verified.
2	To test a specimen using Rockwell hardness testing machine.	The hardness of the material is found out and verified.
3	To perform tension test on mild steel a rod using universal testing machine.	The yield load, ultimate load of the mild steel rod is found out.
4	To perform torsion test on a mild steel rod using universal testing machine.	The ultimate torque of the mild steel rod is found out.
5	To perform impact test using Izod impact testing machine.	The impact load of the material is found out.
6	To perform impact test using Charpy impact testing machine.	The impact load of the material is found out.
7	To perform fatigue test in rotating beam using fatigue tester	The fatigue load of the rotating beam is found out.
8	To perform tension and compression test on open and closed helical spring setup.	The ultimate compressive load and tensile loads are found out.
9	To perform tension and compression test on wood using UTM .	The ultimate compressive load is found out
10.	To verify Maxwell reciprocal theorem	Maxwell reciprocal thermo is verified.

LIST OF EXPERIMENTS

1. Hardness test - a)Vickers b) Brinell c) Rockwell
2. Tension test
3. Torsion test
4. Impact test – a) Izod b) Charpy c) Drop Test.
5. Fatigue test - a) Reverse plate bending b) Rotating Beam
6. Testing of springs
7. Block Compression Test

LIST OF EQUIPMENTS

S.No	Details of Equipments	Qty Required	For Experiments
1	Brinell Hardness Testing Machine	1	1
2	Rockwell Hardness Testing Machine	1	1
3.	Universal Testing Machine	1	2,3,7
4.	Izod Impact Testing Machine	1	4
5.	Charpy Impact Testing Machine	1	4
6.	Fatigue tester- Rotating Beam	1	5
7.	Fatigue tester –Reverse plate bending	1	5

CS 1233	COMPUTER PROGRAMMING LAB - II	L T P C 0 0 3 1
GOAL	To make the students understand the basics of programs in C++ and JAVA	

OBJECTIVES	OUTCOME
1.To develop a program for compile time polymorphism	1. Understand the compile time polymorphism.
2. To develop a program for runtime polymorphism	2.Clearly understand the runtime polymorphism
3. To develop a program for file handling	3. To get a clear idea file handling in C++
4. To develop a program for simple JAVA applications.	4. To get a clear idea about simple JAVA applications.
5. To develop a program for simple package creation	5.Understand the program for simple package creation
6. To develop a program for user defined interfaces	6. To Understand user defined interfaces
7. To develop a program for threads and multi threading	7. To Understand threads and multi threading
8.To develop a program for handling pre-defined exceptions	8.Can clearly understand the handling pre-defined exceptions
9.To develop a program for designing a web page using applets	9. To understand importance of designing a web page using applets
10. To process file in JAVA	10.To understand importance of processing file in JAVA

LIST OF EXPERIMENTS
C++

1. Compile time Polymorphism
   Operator overloading including Unary and Binary Operators.
   Function Overloading

2. Runtime Polymorphism
   Inheritance
   Virtual Functions
   Virtual Base Classes
   Templates

3. File Handling
   Sequential Access
   Random Access

JAVA

1. Simple Java Applications
   - for understanding reference to an instance of a class(object),methods
   - Handling Strings in Java

2. Simple package creation.
   - Developing user-defined packages in Java

3. Interfaces
   - Developing user- defined Interfaces and implementation
   - use of predetermined Interfaces

4. Threading
   - Creation of threads in Java Applications
   - Multithreading

5. Exception Handling Mechanism in Java
   - Handling pre-defined exceptions
   - Handling user-defined exceptions

6. Applets
   - Designing a web page using Applets
   - Graphics Programming

7. File Processing

TOTAL: 60

AE 1207	THEROMODYNAMICS LAB	L T P C 0 0 3 1
GOAL	To make the students understand the basics of Thermodynamics and carry out various experiments on Heat exchanger and stroke engines	

OBJECTIVES	OUTCOME
1.To carry out performance test on a 4 stroke region	1.Understand the 4 stroke engine cycle and performance
2. To carry out valve timing of a 4 stroke engine and Port timing of a 2 stroke engine	2.Clearly understand the port timing mechanism and valve timing mechanism of stroke engine
3.To carry out test on effectiveness of a parallel flow heat exchanger	3. To get a clear idea about effectiveness of a parallel flow heat exchanger
4. To carry out test on effectiveness of a counter flow heat exchanger	4. To get a clear idea about effectiveness of a counter flow heat exchanger
5.To carry out test for determination of viscosity of a given liquid	5.Understand the viscosity effects in a given fluid flow
6. To carry COP test on a vapour compression refrigeration test rig.	6. To carry COP test on a vapour compression refrigeration test rig
7. To carry COP test on a vapour compression A/C test rig	7. To carry COP test on a vapour compression A/C test rig
8.To study about the characteristics of a Gas turbine Engine	8.Can clearly understand the performance of a Gas Turbine Engine
9.To carry out experiment on evaluation of conductive Heat transfer coefficient	9. To understand importance of thermal resistance of composite wall
10. To carry out experiment on evaluation of thermal resistance of composite wall	10.To understand importance of thermal resistance of composite wall

LIST OF EXPERIMENTS

1. Performance test on a 4-stroke engine
2. Valve timing of a 4 – stroke engine and port timing of a 2 stroke engine
3. Determination of effectiveness of a parallel flow heat exchanger
4. Determination of effectiveness of a counter flow heat exchanger
5. Determination of the viscosity coefficient of a given liquid
6. COP test on a vapour compression refrigeration test rig
7. COP test on a vapour compression air-conditioning test rig
8. Study of a Gas Turbine Engine.
9. Determination of Conductive Heat Transfer Coefficient.
10. Determination of Thermal Resistance of a Composite wall.

LIST OF EQUIPMENTS

Sl.No	**Details of Equipments**	**Qty Req.**	**Experiment No.**
1.	4 stroke twin cylinder diesel engine	1	1
2.	Cut section model of 4 stroke kirloskar diesel engine and cut section model of 2 stroke petrol engine	1	2
3.	Parallel and counter flow heat exchanger test rig	1	3,4
4.	Red wood viscometer	1	5
5.	Vapour compression refrigeration test rig	1	6

SEMESTER IV

MA 1204	NUMERICAL METHODS	L T P C 3 1 0 4
Goal	To create the awareness and comprehensive knowledge in numerical solutions.	

Objectives	Outcome
The course should enable the students to: 1) Learn the techniques of solving the algebraic and transcendental equations. 2) Learn to interpolate using Newton's forward and backward difference formulae for equal and unequal intervals 3) Understand the use of numerical differentiation and understands to find the approximate area using numerical integration. 4) Understand solving numerically the initial value problems for ordinary differential equations using single step and multi step method. 5) Learn the methods of solving second order partial differential equations numerically and use it to solve initial and boundary value problems for partial differential equations.	The students should be able to: 1) Find out the roots of nonlinear (algebraic or transcendental) equations, solutions of large system of linear equations by direct and indirect methods. 2) Solve problems where huge amounts of experimental data are involved, the methods discussed on interpolation will be useful in constructing approximate polynomial to represent the data and to find the intermediate values. 3) Use the numerical differentiation and integration when the function in the analytical form is too complicated or the huge amounts of data are given such as series of measurements, observations or some other empirical information. 4) Solve engineering problems which are characterized in the form of nonlinear ordinary differential equations, since many physical laws are couched in terms of rate of change of oneindependent variable 5) Solve the initial and boundary value problems related heat flow, both one and two dimensional and vibration problems. Understands the numerical techniques of solving the partial differential equation in engineering applications.

UNIT I SOLUTION OF ALGEBRAIC AND TRANSCENDENTAL EQUATIONS 12

Linear interpolation methods (method of false position) – Newton's method – Statement of Fixed Point Theorem - Fixed point iteration: x=g(x) method. Solution of linear algebraic system of equations – Direct methods - Gauss-Jordon method and Crout's method - Iterative method: Gauss-Seidel method.

UNIT II INTERPOLATION AND APPROXIMATION 12

Interpolation – equal intervals – Newton's forward and backward difference formulae – problems. Interpolation-unequal intervals – Newton's divided difference formula – Lagrange's and inverse interpolation-problems.

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 12

Numerical differentiation – Newton's forward and backward difference - Divided differences and finite differences – Numerical integration by trapezoidal and Simpson's 1/3 and 3/8 rules. Two and Three point Gaussian quadrature formulae – Double integrals using trapezoidal and Simpson's rules.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 12

Single step methods: Taylor series method – first order-second order and simultaneous – Euler and Modified Euler methods. Fourth orderRunge – Kutta method for solving first and second order equations – Multi-step methods: Milne's and Adam's predictor and corrector methods.

UNIT V INITIAL AND BOUNDARY VALUE PROBLEMS FOR PARTIAL DIFFERENTIAL EQUATIONS 12

Finite difference solution of second order ordinary differential equation – classification of partial differential equations - Finite difference solution of two dimensional heat flow equations Laplace and Poisson equations. One dimensional heat equation by explicit and implicit methods – One dimensional wave equation

TOTAL: 60

TEXT BOOKS

1. Kandasamy P, Thilagavathy K, Gunavathy K, "*Numerical Methods*", S.Chand Co. Ltd., New Delhi, 2003.
2. Chandrasekaran A. and Beena James, "*Numerical Methods*", Dhanam publications, Chennai, 2011.

REFERENCES

1. Burden R.L, and Faires T.D, "*Numerical Analysis*", Seventh Edition, Thomson Asia Pvt. Ltd., Singapore, 2002.
2. Gerald C.F, Wheatley P.O, "*Applied Numerical Analysis*", Sixth Edition, Pearson Education Asia, New Delhi, 2002.
3. Balagurusamy E, "*Numerical Methods*", Tata McGraw-Hill Pub.Co.Ltd, New Delhi, 1999.

AS1202	AEROSPACE STRUCTURES – I	L T P C 3 1 0 4
GOAL	Analysis and design simple a/c structural components	

OBJECTIVES	OUTCOME
The course should enable the student : 1. Understand various structural elements 2. Understand statically determinate and indeterminate structural analysis. 3. Understand various energy method 4. able to understand columns with various end condition. 5. To understand various failure theories	The students should be able to: 1. Analysis structural elements in aircraft. 2. Solve three moment equation and moment distribution. 3. To make simplified analysis of a/c structures & apply energy methods. 4. Understand and solve the column problems 5. Apply failure theories for various loading conditions

UNIT I STATICALLY DETERMINATE STRUCTURES **12**

Analysis of plane truss – Method of joints – 3 D Truss - Plane frames

UNIT II STATICALLY INDETERMINATE STRUCTURES **12**

Composite beam - Clapeyron's Three Moment Equation - Moment Distribution Method.

UNIT III ENERGY METHODS **12**

Strain Energy due to axial, bending and Torsional loads – Castigliano's theorem - Maxwell's Reciprocal theorem, Unit load method - application to beams, trusses, frames, rings, etc.

UNIT IV COLUMNS **12**

Columns with various end conditions – Euler's Column curve – Rankine's formula - Column with initial curvature - Eccentric loading – South well plot – Beam column.

UNIT V FAILURE THEORY **12**

Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum Strain energy theory – Application to aircraft Structural problems.

TOTAL 60

TEXT BOOK1. Donaldson, B.K., "*Analysis of Aircraft Structures – An Introduction*", McGraw-Hill, 1993.

REFERENCE

Timoshenko, S., "*Strength of Materials"*, Vol. I and II, Princeton D. Von Nostrand Co, 1990.

AE 1208	AERODYNAMICS – I	L T P C 3 1 0 4
GOAL	To study aerodynamic concepts and understanding motion of air around an object enables the calculation of forces and moments acting on the object.	

OBJECTIVES	OUTCOME
The course should enable the student : 1) To understand the fluid mechanics concepts for advanced applications 2) To study two dimensional flows in aerodynamics 3) To integrate the mathematics with aerodynamics 4) To study ideal flows over wings 5) To study real time viscous flows	Student should able to: 1) Should be able to apply fluid mechanics concepts 2) Should be able to model flow over wing 3) Should be able to differentiate between ideal and real flows 4) Develops mathematical modelling ability. 5) Understand the real time viscous flow and Boundary Layer behaviour.

UNIT I REVIEW OF BASIC FLUID MECHANICS 6

Continuity, momentum and energy equations.

UNIT II TWO DIMENSIONAL FLOWS 14

Basic flows – Source, Sink, Free and Forced vortex, uniform parallel flow. Their combinations,Pressure and velocity distributions on bodies with and without circulation in ideal and real fluidflows. KuttaJoukowski's theorem.

UNIT III CONFORMAL TRANSFORMATION 12

Joukowski transformation and its application to fluid flow problems, Kutta condition, Blasius theorem.

UNIT IV AIRFOIL AND WING THEORY 14

Joukowski, Karman - Trefftz, Profiles - Thin aerofoil theory and its applications. Vortex line, Horse shoe vortex, Biot and Savart law, Lifting line theory and its limitations

UNIT V VISCOUS FLOW 14

Newton's law of viscosity, Boundary Layer, Navier-Stokes equation, displacement, Momentum thickness, Flow over a flat plate, Blasins solution.

TOTAL 60

TEXT BOOKS

1. Anderson, J.D., *"Fundamentals of Aerodynamics"*, McGraw-Hill Book Co., New York, 1985.

REFERENCES

1. Houghton, E.L., and Carruthers, N.B., *"Aerodynamics for Engineering students"*, Edward Arnold Publishers Ltd., London, 1989.

2. Milne Thomson, L.H., "*Theoretical aerodynamics*", Macmillan, 1985.

3. Clancey, L.J., "*Aerodynamics"*, Pitman, 1986

AS1203	PROPULSION-I	L T P C 3 1 0 4
GOAL	To study in detail about fundamentals of aircraft propulsion, advanced propulsion systems in gas turbine engine and rocket propulsion.	

Objectives	Outcome
The course should enable the student to : 1. To know the fundamentals of gas turbines and its components 2. To know the steady one dimensional flow of perfect gas. 3. To know the different types of gas turbine engines and engine performances. 4. To study the fundamentals of rocket propulsion. 5. To study the performance of aerospace vechilces.	The student should be able to understand : Understand the working principle of gas turbine engines, thermodynamic cycles and performance characteristics of gas turbine engines. To understand the internal flow and external characteristics near the inlets. Starting problems and different modes of operation in supersonic inlets. To understand the types and working of gas tubine engines To understand the types of rocket, missiles and its basic configuration To know the performance charectersitcs of solid, liquid and hybrid rocket..

UNIT I INTRODUCTION TO AIRCRAFT PROPULSION 11

Introduction to propulsion , Basic thermodynamics , Fundamental equations, Types of aircraft engines , Performance parameters , thrust equation , factors affecting thrust and efficiencies.

UNIT II STEADY ONE DIMENSIONAL FLOW 11

One dimensional flow of a perfect gas, isentropic flow, non-isentropic flow , frictionless constant area flow , constant area flow with friction , without friction , normal shock and oblique shocks

UNIT III FUNDAMENTALS OF GAS TURBINE ENGINES 13

Working principle of gas turbine engine, gas turbine cycle, turboprop, turbofan and turbojet engines – Thrust and efficiency – Methods of thrust augmentation — Engine Performance characteristics.

UNIT IV FUNDAMENTALS OF ROCKET PROPULSION 12

History of rocket propulsion, types of rocket, Basic configurations and application –Types of missiles and their structure, Heat transfer and cooling system in rocket , classification of Chemical rocket propulsion system.

UNIT V PERFORMANCE OF AEROSPACE VEHICLES **13**

Static performance, vehicle acceleration, performance characteristics, nozzle, solid, liquid and hybrid rocket and their propellants..

TOTAL: 60

TEXT BOOKS

1. Hill, P.G. & Peterson, C.R. “Mechanics & Thermodynamics of Propulsion” Addison – Wesley Longman INC, 1999.
2. G.P Sutton & O. Biblarz, “Rocket Propulsion Elements”, John Wiley & Son Inc., 2001.

REFERENCES

1. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H. “Gas Turbine Theory”, Longman, 1989.
3. Oates, G.C., “Aero thermodynamics of Aircraft Engine Components”, AIAA Education Series, New York, 1985.
4. “Rolls Royce Jet Engine” – Third Edition – 1983.
5. Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors,Delhi,1999.

AE 1211	CONTROL ENGINEERING	L T P C 3 0 0 3
GOAL	To understand the basic concepts of flight control system.	

OBJECTIVES	OUTCOME
The course should enable the student to :	The student should be able to understand :
1.Study and solve problems on Simple pneumatic, hydraulic and thermal systems, Mechanical and electrical component analogies.	1.The Simple pneumatic, hydraulic and thermal systems, Mechanical and electrical component analogies based problems.
2.Study and solve problems on Block diagram representation of control systems, Reduction of block diagrams, Signal flow graph.	2.The Block diagram representation of control systems, Reduction of block diagrams, Signal flow graph and problems based on it.
3.Study and solve problems on Response of systems to different inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit.	3.The Response of systems to different inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit and problems based on it.
4.Study and solve problems on Routh – Hurwitz criteria of stability, Root locus and Bode techniques, Concept and construction, frequency response	4.The Routh – Hurwitz criteria of stability, Root locus and Bode techniques, Concept and construction, frequency response and problems based on it.
5.Study about digital control system, Digital Controllers and Digital PID Controllers.	5.The digital control system, Digital Controllers and Digital PID Controllers.

UNIT I INTRODUCTION 6

Historical review - Simple pneumatic, hydraulic and thermal systems, Series and parallel systems, Analogies - Mechanical and electrical components, Development of flight control systems.

UNIT II OPEN AND CLOSED LOOP SYSTEMS 6

Feedback control systems – Block diagram representation of control systems, Reduction of block diagrams, Output to input ratios, Signal flow graph.

UNIT III CHARACTERISTIC EQUATION AND FUNCTIONS 10

Laplace transformation, Response of systems to different inputs viz., Step input, impulse, ramp, parabolic and sinusoidal inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit.

UNIT IV CONCEPT OF STABILITY 15

Necessary and sufficient conditions, Routh – Hurwitz criteria of stability, Root locus and Bode techniques, Concept and construction, frequency response.

UNIT V SAMPLED DATA SYSTEMS 8

Introduction to digital control system, Digital Controllers and Digital PID Controllers.

TOTAL 45

TEXT BOOKS

1. OGATO, "*Modern Control Engineering*", Prentice – Hall of India Pvt. Ltd. New Delhi, 1991.
2. GOPAL.M. "*Control Systems, Principles and design*" – Tata McGraw-Hill Publication, New Delhi, 2000.

REFERENCES

1. Azzo, J.J.D. and C.H. Houpis, "*Feed back control system analysis and synthesis*", McGraw – Hill International, 3rd Edition, 1998.
2. Kuo, B.C., "*Automatic control systems*", Prentice – Hall of India Pvt. Ltd., New Delhi, 1998.
3. Houpis, C.H. and Lamont, G.B., "*Digital Control Systems*", McGraw-Hill Book Co. New York, USA 1995.
4. Naresh K. Sinha, "*Control Systems*", New Age International Publishers, New Delhi

AS 1204	ELEMENTS OF AVIONICS	L T P C 3 0 0 3
GOAL	To understand the basic concepts of avionics systems.	

OBJECTIVES	OUTCOME
The course should enable the student to : 1.Study about Need for Avionics in civil and military aircraft and space systems 2.Study about the principles of digital systems 3. Study about some of the digital avionics architecture. 4.to study about the flight deck and cockpit instruments. 5.Study about avionics systems like communication system and navigation systems.	The student should be able to understand : 1.The avionics system in weapons design and technologies are studied. 2.The digital computers, microprocessors and memories are studied. 3.The avionics system architecture like date bus MIL STD 1553, B ARINC 429 are studied. 4.The control and display technologies like CRT, LED, LCD EL and plasma panel are studied. 5.The communication system , flight control system and radar electronic warfare.

UNIT I INTRODUCTION TO AVIONICS 6

Need for Avionics in civil and military aircraft and space systems – Integrated Avionics and Weapon system – Typical avionics sub systems – Design and Technologies.

UNIT II PRINCIPLES OF DIGITAL SYSTEMS 10

Digital Computers – Microprocessors – Memories

UNIT III DIGITAL AVIONICS ARCHITECTURE 6

Avionics system architecture–Data buses MIL–STD 1553 B–ARINC 429–ARINC 629.

UNIT IV FLIGHT DECK AND COCKPITS 8

Control and display technologies CRT, LED, LCD, EL and plasma panel - Touch screen - Direct voice input (DVI) - Civil cockpit and military cockpit : MFDS, HUD, MFK, HOTAS

UNIT V INTRODUCTION TO AVIONICS SYSTEMS 15

Communication Systems - Navigation systems - Flight control systems - Radar electronic warfare - Utility systems Reliability and maintainability - Certification.

TOTAL: 45

TEXT BOOKS

1. Malcrno A.P. and Leach, D.P., “Digital Principles and Application”, Tata McGraw-Hill, 1990.
2. Gaonkar, R.S., “Microprocessors Architecture – Programming and Application”, Wiley and Sons Ltd., New Delhi, 1990.

REFERENCES

1. Middleton, D.H., Ed., “Avionics Systems, Longman Scientific and Technical”, Longman Group UK Ltd., England, 1919.
2. Spitzer, C.R., “Digital Avionic Systems”, Prentice Hall, Englewood Cliffs, N.J., USA., 1917.
3. Brain Kendal, “Manual of Avionics”, The English Book HOuse, 3rd Edition, New Delhi, 1993.

AS1205	AEROSPACE STRUCTURES LAB - I	L T P C 0 0 3 1
GOAL	The objective of conducting the aerospace structure laboratory is to make the students understand and appreciate various principle and theorems involved in the theory of aerospace structures, vibrations and experimental stress analyzing the results. This will immensely help the students to enrich their knowledge in the design of various aerospace structural components, namely, wings, fuselage, landing gear, control surfaces, etc.	

OBJECTIVES	OUTCOME
1.Determination of young's modulus of steel using mechanical extensometers.	To understand the basic concepts of material and science and real experience getting to determine a young's modulus value of Aluminum.
2. Determination of young's modulus of steel using Electrical extensometers.	To understand the difference of accuracy and precision value from both mechanical and electrical extensometer.
3. Determination of fracture strength and fracture pattern of ductile materials.	To understand the breaking strength which specimen fail via fracture. Determined by given the specimen by tensile load test. More understand about materials stress strain relationship.
1. Determination of fracture strength and fracture pattern of brittle materials.	To understand the difference of brittle and ductile materials. Studies on deformation elastic and plastic and metal fatique. More understand that failure of compressive stress.
2. Stress strain curve for various engineering materials	To understand the application of Aircraft material science.
3. Deflection of beams at various end condition	To determine the deflection of a simply supported beams and better understand of types of beams and application.
4. Verification of Maxwell's reciprocal theorem and principle of super position	To verify the Maxwell's theorem using the supported beam and tested.
5. Column Testing	To determine the buckling load of the column in various section like fixed and hinged.
6. South – Well's plot	To determine the buckling load of the column in various section like fixed and hinged and more understand about the south well's theorem.
7. Riveted joints	To analyze the riveted joints and type s. and more understand about the high strength structural steel rivet, semi tabular rivet, blind rivet, drive rivet, flush and frictional lock rivet.

LIST OF EXPERIMENTS

1. Determination of Young's modulus of steel using mechanical extensometers.
2. Determination of Young's modulus of aluminium using electrical extensometers
3. Determination of fracture strength and fracture pattern of ductile materials
4. Determination of fracture strength and fracture pattern of brittle materials
5. Stress Strain curve for various engineering materials.
6. Deflection of beams with various end conditions.
7. Verification of Maxwell's Reciprocal theorem & principle of superposition
8. Column – Testing
9. South – well's plot.
10. Riveted Joints.

LIST OF EQUIPMENTS

Sl. No.	Equipments	Qty	Experiments No.
1.	Universal Testing Machine	1	1,2,3,4,5,10
2.	Mechanical Extensometer	1	1
3.	Electrical stain gauge	10	2
4.	Stain indicator	1	2,5
5.	Dial Gauges	12	3,4
6.	Beam Test set up with various end conditions	2	6,7
7.	Weight 1 Kg	10	6,7
8.	Weight 2 Kg	10	6.7.8
9.	Weight Pans	6	6,7,8
10.	Column Test Apparatus	1	5,6.7,8
11.	Rivet	30	10

AE 1213	FLUID MECHANICS AND MACHINERY LAB	L T P C 0 0 3 1
GOAL	To find the performance of pump like centrifugal pump, reciprocating pump, Gear pump. To find the coefficient of discharge of orifice meter and venturimeter. Conducting the characteristic curves of Kaplan turbine, Francis turbine and Pelton wheel.	

OBJECTIVES	OUTCOME
The subject should enable the student to:	The students should be able to:
1. Understand the properties of the fluid and also to learn about the pressure and velocity of the flowing fluid using venturimeter, orifice meter.	1. Determine the coefficient of discharge of orifice meter and venturimeter.
2. Understand the discharge of fluid by using pump like centrifugal, reciprocating and gear pump and also to find the rate of flow using rota meter.	2. Conduct experiments and draw the characteristic curves of centrifugal pump, submergible pump, reciprocating pump, Gear pump and also can find the discharge of the pump.
3. Understand the efficiency of turbine like Kaplan and francis.	3. Conduct experiments and draw the characteristics curves of Francis turbine and Kaplan turbine and also can find the efficiency of the turbine.
4. Understand the change in pressure (friction factor) of given set of pipes.	4. Conduct experiments and draw the characteristics curves of Pelton wheel.
5. Understand the efficiency of Pelton wheel.	5. Determine the friction factor of given set of pipes when there is change in pressure& Calculate the rate of flow using Rotameter.

LIST OF EXPERIMENTS

1. Calibration of venturimeter
2. Pressure measurement with Pitot static tube
3. Determination of pipe flow losses.
4. Verification of Bernoulli's theorem
5. Flow visualization by Heleshaw apparatus
6. Performance test on centrifugal pumps
7. Performance test on reciprocating pumps
8. Performance test on pelton wheel turbine
9. Performance test on Francis turbine
10. Determination of Viscosity of a Fluid

LIST OF EQUIPMENTS

Sl.No	Details of Equipments	Qty Req.	Experiment No.
1.	Venturimeter setup	1	1,3
2.	Pipe friction set up	1	3
3.	Pitot tube set up	1	2,4
4.	Jet pump	1	6
5.	Submersible pump	1	6
6.	Centrifugal pump	1	6
7.	Reciprocating pump	1	7
8.	Pelton wheel turbine and Francis turbine	1	8,9
9.	Viscosity Meter	1	10
10.	Hele-shaw apparatus	1	5

AS1206	AERODYNAMICS LAB I	L T P C 0 0 3 1
GOAL	To study experimentally the aerodynamic forces on different bodies at low speeds.	

OBJECTIVES	OUTCOME
The course should enable the student : 1. To study performance of subsonic wind tunnel. 2.To study experimentally the pressure distribution of circular, symmetric and unsymmetrical aerofoil 3. To know theForce measurement using wind tunnel balance 4. To study Flow visualization studies in low speed flow over airfoil with different angle of incidence 5. To study performance of supersonic wind tunnel.	The students should be able to: 1. Measure the velocity of the subsonic wind tunnel at various RPM 2. Pressure distribution of various aerofoils can be identified and lift can be calculated 3. Coefficient of Lift and drag for symmetric and unsymmetrical aerofoils are analysed. 4. Identify the various flows acting on the aerofoil 5. Study the Supersonic flow and characteristics of it.

To study experimentally the aerodynamic forces on different bodies at low speeds.

LIST OF EXPERIMENTS

1. Calibration of subsonic wind tunnel.
2. Pressure distribution over smooth and rough cylinder.
3. Pressure distribution over symmetric airfoil.
4. Pressure distribution over cambered airfoil& thin airfoils
5. Force measurement using wind tunnel balance.
6. Flow over a flat plate at different angles of incidence
7. Flow visualization studies in low speed flow over cylinders
8. Flow visualization studies in low speed flow over airfoil with different angle of incidence
9. Calibration of supersonic wind tunnel.
10. Supersonic flow visualization with Schlieren system.

LIST OF EQUIPMENT

Sl.No.	Items	Quantity	Experiment No.
1.	Wind Tunnel test section size around 300 x 300 mm with test section flow speed of 70 m/s.	1 No.	1, 2,3,4,5
2.	Wings of various airfoil sections (Symmetrical & cambered airfoils)	2 Nos. each	3, 4
3.	Angle of incidence changing mechanism	1 No.	3, 4
4.	Multiple Manometer stands with 20 – 30 manometer tubes	4 Nos.	2,3,4
5.	U-Tube Manometer	1 No.	1,2,3,4
6.	Static Pressure Probes	4 Nos.	1,2,3,4
7.	Total Pressure Probest	4 Nos.	1,2,3,4
8.	Pitot-Static Tubes	4 Nos.	1,2,3,4
9.	Wooden Models of Three Dimensional bodies (eg. Cylinder etc.,)	2 Nos. each	2
10.	Wind Tunnel balances (3 or 5 or 6 components)	1 No.	5
11.	Pressure Transducers with digital display	1 No.	1,2,3,4
12.	Hele-Shaw apparatus, Smoke Tunnel, Water flow channel	1 each	6,7,8
13.	Supersonic Wind tunnel of test section size 100 x 100 mm with storage tank capacity of 500ft^2 at 20 bar	1 No.	9,10
14.	Wooden models of cone, wedge and blunt body configurations of suitable size for flow visualization in a supersonic wind tunnel test section	1 No.	9,10
15.	Schlieren System	1 No.	9,10

SEMESTER – V

AS 1301	AEROSPACE STRUCTURES –II	L T P C 3 1 0 4
GOAL	**ANALYSIS AND DESIGN OF AIRCRAFT STRUCTURES**	
OBJECTIVES		**OUTCOME**
The course should enable to 1.Understand Unsymmetrical bending 2. Understand shear centre and shear flow 3.Resistance of torque by cells 4. Understand buckling problems 5.Study Tension field beams		Student should able to 1.Analyze for maximum bending stress in unsymmetrical sections 2.Analyze for flexural shear stress 3.Analyze for Torsional shear stress 4.Panel Buckling allowable load 5.Analyze for flange and web load

UNIT I - UNSYMMETRICAL BENDING 11

Bending stresses in beams of unsymmetrical sections – Bending of symmetric sections with Skew loads.

UNIT II - SHEAR FLOW IN OPEN SECTIONS 13

Thin walled beams, Concept of shear flow, shear centre, Elastic axis. With one axis of Symmetry, with wall effective and ineffective in bending, unsymmetrical beam sections.

UNIT III -SHEAR FLOW IN CLOSED SECTIONS 13

Bredt – Batho formula, Single and multi cell structures. Approximate methods. Shear flow in single & multi cell structures under torsion. Shear flow in single and multicell under bending with walls effective and ineffective.

UNIT IV- BUCKLING OF PLATES 13

Rectangular sheets under compression, Local buckling stress of thin walled sections, Crippling stresses by Needham's and Gerard's methods. Thin walled column strength. Sheet stiffener panels. Effective width, inter rivet and sheet wrinkling failures.

UNIT V STRESS ANALYSIS IN WING AND FUSELAGE 10

Shear and bending moment distribution for semi cantilever and other types of wings and Fuselage, thin webbed beam. With parallel and non parallel flanges, Shear resistant web beams, Tension field web beams (Wagner's).

TOTAL :60

TEXT BOOK

1.Bruhn. E.H. "*Analysis and Design of Flight vehicles Structures*", Tri – state off set company, USA, 1973.

REFERENCES

1. Peery, D.J., and Azar, J.J., "*Aircraft Structures*", 2nd edition, McGraw–Hill, N.Y., 1993.

2. Megson, T.M.G., "*Aircraft Structures for Engineering Students"*, Edward Arnold, 1995.

3.Rivello, R.M., "*Theory and Analysis of Flight Structures*", McGraw-Hill, 1993.

AS 1302	FLIGHT MECHANICS-I	L T P C 3 1 0 4
GOAL	To study the aircraft properties and performances and to learn the drag characteristics of the airplane.	

OBJECTIVES The course should enable the student to	OUTCOME The students should be able to:
Study about the various characteristics of aircraft.	Understand the airplane as a dynamic system, equilibrium conditions.
To understand drag force acting on an airplane, and variations due to velocity and altitude.	The different types of drag and drag polar.
To study about the various types of power plant and its characteristics.	Understand the variation of thrust, power, SFC with velocity and altitude.
To understand elements of airplane performance.	Understanding about performance in level flight, minimum drag and power required, climbing, gliding and turning flight, VN diagram and load factor.
To understand the basics of helicopter mechanics	Understand the principles and mechanics behind the Helicopter flight.

UNIT I AIRCRAFT PROPERTIES 12

The airplane as a rigid body, the airplane as a dynamic system, Equilibrium conditions, Static stability conditions, Airplane dynamics, Airplane control .Aerodynamic properties of wing and its components.

UNIT II DRAG ESTIMATION 12

Drag aerodynamics – Dimensional Analysis, Potential flow, induced drag, Flow of viscous fluid, parasite drag, and flow of a compressible fluid. Aerodynamic data – section characteristics, plan form characteristics, high lift and control devices, Determination of three dimensional wing data. Estimation of airplane drag, low speed drag estimation, high speed drag estimation.

UNIT III PROPULSION 12

Power plant type & efficiency, power plant data, reciprocating engine cooling drag, propeller charts.

UNIT IV AIRPLANE PERFORMANCE **12**

Performance computation , generalized performance method, compressibility speed correction , Range and Endurance, Take – off and landing distances , acceleration in climb , turning performance , design performance.

UNIT V HELICOPTER ROTOR AERODYNAMICS AND PERFORMANCE **12**

Introduction, effect of gyroscopic precession, Torque reaction and directional control, dissymmetry of lift, Blade tip stall , Translating tendency and its correction, coriolis effect and compensation, vortex ring state, power settling, over pitching, Auto-rotation, Ground effect.

TOTAL: 60

TEXT BOOKS

1. Perkins, C.D., and Hage, R.E., "Airplane Performance Stability and Control", John Wiley & son Inc., New York, 1988.

2. Leishman, J.G., "Principle of Helicopter Aerodynamics", Cambridge Aerospace.

REFERENCES

1. Etkin, B., "Dynamics of Flight Stability and Control", Edn. 2, John Wiley, New York, 1982.
2. Babister, A.W., "Aircraft Dynamic Stability and Response", Pergamon Press, Oxford, 1980.
3. Dommasch, D.O., Shelby, S.S., and Connolly, T.F., "Aeroplane Aero dynamics", Third Edition, Issac Pitman, London, 1981.
4. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 1998.

AE 1304	AERODYNAMICS - II	L T P C 3 1 0 4
GOAL	To understand the behaviour of airflow both internal and external in compressible flow regime with particular emphasis on supersonic flows	

OBJECTIVES	OUTCOME
The course should enable the student to :	The student should be able to understand :
1. Study the basic equations of one dimensional compressible flow.	1. The energy, momentum and continuity equations.
2. Study about the normal, oblique shock waves and expansion waves.	2. The various parameters affecting the normal and oblique shock waves.
3. Study the differential equations of motion for steady compressible flow.	3. The various theories regarding the steady compressible flow.
4. Study about the airfoils in high speed flows.	4. The various parameters of airfoil in high speed flow.
5. Study about the high speed wind tunnels.	5. The various methods for creating supersonic flow in wind tunnels.

UNIT I ONE DIMENSIONAL COMPRESSIBLE FLOW 10

Energy, Momentum, continuity and state equations, velocity of sound, Adiabatic steady state flow equations, Flow through converging, diverging passages, Performance under various back pressures.

UNIT II NORMAL, OBLIQUE SHOCKS AND EXPANSION WAVES 18

Prandtl equation and Rankine – Hugonoit relation, Normal shock equations, Pitot static tube, corrections for subsonic and supersonic flows, Oblique shocks and corresponding equations, Hodograph and pressure turning angle, shock polars, flow past wedges and concave corners, strong, weak and detached shocks, Rayleigh and Fanno Flow. Flow past convex corners, Expansion hodograph, Reflection and interaction of shocks and expansion, waves, Families of shocks, Methods of Characteristics, Two dimensional supersonic nozzle contours.

UNIT III DIFFERENTIAL EQUATIONS OF MOTION FOR STEADY COMPRESSIBLE FLOW 12

Small perturbation potential theory, solutions for supersonic flows, Mach waves and Mach angles, Prandtl-Glauert affine transformation relations for subsonic flows, Linearised two dimensional supersonic flow theory, Lift, drag pitching moment and center of pressure of supersonic profiles.

UNIT I V AIRFOIL IN HIGH SPEED FLOWS 9

Lower and upper critical Mach numbers, Lift and drag divergence, shock induced separation, Characteristics of swept wings, Effects of thickness, camber and aspect ratio of wings, Transonic area rule, Tip effects.

UNIT V HIGH SPEED WIND TUNNELS 11

Blow down, indraft and induction tunnel layouts and their design features, Transonic, supersonic and hypersonic tunnels and their peculiarities, Helium and gun tunnels, Shock tubes, Optical methods of flow visualization.

TOTAL: 60

TEXT BOOK

1. Rathakrishnan, E., “Gas Dynamics”, Prentice Hall of India, 2003.

REFERENCES

1. Shapiro, A.H., “Dynamics and Thermodynamics of Compressible Fluid Flow”, Ronold Press, 1982.
2. Zucrow, M.J. and Anderson, J.D., “Elements of gas dynamics”, McGraw-Hill Book Co., New York, 1989.
3. Mc Cornick. W., “Aerodynamics, Aeronautics and Flight Mechanics”, John Wiley, New York, 1979.
4. Anderson Jr., D., – “Modern compressible flows”, McGraw-Hill Book Co., New York 1999.

AS 1303	PROPULSION-II	L T P C 3 1 0 4
GOAL	To study in detail about fundamentals of aircraft propulsion, advanced propulsion systems in gas turbine engine.	

Objectives	Outcome
The course should enable the student to : 1. To know the design and performance of subsonic and supersonic inlets. 2. To study the axial compressors and their working principles. 3. To study the centrifugal compressors and their working principle. 4. To know the different types of combustion chambers and factors affecting the combustors. 5. To study the types of nozzles and flow conditions in nozzles.	The student should be able to understand : To understand the internal flow and external characteristics near the inlets. Starting problems and different modes of operation in supersonic inlets. To know the types and working principles of axial compressors, its velocity diagrams, blade design and performance characteristics of compressors. To know about the working principles of centrifugal compressors, its velocity diagrams. To understand the types and working methods in combustion chambers. The flame stabilization and flame techniques. To understand the flow through nozzle, choking, losses in nozzle, variable area nozzle and thrust vectoring.

UNIT I DIFFUSER 12

Subsonic inlet and Internal flow – Major features of external flow – Relation between minimum area ratio and external deceleration ratio – Supersonic inlets – Starting problem on supersonic inlets – Shock swallowing by area variation – External deceleration – Modes of inlet operation.

UNIT II AXIAL COMPRESSOR 12

Working principle of axial compressor, Elementary theory – Velocity triangles, Degree of reaction – Three dimensional flow – Compressor blade design & stage performance calculation – Factors affecting stage pressure ratio , off design performance- Axial compressor performance characteristics.

UNIT III CENTRIFUGAL COMPRESSOR 12

Working principle of centrifugal compressor – Work done and pressure rise – Inducer and impellor - Velocity diagrams – Compressor stage design – Concept of pre-whirl – Rotation stall –Centrifugal compressor performance characteristics.

UNIT IV COMBUSTION CHAMBERS 12

Classification of combustion chambers – Important factors affecting combustion chamber design – Combustion process – Combustion chamber performance – Effect of operating variables on performance – Flame tube cooling – Flame stabilization – Use of flame holders – Numerical problems.

UNIT V NOZZLES 12

Theory of flow in isentropic nozzles – Convergent nozzles and nozzle choking – Nozzle throat conditions – Nozzle efficiency – Losses in nozzles – Over expanded , under – expanded nozzles , Ejector and variable area nozzles .

TOTAL: 60

TEXT BOOKS

1. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Addison – Wesley Longman INC, 1999.

REFERENCES

1. Cohen, H., Rogers, G.F.C. and Saravanamuttoo, H.I.H., "Gas Turbine Theory", Longman Co., ELBS Ed., 1989.
2. Mathur, M., and Sharma, R.P., "Gas Turbines and Jet and Rocket Propulsion", Standard Publishers, New Delhi, 1988.

AS 1304	AIRCRAFT MAINTENANCE PRACTICES	L T P C 3 0 1 3
GOAL	To study the aircraft maintenance practices and the tools used for the same and also to understand the non destructive testing procedures.	

Objectives	Outcome
The course should enable the student to :	The student should be able to understand :
1. To know the various maintenance practices made in an aircraft.	The maintenance practices, tools and wrenches.
2. To study about the various devices, tools and drawings of components.	The tools used and drawings and diagrams of nuts and bearings.
3. To study about the various aircraft materials and corrosion types.	The various materials and corrosion control and protection.
4. To study about the various NDT methods, welding, soldering and brazing.	The NDT methods, welding, soldering and brazing.
5. To study about the electric cables, connectors, hoses and cables.	The electric cables, connectors, instruments, testing equipments and calibration methods.

UNIT I AIRCRAFT MAINTENANCE PRACTICES 9

Standard Maintenance Practices - Aircraft Maintenance Practices - General Purpose Tools - Measuring Tools - Torque Wrenches and Torque Loading Practice

UNIT II TOOLS 7

Aircraft Fastening Devices – Bolts and Screws, Nuts and Washers, Locking Devices and Springs, Engineering Drawings and Diagrams, Bearings and Gears,

UNIT III AIRCRAFT MATERIALS 11

Aircraft Materials – Ferrous, Non-Ferrous and Composite/Non-Metallic. Corrosion and Corrosion Control and Protection

UNIT IV NON-DESTRUCTIVE TESTING (NDT) AND WELDING 11

Penetrant Methods, Non-Destructive Testing Processes. Soldering, Welding and Brazing

UNIT V AIRCRAFT MISCELLANOUS 7

Electrical Cables and Connectors, Usage of Electrical Instruments and Equipment, Testing and Calibration Methods, Pipes, Hoses and Control Cables, Aircraft Weight and Balance Control, Quality System and Procedures.

TOTAL: 45

REFERENCES:

1. Civil Aircraft Inspection Procedures (CAP 459-Part I, Basic)
2. Airframe & Powerplant Mechanics (General Handbook EA-AC 65-9A)
3. James Anderson Earl E. Tatro , “Shop Theory”
4. Dale Crane, “Training Manual General Section Book 1 thru 7”
5. Titterton , “Aircraft Materials & Processes”
6. AC Parkinsons, “Machine Drawing”
7. Cindy Foreman, “Advanced Composites (EA-358)”
8. Malvino and Leech , “Digital Fundamentals”
9. Standard Aviation Maintenance Handbook EA-282-0
10. Larry Reithmaier , “Standard Aircraft Handbook (5th Edition)”

AS 1305	ELEMENTS OF VIBRATION	L T P C 3 0 0 3
GOAL	To study the dynamic behaviour of different aircraft components and the interaction among the aerodynamic, elastic and inertia forces	

Objectives	Outcome
The course should enable the student to :	The student should be able to understand :
1. To know the basic notations used in vibration.	The SHM, Newton's Law AND Energy methods.
2. To study about the systems with single degree of freedom.	The concept of free vibrations, damped vibrations and forced vibrations with and without damping.
3. To study about the systems with two degree of freedom.	The concept of static and dynamic coupling vibration absorber and Eigen value problems.
4. To study about the systems with multi degree of freedom.	The Hamilton's principle- Lagrangean equation its application and Vibration of elastic bodies.
5. To study about the methods used to solve vibration problems	The various computational techniques in vibration and equation of motion of complete system.

UNIT I BASIC NOTIONS 7

Simple harmonic motion – Terminologies – Newton's Law – D' Alembert's principle – Energy Methods

UNIT II SINGLE DEGREE OF FREEDOM SYSTEMS 10

Free vibrations – Damped vibrations – Forced Vibrations, with and without damping – support excitation – Vibration measuring instruments.

UNIT III . TWO DEGREES OF FREEDOM SYSTEMS 10

Two degrees of freedom systems – Static and Dynamic couplings vibration absorber- Principal co-ordinates, Principal modes and orthogonal condition – Eigen value problems.

UNIT IV MULTI DEGREE FREEDOM SYSTEM 10

Hamilton's principle- Lagrangean equation and application – Vibration of elastic bodies- Vibration of strings- Longitudinal, Lateral and Torsional vibrations.

UNIT V SOLUTION METHOD 8

Computational technique in vibration, Vibrating string, General method, Beam element, Global matrices, Transformation of matrices, Equation of motion of complete system, Consistent and Lambard mass.

TOTAL: 45

TEXT BOOKS

1. Timoshenko S., “Vibration Problems in Engineering”– John Wiley and Sons, New York, 1993.

REFERENCES

1. Tse. F.s., Morse, I.F., Hunkle, R.T., “Mechanical Vibrations”, – Prentice Hall, New York, 1984.
2. Scanlan R.H. & Rosenbaum. R., “Introduction to the study of Aircraft Vibration & Flutter”, John Wiley and Sons. New York, 1982.
3. Benson H.Tongue, “Principles of Vibration”, Oxford University Press, 2000

AS 1306	PROPULSION LAB - I	L T P C 0 0 3 1
GOAL	To understand concepts of aircraft propulsion and carry out experiments	

OBJECTIVES	OUTCOME
1. To study aircraft piston engine, and the assembly of sub systems	1.Knowledge about the various systems of aircraft piston engine and show the systems on the engines available in the Lab
2. To understand aircraft piston engine's components, functions, operating principles	2. Learn about the working cycle of the aircraft piston engine and description of various components and its functions.
3. To study aircraft jet engine, and the assembly of sub systems	3.Gain knowledge about systems that form a jet engine by showing the systems on the engines that are available in the Aero Hangar
4. To understand aircraft jet engine's components, functions, operating principles	4. Learn about the working cycle of the aircraft jet engine and description of various components and its functions by visually them on the engines available in the Aero Hangar.
5. To study about forced Convective Heat transfer	5.Understanding the concept of forced convective heat transfer and perform experiment on the heat transfer apparatus
6. To study about free Convective heat transfer	6.Understanding the concept of free convection heat transfer and perform experiment on the heat transfer apparatus

LIST OF EXPERIMENTS

1. Study of an aircraft piston engine - assembly of sub systems
2. Study of an aircraft piston engine - various components, their functions and operating principles
3. Study of an aircraft jet engine - assembly of sub systems,
4. Study of an aircraft jet engine - various components, their functions and operating principles
5. Study of forced convective heat transfer.
6. Study of free convective heat transfer.

LIST OF EQUIPMENTS

Sl.No	Equipments	Qty	Experiments No.
1	Piston engines	2	1
2	Jet Engine /Engine model	1	2
3	Forced Convective apparatus	1	3
4	Free Convective apparatus	1	4

AS 1307	AERODYNAMICS LAB - II	L T P C 0 0 3 1
GOAL	To study experimentally the aerodynamic forces on different bodies at low speeds.	

OBJECTIVES	OUTCOME
The course should enable the student to perform experiments in wind tunnel for	The student should be able to understand
1. A flat plate at different angles of incidence	1. Flow over the flat plate at low speed.
2. Flow visualisation over cylinder at low speeds.	2.Flow patterns on the cylinder.
3. Flow visualisation over an airfoil at low speeds with various angle of incidence.	3. Flow patterns on the airfoil with various angle of attack.
4.Calibration of supersonic wind tunnel	4.The methods involved in calibrating the supersonic wind tunnel.
5.Supersonic flow visualisation with Schlieren method	5.The Schliren method of flow visualisation
6. Flow visualisation over a missile body.	6. Flow patterns on a missile body.
7. Boundary Layer Calculation.	7. The method for calculating the boundary layer.

LIST OF EXPERIMENTS

1. Flow over a flat plate at different angles of incidence
2. Flow visualization studies in low speed flows over cylinders
3. Flow visualization studies in low speed flows over airfoil with different angle of incidence
4. Calibration of supersonic wind tunnel.
5. Supersonic flow visualization with Schlieren system.
6. Flow visualization over missile body.
7. Boundary Layer Calculation.

LIST OF EQUIPMENT

1.	Pressure Transducers with digital display	1 No.	1,2,3,4
2.	Hele-Shaw apparatus, Smoke Tunnel, Water flow channel	1 each	1,2,3
3.	Supersonic Wind tunnel of test section size 100 x 100 mm with storage tank capacity of 500ft^2 at 20 bar	1 No.	4,5
4.	Wooden models of cone, wedge and blunt body configurations of suitable size for flow visualization in a supersonic wind tunnel test section	1 No.	4,5
5.	Schlieren System	1 No.	4,5

AS 1308	FLIGHT DYNAMICS LAB	L T P C 0 0 3 1
GOAL	To understand the flight behavior of aerospace vehicle.	

OBJECTIVES	OUTCOME
The course should enable the student to	The student should be able to understand
1.Learn about various instrumentation techniques and data reduction methods.	1.The instrumentation techniques and data reduction methods.
2. Calibration of flight and special flight test instruments.	2. The testing method for calibrating the flight.
3. Evaluation of glider drag polar.	3.The methods used for evaluating the drag polar of gliders.
4. Evaluation of cruise and climb Performance of a small airplane.	4. The methods used for evaluating climb and cruise performance of aircraft.
5. Determination of static and maneuver stability and control characteristics.	5. The methods used for Determination of static and maneuver stability and control characteristics.
6. Observations of airplane dynamic modes and stall characteristics.	6. The methods used for Observing of airplane dynamic modes and stall characteristics.
7. Study about GPS and auto pilot	7. The aspects of GPS and auto pilot

LIST OF EXPERIMENTS

1. Introduction to flight testing,
2. Instrumentation, techniques and data reduction methods,
3. Calibration of flight and special flight test instruments.
4. Evaluation of glider drag polar.
5. Evaluation of cruise and climb performance of a small airplane.
6. Determination of static and maneuvre stability and control characteristics.
7. Observations of airplane dynamic modes and stall characteristics.
8. Introduction to GPS based navigation.
9. Introduction to auto-pilot.

SEMESTER- VI

AS 1310	PROPULSION-III	L T P C 3 1 0 4
GOAL	To study in detail about fundamentals of rocket propulsion, chemical rockets, advanced propulsion systems.	

Objectives	**Outcome**
The course should enable the student to : 1. To study the basics of ramjet with their performance characteristics 2. To study the solid rocket propellant and their working principles 3. To study about liquid rocket propellants and their components 4. To study the advances in rocket propulsion and space propulsion 1. 5. To study the basics of scramjet with their performance characteristics	The student should be able to understand : To understand the operating principle of ramjet, combustion and its performance. To understand the solid rocket operating principles and components of solid rocket motor. To understand in detail about liquid propellant rockets and the various types of propellants used with their burning rates. To understand about electric, ion and nuclear rockets. The basics of solar sails and its operating principle. Basics of scramjet engine and integral ram engine.

UNIT I RAMJET PROPULSION 13

Operating principle – Sub critical, critical and supercritical operation – Combustion in ramjet engine – Ramjet performance – Sample ramjet design calculations – Introduction to scramjet – supersonic combustion – Numerical problems.

UNIT II SOLID PROPELLANT ROCKETS 13

Solid propellant rockets – Selection criteria of solid propellants, hazards – Important hardware components of solid rockets – Propellant grain design considerations , combustion of solid propellants, Numerical problems.

UNIT III LIQUID PROPELLANT ROCKETS 13

Liquid propellant rockets – Selection of liquid propellants – Thrust control in liquid rockets – Cooling in liquid rockets – Limitations of hybrid rockets – Relative advantages of liquid rockets over solid rockets- Numerical Problems.

UNIT IV ADVANCED PROPULSION TECHNIQUES 9

Electric rocket propulsion –Electrostatic , Electro thermal ,Electro magnetic thruster , Ion propulsion techniques – Nuclear rocket propulsion – Types , applications – Solar propulsion system, solar sail.

UNIT V SCRAMJET PROPULSION 12

Fundamentals of hypersonic air birthing vehicles, Preliminary concepts in engine airframe integration, Various types of supersonic combustors, Requirements for supersonic combustors, Performance estimation of supersonic combustors.

TOTAL: 60

TEXT BOOKS

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edition, 1993.
2. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Addison – Wesley Longman INC, 1999.

REFERENCES

1. Gorden, C.V., "Aero thermodynamics of Gas Turbine and Rocket Propulsion", AIAA Education Series, New York, 1989.
2. Mathur, M., and Sharma, R.P., "Gas Turbines and Jet and Rocket Propulsion", Standard Publishers, New Delhi, 1988.

AS1311	FLIGHT MECHANICS II	L T P C 3 1 0 4
GOAL	To understand the performance of an aircraft in various operating conditions, and static, dynamic response for different disturbances	

OBJECTIVES	OUTCOME
1. To understand static longitudinal stability of an aircraft(stick fixed)	Knowledge about degrees of stability stability, stability criteria, effect of fuselage and CG location, stick forces, aerodynamic balancing.(stick fixed)
2. To understand static longitudinal stability of an aircraft(stick free condition)	Knowledge about degrees of stability stability, stability criteria, effect of fuselage and CG location, stick forces, aerodynamic balancing.(stick free condition)
3. To understand lateral and directional stability	3. Understanding about lateral control, rolling and yawing moments, static directional stability, rudder and aileron control requirements and rudder lock
4. To understand dynamic stability of an aircraft	4. Understanding about dynamic longitudinal stability, stability derivatives, modes and stability criterion, lateral and directional dynamic stability
5. To understand the helicopter flight dynamics	5. Understanding the rotor function in vertical flight, rotor mechanism

UNIT I STATIC LONGITUDINAL STABILITY AND CONTROL (Stick Fixed) 13

Degree of freedom of rigid bodies in space - Static and dynamic stability - Purpose of controls in airplanes -Inherently stable and marginal stable airplanes – Static, Longitudinal stability - Stick fixed stability - Basic equilibrium equation - Stability criterion - Effects of fuselage and nacelle - Influence of CG location - Power effects - Stick fixed neutral point.

UNIT II STATIC LONGITUDINAL STABILITY AND CONTROL (Stick Free) 13

Stick free stability-Hinge moment coefficient - Stick free neutral points-Symmetric maneuvers - Stick force gradients - Stick _ force per 'g' - Aerodynamic balancing. Determination of neutral points and maneuver points from flight test.

UNIT III LATERAL AND DIRECTIONAL STABILITY 11

Dihedral effect - Lateral control - Coupling between rolling and yawing moments - Adverse yaw effects - Aileron reversal - Static directional stability - Weather cocking effect - Rudder requirements - One engine inoperative condition - Rudder lock.

UNIT IV DYNAMIC STABILITY 13

Dynamic longitudinal stability: Equations of motion - Stability derivatives - Characteristic equation of stick fixed case - Modes and stability criterion - Effect of freeing-the stick - Brief description of lateral and directional. Dynamic stability - Spiral, divergence, Dutch roll, auto rotation and spin.

UNIT V HELICOPTER FLIGHT DYNAMICS 10

Rotor function in vertical flight, Rotor Mechanism for forward flight, Trim, Stability and control.

TOTAL: 60

TEXT BOOKS

1. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley & Son:, Inc, New York, 1988.
2. J.Seddon, "Basic Helicopter Aerodynamics", AIAA Series, 1990.

REFERENCES

1 . Etkin, B., "Dynamics of Flight Stability and Control", Edn. 2, John Wiley, New York, 1982.
2. Babister, A.W., "Aircraft Dynamic Stability and Response", Pergamon Press, Oxford, 1980.
3. Dommasch, D.O., Shelby, S.S., and Connolly, T.F., "Aeroplane Aero dynamics", Third Edition, Issac Pitman, London, 1981.
4. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 1998.

AS1312	ADVANCED MATERIALS & PERFORMANCE	L T P C 3 0 0 3
GOAL	To understand the definition of various terms used for classification of materials. Mechanical properties. Testing of aircraft materials. Classification of alloys of aluminum, steel, titanium etc.	

OBJECTIVES	OUTCOME
1. To study about the various materials and alloys.	Knowledge about materials their properties, testing and classification of alloys.
2. To study about the various smart and intelligent materials	Knowledge about piezo, pyro, and ferro electric effects and its application to aerospace vechicles.
2. To study about fatigue performance of materials	3. Understanding about S-N curves, high and low cycle fatigue.
3. To study about the materials used in cryogenic temperature.	4. Understanding about cryogenic testing equipment, experimental program and low temperature alloys.
4. To study about materials at high temperature.	5. Understanding about the various materials used at high temperature like ceramic and refractory materials.

UNIT I MATERIALS AND ALLOYS **9**

Classification of materials, Mechanical properties, testing of aerospace materials, Classification of alloys – aluminum, steel, titanium, and other alloys used in aerospace.

UNIT II SMART AND INTELLIGENT MATERIALS **9**

Introduction, piezo, pyro and Ferro electric effects, hysteretic effects, fundamentals of continuum mechanics. Application to aerospace vehicles.

UNIT III FATIGUE PERFORMANCE **9**

S-N curves, endurance limits, effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams, Notches and stress concentration factors, plastic stress concentration factors, High cycle and low cycle fatigue, cumulative damage – Minor's theory.

UNIT IV MATERIALS AT CRYOGENIC TEMPERATURE **9**

Cryogenic testing equipment, Experimental program, cold worked 300 series stainless steel, aluminum alloys, titanium alloys.

UNIT V MATERIALS AT HIGH TEMPERATURE **9**

Material requirements and principles, component system analysis, structural and material analysis, material system principles, ceramic reinforced, refractory materials.

TOTAL: 45

TEXT BOOK

1. E.R.Parker, “Materials for Missiles and Spacecraft”, McGraw Hill Book Co. Inc, 1978

REFERENCES

1. Madayag, A.F., “Metal Fatigue: Theory and Design”, John Wiley & Sons, Inc.1968
2. Broutman, L. J., “Fatigue and Fracture”, Vol. 5, ACADEMIC PRESS, 1974
3. HAND BOOK OF AIRCRAFT MATERIALS, ASTM, 1983

AS 1313	PROPULSION LAB -II	L T P C 0 0 3 1
GOAL	To understand the basic concepts and carryout experiments in Aerospace Propulsion.	

OBJECTIVES	OUTCOME
The course should enable the student to perform	The student should be able to understand
1. Cascade testing of a model of axial compressor blade row.	1.The techniques and methods used in cascade testing of axial compressor.
2. Study of performance of propeller.	2. The performance of propeller and the parameters of propellers.
3.Determination of heat of combustion of aviation fuel using bomb calorimeter.	3.The methods used for finding the heat combustion value of ATF.
4. Combustion performance studies in a jet engine combustion chamber.	4. The methods used for evaluating combustion performance of combustion chamber in jet engine.
5. Study of free jet.	5. The methods used for determining the velocity in free jet.
6. Study of wall jet.	6. The methods used for determining the velocity in wall jet

LIST OF EXPERIMENTS

1. Cascade testing of a model of axial compressor blade row.
2. Study of performance of a propeller.
3. Determination of heat of combustion of aviation fuel.
4. Combustion performance studies in a jet engine combustion chamber.
5. Study of free jet.
6. Study of wall jet

TOTAL : 60

LIST OF EQUIPMENTS

(for a batch of 30 students)

Sl.No	Equipments	Qty	Experiments No.
1	Axial compressor blade row model with pressure tapping	1	1
2	Watertube manometers (20 tubes)	2	1,5,6
3	Subsonic wind tunnel	1	2
4	Propeller model static and total pressure probes	4	2,5,6
5	2-D travers in mechanism	2	1
6.	Freejet test setup	1	5
7	Aluminium plates with deflection mechanisms	1	6

AS 1314	AERODYNAMICS DESIGN LABORATORY	L T P C 1 0 3 1
GOAL	To study and design of model and measurement of Turbulence and Boundary.	

OBJECTIVES	OUTCOME
The course should enable the student to perform 1. Calibration Technique 2. Modelling and scaling 3. Design of a model 4. Flow visualisation 5. Boundary layer & Turbulences	The student should be able to understand 1. Different techniques used in Wind tunnel 2. Parameters related to modelling 3. Steps involved in design 4. Understanding of flows 5. Effect of Boundary and turbulences

LIST OF EXPERIMENTS

6. Simulation of Wind tunnel and calibration
7. Oil flow visualisation technique
8. Modelling and scaling
4. Design of a model and verification of pressure distribution
5. Boundary layer measurement
6. Turbulence effect measurement

AS 1315	EXPERIMENTAL STRESS ANALYSIS LABORATORY	L T P C 0 0 3 1
GOAL	To study and analysis of stress and strain.	

OBJECTIVES	OUTCOME
The course should enable the student to perform 1. Calibration techniques 2. Strain gauges & Usages 3. Fringes 4. Photo elasticity 5. Stress strain curve	The course should be able to understand Different type of strain gauges, balancing of strain Gauges. Calibration techniques. Photo elasticity Methods and visualisation of patterns. Stress strain curve validation.

LIST OF EXPERIMENTS

1. Calibration of electrical strain gauge
2. Calibration of photo elastic model material
3. Wiring electrical strain gauge rosettes to load cells etc.
4. Study of fringes, fringe orders etc., in two-dimensional photo elasticity.
5. Experimental validation for stress strain curve.(aluminum)

EL1331	COMMUNICATION SKILLS LABORATORY II	L T P C 2 0 2 3
Goal	The goal of the programme is to provide an **advanced practical input** towards moulding student-achievers who can use the English language with ease.	

OBJECTIVES	OUTCOME
1. To extend the power of the learners to listen to English at an advanced level and comment on it. 2. To guide the learners to speak English at the formal and informal levels. 3. To enable learners to read and grasp the in-depth meaning of technical and non-technical passages in English. 4. To help the learners develop the art of writing at the formal and informal levels. 5. To expand the thinking capability of the learners so that they would learn how to be original in their thoughts.	1. The learners will be able to listen to and understand English at an advanced level and interpret its meaning. 2. The learners would have developed English at the formal and informal levels and thus gained the confidence to use it without fear. 3. The learners will be able to read and grasp the in-depth meaning of technical and non-technical passages in English. 4. The learners will have developed the art of formal and informal writing. 5. The learners will be able to think independently and creatively and also verbalize their thoughts fearlessly.

SEMESTER VII

AS1401	FLIGHT MECHANICS III	L T P C 3 1 0 4
GOAL	To study the performance of airplanes under various operating conditions and the fundamentals of space mechanics, to study the basic concepts of orbital mechanics with particular emphasis on satellite launching and interplanetary trajectory.	

OBJECTIVES	OUTCOME
To enable the student to 1. Study the basic concepts of space mechanics. 2. Study about the N- body problem in the universe. 3. Study about satellite injection and satellite orbit perturbations. 4. Study about the various stages of ballistic missile trajectory. 5. Study about the interplanetary trajectories.	The student will able to 1. Understand solar time solar system and associated basic terms 2. Understand satellite orbits relation between position and time. 3. Understand satellite orbit transfer, special perturbations. 4. Understand about the various phases in missile launching. 5. Understand about the spacecraft trajectories between planets.

UNIT I BASIC CONCEPTS 12

The solar system, Reference frame and coordinate, the celestial sphere, the ecliptic , sidereal time, solar time, standard time, the earth atmosphere.

UNIT II N- BODY PROBLEM : **12**

The many body problem , circular restricted three body problem , liberation points , two body problem , satellite orbits , relation between position and time, orbital elements .

UNIT III SATELLITE INJECTION AND SATELLITE ORBIT PERTURBATIONS 12

Introduction to satellite injection , satellite orbit transfer, orbit deviation due to injection errors, special and general perturbations, methods of vibration of orbital elements.

UNIT IV BALLISTIC MISSILE TRAJECTORY 12

The boost phase , the ballistic phase, trajectory geometry, optimal flights , time of flight, re-entry phase, the position of the impact point , influence coefficients.

UNIT V INTERPLANETARY TRAJECTORIES 12

Two dimensional interplanetary trajectories, Fast interplanetary trajectories, three dimensional interplanetary trajectories, Launch of Interplanetary spacecraft, Trajectory about the target planet.

TOTAL: 60

TEXT BOOK

1. Cornelisse, J.W., " Rocket propulsion and space dynamics ", W.H. Freeman & co,1984.

REFERENCE

1. Sutton, G. P., "Rocket Propulsion Elements", John Wiley, 1993
2. Van de Kamp, P., "Elements of Astromechanics", Pitman, 1979
3. Parker, E. R., "Materials for Missile and Spacecraft", McGraw-Hill Book Co. Inc., 1982.

AS1402	INTRODUCTION TO COMPOSITE MATERIALS AND STRUCTURES	L T P C 3 1 0 4
GOAL	Analysis and design of composite structures using moulding methods of construction, fabrication to evaluate and understand the concept of laminated plates.	

OBJECTIVES	OUTCOMES
The course should enable the student to : 1. Know the types of composites 2. Understand the need for stress strain relation 3. Understand the fabrication methods 4. Understand the laminated plates 5. Study and understand the different methods & analysis of composite materials.	The students should be able to: 1. Analysis of composite structures 2. Should do microscopic and macroscopic analysis 3. Should analyze sandwich and laminated plates 4. Should be aware of fabrication techniques 5. Should be able to construct and analysis different composite technique.

UNIT I STRESS STRAIN RELATION 9

Introduction- Advantages and application of composite materials, reinforcements and matrices – Generalised Hooke's Law – Elastic constants for anisotropic, orthotropic and isotropic materials.

UNIT II METHODS OF ANALYSIS 15

Micro mechanics – Mechanics of materials approach, elasticity approach to determine material properties – Macro Mechanics – Stress-strain relations with respect to natural axis, arbitrary axis – Determination of material properties. Experimental characterization of lamina.

UNIT III LAMINATED PLATES 15

Governing differential equation for a general laminate, angle ply and cross ply laminates. Failure criteria for composites.

UNIT IV SANDWICH CONSTRUCTIONS 11

Basic design concepts of sandwich construction -Materials used for sandwich construction - Failure modes of sandwich panels.

UNIT V FABRICATION PROCESS 10

Various Open and closed mould processes. Manufacture of fibers – Types of resins and properties and applications – Netting analysis.

TOTAL : 60

TEXT BOOKS

1. Calcote, L R. “The Analysis of laminated Composite Structures”, Von – Noastrand Reinhold Company, New York 1991.
2. Jones, R.M., “Mechanics of Composite Materials”, McGraw-Hill, Kogakusha Ltd., Tokyo, 1915.

REFERENCES

1. Agarwal, B.D., and Broutman, L.J., “Analysis and Performance of Fibre Composites”, John Wiley and sons. Inc., New York, 1995.
2. Lubin, G., “Handbook on Advanced Plastics and Fibre Glass”, Von Nostrand Reinhold Co., New York, 1919.

AS1403	SATELLITES AND SPACE SYSTEM DESIGN	L T P C 3 1 0 4
Pre Requisite	PROPULSION-III	
Goal	To study the fundamentals of the spacecraft and satellite systems design	

Objectives	Outcome
The course should enable the student to :	The student should be able to understand :
To study about the Space system design	To know about the Payloads and missions, system view of spacecraft propulsion system, launch vehicles, and spacecraft mechanisms
To study the Space craft environment and its effects on design	To know about the about Preoperational spacecraft environment, operational spacecraft environments, Environmental effects on design, the sun, the earth, and spacecraft effects, spacecraft structure and thermal control.
To study the Space craft systems	To know about the various Attitude control, Electrical power systems, Telecommunications, telemetry command, data handling and process.
To study the Product assurance of satellite systems and components	To know about the various Failures, Reliability, material and process, safety, configuration control, build and verification, system engineering, case studies
To study the Satellite engineering and applications	To know about the Satellite design philosophy, satellite system design, COTS components in the space environment. Micro satellites, mini satellites and nano satellites, in orbit operation, satellite application for meteorology, navigation, communication, geo observation, and space environment study

UNIT I SPACE SYSTEM DESIGN **12**

Payloads and missions, system view of spacecraft propulsion system, launch vehicles, spacecraft mechanisms.

UNIT II SPCAECRAFT ENVIRONMENT AND ITS EFFECTS ON DESIGN **12**

Preoperational spacecraft environment, operational spacecraft environments, Environmental effects on design, the sun, the earth, and spacecraft effects, spacecraft structure, thermal control.

UNIT III SPACECRAFT SYSTEMS **12**

Attitude control, Electrical power systems, Telecommunications, telemetry command, data handling and process.

UNIT IV PRODUCT ASSURANCE **12**

Failures, Reliability, material and process, safety, configuration control, build and verification, system engineering, case studies

UNIT V SATELLITE ENGINEERING AND APPLICATIONS **12**

Satellite design philoshopy, satellite system design, COTS components in the space environment. Micro satellites, mini satellites and nano satellites, in orbit operation, satellite application for meteorology, navigation, communication, geo observation, and space environment study

TOTAL: 60

TEXT BOOK

1. P.Fortescue J. Stark, and G.Swinerd, “Spcaecraft systems engineering”, John Wiley and sons, 2002

AE 1407	ROCKET AND MISSILES	L T P C 3 0 0 3
GOAL	To introduce basic concepts of design and trajectory estimation of rocket and missiles, to study the performance of rocket and missiles under various operating conditions and the fundamentals of design concepts	

OBJECTIVE	OUTCOME
The course should enable the student to:	**The student should able to:**
1. To know the various system of rocket, its functions and operations.	1. Design Consideration of liquid Rocket Combustion Chamber.
2. To know the working principle and System in rockets.	2. Igniter Design Considerations and types of igniters.
3. To understand the Aerodynamics of Rockets, Missiles and Airframe Components.	3. Describe the drag and lift forces acting on rocket and missile.The various methods of
4. To study the Rocket Motion in Free Space and Gravitational Field.	4. Describing Aerodynamic Forces and Moments.Lateral Damping Moment and Longitudinal Moment of a Rocket. 5. Explain the One Dimensional and Two Dimensional rocket Motions in Free Space and Homogeneous Gravitational Fields.
5. Determination of range and Altitude Simple Approximations to Burnout Velocity.	6. Explain the description of Vertical and Inclined and Gravity Turn Trajectories.It will give the various methods of thrust determinations and thrust vector control. It will also describethe rocket s Separation Techniques.
6. To know the Staging and Control of Rockets and Missiles.	7. Understanding of selection criteria for materials and Special Requirements of Materials to Perform under Adverse Conditions
7. Selection of Materials for Rockets and Missiles.	

UNIT I ROCKETS SYSTEM 10

Ignition System in rockets – types of Igniters – Igniter Design Considerations – Design Consideration of liquid Rocket Combustion Chamber, Injector Propellant Feed Lines, Valves, Propellant Tanks Outlet and Helium Pressurized and Turbine feed Systems – Propellant Slosh and Propellant Hammer – Elimination of Geysering Effect in Missiles – Combustion System of Solid Rockets.

UNIT II AERODYNAMICS OF ROCKETS AND MISSILES 13

Airframe Components of Rockets and Missiles – Forces Acting on a Missile While Passing Through Atmosphere – Classification of Missiles – methods of Describing Aerodynamic Forces and Moments – Lateral Aerodynamic Moment – Lateral Damping Moment and Longitudinal Moment of a Rocket – lift and Drag Forces – Drag Estimation – Body Upwash and Downwash in Missiles – Rocket Dispersion – Numerical Problems.

UNIT III ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD 10

One Dimensional and Two Dimensional rocket Motions in Free Space and Homogeneous Gravitational Fields – description of Vertical, Inclined and Gravity Turn Trajectories – Determination of range and Altitude Simple Approximations to Burnout Velocity.

UNIT IV STAGING AND CONTROL OF ROCKETS AND MISSILES 7

Rocket Vector Control – Methods – Thrust determination – SITVC – Multistaging of rockets – Vehicle Optimization – Stage Separation Dynamics – Separation Techniques.

UNIT V MATERIALS FOR ROCKETS AND MISSILES 5

Selection of Materials – Special Requirements of Materials to Perform under Adverse Conditions.

TOTAL: 45

TEXT BOOKS

1. Sutton, G.P., et al., “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 1993.

REFERENCES

1. Mathur, M., and Sharma, R.P., “ Gas Turbines and Jet and Rocket Propulsion”, Standard Publishers, New Delhi 1991.
2. Cornelisse, J.W., “ Rocket Propulsion and Space Dynamics”, J.W., Freeman & Co. Ltd., London, 1912.
3. Parket, E.R., “ Materials for Missiles and Spacecraft”, McGraw-Hill Book Co. Inc., 1912.

MG 1401	TOTAL QUALITY MANAGEMENT	L T P C 3 0 0 3
Goal	To understand the Total Quality Management concepts and principles and the various tools available to achieve Total Quality Management and also to understand the statistical approach for quality control.	

Objectives	Outcome
The course should enable the students to : 1.Understand the basic concepts of Total Quality Management. 2. Be familiar with the total quality management principles. 3. Know about the various process control tools available to achieve Total Quality Management. 4. Study about quality function deployment and total productive maintenance. 5.Get awareness about the ISO certification process and their need in various industries.	The students will be able to : 1. Apply the concepts of quality planning, quality control etc., in the appropriate places. 2. Apply the total quality management principles in issues like customer complaints, customer retention, relationship development etc., 3. Describe the tools of quality, management tools, process capability etc., 4. Describe quality function deployment and total productive maintenance. 5. Implement the quality systems for various industries.

UNIT I INTRODUCTION 9

Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs - Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

UNIT II TQM PRINCIPLES 9

Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.

UNIT III STATISTICAL PROCESS CONTROL (SPC) 9

The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.

UNIT IV TQM TOOLS 9

Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA.

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, TS 16949, ISO 14000 – Concept, Requirements and Benefits.

TOTAL: 45

TEXT BOOK

1. Dale H.Besterfiled, et al., "Total Quality Management", Pearson Education, Inc. 2003. (Indian reprint 2004). ISBN 11-297-0260-6.

REFERENCES

1. James R.Evans & William M.Lidsay, "The Management and Control of Quality", (5th Edition), South-Western (Thomson Learning), 2002 (ISBN 0-324-06610-5).
2. Feigenbaum.A.V. "Total Quality Management", McGraw-Hill, 1991.
3. Oakland.J.S. "Total Quality Management", Butterworth Hcinemann Ltd., Oxford, 1919.
4. Narayana V. and Sreenivasan, N.S. "Quality Management – Concepts and Tasks", New Age International 1996.
5. Zeiri. "Total Quality Management for Engineers", Wood Head Publishers, 1991.

GE1401	PROFESSIONAL ETHICS AND HUMAN VALUES	3 Credits
Goal	**To introduce the students to basic concepts of Engineering Ethics and Human Values.**	

Objectives	Outcome
The course should enable the students to : 1.To create an awareness on Human Values. 2. To be familiar with the various theories on Engineering Ethics. 3. Throw light on moral social values and Loyalty of professional. 4.To create am awareness about the safety aspects responsibilities and various rights of professionals.	The students will be able to: 1. Gain knowledge in Human values. 2. Use the senses of Engineering Ethics and ethical theories.. 3. Be acquainted with the Global issues on Environmental Ethics and Computer Ethics. 4. Get awareness on the Ethics and responsibilities of a professional. 5. Get awareness on Engineering Ethics and Human Values.

UNIT I HUMAN VALUES 10

Morals, Values and Ethics – Integrity – Work Ethic – Service Learning – Civic Virtue – Respect for Others – Living Peacefully – caring – Sharing – Honesty – Courage – Valuing Time – Co-operation – Commitment – Empathy – Self-Confidence – Character – Spirituality

UNIT II ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' - variety of moral issued - types of inquiry - moral dilemmas - moral autonomy - Kohlberg's theory - Gilligan's theory - consensus and controversy – Models of Professional Roles - theories about right action - Self-interest - customs and religion - uses of ethical theories.

UNIT III ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as experimentation - engineers as responsible experimenters - codes of ethics - a balanced outlook on law - the challenger case study

UNIT IV SAFETY, RESPONSIBILITIES AND RIGHTS 9

Safety and risk - assessment of safety and risk - risk benefit analysis and reducing risk - the three mile island and chernobyl case studies.

Collegiality and loyalty - respect for authority - collective bargaining - confidentiality - conflicts of interest - occupational crime - professional rights - employee rights - Intellectual Property Rights (IPR) - discrimination.

UNIT V GLOBAL ISSUES 8

Multinational corporations - Environmental ethics - computer ethics - weapons development - engineers as managers-consulting engineers-engineers as expert witnesses and advisors -moral leadership-sample code of Ethics like ASME, ASCE, IEEE, Institution of Engineers (India), Indian Institute of Materials Management, Institution of electronics and telecommunication engineers (IETE), India, etc.

TOTAL: 45

TEXT BOOKS

1. Mike Martin and Roland Schinzinger, “Ethics in Engineering”, McGraw-Hill, New York 1996.
2. Govindarajan M, Natarajan S, Senthil Kumar V. S, “Engineering Ethics”, Prentice Hall of India, New Delhi, 2004.

REFERENCES

1. Charles D. Fleddermann, “Engineering Ethics”, Pearson Education / Prentice Hall, New Jersey, 2004 (Indian Reprint now available).
2. Charles E Harris, Michael S. Protchard and Michael J Rabins, “Engineering Ethics – Concepts and Cases”, Wadsworth Thompson Leatning, United States, 2000 (Indian Reprint now available)
3. John R Boatright, “Ethics and the Conduct of Business”, Pearson Education, New Delhi, 03.
4. Edmund G Seebauer and Robert L Barry, “Fundamentals of Ethics for Scientists and Engineers”, Oxford University Press, Oxford, 2001.

AS 1404	STRUCTURAL DESIGN LABORATORY	L T P C 0 0 3 1
GOAL	To understand the structural behaviour of advanced material systems.	

OBJECTIVES	OUTCOME
The course should enable the student to perform 1. Fabrication of Composite plate 2. Measurement of Volume fraction 3. Testing of Composite Plate (buckling test) 4. Identification of Mechanical properties (Tensile test).	The course should be able to understand Method of fabricating composites. Method of measuring volume fraction of composites. Method of performing buckling test in composite plate. Method of performing tensile test in composite plate to get the mechanical properties.

LIST OF EXPERIMENTS

1. Fabrication of Composite plate
2. Measurement of Volume fraction
3. Testing of Composite Plate (buckling test)
4. Identification of Mechanical properties (Tensile test)

AS 1405	SPACE PROPULSION LABORATORY	L T P C 0 0 3 1
GOAL	To understand the advanced space propulsion system.	

OBJECTIVES	OUTCOME
The course should enable the student to perform	The course should be able to understand
1. Preparation of propellant for rockets.	Method of preparing the propellants.
2. Identifying the burning rate of the propellant.	Method of identifying the burning rate of the propellant.
3. Finding the calorific value of the propellant.	Method of finding the calorific value of the propellant.
4. Ignition delay measurement on rocket engine.	Method of finding the ignition delay in rocket.
5. Study about water jet.	The principle of water jet and measuring the velocity.
6. Testing of hybrid motor.	Testing the hybrid motor.

LIST OF EXPERIMENTS

1. Preparation of propellant
2. Identification of burning rate
3. Calorific value estimation
4. Ignition Delay Measurement
5. Water jet study
6. Hybrid motor testing

AS 1406	IDENTIFICATION OF PROJECT WORK	L T P C 0 0 2 0
GOAL	To find out the tentative area of the project work and presentation.	

OBJECTIVES	OUTCOME
To find a suitable project in the areas of aircraft, spacecraft and satellite	To understand basics of aircraft, spacecraft and satellite and progress in the relevant areas

AREAS:
1. Aircraft
2. Space craft
3. Satellite and Orbital Mechanics

SEMESTER VIII

AS 1407 PROJECT WORK 0 0 24 6

(Common to all Branches)

OBJECTIVE

The objective of the project work is to enable the students in convenient groups of not more than 4 members on a project involving theoretical and experimental studies related to the branch of study. Every project work shall have a guide who is the member of the faculty of the institution. Six periods per week shall be allotted in the time table and this time shall be utilized by the students to receive the directions from the guide, on library reading, laboratory work, computer analysis or field work as assigned by the guide and also to present in periodical seminars on the progress made in the project.

Each student shall finally produce a comprehensive report covering back round information, literature survey, problem statement, project work details and conclusion. This final report shall be typewritten form as specified in the guidelines.

The continuous assessment shall be made as prescribed by the regulation (Hindustan University Regulations 2008 for B.E., B.Tech. programs)

ELECTIVES

ELECTIVES FOR SEMESTER – VI

AS1351	ADVANCED AERODYNAMICS	L T P C 3 0 0 3
GOAL	To study the aerodynamics of aircraft in high speed flows and the flow of real and unsteady gases.	

OBJECTIVES	OUTCOME
The course should enable the student to: 1. To know about the element of supersonic flow. 2. To know about the elements of hypersonic flow. 3. To know about mixed flow subsonic and supersonic flow. 4. To know about unsteady motion of shock waves. 5. To know about the real flow of gases.	**The student should able to:** 1. Understand the basics of supersonic flow 2. Understand the basics of hypersonic flow. 3. Understand the method of viewing mixed flow, drag and lift at transonic speeds. 4. Understand the unsteady wave motion of shock waves. 5. Understand the flow of real gases

UNIT I SUPERSONIC FLOW 9

Linearized supersonic flow, Supersonic airfoil, Method of characterization of supersonic flow, Oblique shocks, Axial symmetric supersonic flow over finite wing.

UNIT II HYPERSONIC FLOW 9

Similarity laws, Oblique shock relations, Simple wave expansion relations, Hypersonic performance of 2-D profile, Hypersonic performance of bodies of Revolution, Introduction to inviscid hypersonic flow, Viscous hypersonic flow.

UNIT III MIXED FLOW 9

Hodograph method for mixed subsonic-supersonic flow, Transonic flow, Drag and lift at transonic speeds.

UNIT IV UNSTEADY MOTION 9

Unsteady wave motion of small amplitude, Unsteady 1-D continuous flow, Unsteady 1-D shockwaves.

UNIT V FLOW OF REAL GASES 9

Laminar boundary Layer, Turbulent boundary layer, Boundary layers in tubes, Shockwave effects.

TOTAL: 45

TEXTBOOK

1. A.H. Shapiro, "The Dynamic and Thermodynamic of Compressible flow", Vol-II, John Wiley and Sons, 1992.

REFERENCES

1. J.D.Anderson (Jr), 'Hypersonic and High temperature Gas Dynamics', AIAA Ed.series, 1989.
2. Lipsman and Rusko, 'Gas Dynamics', John Wiley and sons, 1982.

AS1352	ADVANCED STRENGTH OF MATERIALS	L T P C 3 0 0 3
GOAL	To analyse the stresses and deformations through advanced mathematical models, and to estimate the design strength of various industrial equipments.	

OBJECTIVES	OUTCOME
The course should enable the student to: 1. Study about the analysis of plates with different loads. 2. Study about the analysis of thick cylinders and spheres with applied stress. 3. Study about the analysis of rotating discs with various theorems. 4. Study about the beams with different kinds of loads. 5. Study about the curved beams and clamps with load applied.	The course should enable the student to: Understand various methods for analysing the plates with various stresses and designs. Understand the methods of solving problems related to different cylinders and spheres. Understand the theorems for analysing the rotating discs. Understanding the problems solving beams with different kinds of loads. Understanding the problem related to beams with large curvature.

UNIT I ANALYSIS OF PLATES 8

Mathematical modeling of plates with normal loads – Point and Distributed Loads – Support conditions – Rectangular plates - Stresses along coordinate axes – Plate deformations – Axi-symmetric plates – Radial and tangential stresses – plate deflections.

UNIT II THICK CYLINDERS AND SPHERES 10

Equilibrium and compatibility conditions - Lame's Theorem – Boundary conditions – distribution of radial and tangential stresses – compound cylinders – Interference fits - Stresses due to temperature distributions.

UNIT III ROTATING DISCS 10

Lame-Clayperon Theorem – radial and tangential stresses in discs due to centrifugal effects – boundary conditions – solid and hollow discs – Interference fit on shafts –Strengthening of the hub – residual stresses – Autofrettege – Discs of variable thickness – Disc profile for uniform strength.

UNIT IV BEAMS ON ELASTIC FOUNDATION 8

Infinite beam subjected to concentrated load – Boundary Conditions – Infinite beam subjected to a distributed load segment – Triangular load – Semi infinite beam subjected to loads at the ends and concentrated load near the ends – Short beams.

UNIT V CURVED BEAMS AND CONTACT STRESSES 9

Analysis of stresses in beams with large curvature – Stress distribution in curved beams – Stresses in crane hooks and C clamps – Contact Stresses – Hertz equation for contact stresses – applications to rolling contact elements.

TOTAL: 45

TEXT BOOKS

1. Boresi A.P., Schmidt R.J., "Advanced Mechanics of Materials", John Wiley and Sons, Sixth edition, 2003.
2. Dally J.W. and Riley W.F, "Experimental Stress Analysis", John Wiley and Sons 2003

REFERENCES

1. Burr A. H., CheathAm J.B., "Mechanical Analysis and Design", Prentice Hall of India, Second edition, 2001.
2. Den-Hartog J.P., "Strength of Materials", John Wiley and Sons.

AS1353	TURBO-MACHINERYAND DYNAMICS	L T P C 3 0 0 3
GOAL	To appreciate the unified theory applicable for all classes of turbo machines, to gain the fundamental knowledge about the design variations of thermal turbo machines, and to perform the design of the thermal turbo machines.	

OBJECTIVES	OUTCOME
The course should enable the student to:	The student should able to:
1. To know about the all kinds of turbo machines their working and parameters.	Understand the principles behind the turbo machines
2. To know about the centrifugal fans, blowers its performance and characteristics.	Understand the various principles behind the centrifugal fans, blower and its performances.
3. To know about the axial fans and propellers its performance.	Understand the principle behind the axial fans and propeller and its performances.
4. To know about the axial flow turbines its performance and characteristics.	Understand the principle of axial flow turbine and its performances.
5. To know about the radial flow turbine and wind turbines its performance and characteristics.	Understand the principles behind radial flow turbine and wind turbines its performance and characteristics.

UNIT I INTRODUCTION TO TURBO MACHINES 9

Turbines, Pumps, Compressors, Fans and Blowers – Stages of Turbo machines – Energy transfer between fluid and rotor – Stage velocity triangles Thermal Turbo machines – Classification – General energy equation – Modified to turbo machines – compression and expansion process – Velocity triangles – Work – T-S and H-S diagram, Total – to – Total and Total – to – Static efficiencies. Dimensional analysis – Non dimensional parameters of compressible flow Turbo machines – Similarity laws, applications and limitations.

UNIT II CENTRIFUGAL FANS AND BLOWERS 9

Definition, selection and classifications –Types of blading design-velocity triangles - Stage Parameters – Flow analysis in impeller blades –Design parameter- Volute and Diffusers – Efficiencies and Losses – Fan noises – Causes and remedial measures. Centrifugal Compressors: - Constructional details – Stage velocity triangles — Stage work – Stage pressure rise – Stage efficiency – Degree of reaction – Slip factor – H-S diagram – Efficiencies – Performance characteristics.

UNIT III AXIAL FANS AND PROPELLERS 9

Definition and classifications – Stage parameters – Types of fan stages-performance characteristics. Cascade of blades – Cascade tunnel - Blade geometry-Cascade variables-Energy transfer and loss in terms of lift and drag - Axial Flow Compressors: definition and classifications – Constructional details

Stage velocity triangles – Stage work – Stage pressure rise – H-S diagram – Stage efficiencies and losses- Degree of reaction – Radial equilibrium-Surging and Stalling – Performance characteristics.

UNIT IV AXIAL FLOW TURBINES 9

Construction details –90° IFR turbine- Stage work – Stage Velocity triangles – Stage pressure rise – Impulse and reaction stage – Effect of degree of reaction – H-S diagram – Efficiencies and Losses – Performance characteristics.

UNIT V RADIAL FLOW TURBINES AND WIND TURBINES 9

Constructional details — Stage velocity triangles – H-S diagram – Stage efficiencies and losses – Performance characteristics.Wind turbines: definition and classifications – Constructional details – Horizontal axis wind turbine- Power developed – Axial thrust – Efficiency.

TOTAL: 45

TEXT BOOKS

1. Yahya, S.H., “Turbines, Compressors and Fans”, Tata McGraw-Hill Publishing Company, 1996.
2. Dixon S.L “Fluid Mechanics, Thermodynamics of turbomachines”-2nd Edition, Pergamon press 1990.

REFERENCES

1. Kadambi V and Manohar Prasad- “An Introduction to energy conversion - Vol. III”, Turbomachines- Wiley Eastern India Ltd, 1977.
2. Shepherd D.H. – “Principles of Turbomachinery”- The Macmillan Company, 1969**.**

AS1354	FEM IN AEROSPACE	L T P C 3 0 0 3
GOAL .	Finite Element Method capable of writing to solve different problems such as Boundary value problems, Linear equation to approximate the solution stepwise integration algorithms have to written in Mathematical Script	

OBJECTIVE	OUTCOME
1.To understand the basic steps in finite element method and convergence criteria	Able to write flow chart of finite element steps and understand the convergence of the problem
2. To discretize the domain in to finite elements and to obtain stiffness matrix for bar, beam and frame elements.	Able to solve stiffness matrix for bar, beam and frame problems using suitable boundary condition.
3. To know the plane stress and plane strain problem application in 2d structures.	Plane stress and plane strain condition are used to understand 2d structures.
4. To know the application of isoparametric problems in 3d structures.	Modelling of 2d and 3d structures using isoparametric elements
5. To understand the application of finite element methods in heat transfer and fluid flow problems.	Apply the concepts of finite element methods to solve fluid flow and heat transfer problems

UNIT I INTRODUCTION **4**

Review of basic analysis – Stiffness and Flexibility matrix for simple cases – Governing equation and convergence criteria of finite element method.

UNIT II DISCRETE ELEMENTS **12**

Bar, Frame, beam elements – Application to static, dynamic and stability analysis.

UNIT III CONTINUUM ELEMENTS **10**

Various types of 2-D-elements Application to plane stress, plane strain and axisymmetric problems.

UNIT IV ISOPARAMETRIC ELEMENTS **10**

Applications to two and three-dimensional problems.

UNIT V FIELD PROBLEM **9**

Applications to other field problems like heat transfer and fluid flow.

TOTAL: 45

TEXT BOOK

1. Tirupathi.R. Chandrapatha and Ashok D. Belegundu, “Introduction to Finite Elements in Engineering”, Prentice Hall India, Third Edition, 2003.

REFERENCES

1. Reddy J.N. “An Introduction to Finite Element Method”, McGraw-Hill, 2000.
2. Krishnamurthy, C.S., “Finite Element Analysis”, Tata McGraw-Hill, 2000.
3. Bathe, K.J. and Wilson, E.L., “Numerical Methods in Finite Elements Analysis”, Prentice Hall of India, 1985.

AS1355	AERO ELASTICITY	L T P C 3 0 0 3
GOAL	To study the effects of aero elasticity and wind tunnel testing, also to give a basic introduction to MATLAB.	

OBJECTIVES	OUTCOME
1. To understand the aero elasticity phenomena and its related functions.	The learner will able to understand the phenomenon of aero elasticity.
2. To understand the systems having single degrees of freedom.	The learner will able to solve problem related to single degrees of freedom
3. To understand the theories regarding multiple degrees of freedom.	The learner will able to solve problems using the theorems of multiple degrees of freedom.
4. To understand the static problem of aero elasticity of various practical devices.	The learner will able to solve problems by analysing the systems which undergo static aero elasticity problems.
5. To understand the basics of MATLAB and its applications.	The learner will able to solve problems in aero elasticity using MATLAB.

UNIT I INTRODUCTION **9**

Aero elasticity phenomena, flutter, divergence, control reversal, flexibility effects on stability and control.

UNIT II SINGLE DEGREE OF FREEDOM **9**

Introduction to degrees of freedom , Response of single degree of freedom, system, Laplace transform, Harmonic excitation virtual work, lagrange's equation.

UNIT III MULTIPLE DEGREES OF FREEDOM **9**

Classical theories of multi degree freedom system, Undamped mode and frequencies.

UNIT IV STATIC AEROELASTICIY **9**

Static problem, divergence of wind tunnel models, wall – sting and strut – mounted models, control reversal, classical flutter analysis, one and two – degree of freedom flutter, flutter boundary characteristics.

UNIT V MAT LAB **9**

Introduction to Mat Lab, application of mat lab for solving aero elastic problem. Design of spline mat lab coading.

TOTAL: 45

TEXT BOOK

1. Y.C. Fung, " An Introduction to the Theory of Aero elasticity (2002) ", John wiley &Sons,.

AS1356	TRANSPORT PROCESSES IN REACTING FLOWS	L T P C 3 0 0 3
GOAL	To study different transfer processes in aircraft components and their effects.	

OBJECTIVES	OUTCOME
1. To understand the basic principles of heat transfer and its applications. 2. To understand the process of combustion and the factors of it energy. 3. To understand the combustion reaction, combustion waves and its propagation. 4. To understand the process of flame, its types and its features. 5. To understand the process of flame propagation.	The learner will able to understand the physics of heat transfer and its parameters. The learner will able to understand the process of combustion and related equations. The learner will able to learn about the combustion wave sand factors affecting it. The learner will able to learn about the fundamentals of combustion and flame. The learner will able to learn about the premix flame and influence of boundary layer on flame and its limits.

UNIT I HEAT TRANSFER 9

Principle of heat transfer: conduction, convection and radiation, mass and momentum transfer, elements of mass diffusion and boundary layer theory

UNIT II THERMOCHEMISTRY OF COMBUSTION 9

Chemical kinetics and equilibrium chemistry, generation of heat energy, adiabatic flame temperature, chemical reaction, evolution of chemical energy.

UNIT III COMBUSTION WAVE PROPAGATION 9

Combustion reactions, combustion waves of a premixed gas, structures of combustion waves, ignition reaction, combustion waves of energetic materials.

UNIT IV FUNDAMENTALS OF COMBUSTION AND FLAME 9

Types of flame, flame theory, flammability limits, ignition of a flammable mixture, limit flame extinction, flame quenching

UNIT V FLAME PROPAGATION 9

Premix flame velocity, influence of boundary condition, laminar flame, turbulent flame, instability phenomena during flame propagation.

TOTAL: 45

TEXT BOOK

1. Chandramohan and Sharma, “Flame propagation and stability”,1994

REFERENCES

1. Liews, Albel and Van-karman, “Combustion propagation and Explosion”
2. J.Jaroski and B. Veyssiere, “Combustion phenomena”, CRS press 1994.

AS1357	THEORY OF COMBUSTION	L T P C 3 0 0 3
GOAL	To study the different processes in combustion, difficulties faced and the methods to overcome them.	

OBJECTIVES	OUTCOME
1. To understand the basic principles of combustion and its characteristics. 2. To understand the dynamics of combustion and methods for modelling the combustion. 3. To understand the reduced kinetic schemes in combustion. 4. To understand the process of combustion instability. 5. To understand the process of combustion diagnostics.	The learner will able to understand the combustion chemistry and its characteristics. The learner will able to learn about the problem related to the combustion process and its simulation. The learner will able to learn about the H-O, H-C flame and propellant deflagration. The learner will able to learn about the Theory of instability and analysis of instabilities. The learner will able to learn about the various combustion diagnostics like absorption, fluorescence etc.

UNIT I INTRODUCTION 9

Combustion chemistry, Droplet combustion, reduced kinetic schemes, Combustion instability, Combustion enhancement, Modeling and simulation, Combustion diagnostics.

UNIT II CHEMISTRY AND DYNAMICS 9

Experimental and theoretical methods, Matrix isolation, Computational chemistry methods, Determination of strain energies and heat of formation of model compound, Determination of the chemical mechanism of strain energy.

UNIT III REDUCED KINETIC SCHEMES IN COMBUSTION 9

Different approach, Hydrogen-Oxygen and hydrocarbon flame, Propellant deflagration.

UNIT IV COMBUSTION INSTABILITY 9

Types of instability, Theoretical analysis, Numerical simulation, Experimental studies.

UNIT V COMBUSTION DIAGNOSTICS 9

Nonresonant techniques, Absorption, Fluorescence, Algebraic turbulence, Closures for two-phase flows, Stochastic modeling.

TOTAL: 45

TEXT BOOK

1. G.D.Roy,"Propulsion Combustion", Taylor & Francis, 1997

REFERENCES

1. N.Kuboto, "Propellants and Explosives", Wiley-VCH Verkeg Gmbh & co KGOA, 2007.

AS 1358	EXPERIMENTAL STRESS ANALYSIS	L T P C 3 0 0 3
GOAL	To determines the stress and strain in materials and structures subjected to static or dynamic forces or loads.	

OBJECTIVES	OUTCOMES
The course should enable the student : 1. To understand instrumentation concepts 2. To understand optics and its application to photo elasticity 3. To understand strain gauges and their applications 4. Understand significance of NDT Methods. 5. Understand the Concept of two dimensional photo elasticity	The students should be able to: 1. Analyze instruments for measurements 2. Awareness of NDT methods 3. Use strain gauge effectively 4. Analyze photo elastic results 5. To estimate the Interpretation of fringe pattern

UNIT I - MEASUREMENTS **4**

Principles of measurements, Accuracy, Sensitivity and range of measurements.

UNIT II - EXTENSOMETERS **6**

Mechanical, Optical, Acoustical and Electrical extensometers and their uses. Advantages and disadvantages.

UNIT III - ELECTRICAL RESISTANCE STRAIN GAUGES **10**

Principle of operation and requirements of electrical strain gauges. Types and their uses,
Materials for strain gauge. Calibration and temperature compensation, cross sensitivity, Rosetteanalysis. Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators.

UNIT IV - PHOTOELASTICITY **10**

Two dimensional photo elasticity, Concept of light – photo elastic effects, stress optic law,
Interpretation of fringe pattern, Compensation and separation techniques, Photo elasticmaterials. Introduction to three dimensional photo elasticity.

UNIT V - NON – DESTRUCTIVE TESTING **15**

Fundamentals of NDT. Radiography, ultrasonic, magnetic particle inspection, Fluorescent penetrant technique, Eddy current testing, Acoustic Emission Technique, Fundamentals of brittlecoating methods, Introduction to Moiré techniques, Holography, ultrasonic C- Scan, Thermograph,Fiber – optic Sensors.

TOTAL 45

TEXT BOOKS

1. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., "*Experimental Stress Analysis*", Tata McGraw-Hill, New Delhi, 1914.

REFERENCES

1. Dally, J.W., and Riley, W.F., "*Experimental Stress Analysis*", McGraw-Hill Inc., New York, 1991.
2. Hetyenyi, M., "*Hand book of Experimental Stress Analysis*", John Wiley and Sons Inc., New York, 1972.
3. Pollock A.A., "*Acoustic Emission in Acoustics and Vibration Progress*", Ed. Stephens R.W.B., Chapman and Hall, 1993.

AS1359	HIGH TEMPERATURE MATERIALS	L T P C 3 0 0 3
GOAL	To learn damage mechanism and failure of components at elevated temperatures	

OBJECTIVE	OUTCOME
1. To Study creep behaviour and effect of different factors like stress, temporary, strain rate on creep.	1. Creep behaviour, and effect of different factors like stress, temporary, strain rate on creep.
2. To study design transient creep, different phenomenon like time hardening, strain hardening, expressions of rupture life of creep, ductile and brittle materials, Monk man-Grant relationship.	2. Design of transient creep, time hardening, strain hardening, expressions of rupture life of creep, ductile and brittle materials, Monkman-Grant relationship.
3. Tostudyfractureandvarioustypesandfracture mapsfordifferntalloysandoxides.	3. Various types of fracture, brittle to ductile from low temperature to high temperature, cleavage fracture, ductile fracture due to micro-void diffusion controlled void growth; fracture maps for different alloys and oxides.
4. To study oxidation and hot corrosion; alloy additions and effect of alloying elements on oxidation and hot-corrosion.	4. Oxidation, Pilling, Bed-worthratio, kinetic laws of oxidation-defect structure and control of oxidation by alloy additions, hot gas corrosion deposit, modified hot gas corrosion, fluxing mechanisms, effect of alloying elements on hot corrosion, interaction of hot corrosion and creep, methods of corrosion.
5. To introduce super alloys and various types; different fabrication methods and inter-metallic, high temperature ceramics.	5. Iron base, Nickel base and Cobalt base super-alloys, composition control, solid solution strengthening, precipitation hardening by gamma prime, grain boundary strengthening, TCP phase, embrittlement, solidification of single crystals, Inter-metallic, high temperature ceramics.

UNIT I CREEP **9**

Factors influencing functional life of components at elevated temperatures, definition of creep curve, various stages of creep, metallurgical factors influencing various stages, effect of stress, temperature and strain rate.

UNIT II DESIGN FOR CREEP RESISTANCE **9**

Design of transient creep time, hardening, strain hardening, expressions of rupture life of creep, ductile and brittle materials, Monkman-Grant relationship.

UNIT III FRACTURE **9**

Various types of fracture, brittle to ductile from low temperature to high temperature, cleavage fracture, and ductile fracture due to micro void coalescence-diffusion controlled void growth; fracture maps for different alloys and oxides.

UNIT IV OXIDATION AND HOT CORROSION 9

Oxidation, Pilling, Bedworth ratio, kinetic laws of oxidation- defect structure and control of oxidation by alloy additions, hot gas corrosion deposit, modified hot gas corrosion, fluxing mechanisms, effect of alloying elements on hot corrosion, interaction of hot corrosion and creep, methods of combat hot corrosion.

UNIT V SUPERALLOYS AND OTHER MATERIALS 9

Iron base, Nickel base and Cobalt base super alloys, composition control, solid solution strengthening, precipitation hardening by gamma prime, grain boundary strengthening, TCP phase, embrittlement, solidification of single crystals, Intermetallics, high temperature ceramics.

TOTAL 45

TEXT BOOKS

1. Raj. R., "*Flow and Fracture at Elevated Temperatures*", American Society for Metals, USA, 1915.
2. Hertzberg R. W., "*Deformation and Fracture Mechanics of Engineering materials*", 4th Edition, John Wiley, USA, 1996.
3. Courtney T.H, "*Mechanical Behavior of Materials*", McGraw-Hill, USA, 1990.

REFERENCES

1. Boyle J.T, Spencer J, "*Stress Analysis for Creep*", Butterworths, UK, 1913.
2. Bressers. J., "*Creep and Fatigue in High Temperature Alloys*", Applied Science, 1911.
3. McLean D., "*Directionally Solidified Materials for High Temperature Service*", The Metals Society, USA, 1915.

ELECTIVES FOR SEMESTER – VIII

AE 1418	COMPUTATIONAL FLUID DYNAMICS	L T P C 3 0 0 3
GOAL	To make the students to understand the basic concepts of fluid dynamics and to et a clear picture of the condition of a flow in real motion.	

OBJECTIVE	OUTCOME
The subject should enable the students to	The students should be able to
1. Understand the basic flow equations, characteristicsof mathematical models for a given flow.	1. Describe the flow phenomena in a flow field with correspondence with elliptic, parabolic and hyperbolic equations
2. Know the importance and significance of panel methods	2. Clearly understand the steps involved in Source and panel methods
3. Understand the concept of discretization, upwind differencing and implicit explicit solutions	3. Describe the upwind concept and its effects in a given flow. Can understand the discretization of a flow model for analysis
4. Familiarize with Finite element techniques in Computational Fluid dynamics.	4. .Can clearly understand the weighted variational formulae and Galerkin method for finite volume technique
5. Familiarize with Finite Volume techniques in Computational fluid analysis	5. Know the numerical finite volume methods(RungeKutta method, Lax wendroff) in Computational analysis

UNIT I FUNDAMENTAL CONCEPTS 10

Introduction - Basic Equations of Fluid Dynamics - Incompressible In viscid Flows: Source, vortex and doublet panel, methods - lifting flows over arbitrary bodies. Mathematical properties of Fluid Dynamics Equations -_ Elliptic, Parabolic and Hyperbolic equations - Well posed problems - discretization of partial Differential Equations -Transformations and grids - Explicit finite difference methods of subsonic, supersonic and viscous flows.

UNIT II PANEL METHODS 7

Introduction – Source panel method – Vortex panel method – Applications.

UNIT III DISCRETIZATION 8

Boundary layer Equations and methods of solution -Implicit time dependent methods for inviscid and viscous compressible flows - Concept of numerical dissipation --Stability properties of explicit and implicit methods - Conservative upwind discretization for Hyperbolic systems - Further advantages of upwind differencing.

UNIT IV FINITE ELEMENT TECHNIQUES 10

Finite Element Techniques in Computational Fluid Dynamics; introduction - Strong and Weak Formulations of a Boundary Value Problem - Strong formulation - Weighted Residual Formulation –

Galerkin Formulation - Weak Formulation - Variational Formulation - Piecewise defined shape functions - Implementation of the FEM - The Solution Procedure.

UNIT V FINITE VOLUME TECHNIQUES 10

Finite Volume Techniques - Cell Centered Formulation - ~ Lax - Vendoroff Time Stepping - Runge - Kutta Time Stepping - Multi - stage Time Stepping - Accuracy -. Cell Vertex Formulation - Multistage Time Stepping - FDM -like Finite Volume Techniques - Central and Up-wind Type Discretizations - Treatment of Derivatives

TOTAL: 45

TEXT BOOK

1. Fletcher, C.A.J., “Computational Techniques for Fluid Dynamics”, Vols. I and II, Springer - Verlag, Berlin, 1988.

REFERENCES

1. John F. Wendt (Editor), “Computational Fluid Dynamics - An Introduction”, Springer – Verlag, Berlin, 1992
2. Charles Hirsch, “Numerical Computation of Internal and External Flows”, Vols. I and II. John Wiley & Sons, New York, 1988.
3. Klaus A Hoffmann and Steve T. Chiang. “Computational Fluid Dynamics for Engineers”, Vols. I & II Engineering Education System, P.O. Box 20078, W. Wichita, K.S., 67208 - 1078 USA, 1993.
4. Anderson, Jr.D., “Fundamentals of Aerodynamics”, McGraw-Hill, 2000.

AS1408	FLIGHT TESTING	L T P C 3 0 0 3
GOAL	To study the testing of flights, parameters, conditions and performance	

OBJECTIVES	OUTCOME
The subject should enable the students to Axis systems and equation of motion, Flight parameters, Take off, landing, acceleration, Dynamic performances, Cruise flow modelling	The students should be able to Describe the axis, Flight path and parameters like loads and forces. Instrumentation parameters, Ground tests, Flight test and data analysis. Familiarisation parameters like altitude, Thrust, lift & drag. In flight conditions like cruise, acceleration, turning conditions.Dynamic and Special performance and Cruise fuel flow modeling.

UNIT I AXIS SYSTEMS AND EQUATIONS OF MOTION **9**

Flight path axis, Body axis, True AOA and sideslip definition, In-flight forces, Primary instrumentation parameters, Ground tests, Flight maneuvers and data analysis.

UNIT II PARAMETERS: **9**

Altitude, Airspeed, Lift and drag, Thrust.

UNIT III IN FLIGHT: **9**

Flight path accelerations, Takeoff, Landing.

UNIT IV. SPECIAL CONDITIONS: **9**

Cruise, Acceleration and climb, Turning.

UNIT V PERFORMANCE: **9**

Dynamic performance, Special performance, Standardization, Sample performance model, Cruise fuel flow modeling.

TOTAL: 45

TEXT BOOK:

1. W.M.Olsom. ‘Aircraft performance Flight testing’

REFERENCES:

1. R.D. Kimberlin , “Flight testing of Fixed wing aircraft” by , AIAA Education series, 1992.
2. D.F. Anderson and S.Eberhandt , “Understanding Flight”, McGraw-Hill Publication, 1984.

AS1409	DESIGN OF GAS TURBINES	L T P C 3 0 0 3
Pre Requisite	PROPULSION-I,II & III	
Goal	To study the aircraft gas turbines and their design, cycle analysis of ideal and real engine	

Objectives	**Outcome**
The course should enable the student to :	The student should be able to understand :
To study about the Elements of propulsion	To know about the Propulsion and thrust, Operational envelope, Types of air breathing engines and parameters of aircraft performance.
To study the Aircraft gas turbine engine	To know about the Gas turbine engine components, Brayton cycle, Aircraft design, Parametric cycle analysis, Eulers’s turbo machinery equation, Axial and centrifugal system.
To study the Component performance and engine performance analysis	To know about the Variation in gas properties, Component performance, Inlet and diffuser function, Compressor and turbine efficiency, Burner, Exhaust, Nozzle, Mechanical efficiency, Component performance, Turbo engine, Turbo engine with after burner and turbo engine with separate exhaust and convergent nozzle.
To study the Cycle analysis of ideal engine	To know about the Design input, Steps of engine parameter analysis, Ideal cases of Ramjet, Turbojet, Turbofan, Turbojet with afterburner, Turbofan with optimum bypass ratio, Turbofan with optimum fan pressure ratio, Ideal pulse detonation engine.
To study the Parametric cycle analysis of real engine	To know about the Turbojet, Turbojet with afterburner, Turbofan repeated exhaust stream, Blade and material approach, Nozzle design.

UNIT I ELEMENTS OF PROPULSION **9**

Propulsion and thrust, Operational envelope, Types of air breathing engines and parameters of aircraft performance.

UNIT II AIRCRAFT GAS TURBINE ENGINE **9**

Gas turbine engine components, Brayton cycle, Aircraft design, Parametric cycle analysis, Eulers's turbo machinery equation, Axil and centrifugal system.

UNIT III COMPONENT PERFORMANCE AND ENGINE PERFORMANCE ANALYSIS 9

Variation in gas properties, Component performance, Inlet and diffuser function, Compressor and turbine efficiency, Burner, Exhaust, Nozzle, Mechanical efficiency, Component performance, Turbo engine, Turbo engine with after burner and turbo engine with separate exhaust and convergent nozzle.

UNIT IV CYCLE ANALYSIS OF IDEAL ENGINE 9

Design input, Steps of engine parameter analysis, Ideal cases of Ramjet, Turbojet, Turbofan, Turbojet with afterburner, Turbofan with optimum bypass ratio, Turbofan with optimum fan pressure ratio, Ideal pulse detonation engine.

UNIT V PARAMETRIC CYCLE ANALYSIS OF REAL ENGINE 9

Turbojet, Turbojet with afterburner, Turbofan repeated exhaust stream, Blade and material approach, Nozzle design.

TOTAL: 45

TEXTBOOK:

1. J.D.Mattingly, and H.V.Oha, "Elements of propulsion: Gas Turbines and Rockets", AIAA Ed. Series, 2006.

REFERENCES:

1. W.J. Hesse and N.V.S Mumford (Jr), "Jet propulsion for aerospace applications", Pitman Pub. Co, New York, 1974.

2. P.G.Hill & C.R. Peterson, 'Mechanics of Thermodynamics of Propulsion', AWA Longman, Inc 1999.

AS1410	FUNDAMENTALS OF SPACE VEHICLE DESIGN	L T P C 3 0 0 3
GOAL	To study the fundamentals of space vehicle, spacecraft configuration, spacecraft design management.	

OBJECTIVES	OUTCOME
The course should enable the student to : 1. Understand Space Mission analysis and Design process 2. To impart spacecraft configuration and structural design 3. To gain knowledge on thermal control on space craft 4. Understand space craft attitude, control and instrumentation 5. Understand space craft design management	The student should be able to understand 1. Mission objectives, needs, requirements and constraints, logistics 2. Design requirements, process, analysis and verification with future space structure 3. Thermal design, balance and analysis of satellite 4. Basic launch vehicle consideration, selection process, spacecraft design envelope, Attitude requirements, Space control system, Navigation & Telecommunication, Onboard systems, Science instruments 5. Vehicle design and mission concept, System engineering, Product assurance, Spacecraft integration and test, reliability and quality assurance, Small satellite engineering and application and its costing system

UNIT I SPACE MISSION ANALYSIS AND DESIGN PROCESS 9

Space mission life cycle, Mission objectives, Mission needs, Mission requirements and constraints, Space environment and survivability, Space logistics and reliability, Orbital debris

UNIT II SPACECRAFT CONFIGURATION AND STRUCTURAL DESIGN 9

Design requirements, Design process, Material solution, Analysis, Design verification, Impact protection, Configuration, The future of space structure.

UNIT III THERMAL CONTROL OF SPACECRAFT 9

Thermal environment, Thermal balance, Thermal analysis, Thermal design, Thermal technology, Thermal design verification, Satellite thermal design.

UNIT IV SPACECRAFT ATTITUDE, CONTROL AND INSTRUMENTATION 9

Basic launch vehicle consideration, Launch system selection process, Determining the spacecraft design envelope, Attitude requirements, kinematics, measurements, estimation and dynamics, Space control system, Telecommunication, Onboard systems, Science instruments, Navigation.

UNIT V SPACECRAFT DESIGN MANAGEMENT 9

Vehicle design and mission concept, System engineering, Product assurance, Spacecraft integration and test, Spacecraft reliability and quality assurance, Small satellite engineering and application, Cost.

TOTAL: 45

TEXT BOOKS

1. V.L. Pisacane and R.C. Moore, “Fundamentals of Space Systems”, AIAA Series, 2003

REFERENCES:

1. P. Fortescue, J. stark, and G. Swinerd, “ Spacecraft Systems Engineering” AIAA Series, 2005
2. W.J. Larson and J. R. Wertz., “Space Mission Analysis and design”, AIAA Series, 1998
3. M.J.L. Turner, “Rocket and Spacecraft Propulsion” (Principles, Practice and New Developments).

AS1411	AVIONICS & INSTRUMENTATION	L T P C 3 0 0 3
GOAL	To gain knowledge in the field of instruments and electronics that the aircraft carry on-board	
OBJECTIVES		OUTCOME

The course should enable the student to	The student should be able to understand
1. Understand VHF OMNI range navigation	1. VOR Navigation Concepts, Principles of COR, Operation, Receiver Operation, Performance Validation, Operating Procedures.
2.Understand Instrument Landing systems and distance measuring	2. Principles of Localizer, Glide slope Operation, Marker Beacon operation, Navigation Receiver, Automated Test Equipment, Microwave Landing Systems, DME Navigation Concepts, Principles of DME System Operation, DME Transceiver Operation, DME Navigation Procedures
3.Understand radio beacon transponders and Radar system	3. Principles of ATC Radar Surveillance System Operation, Radio Beacon Transponder Operation, Traffic Alert and Collision Avoidance System (TCAS), Weather Radar (WX) System Description, Analog Versus Digital Radar Systems, Installation Procedures and test procedures, Passive Weather Detection Systems, Radar Altimeter Systems- Radio Altimeter (RAD ALT) System Description
4. Understand flight instrumentation	4. Turn-and-Bank Indicator Operation, Angle-of-Attack System Operation, Introduction to Pitot-Static Systems, Altimeter Principles, RADBAR Encoding Altimeter System Operation, Altitude Alerter Operation, Airspeed Indicator Principles, Maximum-Allowable Airspeed/Mach Indicator Operation, TAS/SAT Indicator Operation, Vertical Speed (VS) Indicator Principles.
5.Understand long range navigation	5. The Gyrosyn Compass System, Inertial Navigation Systems (INA) Strap-down Inertial Navigation Systems, Laser Inertial Navigation Systems Long-Range Radio Navigation (LORAN), Very Low Frequency (VLF)/Omega Radio Navigation

UNIT I VHF OMNI RANGE NAVIGATION 7

VOR Navigation Concepts, Principles of COR, Operation, Receiver Operation, Performance Validation, Operating Procedures.

UNIT II INSTRUMENT LANDING SYSTEMS AND DISTANCE MEASURING EQUIPMENT

Principles of Localizer (LOC) Operation, Principles of Glideslope (GS) Operation, Principles of Marker Beacon (MB) Operation, Navigation Receiver, Automated Test Equipment, Microwave Landing Systems, DME Navigation Concepts, Principles of DME System Operation, DME Transceiver Operation, DME Navigation Procedures

UNIT III RADIO BEACON TRANSPONDERS AND RADAR SYSTEM 10

Principles of ATC Radar Surveillance System Operation, Principles of Radio Beacon Transponder Operation, Traffic Alert and Collision Avoidance System (TCAS), Weather Radar (WX) System Description, Analog Versus Digital Radar Systems, Principles of Weather Radar System Operation, Installation Procedures, Passive Weather Detection Systems, Radar Altimeter Systems- Radio Altimeter (RAD ALT) System Description, Radar Altimeter installation and Test Procedures

UNIT IV FLIGHT INSTRUMENTATION 10

Turn-and-Bank Indicator Operation, Angle-of-Attack System Operation, Introduction to Pitot-Static Systems, Alameter Principles, RADBAR Encoding Altimeter System Operation, Altitude Alerter Operation, Airspeed Indicator Principles, Maximum-Allowable Airspeed/Mach Indicator Operation, TAS/SAT Indicator Operation, Vertical Speed (VS) Indicator Principles, Electric Vertical Speed Indicator Operation, TCAS Resolution Advisory/Vertical Speed Indicator Operation, General All Data Computer (CADC) Operation.

UNIT V LONG-RANGE NAVIGATION SYSTEMS 8

The Gyrosyn Compass System, Inertial Navigation Systems (INA) Strap-down Inertial Navigation Systems, Laser Inertial Navigation Systems Long-Range Radio Navigation (LORAN), Very Low Frequency (VLF)/Omega Radio Navigation

TOTAL: 45

TEXT BOOKS

1. Malcrno A.P. and Leach, D.P., “Digital Principles and Application”, Tata McGraw-Hill, 1990.
2. Gaonkar, R.S., “Microprocessors Architecture – Programming and Application”, Wiley and Sons Ltd., New Delhi, 1990.

REFERENCES

1. Middleton, D.H., Ed., “Avionics Systems, Longman Scientific and Technical”, Longman Group UK Ltd., England, 1989.
2. Spitzer, C.R., “Digital Avionic Systems”, Prentice Hall, Englewood Cliffs, N.J., USA., 1987.
3. Brain Kendal, “Manual of Avionics”, The English Book HOuse, 3rd Edition, New Delhi, 1993.

AS1412	RELIABILITY ENGINEERING	L T P C 3 0 0 3
GOAL	To study the statistical concept involved in design and analysis process.	

OBJECTIVES	OUTCOME
The course should enable the student to 1.Understand fundamental concepts	The student should be able to understand 1. Reliability definitions like failure, its density, Rate, Hazard Rate, Mean Time To Failure, maintainability, availability, safety and reliability, Quality, cost and system effectiveness
2. Understand system reliability and modelling	2. Series, parallel, mixed configuration, k- out of n structure, complex systems- enumeration method, conditional probability method, cut set and tie set method, Redundancy, element redundancy, unit redundancy, standby redundancy- types of stand by redundancy. Markov analysis.
3. Understand maintainability and availability	3. Objectives of maintenance, types of maintenance, maintainability, factors affecting maintainability, system down time.
4.Understand system reliability analysis	4. Reliability allocation or apportionment, Reliability apportionment techniques – equal apportionment, AGREE, ARINC, feasibility of objectives apportionment.
5. Understand reliability on system design	5. Material strengths and loads, Safety factor, safety margin, Stress strength interaction, Failure mode effects analysis, severity/criticality analysis , Ishikawa diagram for failure representation , fault tree construction, Delphi methods, Monte-Carlo evaluation

UNIT I FUNDAMENTAL CONCEPTS 10

Reliability definitions, failure, Failure density, Failure Rate, Hazard Rate, Mean Time To Failure, maintainability, availability, safety and reliability, Quality, cost and system effectiveness, Life characteristic phases, modes of failure, Areas of reliability, Quality and reliabilityassurance rules, product liability, Importance of Reliability.

UNIT II SYSTEM RELIABILITY AND MODELLING 8

Series, parallel, mixed configuration, k- out of n structure, complex systems- enumeration method, conditional probability method, cut set and tie set method, Redundancy, element redundancy, unit

redundancy, standby redundancy- types of stand by redundancy, parallel components single redundancy, multiple redundancy. Markov analysis.

UNIT III MAINTAINABILITY AND AVAILABILITY 7

Objectives of maintenance, types of maintenance, maintainability, factors affecting maintainability, system down time, Availability - Inherent, Achieved and Operational availability, reliability and maintainability trade-off.

UNIT IV SYSTEM RELIABILITY ANALYSIS **10**

Reliability allocation or apportionment, Reliability apportionment techniques – equal apportionment, AGREE, ARINC, feasibility of objectives apportionment, dynamic programming apportionment, Reliability block diagrams and models, Reliability predictions from predicted unreliability, minimum effort method.

UNIT V RELIABILITY ON SYSTEMS DESIGN **10**

Material strengths and loads, Reliability testing and reliability growth testing, Safety factor, safety margin, Stress strength interaction, Failure mode effects analysis, severity/criticality analysis , Ishikawa diagram for failure representation , fault tree construction, basic symbols development of functional reliability block diagram, Fault tree analysis, fault tree evaluation techniques, minimal cut set method, Delphi methods, Monte-Carlo evaluation

TOTAL: 45

TEXT BOOKS:

1. A.Birolini , “Reliability Engineering, Theory and Practice”., Third Edition, Springer,1999

REFERENCES

1. L.S. Srinath, “Concepts of Reliability Engg”., Affiliated East-Wast Press (P) Ltd., 1985.
2. A.K. Govil, “Reliability Engineering”., Tata McGraw-Hill Publishing Co. Ltd., 1983.
3. E. Balagurusmy, “Reliability Engineering”., Tata McGraw-Hill Publishing Co. Ltd., 1984.
4. B.S. Dhillion, C. Singh, “Engineering Reliability”., John Wiley & Sons, 1980.
5. M.L. Shooman, “Probabilistic, Reliability”., McGraw-Hill Book Co., 1968.
6. P.D.T. Conor, “Practical Reliability Engg”.., John Wiley & Sons, 1985.
7. K.C. Kapur, L.R. Lamberson, “Reliability in Engineering Design”., John Wiley & Sons,1977.

AS1413	CRYOGENIC PROPULSION	L T P C 3 0 0 3
GOAL	To study the engineering concept of cryogenic and its application in various field	

OBJECTIVES	OUTCOME
1. To study the basics of cryogenic technology and its applications.	The learner will able to understand the background of cryogenic technology and its applications.
2. To study the different properties of cryogenic materials and their process.	The learner will able to understand the properties of cryogenic materials and their production.
3. To study the technique of cryogenic insulation.	The learner will able to understand the different methods used for cryogenic insulation.
4. To study the different methods for storing the cryogenics and instruments used in cryogenics.	The learner will able to understand the technique for storing cryogenics.
5. To study the different cryogenic equipments used for various process.	The learner will able to understand the different cryogenic equipments and theri applications.

UNIT I INTRODUCTION TO CRYOGENIC ENGINEERING 10

Thermo physical and fluid dynamic properties of liquid and gas hydrogen, Thermo physical and fluid dynamic properties of liquid and gas helium, Liquefaction systems of hydrogen and helium gases, Liquefaction systems of hydrogen and helium gases, Refrigeration and liquefaction principals; Joule Thomson effect and inversion curve; Adiabatic and isenthalpic expansion with their comparison

UNIT II PROPERTIES 10

Cryogenic fluids, Solids at cryogenic temperatures; Superconductivity, Recuperative – Linde – Hampson, Claude, Cascade, Heylandt, Kapitza, Collins, Simon; Regenerative – Stirling cycle and refrigerator, Slovay refrigerator, Gifford-McMahon refrigerator, Vuilleumier refrigerator, Pulse Tube refrigerator; Liquefaction of natural gas

UNIT III CRYOGENIC INSULATION 6

Vacuum insulation, Evacuated porous insulation, Gas filled Powders and fibrous materials, Solid foams, Multilayer insulation, Liquid and vapour Shields, Composite insulations.

UNIT IV STORAGE AND INSTRUMENTATION OF CRYOGENIC LIQUIDS 9

Design considerations of storage vessel; Dewar vessels; Industrial storage vessels; Storage of cryogenic fluids in space; Transfer systems and Lines for cryogenic liquids; Cryogenic valves in transfer lines; Two phase flow in Transfer system; Cool-down of storage and transfer systems, Measurement of strain, pressure, flow, liquid level and Temperature in cryogenic environment; Cryostats.

UNIT V CRYOGENIC EQUIPMENT 10

Cryogenic heat exchangers – recuperative and regenerative; Variables affecting heat exchanger and system performance; Cryogenic compressors, Pumps, expanders; Turbo alternators; Effect of component inefficiencies; System Optimization, Magneto-caloric refrigerator; 3He-4He Dilution refrigerator; Cryopumping; Cryogenic Engineering applications in energy, aeronautics, space, industry, biology, preservation Application of Cryogenic Engineering in Transport

TOTAL: 45

TEXT BOOK

1. T.M. Flynn, Marcel Dekker., Cryogenic Engineering,

REFERENCES

1. A. Bose and P. Sengupta, “Cryogenics: Applications and Progress”, Tata McGraw Hill.
2. J.G. Weisend II, Taylor and Francis , “Handbook of Cryogenic Engineering”,
3.R.Barron,“Cryogenic Systems”, Oxford University Press.
4.K.D.Timmerhaus and T.M. Flynn , “Cryogenic Process Engineering”, Plenum Press.
5.G.G.Haselden,“CryogenicFundamentals”,AcademicPress.
6.C.A.Bailey,“AdvancedCryogenics”,PlenumPress.
7. R.W. Vance and W.M. Duke , “Applied Cryogenic Engineering” , John Wiley & sons

AS1414	PRODUCT DESIGN AND DEVELOPMENT	L T P C 3 0 0 3
GOAL	To know the process of product development and design.	

OBJECTIVES	OUTCOME
1. To study the basics of product development history and product development process tool	The learner will able to understand the background of product development process tool.
2. To study the method of product tear down and experimentation.	The learner will able to understand the techniques used in product development.
3. To study the process of concepts and modelling	The learner will able to understand the technique of concept and modelling.
4. To study the process of design for manufacturing and assembly.	The learner will able to understand the technique of design for manufacturing and assembly.

UNIT I PRODUCT DEVELOPMENT HISTORY AND PRODUCT DEVELOPMENT PROCESS TOOL 11

Product development verses design, modern product development theories and methodologist in design. Product development teams. Product development planning, technical and business concerns. Understanding customer needs, Establishing product functions. Functional decomposition, modeling process, Function trees system functionality, augmentation. Aggregation, common basis, functional modeling methods.

UNIT II PRODUCT TEAR DOWN AND EXPERIMENTATION 11

Benchmarking and establishing engineering specification. Product portfolios and portfolio architecture. Tear down process, tear down methods, post teardown reporting, benchmarking approach, support tools, setting specifications, portfolio architecture, types, platform, functional architecting, optimization selection. Product modularity, modular design.

UNIT III CONCEPTS AND MODELING 12

Generation of concepts, information gathering and brain storming, directed search, morphological analysis, combining solutions. Decision making, estimation of technical feasibility, concept selection process, selection charts, measurement theory, numerical concept scoring, design evaluation scheme, concept embodiment, geometry and layout, system modeling, modeling of product metrics, selection of model by performance specifications, physical prototyping, informal and formal models.

UNIT IV DESIGN FOR MANUFACTURING AND ASSEMBLY 11

Design for the environment, design for assembly, piece part production, cost analysis, environmental objectives, life cycle assessments, techniques to reduce environmental impact like minimum material usage, disassembly, recycle ability, remanufacturing, high impact material reduction, energy efficiency, regulation and standards.

TOTAL: 45

TEXT BOOK

1. NFM Roozenburg, and J Eekels, "Product Design : fundamentals and methods", John Wiley and sons Ltd.

REFERENCES

1. Geoftry Boothroyd, and Peter Dewhurst, "Product Design for manufacturing and Assembly ", Winstrn Knight Marcel Dekker Inc., USA.

2. Mike Baxter, "Product Design : A practical guide to systematic methods of new product development", Champman and Hall.

3. A. K. Chitale and R.C. Gupta, "Product Design and manufacturing", Prentice – Hall India

4. John R.Lindbeck, "Product Design and Manufacture", Prentice Hall International Editime.

5. Kevin Otto, "Product Design :Techniques in Revenue Engineering and New product development", Kristin wood Pearson Education Inc.

AS1415	CERAMICS TECHNOLOGY	L T P C 3 0 0 3
GOAL	To know about the properties and application areas of ceramic material	

OBJECTIVES	OUTCOME
1. To study the basics of ceramics technology and its applications.	The learner will able to understand the background of ceramic technology and its applications.
2. To study the different types of refractories and their technology.	The learner will able to understand the different refractory process for ceramics production
3. To study the different types of whitewares and their technology.	The learner will able to understand the technique of whiteware production
4. To study the process of ceramic coating using various methods.	The learner will able to understand the technique of ceramic coating technique.
5. To study the different engineering ceramic materials and their applications.	The learner will able to understand the different engineering ceramic materials and their applications.

UNIT I GENERAL 8

Concepts of materials science, Definition & scope of ceramics and ceramic materials, classification of ceramic materials – conventional and advanced, Areas of applications.

UNIT II REFRACTORIES 10

Classification of Refractories, Modern trends and developments, Basic raw materials, lementary idea of manufacturing process technology, Flow diagram of steps necessary for manufacture, basic properties and areas of application, Physical properties

UNIT III WHITEWARES 9

Classification and type of Whitewares, Elementary idea of manufacturing process technology including body preparation, basic properties and application areas.

UNIT IV CERAMIC COATINGS 8

Types of glazes and enamels, Elementary ideas on compositions, Process of enameling & glazing and their properties.

UNIT V ENGINEERING CERAMICS AND APPLICATIONS 10

Carbides - Boron carbide, Silicon carbide, Titanium carbide, Zirconium carbide, Hafnium carbide & Uranium carbide. Nitrides : Boron, Silicon & Aluminium nitrides. Silicides, Molybdenum disilicide, Borides. Sialon. Graphite, Cermets & Composites. Ceramics used in advanced applications- Nuclear energy, Magneto- hydrodynamic, generation, Gas turbine blades, Abrasives, Aerospace, Diesel engines, Heat Exchangers, Cutting Tools, Wear Applications

TOTAL: 45

TEXT BOOKS:

1. F.H Norton , “Elements of Ceramics”

2. Barsoum, “Fundamentals of Ceramics”

REFERENCES:

1. W.D Kingery, “ Introduction to Ceramics”

2. Smith , “Materials Science”

3. Singer & Singer , “Industrial Ceramics”

AS1416	INTRODUCTION TO NDT	L T P C 3 0 0 3
GOAL	To study the various process involved in non destructive testing.	

OBJECTIVES	OUTCOME
1. To study the basics of NDT, its history and applications.	The learner will able to understand the background of NDT and its applications.
2. To study the process of various visual testing techniques used in NDT.	The learner will able to understand the different methods of visual testing and their advantages.
3. To study the process of radiographic testing and its applications.	The learner will able to understand the technique of radiographic testing and its equipments.
4. To study the process of ultrasonic testing and its applications.	The learner will able to understand the technique of ultrasonic testing and its equipments
5. To study the other methods used in NDT technique.	The learner will able to understand other different method used in NDT.

UNIT I INTRODUCTION 8

Introduction to NDT, concern in NDT, History, NDT vs. Destructive, Conditions for NDT, Personal Considerations, Certification, Primary production of metal, castings, cracks, welding discontinuities, corrosion induced discontinuities, fatigue cracking, creep, brittle fracture, geometric discontinues.

UNIT II VISUAL TESTING 10

History and Development, Theory and Principles, Equipment and Accessories, Applications and Techniques, Evaluation of Test Results, Advantages and Limitations, Penetrate Testing- Introduction, History and Development, Theory and Principles, Penetrate Equipment and Materials, Penetrant Procedures, Techniques and Variables, Evaluation and Disposition, Penetrate Testing Applications, Quality Control Considerations, Advantages and Limitations, Glossary of Penetrate Testing Terms, Magnetic Particle Testing - History and Development, Theory and Principles, Equipment and Accessories, Techniques, Variables, Evaluation of Test Results and Reporting, Applications, Advantages and Limitations.

UNIT III RADIOGRAPHIC TEST 10

History and Development, Theory and Principles, Radiographic Equipment and Accessories, Variables, Techniques and Procedures, Radiographic Evaluation, Applications, Advantages and Limitations of Radiography, Compendium of Radiographs

UNIT IV ULTRASONIC TESTING 10

History, Theory and Principles, Equipment for Ultrasonic Applications, Techniques, Variables, Evaluation of Test Results, Applications, Advantages and Limitations, Eddy Current Testing- History and Development, Theory and Principles, Alternating Current Principles, Eddy Currents, Test Equipment, Eddy Current Applications and Signal Display, Advantages and Limitations, Other Electromagnetic Test Techniques

UNIT V OTHER METHODS 7

Thermal Infrared Testing - History and Development, Theory and Principles, Equipment and Accessories, Techniques, Variables, Data Storage, Applications, Advantages and Limitations, Acoustic Emission Testing - History and Development, Principles of Acoustic Emission Testing, Advantages and Limitations of Acoustic Emission Testing.

TOTAL: 45

TEXT BOOK:

1. P. E. Mix, “Introduction to non-destructive testing”, Wiley Interscience,, John Wiley & Sons, Inc, Publ., 2005

REFERENCES:

1. C. Hellier, “Handbook of Nondestructive Evaluation”, McGraw-Hill, 1994.

AS1417	OPTIMIZATION TECHNIQUES	L T P C 3 0 0 3
GOAL	To study the various processes involved in design optimisation of engineering product.	

OBJECTIVES	OUTCOME
1. To study the process of optimization, parameter and its application. 2. To study the process of linear and non-linear programming in problem solving. 3. To study the process of unconstrained optimization techniques. 4. To study the process of constrained optimization techniques. 5. To study the non- traditional method used in optimization method.	The learner will able to understand the process of optimization and its techniques. The learner will able to understand the different methods used in analysis and design of engineering systems. The learner will able to understand the different method of unconstrained optimization techniques, The learner will able to understand the different method of constrained optimization techniques, The learner will able to understand the different method of non-traditional optimization techniques,

UNIT I INTRODUCTION 9

Engineering application of optimization, statement of an optimization problem with example for

minimum weight and optimum cost consideration, classification of optimization problems and techniques, Single variable optimisation , multivariable optimization with equality and inequality constraints and without constraints.

UNIT II LINEAR AND NON LINEAR PROGRAMMING 9

Introduction,standard form of the problem, Geometry,basic terminology Techniques of linear programming: Simplex method, Revised simplex method:Duality in linear programming,decomposition principle, post-optimality analysis, applications to engineering design, elimination methods:various search methods-Fibonacci method and golden section method Interpolation method-Quadratic and cubic interpolation methods, Direct root method.

UNIT III UNCONSTRAINED OPTIMIZATION TECHNIQUES 9

Introduction; Standard form of the problem and basic terminology; Direct search method- Simplex method, Random search method, Univariate and pattern search method Indirect search method-Steepest Descent (Cauchy) method, Conjugate gradient method, Newton's method, Application to engineering problems

UNIT IV CONSTRAINED OPTIMIZATION 9

Introduction; Standard form of the problem and basic terminology; direct method: Sequential Linear Programming; Generalised Reduced gradient method, Methods of feasible direction Indirect method: Penalty function method Interior and exterior penalty function method, Convex programming problem, Check for convergence Application to engineering problems

UNIT V INTRODUCTION TO NON-TRADITIONAL METHODS 9

Genetic Algorithm: Introduction, Representation of design variables, objective function and constraints, Genetic operators and numerical results, Introduction to Neural network based optimisation

TOTAL: 45

TEXT BOOK

1. S.S.Rao, ''Engineering Optimisation- Theory and Practice'', New Age International.

REFERENCES

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