HINDUSTAN
INSTITUTE OF TECHNOLOGY & SCIENCE
(DEEMED TO BE UNIVERSITY)

DEPARTMENT OF AERONAUTICAL ENGINEERING

CURRICULUM AND SYLLABUS

Under CBCS

(Applicable for Students admitted from Academic Year 2018-19)

B. Tech. Aeronautical Engineering / B. Tech. Aeronautical Engineering (with specialization in Avionics)

DEPARTMENT OF AERONAUTICAL ENGINEERING

SCHOOL OF AERONAUTICAL SCIENCES

HINDUSTAN INSTITUTE OF TECHNOLOGY & SCIENCE
VISION AND MISSION

MOTTO

"TO MAKE EVERY MAN A SUCCESS AND NO MAN A FAILURE"

VISION

To be an International Institute of Excellence, providing a conducive environment for education with a strong emphasis on innovation, quality, research and strategic partnership blended with values and commitment to society.

MISSION

- To create an ecosystem that promotes learning and world class research.
- To nurture creativity and innovation.
- To instill highest ethical standards and values.
- To pursue activities for the development of the Society.
- To develop national and international collaborations with institutes and industries of eminence.
- To enable graduates to become future leaders and innovators.

Value Statement

- Integrity, Innovation, Internationalization.

SCHOOL OF AERONAUTICAL SCIENCES

VISION AND MISSION

VISION

To excel in education, research and innovation in Aeronautical Engineering.

MISSION

To provide every graduate with professionally competent education through a well-designed teaching and learning process in all spheres of aeronautical engineering and technology combined with professional ethics and training for lifelong learning.

B. Tech. Aeronautical Engineering

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

The Programme Educational Objectives (PEOs) of B. Tech Aeronautical engineering are:

PEO I **Successful career and adoptability to industry:** Graduates of the programme will attain adequate academic knowledge and skills to adapt themselves in any aircraft and allied industries and have successful professional career

PEO II **Modern design tools and multi-disciplinary project execution:** Graduates of the programme will have knowledge on modern design tools and apply to multi-disciplinary projects through teamwork with a high degree of professional ethics and standards

PEO III **Contribution to aeronautical field and lifelong learning**: Graduates of the programme will have innovative ideas, sustained interest and potential to contribute for the development and current needs of the aeronautical industries in the country and the world

PROGRAMME OUTCOMES (PO's)

Engineering Graduates will be able to:

PO1 : **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals,and an engineering specialization to the solution of complex engineering problems.

PO2 : **Problem Analysis**: Identify, formulate, review research literature, and analyze complex engineeringproblems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO3 : **Design Development of Solutions**: Design solutions for complex engineering problems and designsystem components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 : **Conduct Investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 : **Modern Tool Usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 : **The Engineer & Society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 : **Environment & Sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 : **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 : **Individual & Team Work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO10 : **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 : **Project Management & Finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 : **Life-Long Learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES: (PSO's)

PSO1 : Design, analyse, interpret, formulate and to find the solution for Aerospace related problems

PSO2 : Ability to excel in Aero modelling, UAV design, Aircraft Structures, Computational Aerodynamics and Combustion related problems

ACADEMIC REGULATIONS FOR

B. TECH. / B. TECH. (HONS.) DEGREE PROGRAMME

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I. PREAMBLE

As per the recommendations of UGC, the Hindustan Institute of Technology and Science (HITS) has introduced Choice Based Credit System (CBCS) from the academic year 2015-16. Choice Based Credit System (CBCS) is a proven, flexible mode of learning in higher education which facilitates a student to have guided freedom in selecting his/her own choices of courses in the curriculum for completing a degree program. This revision of regulations, curriculum and syllabi has been carried out further to make it more flexible and adaptive to the technology advancements happening in the world. CBCS offers a flexible system of learning.

The system permits a student to

(i) Learn at their own pace through flexible registration process

(ii) Choose electives from a wide range of courses offered within and outside their departments

(iii) Undergo additional courses and acquire more than required number of credits to obtain B. Tech (Hons)

(iv) Undergo additional courses in their special areas of interest and earn additional credits to obtain B. Tech with Minor Specialization

(v) Adopt an interdisciplinary approach in learning

(vi) Avail transfer of Credits

(vii) Gain Non – CGPA credits to enhance skill/employability by taking up additional project work, entrepreneurship, co-curricular and vocational training.

(viii) Make the best use of the expertise of available faculty.

(ix) Learn and earn credits through MOOC and Project Based Learning

(x) Enhance their Knowledge, Skill and Attitude through participation in innovative Curriculum Design, Delivery and Assessments.

The Curriculum is designed to take into the factors listed in the Choice Based Credit System (CBCS) with focus on Project Based Learning and Industrial Training so as to enable the students become eligible and fully equipped for employment in industries choose higher studies or entrepreneurship.

II. DEFINITIONS AND NOMENCLATURE

In these Regulations, unless the context otherwise requires:

1. “Programme” means Degree Programme like B.Tech. Degree Programme.
2. “Discipline” means specialization or branch of B.Tech. Degree Programme, (e.g. Civil Engineering).
3. “Course” means a theory or practical subject that is normally studied in a semester, (e.g. Mathematics, Physics, etc.).

4. "Vice – Chancellor of HITS" means the Head of the Institution.
5. "Registrar" is the Head of all Academic and General Administration of the Institute.
6. "Dean Academics" means the authority of the University who is responsible for all academic activities of various programmes and implementation of relevant rules of these Regulations pertaining to the Academic Programmes.
7. "Controller of Examinations" means the authority of the University who is responsible for all activities related to the University Examinations, publication of results, award of grade sheets and degrees.
8. "Dean – Student Affairs" is responsible for all student related activities including student discipline, extra and co – curricular activities, attendance and meetings with class representatives, Student Council and parent – teacher meet.
9. "HoD" means the Head of the Department concerned.
10. "Institute" means Hindustan Institute of Technology and Science (HITS), Chennai.
11. "TCH" means Total Contact Hours – refers to the teaching – learning periods.
12. "DEC" means Department Exam Committee.
13. "BoS" means Board of Studies.
14. "BoM" means Board of Management.
15. "ACM" means Academic Council meeting the highest authoritative body for approval for all Academic Policies.
16. "Class Teacher" is a faculty of the class who takes care of the attendance, academic performance and the general conduct of the students of that class.
17. "CIA" is Continuous Internal Assessment which is assessed for every student for every course during the semester.
18. "ESE" is End Semester Examination conducted by the Institute at the End of the Semester for all the courses of that semester.
19. "AICTE" means All India Council for Technical Education.
20. "UGC" means University Grants Commission.
21. "MHRD" means Ministry of Human Resource Development, Govt. of India.

ACADEMIC REGULATIONS FOR B. Tech. / B.Tech. (Hons.)
Under Choice Based Credit System (CBCS)
(Effective from Academic year 2018 - 19)

1.0 Vision, Mission and Objectives

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

1.1 The Mission of the institute is

- To create an ecosystem that promotes learning and world class research.
- To nurture creativity and innovation.
- To instil highest ethical standards and values.
- To pursue activities for the development of the Society.
- To develop national and international collaborations with institutes and industries of eminence.
- To enable graduates to become future leaders and innovators.

Value Statement

Integrity, Innovation, Internationalization

1.2 Further, the Institute always strives

- To train our graduates with the latest and the best in the rapidly changing fields of Architecture, Engineering, Technology, Management studies, Science and Humanities and Liberal Arts.
- To develop graduates, with a global outlook, possessing Knowledge, Skills and Attitude and capable of taking up challenging responsibilities in the respective fields.
- To mould our graduates 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 Architecture, Engineering, Technology, Management studies, Science and Humanities and Liberal Arts and Allied disciplines.

1.3 Aims and Objectives of the Institute are focused on

- Providing state of the art education in Engineering, Technology, Applied Sciences and Management studies.
- Keeping pace with the ever – changing technological scenario and help the graduates to gain proper direction to emerge as competent professionals fully aware of their commitment to the society and the nation.
- To inculcate a flair for Research, Development and Entrepreneurship.

2.0 Admission

The admission policy and procedure shall be decided from time to time by the Board of Management (BOM) of the Institute, based on the guidelines issued by the UGC/ Ministry of Human Resource Development (MHRD), Government of India. The number of seats in each of the B. Tech. degree programme will be decided by the Board of Management of the Institute as per the directives of AICTE/ UGC / MHRD, Government of India, taking into account, the market demands. Seats are also made available up to 20% of the sanctioned intake for Non – Resident Indians and foreign nationals, who satisfy the admission eligibility norms of the Institute.

2.1. Eligibility for Admission

(i) Regular Entry

Passed 10 + 2 examination with Physics and Mathematics as compulsory subjects along with one of the other subjects as Chemistry/ Biotechnology/ Biology/ Technical Vocational course.

The candidates should have obtained the minimum marks as per AICTE norms.

(ii) Lateral Entry

The candidates possessing a Diploma in Engineering/Technology in the relevant discipline of specialization with minimum 50% marks awarded by the State Boards of Technical Education, India or any other competent authority as accepted by the Board of Management of the Institute as equivalent thereto are eligible for admission to the 3rd Semester of the B. Tech degree programme.

2.2 The candidate has to fulfil all the prescribed admission requirements / norms of the Institute.

2.3. In all matters relating to admission to the B. Tech degree programme, the decision of the Board of Management of the Institute shall be final.

2.4. At any time after admission, if found that a candidate has not fulfilled one or many of the requirements stipulated by the Institute, or submitted forged certificates, the Institute has the right to revoke the admission and forfeit the fee paid. In addition, legal action may be taken against the candidate as decided by the Board of Management.

3.0 Student Discipline

Every student is required to observe utmost discipline and decorum both inside and outside the campus and not to indulge in any activity which may affect adversely the prestige reputation of the Institute.

3.1 Any act of indiscipline of a student reported to the Dean (Student affairs) and Head of the Department will be referred to a Discipline Committee constituted for the purpose. The Committee will enquire into the charges and decide on a suitable punishment if the charges are substantiated. The committee will also authorize the Dean (Student Affairs) to recommend to the Vice-Chancellor for the implementation of the decision. The student concerned may appeal to the Vice-Chancellor, whose decision will be the final.

3.2 Ragging in any form is a criminal and non-bailable offence in our country. The current State and Central legislations provide stringent punishments including imprisonment. Once the involvement of a student(s) is established in ragging, offending fellow students/staff, harassment of any nature to the fellow students/staff etc. the student(s) will be liable to be dismissed from the Institute, as per the laid down procedures of the UGC / Govt. /Institute. Every senior student of the Institute, along with their parent, shall give an undertaking every year in this regard and the same should be submitted at the time of Registration.

4.0 Structure of the B. Tech Degree Programme

4.1 All B. Tech. degree Programmes will have the curriculum and syllabi (for 4 years) as approved by the respective Board of Studies and Academic Council of the Institute.

4.2 Credits are the weightages, assigned to the courses based on the following general pattern:

One Lecture / Tutorial period per week	--- 1 credit
Up to Three periods of Practical per week	--- 1 credit
4 periods of Practical per week	--- 2 credits

4.3 The curriculum for B. Tech. programme is designed to have a minimum of **165 credits + 4 Non – CGPA credits** that aredistributed across eight semesters of study for the award of degree.

Choice Based Credit System (CBCS) was introduced from the Academic year 2015-16 in the curriculum to provide the students, a balanced approach to their educational endeavour.

Under CBCS, the degree programme will consist of the following categories of courses:

i) **General Core foundation** (**CF**) courses comprising of

- Humanities courses;
- Basic Sciences (BS)including Physics, Chemistry and Mathematics;
- Engineering Sciences (ES), including Basic Engineering courses such as Material Science, Basic Workshop, Engineering Drawing, Engineering Graphics, Digital systems, etc.

ii) **Compulsory Courses (CC) consist of the following.**

a. **Professional Core (PC)** courses: These courses expose the students to the foundation of Engineering topics related to the chosen programme of study comprising of theory and Practical/ field work/ Design project/ Project.

b. **Departmental Elective** (**DE**): These courses enable the students to take up a group of courses of their interest in the area of specialization offered by the parent Department / School.

iii) **Non –Departmental Electives (NE):** These courses are offered by Engineering and Non-Engineering departments (across the disciplines) other than their parent Department. Two groups of Electives are available under NE namely, Engineering Electives, offered by the Engineering Departments and Open Electives, offered by the Non – Engineering departments.

iv) **Indexed Journal / Conference Publications:** If a student publishes a research paper as main author in indexed Journal / Conference, the same can be considered as equivalent to two – credit course under NE.

v) **Non-CGPA courses:** These courses are offered in certain semesters are compulsory, but are not used for calculation of GPA and CGPA. However, the credits will be mentioned in the grade sheet.

4.4 Non – CGPA courses

The student shall select any two courses /activity listed in **Table 1** during the course of study. The student has to make his / her own efforts for earning the credits. The grades given will be Pass / Fail (P/F). The respective class teachers have to encourage, monitor and record the

relevant activities of the students, based on the rules issued from time to time by the Institute and submit the End semester report to the Head of the Department.

Table 1. Non – CGPA Courses

No.	Course / Activity	Credits
1.	Start ups	2
2.	Industrial Training	2
3.	Technical conference, seminar, competitions, Professional Societies	2
4.	Management courses	2
5.	Technical Certification Course	2
6.	Sports	2
7.	NCC	2
8.	NSS	2
9.	YRC	2
10.	Art and Cultural activities	2
11.	English Proficiency Certification	2
12.	Aptitude Proficiency Certification	2
13.	Foreign Languages Level II and above	2
14.	Publication in Conferences / Seminar	2

4.5 A student must earn compulsorily, the credits mentioned under each category shown in **Table 2** and also a minimum total of **169 credits - 165 credits (CGPA) + 4 credits (Non CGPA)** for the award of B. Tech. degree. For Lateral entry students, the 41 credits required for first and second semester of B. Tech shall be deemed to have been earned based on their curriculum in the diploma course. They have to earn a minimum of **128 credits (124 credits + 4 Non CGPA credits)** for the award of B. Tech. degree.

4.6 Students are eligible for award of **B.Tech.(Hons)** upon successful completion of **181 credits (165 regular credits + 12 Additional Credits+ 4 Non CGPA credits)** maintaining a CGPA of 8.0 during their period of study (4 years) and no history of arrears as detailed in clause 7.0.

4.7 Students are eligible for the award of **B.Tech. with Minor specialisation** upon successful completion of 12 additional credits totaling **181 credits (165 regular credits + 12 Additional Credits+ 4 Non – CGPA credits)** as detailed in clause 8.0

Table 2. Distribution of Credits

No.	Category	Credits	Percentage
1	Basic Sciences (BS)	32	20
2	Humanities Courses (HS)	7	4
3	Professional Core (PC)	90	53
4	Department Elective (DE)	15	9
5	Non – Department Electives (NE)	10	6
6	Design Project	3	2
7	Internship	1	0.5
8	Project	8	5
9	Comprehension	1	0.5
	Total Credits	**165**	**100**
NON – CGPA			
10	Professional Development	4	---

4.8 The medium of instruction is English for all courses, examinations, seminar presentations and project reports.

5.0 Faculty Advisor

To help the students in planning their selection of courses and programme 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. Such Faculty Advisor will continue to mentor the students assigned to him/her for the entire duration of the programme.

5.1 Class Committee

5.2 Every section / batch of the B. Tech. Degree programme will have a Class Committee consisting of Faculty and students.

5.3 The constitution of the Class Committee will be as follows:

a. One Professor not associated with teaching the particular class shall be nominated by the Head of the Department to act as the Chairman of the Class Committee as approved by the Dean Academics.
b. Course coordinator of each of the lecture – based courses (for common courses).
c. Class teacher of the class.

d. All Faculty handling the courses for that class in the semester.
e. Workshop Superintendent (for first two semesters); as applicable.
f. Four students from the respective class nominated by Head of the Department
g. Faculty Advisors of the respective class.

5.4 Course committee

A course committee shall be constituted by the HOD for all the common courses, with the faculty who are teaching the courses and with a Professor of the core department as the Chairman. The Course committee shall meet periodically to ensure the quality of progression of the course in the semester.

5.5 The basic responsibilities of the Class Committee and Course committee are

a. To review periodically the progress of the students.
b. To discuss issues concerning curriculum and syllabi and the conduct of the classes.
c. To inform the students about the method of assessment as recommended by the Department Exam Committee ("DEC") at the beginning of the semester. Each class committee / course committee will communicate its recommendations and the minutes of the meetings to the Head of the Department, Dean (Academics) and the Dean (Student Affairs).
d. To conduct meetings at least thrice in a semester as per the Academic Plan issued by the Dean – Academics.
e. To review the academic performance of the students including attendance, internal assessment and other issues like discipline, maintenance etc.

6.0 Registration for courses in a Semester

A student will be eligible for registration of courses only if he/she satisfies the regulation clause 12.0 (progression), and clause 13.0 (maximum duration) and has cleared all dues to the Institute, Hostel and Library up to the end of the previous semester provided that student is not debarred from enrolment on disciplinary grounds.

6.1 The institute follows a flexible Choice Based Credit System and Slot based table. Accordingly, the students shall be given the option for selecting their courses, credits, teachers, slots and create their time table. The student is given the option of selecting the number of credits to undergo in a semester, subject to the curriculum requirements of minimum and maximum.

Except for the first year courses, registration for a semester will be done during a specified week before the start of the semester as per the Academic Schedule.

Late registration /enrolment will be permitted by the Dean – Academics for genuine cases, on recommendation by the Head of the respective department, with a late fee as decided from time to time.

6.2 The student shall make the choice of course in consultation with the Faculty Advisor and as stipulated from time to time.

6.3 Students shall have to pay additional fee as prescribed, for registering in certain elective courses under Non - Departmental Electives courses offered by certain specific Departments and for higher level Foreign Languages, as decided from time to time.

7.0 B. Tech, (Honours) Programme

A new academic programme B.Tech. (Hons.) is introduced in order to facilitate the students to choose additionally the specialized courses of their choice and build their competence in a specialized area. The features of the new programme, include:

a. B.Tech. students in regular stream can opt for B.Tech. (Hons.), provided they have a CGPA of 8.0 up to the end of fourth semester without any history of arrears.
b. The students opting for this program have to take four additional courses of their specialization of a minimum of 3 credits each from 5^{th} to 8^{th} semesters with not more than 2 additional courses in a semester.
c. The list of such additional courses offered by the various Departments of the respective school will be announced in the beginning of the academic year to facilitate the registration process.
d. The student can also opt for post graduate level courses
e. The faculty advisor will suggest the additional courses to be taken by the students based on their choice and level of their academic competence.
f. Students who have obtained “E” or “U” or “RC” / “RA” grade or “DE” category (vide clause 16.0 – Grading) in any course, including the additional credit courses, are not eligible for B.Tech. (Hons) degree.
g. The students have to pay the requisite fee for the additional courses.

8.0 B. Tech with Minor specialization:

Students, who are desirous of pursuing their special interest areas other than the chosen discipline of Engineering / Technology/ Arts/ Fashion/ Humanities/ Management/ Basic Sciences, may opt for additional courses in minor specialisation groups offered by a

department other than their parent department. Such students shall select the stream of courses offered with pre – requisites by the respective departments and earn a Minor Specialization.

a. The number of credits to be earned for Minor specialization is 12 credits.

b. The students are permitted to register for their minor specialization courses from the V semester onwards subject to a maximum of two additional courses per semester.

c. The list of such additional courses offered by the various departments and the schedule will be announced in the beginning of the academic year to facilitate the registration process.

d. The students have to pay the requisite fee for the additional courses.

9.0 Attendance

The faculty handling a course must finalise the attendance, 3 calendar days before the last instructional day of the course and submit to the HoD through the class teacher.

a. A student with less than 75% attendance (Total Contact Hours - "TCH") in any course, will **not** be permitted to appear for the end-semester examination in that particular course, irrespective of the reason for the shortfall of the attendance. The student is however permitted to avail **Academic Leave** up to 10% for attending academic related activities like, Industrial Visits, Seminars, Conferences, Competitions etc., with the prior approval of the HoD. After the event, the student should submit the relevant documents for proof to the HoD for approval of the Academic Leave.

b. The remaining 25% allowance in attendance is given to account for activities under NCC / NSS / Cultural / Sports/ Minor Medical exigencies etc.

c. A student with an attendance ("TCH" – Total Contact Hours) between 40% and 75% in any course will fall under the category "RC", which means Repeat the Course during the Summer / Winter break. Students under "RC" category will **not** be permitted to attend the Regular End Semester Examinations for that course. During the Summer / Winter break, the regular courses of the respective semester will be offered as Summer/Winter Courses, to enable the students to get required attendance and internal assessment marks to appear in the Repeat examination.

d. Students under "RC" category in any course shall attend, the immediately following Summer / Winter course as detailed in clause 11.1. The detailed schedule of the Summer / Winter courses offered in every semester will be announced during the end of that semester. The student who have obtained "RC" has to select their appropriate slots and courses, optimally to attend the courses.

e. The student, whose attendance falls below 40% for a course in any semester, will be categorized as "RA", meaning detained in the particular course for want of

attendance and they will not be permitted to write the End semester exam for that course. The procedure for repeating the course categorized as "RA" is mentioned in Clause 11.2.

9.1 Additional condonation may be considered in rare and genuine cases which includes, approved leave for attending select NCC / Sports Camps, cases requiring prolonged medical treatment and critical illness involving hospitalization.

For such select NCC / Sports Camps prior permission for leave shall be obtained by the respective faculty coordinator / Director of sports from the designated authority, before deputing the students.

9.2 For medical cases, submission of complete medical history and records with prior information from the parent / guardian to Dean (Student Affairs) is mandatory. The assessment of such cases will be done by the attendance sub – committee on the merit of the case and put up recommendations to the Vice – Chancellor. Such condonation is permitted **only twice** for a student in the entire duration of the programme.

The Vice-Chancellor, based on the recommendation of the attendance sub - committee may then give condonation of attendance, only if the Vice-Chancellor deems it fit and deserving. But in any case, the condonation cannot exceed 10%.

10.0 Assessment Procedure

Every course shall have two components of assessment namely,

a. Continuous Internal Assessment "CIA": This assessment will be carried out throughout the semester as per the Academic Schedule.
b. End Semester Examination "ESE": This assessment will be carried out at the end of the Semester as per the Academic Schedule.

The weightages for the various categories of the courses for CIA and ESE is given in Table 3.

Table 3 Weightage of the CIA and ESE for various categories of the courses

No.	Category of Courses	CIA weightage	CIA Minimum	ESE	ESE Minimum	Passing minimum (CIA + ESE)
1	Theory Course	50%	40%	50%	50%	45%
2	Practical Course	80%	50%	20%	50%	50%
3	Theory Course with Practical Components	60%	40%	40%	50%	45%
4	Department Elective (DE)/ Non – Department Elective (NE)	50%	40%	50%	50%	45%
5	Design Project	100%	50%	---	---	50%
6	Comprehension	100%	50%	---	---	50%
7	Internship	100%	50%	---	---	50%
8	Project and Viva Voce	50%	50%	50%	50%	50%

10.1 Theory Course / DE / NE Assessment weightages

The general guidelines for the assessment of Theory Courses, Department Electives "DE" and Non – Department Electives "NE" shall be done on a continuous basis is given in Table 4.

Table 4(a): Weightage for Assessment

No.		Assessment Theory, DE, NE courses	Weightage Theory, DE, NE courses	Duration
1.	CIA	First Periodical Assessment	5%	1 period
2.		Second Periodical Assessment	10%	1 Period
3.		Third Periodical Assessment	10%	1Period
4.		Seminar/Assignments/Project	15%	--
5.		Surprise Test / Quiz etc.,	10%	--
6.	ESE	End Semester Exam	50%	2 to 3 hours

10.2 Practical Course: For practical courses, the assessment will be done by the course teachers as below:

Weekly assignment/Observation / lab records and viva as approved by the Department Exam Committee "DEC"

a. Continuous Internal Assessment -- 80%
b. End Semester Examination -- 20%

10.3 Theory courses with practical Component: For theory courses with practical component the assessment will be calculated as follows as approved by the "DEC".

a. Continuous Internal Assessment -- 60%
b. End Semester Exam -- 40%

Table 4(b): Weightage for Assessment

No.		Assessment Theory, DE, NE courses	Weightage Theory, DE, NE courses	Duration
1.	CIA	First Periodical Assessment	10%	1 period
2.		Second Periodical Assessment	10%	1 Period
3.		Third Periodical Assessment	10%	1Period
4.		Practical Assessment	30%	----
5.	ESE	End Semester Exam	40%	2 to 3 hours

10.4 Design Project – Assessment

The general guidelines for assessment of Design Project is given in Table 5.

Table 5: Assessment pattern for Design Project

No.	Review / Examination scheme	Broad Guidelines	Weightage
1.	First Review	Concept	20%
2.	Second Review	Design	30%
3.	Third Review	Experiment/Analysis	20%
4.	Project report and Viva – Voce	Results and Conclusion	30%

10.5 Comprehension – Assessment

The general guidelines for assessment of Comprehension is given in Table 6.

Table 6: Assessment pattern for Comprehension

No.	Review / Examination scheme	Broad Guidelines	Weightage
1.	First Periodical Assessment – MCQ	Basic Sciences	20%
2.	Second Periodical Assessment – MCQ	Core Engineering	50%
3.	Third Periodical Assessment – Presentation	Emerging Areas	30%

10.6 Internship

A student has to compulsorily attend Summer / Winter internship during 3rd year for a minimum period of one month.

In lieu of Summer / Winter internship, the student is permitted to register for undertaking case study / project work under an engineering faculty of the Institute and carry out the project for minimum period of one month.

In both the cases, the internship report in the prescribed format duly certified by the faculty in-charge shall be submitted to the HoD. The evaluation will be done through presentation and viva. The course will have a weightage of one credit or as defined in the respective curriculum.

10.7 For final year Project / Dissertation / Design Project/ Internship, the assessment will be done on a continuous basis as given in Table 7

Table 7: Assessment of Project work

No.	Review / Examination scheme	Weightage
1.	First Review	10%
2.	Second Review	20%
3.	Third Review	20%
4.	Project report and Viva – Voce	50%

For the final year project and Viva – Voce end semester examination, the student shall submit a Project Report in the prescribed format issued by the Institute. The first three reviews will be conducted by a Committee constituted by the Head of the Department. The end – semester assessment will be based on the project report and a viva on the project conducted by a Committee constituted by the Registrar / Controller of examination. This may include an external expert.

10.8 For Non – CGPA courses, the assessment will be graded "Satisfactory/Not Satisfactory" and grades as Pass/Fail will be awarded.

10.9 Flexibility in Assessment

The respective Departments under the approval of the Department Exam Committee (DEC) may decide the mode of assessment, based on the course requirements.

10.10 A student securing **less than the minimum** specified internal assessment marks in any course (clause 10.0, Table 3), will **not be permitted** to appear for the end-semester examination in that particular course and will be graded under **"RC"** category for that course. This will be denoted in the grade sheet as "RC", till the course is successfully completed in the subsequent semester(s).

11.0 Procedures for Course Repetition / Repeat Examinations

11.1 Summer / Winter Course: - for "RC" Category

a. Students under RC category i.e.
   i. Attendance between 40% and 75% in any course(s) OR
   ii. CIA marks less than the prescribed minimum as specified in 10.0 Table 3 in any course(s) OR
   iii. Falls under both 1 and 2 above

are eligible for registering for the **Summer / Winter Course** which will be conducted during the Summer / Winter break, to improve their Attendance and/or CIA marks in the courses, by paying the **prescribed registration fee fixed from time to time.**.

b. The Odd semester regular courses will be offered only in the Winter and the even semester regular courses will be offered only in the Summer.
c. **RC** students shall register by payment of prescribed fee and attend the classes during the summer / winter break and take assessments to earn minimum internal marks (clause 10.0, Table 3) and/or required attendance, to become eligible for writing the Repeat Examinations (Clause 11.3).
d. The revised CIA marks shall not exceed 60% of the total internal weightage for any repeat course.
e. Re- Registration for 'RC' category

The students under "RC" category who **fail to improve** their attendance and/or CIA marks and **not** become eligible to write the Repeat Examination through the immediate summer/winter course are permitted to **re – register** for the Summer / Winter course again under "RC" category whenever it is offered in the subsequent semester(s) during their period of study by **paying 50% of the prescribed registration fee** as mentioned in Clause 11.1 (a). It is the responsibility of the student to fix the appropriate slots in the Summer / Winter course time table. The student will not be able to register if he/she is unable to fix the slots in the time table. The course will remain in the "RC" category until he / she successfully completes that course.

11.2 Course – Repetition - "RA" Category

a. Students who secure attendance less than **40%** in any course(s) in a semester will be categorized under "RA" - meaning **Repeat the course(s)** for want of minimum attendance. The CIA marks obtained by the students placed under RA category will become null and void.

b. "RA" category students shall re-register for the same course once again whenever it is offered in the subsequent regular semesters and has to secure required minimum attendance and minimum internal assessment marks to become eligible to appear in the end semester examination for that course, by paying the requisite fee.

c. It is the responsibility of the student to schedule their time table to include the "RA" courses without affecting the attendance of the regular courses of the current semester.

d. Normally, a student will be permitted to register for not more than 3 "RA" courses in a semester. However, the students who wish to register for more than 3 "RA" courses are permitted to register only if the student finds suitable slots for doing the course within the framework of the time table for the regular semester. Request for registrations of additional RA courses over and above 3 in a semester shall be got approved by the respective HoDs.

e. The student has the option to drop their regular courses proportionally in their regular semester during the course registration process without affecting the minimum credit requirement specified. Such dropped courses will be categorized as "RA". However, the student has to complete the dropped courses in the subsequent semesters.

f. It is the responsibility of the student to fix the slots for "RA" courses within the framework of the time table and slot availability without affecting his/her regular courses.

g. Detention

A student who secure RC or RA or both in all the theory courses prescribed in a semester shall repeat the semester by registering for the semester in the next academic year. However, he/she is permitted to appear for arrear examination as per eligibility.

11.3 Repeat Examinations

a. Normally, the results of the End Semester Examinations for Regular Theory courses are announced within a period of 10 days after the last regular examination.

b. During the even semester, the Repeat Examinations will be conducted for even semester courses and during the Odd semester the Repeat Examinations will be conducted for Odd semester courses.

c. The schedule for the Repeat Examinations will be notified through the Academic Calendar which will be published at the beginning of every academic year.
d. The students under "RC" category, who have secured the requisite attendance and internal assessment marks as applicable, by successfully completing the Summer / Winter course, are eligible to register for the Repeat Examinations.
e. The students who fail to secure a pass or being absent for genuine reasons in their End Semester Examination for the regular courses are permitted to appear for the Repeat Exams by paying the prescribed fee.
f. For the **Supplementary examinations (refer: Clause 15.2)**, the students with "U" grade in any course (refer clause 10.0 Table 3 and Clause 16.1) shall register by paying requisite fee and appear in the Repeat Examinations.
g. The students who wish to apply for the revaluation of their answer scripts (Regular/ Supplementary / Repeat Examinations) should apply immediately after the announcement of results.

12.0 Progression to higher semester

12.1 B.Tech.– Regular: Student has to satisfy the following conditions as laid down in Table 8 for progression from one academic year to next.

Table 8. Minimum Eligibility for progression B.Tech.- Regular

To enroll for semester	Minimum no. of credits to be earned for progression
3	NIL
5	15 credits* in Theory courses in 1st, 2nd and 3rd Semesters
7	30 credits* in Theory courses up to 5th Semester

** Credit calculation is applicable for Theory / Theory integrated lab only*

If a student fails to satisfy the above clause 12.1 in an academic year, the student has to take a break in study until they become eligible for progression

12.2 B.Tech.- Lateral Entry

Student has to satisfy the following conditions as laid down in Table 9 for progression from one academic year to next.

Table 9. Minimum Eligibility for progression B.Tech.- Lateral Entry

To enroll for semester	Minimum no. of credits to be earned
5	NIL
7	15 credits* in Theory courses in 3rd, 4th and 5th Semesters

**Credit calculation is applicable for Theory / Theory integrated lab only*

If a student fails to satisfy the above clause 12.2 in an academic year, the student has to take a break in study until they become eligible for progression

12.3 If a student is in **RC** category (due to lack of minimum CIA marks **as specified in clause no. 10. Table 3**) or **RA** category (due to lack of minimum attendance as specified in clause 9.0 e) **in all theory courses prescribed in a semester**, he/she will be detained and will not be allowed to proceed to the next semester. He/she has to re-register for all the courses in the following academic year only.

13.0 Maximum Duration of the Programme

A student may complete the programme at a slower pace than the regular pace, but in any case in **not more than 6 years for B. Tech**, **and not more than 5 years for lateral entry students excluding the semesters withdrawn as per clause 14.0.**

A student completing the B.Tech. programme during the extended period will not be eligible for Institute ranking.

14.0 Temporary Withdrawal from the Programme

a. A student is permitted to take a break, up to a maximum of 2 semesters, during the entire programme to clear the backlog of arrears.
b. A student may be permitted by the Vice- Chancellor to withdraw from the entire programme for a maximum of two semesters for reasons of ill health, Start – up venture or other valid reasons as recommended by a committee consisting of Head of Department, Dean (Academic) and Dean (Student Affairs).

15.0 Declaration of results

15.1 A student shall secure the minimum marks as prescribed in Clause 10.1(Table 3) in all categories of courses in all the semesters to secure a pass in that course.

15.2 **Supplementary Examinations:** If a candidate fails to secure a pass in a course and gets a "U" grade as per clause 16.1 he/she shall register and pay the requisite fee for re-appearing in the End Semester Examination during the following semester(s). Such examinations are called Supplementary Examinations and will be conducted along with the Regular /Repeat Examinations. The Supplementary Exams for the Odd semester courses will be conducted during the odd semester and supplementary exams for the even semester courses will be conducted during the even semester only. The student need not attend any contact course. The Internal Assessment marks secured by the candidate will be retained for all such attempts.

15.3 A candidate can apply for the revaluation of his/her end semester examination answer script in a theory course, after the declaration of the results, on payment of a prescribed fee.

15.4 If a candidate fails to secure a pass in Practical/Theory with Practical component / Design Project / Internship / Comprehension courses, due to not satisfying the minimum passing requirement ("U" grade) – as per clause 16.1 he/she shall register for the courses by paying the prescribed fee in the subsequent semester when offered by the departments.

15.5 Revaluation is **not** permitted for Practical/Theory with Practical component/Design Project / Internship / Comprehension courses. However, only for genuine grievances as decided by the Exam Grievance Committee a student may be permitted to apply for revaluation.

15.6 After 5 years, i.e., completion of one year (2 semesters) from the normal duration of the programme, the internal assessment marks obtained by the candidate will not be considered in calculating the passing requirement. A candidate who secures 50% in the end semester examination will be declared to have passed the course and earned the specified credits for the course irrespective of the score in internal assessment marks earned in that course.

15.7 Candidate who earns required credits for the award of degree after 5 years for B.Tech. programme (on expiry of extended period of 2 semesters over and above normal duration of course) he/she will be awarded only *second class* irrespective of his/her CGPA. However, the period approved under temporary withdrawal, if any, from the programme (13.0) will be excluded from the maximum duration as mentioned above.

15.8 Semester Abroad Programme: Students who are allowed to undergo internship or Training in Industries in India or abroad during their course work or attend any National / International Institute under semester abroad programme (SAP) up to a maximum of 2 semesters will be granted credit transfer for the Course Work/project work done by them in the Industry /Foreign Institute as per the recommendations of the credit transfer committee. The leave period of the students for International internships / Semester Abroad programme etc., will be accounted for attendance.

16.0 Grading

16.1 A grading system as shown in Table 10 will be followed.

Table 10: Grading system

Range of Marks	Letter Grade	Grade Points	Remarks
90 – 100	S	10	Outstanding
80-89	A	09	Excellent
70-79	B	08	Very Good
60-69	C	07	Good
50-59	D	06	Average
45 – 49	E	05	Pass
<45	U	00	To Reappear for end-semester examination
--	RC	00	**Repeat Course (Summer / Winter) due to** Attendance deficiency (between 40% and 75%) and/or I. Lack of minimum CIA marks as specified in clause 10.0 Table 3
--	RA	00	Repeat the course due to (i) Lack of minimum attendance (below 40%) in regular course
	--	00	**DETAINED** "RC" or "RA" or both in all registered theory courses of a semester. The student is detained and has to repeat the entire semester. Clause 12.3

16.2 GPA and CGPA

GPA is the ratio of the sum of the product of the number of credits Ci of course "i "and the grade points P_i earned for that course taken over all courses "i" registered and successfully completed by the student to the sum of Ci 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, in any semester, considering all the courses enrolled from the first semester onwards.

16.3 The Grade card will not include the computation of GPA and CGPA for courses with letter grade **RA, RC** and **U** until those grades are converted to the regular grades.

16.4 A course successfully completed cannot be repeated.

17.0 Grade Sheet

17.1 Letter grade

Based on the performance, each student is awarded a final letter grade at the end of the semester in each course. The letter grades and corresponding grade points are given in Table 10.

17.2 A student is considered to have completed a course successfully and earned credits if he/she secures a letter grade other than **U, RC, RA** in that course.

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

a. Program and discipline for which the student has enrolled.
b. Semester of registration.
c. The course code, name of the course, category of course and the credits for each course registered in that semester
d. The letter grade obtained in each course
e. Semester Grade Point Average (GPA)
f. The total number of credits earned by the student up to the end of that semester in each of the course categories.
g. The Cumulative Grade Point Average (CGPA) of all the courses taken from the first semester.
h. Credits earned under Non CGPA courses.
i. Additional credits earned for B. Tech (Hons.) and B. Tech with Minor specialization.

18.0 Class/Division

18.1 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.**

18.2 (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 with effect from II semester, 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 5 years for B. Tech programmes**

(iii) The period of authorized break of the programme (vide clause 14.0) will not be counted for the purpose of the above classification.

(iv) To be eligible for award of **B. Tech (Hons.)** the student must have earned additional 12 credits in the relevant Engineering courses offered by the Departments of the respective Schools, thereby a total of **181 credits (165 regular credits + 12 additional credits + 4 Non CGPA credits) and should have 8.0 CGPA without any history of arrears and should not have secured E, RC, RA, U, in any course during the entire programme.**

(v) To be eligible for award of **B. Tech with Minor Specialization**, the student must have earned additional 12 credits in the relevant courses offered by other than the parent department and has successfully earned **181 credits (165 regular credits + 12 Additional credits + 4 Non CGPA Credits)**

19.0 Transfer of credits

19.1. Within the broad framework of these regulations, the Academic Council, based on the recommendation of the Credit Transfer Committee so constituted may permit students to transfer part of the credit earned in other approved Universities of repute & status in the India or abroad.

19.2 The Academic Council may also approve admission of students who have completed a portion of course work in another approved Institute of repute under lateral entry based on the recommendation of the credit transfer committee on a case to case basis.

19.3 Admission norms for working Professional:

Separate admission guidelines are available for working / experienced professionals for candidates with the industrial / research experience who desire to upgrade their qualification as per recommendation of Credit Transfer Committee.

20.0 Eligibility for Award of the B.Tech. /B. Tech (Hons)/ B. Tech with Minor Specialization Degree

20.1 A student shall be declared to be eligible for award of B. Tech. /B. Tech (Hons) / B. Tech degree with Minor specialization if he/she has satisfied the clauses 4.6 /7.0 / 8.0 respectively within the stipulated time (clause 13, 14).

a. Earned the specified credits in all the categories of courses (vide clause 4.6) as specified in the curriculum corresponding to the discipline of his/ her study ;
b. No dues to the Institute, Hostels, Libraries etc.; and
c. No disciplinary action is pending against him / her.

The award of the degree shall be recommended by the Academic Council and approved by the Board of Management of the Institute.

21.0 Change of Discipline

21.1 If the number of students in any discipline of B.Tech. programme as on the last instructional day of the First Semester is less than the sanctioned strength, then the vacancies in the said disciplines can be filled by transferring students from other disciplines subject to eligibility. All such transfers will be allowed on the basis of merit of the students. The decision of the Vice-Chancellor shall be final while considering such requests.

21.2 All students who have successfully completed the first semester of the course will be eligible for consideration for change of discipline subject to the availability of vacancies and as per norms.

22.0 Power to modify

Notwithstanding all that has been stated above, the Academic Council is vested with powers to modify any or all of the above regulations from time to time, if required, subject to the approval by the Board of Management.

B.TECH - AERONAUTICAL ENGINEERING/
AERONAUTICAL ENGINEERING (WITH SPECIALIZATION IN AVIONICS)
(165 CREDIT STRUCTURE)

SEMESTER - I

SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	BS	MEA4101/ ELA4101	Engineering Graphics and Computer Aided Design / Professional English and soft skills	1	1	2	3	1	4
2	BS	MAA4101	Matrices and Calculus	3	0	2	4	1	5
3	BS	PHA4101/ CYA4101	Engineering Physics / Engineering Materials	3	0	0	3	1	3
4	PC	CSA4101 GEA4102	Problem Solving Using C* / Sustainable Engineering Systems	2	0	2*	3/2	1	4/3
5	PC	AEB4101/ EEB4101	Engineering and Design/ Introduction to Digital Systems	3	0	0	3	1	3
6	BS	GEA4131	Engineering Immersion Lab	0	0	2	0.5	2	2
7	BS	PHA4131/ CYA4131	Engineering Physics Lab/ Materials Chemistry Lab	0	0	2	1	0	2
Total				**12**	**1**	**10**	**17.5/ 16.5**	**7**	**23/ 22**

***Project based Learning**

SEMESTER - II

SL. NO	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
1	BS	MAA4116	Analytical Mathematics	3	0	2	4	0	5
2	BS	CYA4101/ PHA4101	Engineering Materials / Engineering Physics	3	0	0	3	1	3
3	BS	ELA4101/ MEA4101	Professional English and soft skills / Engineering Graphics and Computer Aided Design	1	1	2	3	1	4
4	PC	GEA4102/ CSA4101	Sustainable Engineering Systems/ Problem Solving Using C*	2	0	2*	2/3	1	3/4
5	PC	EEB4101/ AEB4101	Introduction to Digital Systems /Engineering and Design	3	0	0	3	1	3
6	PC	AEB4116	Engineering Mechanics	3	1	0	3	1	4
7	PC	AEB4117	Principles of Flight	3	0	0	3	1	3
8	PC	AEB4131	Aeromodelling Lab	0	0	2	1	1	2
9	BS	GEA4131	Engineering Immersion Lab	0	0	2	0.5	2	2
10	BS	CYA4131/ PHA4131	Materials Chemistry Lab / Engineering Physics Lab	0	0	2	1	0	2
Total				**18**	**2**	**10/ 12**	**23.5/ 24.5**	**9**	**31/ 32**

***Project based Learning**

SEMESTER - III									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	BS	MAA4201	Partial Differential Equations and Transforms	3	1	0	4	0	4
2	PC	AEB4201	Solid Mechanics	3	0	0	3	1	3
3	PC	AEB4202	Aero Thermodynamics	3	0	0	3	1	3
4	PC	AEB4203	Fluid Mechanics and Machinery	3	0	0	3	1	3
5	BS	GEA4216	Professional Ethics and Life Skills	2	0	0	2	1	2
6	NE	NE	Non Department Elective	2	0	0	2	0	2
7	PC	AEB4231	Fluid Mechanics and Machinery Lab	0	0	3	1	0	3
8	PC	AEB4232	Solid mechanics Lab	0	0	3	1	0	3
9	PC	AEB4233	Thermodynamics Lab	0	0	3	1	0	3
Total				**16**	**1**	**9**	**20**	**3**	**26**
Non-CGPA course can be chosen									
SEMESTER - IV									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	BS	MAA4217	Numerical Methods	3	1	0	4	0	4
2	PC	AEB4216	Aircraft Structural Mechanics	3	1	0	4	1	4
3	PC	AEB4217	Aircraft Propulsion	3	1	0	4	1	4
4	PC	AEB4218	Low Speed Aerodynamics*	3	0	2	4	1	5
5	PC	AEB4219	Aircraft Systems and Instrumentation	3	0	0	3	1	3
6	NE	NE	Non Department Elective	2	0	0	2	0	2
7	PC	AEB4241	Aircraft Systems Lab	0	0	3	1	0	3
8	PC	AEB4242	Computer Aided Modelling Lab	0	0	3	1	1	3
Total				**17**	**3**	**8**	**23**	**5**	**28**
***Lab Integrated with Theory**								**Non-CGPA course can be chosen**	

SEMESTER - V									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	BS	MAA4301	Optimization Techniques	3	1	0	4	0	4
2	PC	AEB4301	Composites Materials & Structures	3	0	0	3	1	3
3	PC	AEB4302	Aircraft Structures*	3	0	2	4	1	5
4	PC	AEB4303	Advanced Propulsion	3	0	0	3	1	3
5	PC	AEB4304	Compressible Aerodynamics	3	1	0	4	1	4
6	DE	DE	Department Elective - I	3	0	0	3	0	3
7	NE	NE	Non Department Elective	2	0	0	2	0	2
8	PC	AEB4331	Propulsion Lab	0	0	3	1	0	3
9	PC	AEB4332	Computer Aided Modelling Project	0	0	2	1	1	2
10	PC	AEB4333	Composite Materials and Structures Lab	0	0	3	1	0	3
11	PC	AEB4334	Internship	0	0	0	1	0	0
Total				**20**	**3**	**10**	**27**	**5**	**32**
***Lab Integrated with Theory**								**Non-CGPA course can be chosen**	

SEMESTER - VI									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	BS	GEA4304	Business Economics	3	0	0	2	0	3
2	PC	AEB4317	Aircraft Performance, Stability & Control	3	0	0	3	1	3
3	PC	AEB4318	Control Theory	3	0	0	3	1	3
4	PC	AEB4319	Civil Aviation Requirement-I	3	0	0	3	1	3
5	PC	DE	Department elective - II	3	0	0	3	0	3
6	DE	DE	Department Elective - III	3	0	0	3	0	3
7	NE	NE	Non Department Elective	2	0	0	2	0	2
8	PC	AEB4341	Aircraft Design Project-I	0	0	3	1	1	3
9	PC	AEB4342	Computational Mechanics Lab	0	0	3	1	1	3
10	PC	AEB4343	Comprehension	1	0	2	1	0	1
Total				**21**	**0**	**8**	**22**	**5**	**27**
Non-CGPA course can be chosen									

SEMESTER - VII									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	PC	AEB4401	Avionics	3	0	0	3	1	3
2	PC	AEB4402	Airframe Maintenance & Repair Practices	3	0	0	3	1	3
3	PC	AEB4403	Aero Engine Maintenance and Repair*	3	0	2	4	1	5
4	PC	AEB4404	Civil Aviation Requirement – II	3	0	0	3	1	3
5	DE	DE	Department Elective - IV	3	0	0	3	0	3
6	DE	DE	Department Elective - V	3	0	0	3	0	3
7	NE	NE	Non Department Elective	2	0	0	2	0	2
8	PC	AEB4431	Avionics Laboratory	0	0	3	1	0	3
9	PC	AEB4432	Airframe Repair Lab	0	0	3	1	0	3
10	PC	AEB4433	Aircraft Design Project-II	0	0	3	1	1	3
Total				**20**	**0**	**11**	**24**	**5**	**31**
***Lab Integrated with Theory**							**Non-CGPA course can be chosen**		

SEMESTER - VIII									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	PC	AEB4441	Project & Viva - voce	0	0	24	8	0	24
Total				**0**	**0**	**24**	**8**	**0**	**24**
Total							**165**		

LIST OF DEPARTMENTAL ELECTIVES WITH GROUPING - SEMESTER WISE									
SEM	COURSE CATEGORY	COURSE CODE	NAME OF THE COURSE	L	T	P	C	S	TCH
Department Elective - I									
5	DE	AEC4251	Aircraft materials	3	0	0	3	0	3
5	DE	AEC4252	Measurements & Instrumentation[1]	3	0	0	3	0	3
5	DE	AEC4253	Aerospace developments in India	3	0	0	3	0	3
5	DE	AEC4254	Mechanics of Machines	3	0	0	3	0	3
Department Elective - II									
6	DE	AEC4351	Aircraft General Engineering Maintenance Practices	3	0	0	3	0	3
6	DE	AEC4352	Finite Element Methods	3	0	0	3	0	3
6	DE	AEC4353	Wind Tunnel Techniques	3	0	0	3	0	3
6	DE	AEC4354	Programming in ADA[1]	3	0	0	3	0	3
6	DE	AEC4355	MEMS in Aerospace Applications[1]	3	0	0	3	0	3
Department Elective - III									
6	DE	AEC4356	Microprocessor and Digital Systems[1]	3	0	0	3	0	3
6	DE	AEC4357	Heat Transfer	3	0	0	3	0	3
6	DE	AEC4358	Boundary layer theory	3	0	0	3	0	3
6	DE	AEC4359	Cryogenic Propulsion	3	0	0	3	0	3
6	DE	AEC4360	Experimental Stress Analysis	3	0	0	3	0	3
Department Elective - IV									
7	DE	AEC4366	Computational Fluid Dynamics	3	0	0	3	0	3
7	DE	AEC4367	High Temperature Gas Dynamics	3	0	0	3	0	3
7	DE	AEC4368	Vibration & Aero-Elasticity	3	0	0	3	0	3
7	DE	AEC4369	Composite Manufacturing, Repair And Maintenance	3	0	0	3	0	3
7	DE	AEC4370	Aircraft Navigation Systems[1]	3	0	0	3	0	3
7	DE	AEC4371	Autopilot Systems[1]	3	0	0	3	0	3
7	DE	AEC4372	High Temperature Materials	3	0	0	3	0	3
Department Elective - V									
7	DE	AEC4451	Helicopter Maintenance	3	0	0	3	0	3
7	DE	AEC4452	Fatigue & Fracture Mechanics	3	0	0	3	0	3
7	DE	AEC4453	Helicopter Aerodynamics	3	0	0	3	0	3
7	DE	AEC4454	Rockets & Missiles	3	0	0	3	0	3
7	DE	AEC4455	Hypersonic Aerodynamics	3	0	0	3	0	3
7	DE	AEC4456	Aerospace Structural Health Monitoring System[1]	3	0	0	3	0	3
7	DE	AEC4457	Introduction to Nano-Composites	3	0	0	3	0	3
7	DE	AEC4458	Airborne Radar Systems[1]	3	0	0	3	0	3

[1] Avionics Specialized Electives

[1] A student should earn 15 credits from Avionics specialized DE to get Specialization in B.Tech Aeronautical Engineering with specialization in Avionics.

LIST OF NON DEPARTMENTAL ELECTIVES OFFERED BY AERONAUTICAL DEPARTMENT WITH GROUPING - SEMESTER WISE									
SEM	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
3	NE	AED4281	Aircraft Design	2	0	0	2	0	2
3	NE	AED4282	Elements of Avionics	2	0	0	2	0	2
4	NE	AED4251	Innovative Practices in Aircraft Industry	2	0	0	2	0	2
4	NE	AED4252	Computer Integrated Manufacturing	2	0	0	2	0	2
5	NE	AED4381	Air Transportation & Aircraft Maintenance	2	0	0	2	0	2
5	NE	AED4382	Technical Authoring in Aircraft Manuals	2	0	0	2	0	2
6	NE	AED4391	UAV - Operational And Industrial Aspects	2	0	0	2	0	2
6	NE	AED4392	Vehicle Aerodynamics	2	0	0	2	0	2
6	NE	AED4393	Airport Management	2	0	0	2	0	2
7	NE	AED4481	Maintenance & Reliability Engineering	2	0	0	2	0	2
7	NE	AED4482	Advanced Materials & Performance	2	0	0	2	0	2
7	NE	AED4483	Introduction to NDT	2	0	0	2	0	2

SEMESTER – I

COURSE TITLE	ENGINEERING GRAPHICS AND COMPUTER AIDED DESIGN			CREDITS	3
COURSE CODE	MEA4101	COURSE CATEGORY	BS	L-T-P-S	1- 1- 2- 1
CIA	60%			ESE	40%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	Understand drafting and computer aided drafting. Remember the commands used in AutoCAD to generate simple drawings.	1,3,5,10,12
2	Explain details in a drawing and apply the knowledge to solve simple problems involving straight lines, planes and solids	1,3,5,10,12
3	Understand and Visualize solid objects and apply AutoCAD software commands to generate the graphic models	1,3,5,10,12
4	Apply the 3D model commands to generate and solid object	1,3,5,10,12
5	Apply the viewing AutoCAD commands to generate top view, front view and additional or sectional views.	1,3,5,10,12
6	Student can able to develop any graphical model of geometrical and simple mechanical objects in AutoCAD software.	1,3,5,10,12

Prerequisites : Nil

MODULE 1: BASICS OF ENGINEERING GRAPHICS AND PLANE CURVES (12)

Importance of graphics - BIS conventions and specifications - drawing sheet sizes - Lettering – Dimensioning - Scales. Drafting methods - introduction to Computer Aided Drafting – Computer Hardware – Workstation – Printer and Plotter – Introduction to software for Computer Aided Design and Drafting – Exposure to Solid Modelling software – Geometrical Construction-Coordinate Systems/Basic Entities – 3D printer.

Suggested Reading: Solid modeling Software commands

MODULE 2: VISUALIZATION, ORTHOGRAPHIC PROJECTIONS AND FREE HAND SKETCHING (15)

Visualization concepts and Free Hand sketching: Visualization principles —Representation of Three Dimensional objects — Pictorial Projection methods - Layout of views- Free hand sketching of multiple views from pictorial views of objects. Drafting of simple Geometric Objects/Editing

General principles of presentation of technical drawings as per BIS - Introduction to Orthographic projections - Naming views as per BIS - First angle projection method. Conversion to orthographic views from given pictorial views of objects, including dimensioning – Drafting of Orthographic views from Pictorial views.

Suggested Reading: CAD software commands for sketching a drawing

MODULE 3: GEOMETRICAL MODELING ISOMETRIC VIEWS AND DEVELOPMENT OF SURFACES (15)

Principles of isometric projection and solid modelling. Isometric drawing – IsoPlanes and 3D Modelling commands. Projections of Principal Views from 3-D Models. Solid Modelling – Types of modelling - Wire frame model, Surface Model and Solid Model – Introduction to graphic software for solid modelling. Development of Surfaces.

***Suggested Reading**: Surface modeling and solid modeling commands*

MODULE 4: COMPUTER AIDED DESIGN AND DRAFTING (15)

Preparation of solid models of machine components like slide block, solid bearing block, bushed bearing, gland, wall bracket, guide bracket, shaft bracket, jig plate, shaft support (open type), vertical shaft support etc using appropriate modelling software.

2D views and sectional view, computer aided drafting and dimensioning. Generate 2D drawing from the 3D models – generate and develop the lateral surfaces of the objects. Presentation Techniques of Engineering Drawings – Title Blocks – Printing/Plotting the 2D/3D drawing using printer and printing solid object using 3D printer.

***Suggested Reading**: CAD commands for modeling and views generation*

MODULE 5: SIMPLE DESIGN PROJECTS - COMPUTER AIDED DESIGN AND DRAFTING (15)

Creation of engineering models and their presentation in standard 2D form, 3D Wire-Frame and shaded solids, meshed topologies for engineering analysis, tool-path generation for component manufacture, geometric dimensioning and tolerancing. Use of solid-modelling software for creating associative models at the components and assembly levels in their respective branch of engineering like building floor plans that include: windows, doors, fixtures such as WC, Sink, shower, slide block, etc. Applying colour coding according to drawing practice.

Suggested Reading: CAD commands for modeling and views generation

TEXT BOOKS

1	Jeyapoovan T, Engineering Drawing and Graphics Using AutoCAD, 7th Edition, Vikas Publishing House Pvt Ltd., New Delhi, 2016

REFERENCE BOOKS

1	Introduction to AutoCAD – 2D and 3D Design, A.Yarmwood, Newnes Elsevier, 2011
2	Engineering Drawing and Graphic Technology-International Edition, Thomas E. French, Charles J. Vierck, Robert J. Foster, McGraw-Hill, 2014
3	Engineering Drawing and Design, Sixth Edition, C. Jensen, J.D. Helsel, D.R. Short, McGraw-Hill, 2012
4	Technical Drawing-Fourteenth Edition, F. E. Giesecke, A. Mitchell, H. C. Spencer, I.L. Hill, J.T. Dygdon, J.E., Novak, Prentice-Hall, 2012,
5	Bhatt N.D and Panchal V.M, Engineering Drawing: Plane and Solid Geometry, Charotar Publishing House, 2017.
6	Warren J. Luzadder and Jon. M. Duff, Fundamentals of Engineering Drawing, Prentice Hall of India Pvt. Ltd., Eleventh Edition, 2016.

E BOOKS

1	http://keralatechnologicaluniversity.blogspot.in/2015/06/engineering-graphics-j-benjamin-pentex-free-ebook-pdf-download.html
2	http://keralatechnologicaluniversity.blogspot.in/2015/06/engineering-graphics-p-i-varghese.html

MOOC

1	http://nptel.ac.in/courses/112103019/
2	http://nptel.ac.in/courses/105104148/

COURSE TITLE	PROFESSIONAL ENGLISH AND SOFT SKILLS			CREDITS	3
COURSE CODE	ELA4101	COURSE CATEGORY	BS	L-T-P-S	1-1-2-1
CIA	60%			ESE	40%
LEARNING LEVEL	BTL – 6				

CO	COURSE OUTCOMES	PO
1.	Understanding the importance of professional communication and applying the knowledge.	6,10,12
2.	Integrate the knowledge of phonetics, enhancing the listening skills in formal and real-life situations; enhance pronunciation skills based on the knowledge of phonetics.	6,10,12
3.	Construct appropriate sentences in English Language, applying grammatical rules and mastery in syntax. Develop reading skills and derive the contextual meaning, case studies and analyzing problems	6,10,12
4.	Integrate creativity in the writing skills both in formal and informal situations, related to environment, society and multidisciplinary environments	6,7,10,12
5.	Imbibing soft skills to excel in interpersonal skills essential for workplace	6,10,12

Prerequisites : Plus Two English-Intermediate Level

MODULE 1 – THE ELEMENTS OF COMMUNICATION (9)

Importance of communication through English -Process of communication and factors that influence speaking- Importance of audience and purpose- Principles of Communication-comparing general communication and business Communication-Professional Communication-barriers to communication –strategies to overcome communication barriers-formal and informal communication

Suggested Activities:

Self-introduction-short Conversations-Situational communication-dialogue writing -Language Functions-analyse the speech and comment-distinguish formal and informal style of communication-using bias-free language- news reports.

Suggested Reading:

Rogerson, Trish Stott & Derek Utley.2011

Elements of Effective Communication: 4th Edition, Plain and Precious Publishing, USA, by Randal S. Chase (Author), Wayne Shamo (Author)

Effective Communication Skills, MTD Training & Ventus Publishing (e book)

MODULE 2 – AURAL –ORAL COMMUNICATION IN ENGLISH (9)

Vowels- diphthongs- consonants - International Phonetic Alphabet (IPA) ; phonemic transcription (simple words)-syllable division and word stress –enunciation-GIE script(General Indian English)-neutral accent- sentence rhythm and weak forms - contrastive stress in sentences to highlight different words - intonation varieties of Spoken English : Standard Indian, American and British-Speaking to Communicate-speech acts - Language Patterns

(Note: This unit should be taught in a simple, non-technical manner, avoiding technical terms as far as possible).

Suggested activities: (Audio CD) Listen and repeat, listen to the sentences and fill in the blanks, Listening to passages and answering questions, marking the stressed syllable, phonemic script of simple words, sentence rhythm and intonation (rising tone and falling tone), short speeches. Individual presentations-dynamics of a group discussion

Suggested sources:

Cambridge IELTS , Professional Speaking Skills by Aruna Koneru, Oxford Press, Face to face series Cambridge University Press, Speaking Effectively, Cambridge University Press, Jeremy Comfort, Pamela

MODULE 3 - GRAMMAR AND DEVELOPMENT OF READING SKILLS (9)

Noun Phrase, Verb Phrase, Tense and Aspect, Articles, Pronouns and determiners, Sentence Pattern, interrogative and negative sentences-subject verb agreement -Vocabulary-word formation: prefixes and suffixes, reading passages-inductive vs deductive reading-newspaper articles-comprehension passages –cloze reading-annotating-editing

Suggested Activities:

Identify the errors in sentences, grammar exercises, book reviews, mini project on suggested reading activity - reading technical passages based on students area of specialization answering questions- reading passage for identifying the contextual meaning

Suggested sources:

Skills for the TOEFL IBT Test, Collins IELTS, Cambridge booksPractical English Usage by Michael Swan , Cambridge University Press

MODULE 4 - EFFECTIVE WRITING AND BUSINESS COMMUNICATION (9)

Paragraph writing- topic sentence-connectives - process writing-Memoranda-Business letters-Resumes /Visumes and job applications-drafting a report-agenda and minutes of the meeting-ATR-project proposals-email etiquette- interpreting visual data(bar chart, pie chart, line graphs)

Suggested activities:

Writing short paragraph based on environment protection, societal issues, health, cultural contexts etc., identifying topic sentences, linking pairs of sentences, cause and effect exercises, formal letters, e mails, drafting project proposals, drafting agenda, minutes of the meeting

Suggested sources:

Cambridge Advanced English, Newspapers, library books, IELTS,IELTS Academic Writing 1,New Insights into IELTS, CUP

MODULE 5 – SOFT SKILLS (9)

Introducing Soft Skills &Life Skills- Myers Briggs Type Indicator – the Big Five Model Personality - Employability Skills- Workplace Etiquette- Professional Ethics -Time Management-Stress Management- Lateral Thinking (De Bono's Six Thinking Hats) and Problem Solving Skills

Suggested Activities:

Mock interviews, GD's, short oral presentation, lateral thinking puzzles, Case analysis and self-study assignments, Worksheet activities.

Suggested Sources:

Soft Skills and Employability Skills by Sabina Pillai and Agna Fernandez, Cambridge University Press, 2018.

Soft Skills for Everyone by Jeff Butterfield, Cengage Learning Education and personality development, K. Manoharan English for Life and the Workplace through the LSRW&T skillsLateral Thinking skills by Edward De Bono

TEXT BOOKS	
1.	An Introduction to Profession English and Soft Skills with audio CD by Dr. Bikram K. Das et al. Published by Cambridge University Press. 2009
REFERENCE BOOKS	
1.	Soft Skills & Employability Skills by Sabina Pillai and Agna Fernandez published by Cambridge University Press 2018.
2.	Embark, English for Undergraduates by Steve Hart et al,Cambridge University Press,2016, Edition
3.	Skills for the TOEFL IBT Test, Collins, 2012 edition
4.	Soft Skills for Everyone by Jeff Butterfield, Cengage Learning, 2010 edition
5.	English for Life and the Workplace Through LSRW&T skills, by Dolly John, Pearson Publications, 2014 edition
6.	Professional Speaking Skills by Aruna Koneru, Oxford Publications.
7.	The official Cambridge guide to IELTS for Academic and General Training, Cambridge University Press, 2014 edition.
8.	Cambridge BEC Vantage, Self-Study edition, Practice Tests, CUP, 2002
9.	English for Business Studies, 3rd edition, Ian Mackenzie, Cambridge University Press
10.	Education and Personality Development by Dr. P.K.Manoharan, APH Publishing Corporation, 2015
11.	Speaking Effectively by Jeremy Comfort et al, Cambridge University Press, 2011.
E BOOKS	
1.	https://www.britishcouncil.in/english/courses-business
2.	http://www.bbc.co.uk/learningenglish/english/features/pronunciation
3.	http://www.bbc.co.uk/learningenglish/english/
4.	http://www.antimoon.com/how/pronunc-soundsipa.htm
5.	http://www.cambridgeenglish.org/learning-english/free-resources/write-and-improve/
6.	Oneshopenglish.com
7.	Breakingnews.com
MOOC	
1	https://www.mooc-list.com/tags/english
2	https://www.mooc-list.com/course/adventures-writing-stanford-online
3	http://www.cambridgeenglish.org/learning-english/free-resources/mooc/

COURSE TITLE	MATRICES AND CALCULUS (Common for all Departments)			CREDITS	4
COURSE CODE	MAA4101	COURSE CATEGORY	BS	L-T-P-S	3-0-2-1
CIA	60%			ESE	40%
LEARNING LEVEL	BTL- 4				

CO	COURSE OUTCOMES	PO
1.	Able to study the concepts of matrices and apply them in related engineering problems.	1,2,3,4,5,12
2.	Capable to use the features of Differential Calculus in optimization problems.	1,2,3,4,5,12
3.	Able to extend the concepts of integral calculus in finding area and volume.	1,2,3,4,5,12
4.	Skilled to solve ordinary differential equations in engineering problems.	1,2,3,4,5,12

Prerequisites : Nil

MODULE 1: MATRICES (13L+2P)

Characteristic equation – Eigenvalues and Eigenvectors – Properties – Cayley Hamilton theorem (Statement only) – Verification and inverse of the matrix using Cayley Hamilton theorem- Diagonalization of matrices using similarity transformation. Suggested Reading: Basics of Matrices

Lab 1: Eigenvalues and Eigenvectors, Verification and inverse using Cayley Hamilton theorem- Diagonalization

MODULE 2: DIFFERENTIAL CALCULUS (13L+2P)

Methods of differentiation of functions – Product and Quotient rules – Inverse trigonometric functions – Implicit function – parametric form. Partial differentiation – Total differentiation- Taylor's series – Maxima and minima of functions of two variables

Suggested Reading: Basics of Differentiation

Lab 2: Taylor's series – Maxima and minima of functions of two variables

MODULE 3: INTEGRAL CALCULUS (13L+2P)

Integration – Methods of integration – Substitution method – Integration by parts – Integration using partial fraction – Bernoulli's formula. Applications of Integral Calculus: Area, Surface and Volume.

Suggested Reading: Basics of Integrations

Lab 3: Applications of Integral Calculus: Area, Surface area and Volume.

MODULE 4: ORDINARY DIFFERENTIAL EQUATIONS (13L+2P)

Second order differential equations with constant coefficients – Particular integrals – e^{ax}, $Sinax, Cosax, x^m$, e ^{ax} Cos bx, e ^{ax} Sin bx. Solutions of homogeneous differential equations with variable coefficients – Variation of parameters.

Suggested Reading: Basics of Differential Equations.

Lab 4: Solution of Second order differential equations.

LAB/MINI PROJECT/FIELD WORK

Theory with practical classes

TEXT BOOKS	
1	Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014
2	Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", Eighth Edition, Laxmi Publications Pvt Ltd., 2011.
3	Chandrasekaran A, "A Text book of Engineering Mathematics I", Dhanam Publications, Chennai, 2010
REFERENCE BOOKS	
1	Srimantha Pal and Bhunia, S.C, "Engineering Mathematics" Oxford University Press, 2015.
2	Weir, M.D and Joel Hass, Thomas' Calculus, 12th Edition, Pearson India, 2016.
3	Advanced Engineering Mathematics With Matlab, Third Edition, 2011 by CRC Press.
E BOOKS	
1	http://nptel.ac.in/courses/111105035/
2	https://www.edx.org/.../introduction-engineering-mathematics-utarlingtonx-engr3
MOOC	
1.	https://www.mooc-list.com/tags/engineering-mathematics

COURSE TITLE	ENGINEERING PHYSICS (AERO, MECH, AUTO, CHEMICAL, BIOTECH, CIVIL)			CREDITS	3
COURSE CODE	PHA4101	COURSE CATEGORY	BS	L-T-P-S	3-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1.	Solve basic problems in mechanics and also understand the properties of matter.	1,2,3,4,6,12
2.	Have a knowledge of acoustics and ultrasonics which would facilitate in acoustical design of buildings and also be able to employ ultrasonics as an engineering tool.	1,2,3,4,6,12
3.	Knowledge on fundamental concepts of Quantum physics	1,2,3,4,6,12
4.	Fundamental knowledge on semiconductors and discrete devices.	1,2,3,4,6,12
5.	Understand the concept, working and application of lasers and fiber optics.	1,2,3,4,6,12

Prerequisites: Knowledge in fundamentals of physics at higher secondary level.

MODULE 1 – PROPERTIES OF MATTER AND HEAT (9L)

Elasticity - types of moduli of elasticity - Young's modulus - 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.

Thermal conductivity – experimental determination of thermal conductivities of good and bad conductors – Forbe's method – theory and experiment – Lee's disc method for bad conductors

MODULE 2 – ACOUSTICS AND ULTRASONICS (9L)
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.
MODULE 3 –QUANTUM PHYSICS (9L)
Black body radiation- Planck's theory (derivation) – Deduction of Wien's displacement law and Rayleigh – Jean's law from Planck's theory – Compton effect – Theory and experimental verification – Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one dimensional box Extension to 3 dimension (no derivation)
MODULE 4 –CRYSTAL PHYSICS AND MAGNETISM (9L)
Crystal - 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. Magnetic dipole moment - atomic magnetic moments- magnetic permeability and susceptibility - Types of magnetism: diamagnetism - paramagnetism - ferromagnetism - antiferromagnetism – ferrimagnetism - domain structure – hysteresis - hard and soft magnetic materials – applications.
MODULE 5 –PHOTONICS AND FIBRE OPTICS (9L)
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 - fiber optic communication system.
LAB / MINI PROJECT / FIELD WORK
NA

TEXT BOOKS	
1.	P.Mani, " Engineering Physics", Vol-I & II, Dhanam Publications, Chennai. (2011)
2.	Gaur R.K. and Gupta S.L., "Engineering Physics", 8th edition, Dhanpat Rai publications (P) Ltd., New Delhi. (2010)
REFERENCE BOOKS	
1.	Arthur Beiser, "Concepts of Modern Physics", Tata Mc Graw – Hill Publications. (2007)
2.	Rajendran V. Marikani A., "Applied Physics for engineers", 3rd edition, Tata Mc Graw –Hill publishing company Ltd., New Delhi. (2003)
E BOOKS	
1	https://www.bookyards.com/en/book/details/13921/Elements-Of-Properties-Of-Matter
2	http://iopscience.iop.org/book/978-1-6817-4585-5
3	https://www.springer.com/in/book/9783319206295
MOOC	
1	http://nptel.ac.in/courses/115106061/
2	http://nptel.ac.in/courses/117101054/12

COURSE TITLE	ENGINEERING MATERIALS (Common to ALL Branches of Engineering)			CREDITS	3
COURSE CODE	CYA4101	COURSE CATEGORY	BS	L-T-P-S	3-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1.	Student will be able to - Suggest suitable metals for alloying.	1,2,3,4,6,7,12
2.	Identify the materials apt for engineering applications.	1,2,3,4,6,7,12
3	Select high temperature materials for engineering applications.	1,2,3,4,6,7,12
4.	Map the properties of nanomaterials with their applications.	1,2,3,4,6,7,12
5.	Suggest suitable materials for electronic applications.	1,2,3,4,6,7,12

Prerequisites: Knowledge in fundamentals of chemistry at higher secondary level.

MODULE 1 – CRYSTAL STRUCTURE AND PHASE RULE (9L)

Basic Crystal Systems – Types, characteristics, examples – Space lattice, Unit cell – types – X-ray diffraction and crystal structure.

Basic terminology - Derivation of Gibbs Phase rule- Phase diagrams: One component system (water), Two component system –- Reduced phase rule: Simple Eutectic system, examples, Phase diagram: Ag-Pb system, Pb-Sn system – Applications of phase rule.

MODULE 2 – POWDER METALLURGY, INORGANIC MATERIALS AND COMPOSITES (9L)

Steel – Composition, types, heat-treatment, Abrasives – Classification, Properties, Uses - Refractories – Classification, Properties, Applications. Glasses – Properties, Types, Specialty glasses.

Composites - Introduction - Definition – Constituents – Classification - Fiber-reinforced Composites – Types and Applications.

Powder Metallurgy – Preparation of metal/alloy– Advantages and limitations.

MODULE 3 – NANOMATERIALS AND MOLECULAR SIEVES (9L)

Introduction – Synthesis of Nanomaterials - Bottom-up and Top-down approaches – Methods of preparation – Sol-gel process, Gas-phase condensation, Chemical Vapour Deposition. Properties **–** Optical, Electrical, Magnetic, Chemical properties (introduction only). Characterization **–** FE-SEM, TEM (Principle and Applications only).

Zeolite Molecular sieves – composition, structure, classification - applications – ion exchange, adsorption, separation, laundry, catalysis.

MODULE 4 –MATERIALS FOR ELECTRONIC APPLICATONS (9L)

Liquid Crystals- Introduction – Characteristics – Classification- Thermotropic crystals- - Polymorphism in Thermotropic Liquid Crystals – Molecular arrangement in various states of Liquid Crystals, Lyotropic Liquid Crystals- Applications.

Conducting and Super conducting Organic electronic materials - Applications.

Engineering plastics: Polycarbonate – Properties and uses- Conducting Polymers: Classification, Intrinsic Conducting Polymers, Extrinsic Conducting Polymers, Applications - Biodegradable Polymers, examples and applications.

MODULE 5 – LUBRICANTS, ADHESIVES AND EXPLOSIVES (9L)	
Lubricants – Mechanism of Lubrication, Classification and Properties, Semi Solid Lubricants, Solid Lubricants, MoS_2 and Graphite - Adhesives – Development of Adhesive strength, Physical and Chemical factors influencing adhesive action, Classification of Adhesives – Epoxy Resin (Preparation, Properties and Applications). Explosives – Requisites, Classification, Precautions during storage – Rocket propellants – Requisites - Classification.	
LAB / MINI PROJECT/FIELD WORK	
NA	
TEXT BOOKS	
1	P.C. Jain and Monicka Jain, Engineering Chemistry, Dhanpat Raj Publishing Company (P) Ltd, New Delhi – 2012
2	Puri, Sharma and Pathania, Principles of Physical Chemistry, Vishal Publishing Co. Jalandar, 2004.
3	Composite materials, K.K. Chawala, 3rd ed., (2012) Springer-Verlag, New York
4	Nanocomposite Science and Technology, P. M. Ajayan, L. S. Schadler, P. V. Braun, (2003), Wiley-VCH Verlag GmbH Co. KGaA, Weinheim.
5	Mechanics and Analysis of Composite Materials, V.V. Vasiliev and E.V. Morozov, (2001), Elsevier Science Ltd, The Boulevard, Langford Lane, Kidlington, Oxford OX5 lGB, UK.
E BOOKS	
1	http://www.erforum.net/2016/01/engineering-chemistry-by-jain-and-jain-pdf-free-ebook.html
2	https://abmpk.files.wordpress.com/2014/02/book_maretial-science-callister.pdf`
MOOC	
1	https://www.edx.org/course/materials-science-engineering-misisx-mse1x
2	https://www.mooc-list.com/tags/materials-science

COURSE TITLE	PROBLEM SOLVING USING C			CREDITS	3
COURSE CODE	CSA4101	COURSE CATEGORY	PC	L-T-P-S	2-0-2-0
CIA	60%			ESE	40%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
Upon completion of this course, the students will be able to		
1	Describe the basics of digital computer and programming languages.	1,2,8,12
2	Demonstrate problem solving techniques using flowchart, algorithm/pseudo code to solve the given problem.	1,2,3,5,12
3	Design and Implement C program using Control Statements and Functions.	1,2,3,5,9,10,12
4	Design and Implement C program using Pointers and File operations.	1,2,3,12
5	Identify the need for embedded C in real-time applications.	1,2,6,12

Prerequisites: Nil

MODULE 1 – PROGRAMMING LANGUAGES AND PROBLEM SOLVING TECHNIQUES (6L+6P)

Introduction – Fundamentals of digital computers - Programming languages -Programming Paradigms – Types of Programming Languages – Language Translators – Problem Solving Techniques: Algorithm – Flow Chart - Pseudo code.

Practical Component:

Drawing Flowcharts using E- Chart & Writing pseudo code for the following problems

(i) Greatest of three numbers

(ii) Sum of N numbers

(iii) Computation of nCr

MODULE 2: FUNDAMENTALS OF C (6L+6P)

Evolution of C -Why C language - Applications of C language - Data Types in C – Operators and Expressions – Input and Output statements in C – Decision Statements – Loop Control Statements.

Practical Component:

(i) Program to illustrate arithmetic and logical operators

(ii) Program to read and print data of different types

(iii) Program to calculate area and volume of various geometrical shapes

(iv) Program to compute biggest of three numbers

(v) Program to print multiplication table

(vi) Program to convert days to years, months and days

(vii) Program to find sum of the digits of an integer.

MODULE 3: FUNCTIONS, ARRAYS AND STRINGS (6L+6P)

Functions – Storage Class – Arrays – Strings and standard functions - Pre-processor Statements.

Practical Component:

(i) Program to compute Factorial, Fibonacci series and sum of n numbers using recursion

(ii) Program to compute sum and average of N Numbers stored in an array

(iii) Program to sort the given n numbers stored in an array

(iv) Program to search for the given element in an array
(v) Program to do word count
(vi) Program to insert a substring in a string
(vii) Program to concatenate and compare two strings
(viii) Program using pre-processor statements

MODULE 4: POINTERS, STRUCTURES AND UNION (6L+6P)

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

Practical Component:

(i) Program to compute sum of integers stored in a 1-D array using pointers and dynamic memory allocation
(ii) Program to read and print records of a student/payroll database using structures
(iii) Program to simulate file copy
(iv) Program to illustrate sequential access file
(v) Program to illustrate random access file

MODULE 5: INTRODUCTION TO EMBEDDED C (6L+6P)

Structure of embedded C program - Data Types - Operators - Statements - Functions - Keil C Compiler.

Practical component:

Simple programs using embedded C

LAB / MINI PROJECT / FIELD WORK

NA

TEXT BOOKS

1.	Jeyapoovan T, “Fundamentals of Computing and Programming in C”, Vikas Publishing house, 2015.
2.	Mark Siegesmund, "Embedded C Programming", first edition, Elsevier publications, 2014.

REFERENCE BOOKS

1.	Ashok Kamthane, “Computer Programming”, Pearson Education, 7th Edition, Inc 2017.
2.	Yashavant Kanetkar, “Let us C”, 15th edition, BPP publication, 2016.
3.	S.Sathyalakshmi, S.Dinakar, “Computer Programming Practicals – Computer Lab Manual”, Dhanam Publication, First Edition, July 2013.

E BOOKS

1.	https://en.wikibooks.org/wiki/C_Programming

MOOC

1.	https://onlinecourses.nptel.ac.in/noc18-cs10/preview
2.	http://nptel.ac.in/courses/106105085/2
3.	https://www.udemy.com/c-programming-for-beginners/
4.	https://www.coursera.org/specializations/c-programming

COURSE TITLE	SUSTAINABLE ENGINEERING SYSTEMS (Common to ALL Branches of Engineering)			CREDITS	2
COURSE CODE	GEA4102	COURSE CATEGORY	PC	L-T-P-S	2-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1.	Students learn the principles of sustainability with case studies.	2,3,6,7,8,9,10,12
2.	Students will be able to understand assessing technologies and their impact on environment.	2,3,6,7,8,9,10,12
3	To learn the concept of Green Engineering and to apply in their projects at higher semesters.	2,3,6,7,8,9,10,12
4.	Management of natural resources and waste management from various types of industries.	2,3,6,7,8,9,10,12
5.	Students learn water technology and behavioral aspects of humans.	2,3,6,7,8,9,10,12

Prerequisites: Knowledge in fundamentals of chemistry at higher secondary level.

MODULE 1 – PRINCIPLES OF SUSTAINABLE SYSTEMS (5L)

Sustainability Definitions - Principles of Sustainable Design, Sustainable Engineering -Frameworks for Applying Sustainability Principles - Summary & Activities.

MODULE 2 – TECHNOLOGY DEVELOPMENT AND LIFECYCLE ASSESSMENT (5L)

Technology as a part of anthropogenic environment - Technology readiness levels (TRL) – technical metrics - Emerging, converging, disruptive technologies - Life Cycle Assessment (LCA) methodology - Summary & Activities.

MODULE 3 – GREEN ENGINEERING (5L)

Principles of Green Engineering - Frameworks for assessment of alternatives - Green Engineering examples - Multifunctional Materials and Their Impact on Sustainability - Summary & Activities.

MODULE 4 – RESOURCE MANAGEMENT TECHNOLOGIES (5L)

Waste management purpose and strategies - Recycling: open-loop versus closed-loop thinking - Recycling efficiency - Management of food waste and composting technologies - E-waste stream management - Reuse and redistribution programs - LCA approach to waste management systems - Summary and Activities.

MODULE 5 – SUSTAINABLE WATER AND WASTEWATER SYSTEMS (5L)

Water cycle - Water conservation and protection technologies - Water treatment systemsMetrics for assessment of water management technologies-Summary & Activities.

MODULE 6 - BEHAVIORAL ASPECTS AND FEEDBACKS (5L)

Collaborative Decision Making - Role of Community and Social Networking - Human Factor in Sustainability Paradigm - Summary & Activities.

TEXT BOOKS	
1.	Vanek, F.M., and L.D. Albright, Energy Systems Engineering. Evaluation and Implementation, McGraw Hill, 2008.
2.	C.U. Becker, Sustainability Ethics and Sustainability Research, Springer 2012.
3.	J.B. Guinee et al., Life Cycle Assessment: Past, Present, and Future, Environ. Sci. Technol., 2011, 45, 90-96.
4.	Anastas, P.T., Zimmerman, J.B., Innovationsin Green Chemistry and Green Engineering, Springer 2013.
5.	Solid Waste Technology & Management, Volume 1 & 2, Christensen, T., Ed., Wiley and Sons., *2010.*
6.	Sterman, J.D., in Sustainability Science: The Emerging Paradigm, Weinstein, M.P. and Turner, R.E. (Eds.), Springer Science+Business Media, LLC 2012.
E BOOKS	
1.	David T. Allen, David R. Shonnard, Sustainable Engineering Concepts, Design and Case Studies, Pearson Education, December 2011. (ISBN: 9780132756587)
2.	Gerald Jonker Jan Harmsen, Engineering for Sustainability 1st Edition, A Practical Guide for Sustainable Design, Elsvier 2012. (**ISBN:** 9780444538475).
MOOC	
1.	https://www.coursera.org/learn/sustainability
2.	https://www.academiccourses.com/Certificate/Sustainability-Studies/India/
3.	https://onlinecourses.nptel.ac.in/noc18_ce08/preview
4.	https://www.coursera.org/learn/ecosystem-services

COURSE TITLE	ENGINEERING AND DESIGN			CREDIT	3
COURSE CODE	AEB4101	COURSE CATEGORY	PC	L-T-P-S	3- 0- 0 -1
CIA	60%			ESE	40%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	Students will be able to appreciate the different elements involved in good designs and to apply them in practice when called for.	1,2,3,4,7,10,12
2	Students will be aware of the product oriented and user oriented aspects that make the design a success.	1,2,3,4,7,10,12
3	Students Will be capable to think of innovative designs incorporating different segments of knowledge gained in the course	1,2,3,4,7,10,12
4	Students will have a broader perspective of design covering function, cost, environmental sensitivity, safety and other factors other than engineering analysis.	1,2,3,4,7,10,12
5	Students learn economic and environmental Issues, trade aspects and IPR	1,2,3,4,7,10,12

Prerequisites : Nil

Module 1: INTRODUCTION TO AERONAUTICAL ENGINEERING DESIGN (7L+2P)

Design and its objectives; Design constraints, Design functions, Design means and Design from; Role of Science, Engineering and Technology in design; Engineering as a business proposition; Functional and Strength Designs. Design form, function and strength; How to initiate creative designs? Initiating the thinking process for designing a product of daily use. Need identification; Problem Statement; Market survey-customer requirements; Design attributes and objectives; Ideation; Brain storming approaches; arriving at solutions; Closing on to the Design needs.

Project: An Exercise in the process of design initiation. A simple problem is to be taken up to examine different solutions- Aircraft, Group Presentation and discussion**.**

MODULE 2: PROCESSES IN DESIGN FOR AIRCRAFT SYSTEM (7L+2P)

Design process- Different stages in design and their significance; Defining the design space; Analogies and "thinking outside of the box"; Quality function deployment-meeting what the customer wants; Evaluation and choosing of a design. Design Communication; Realization of the concept into a configuration, drawing and model. Concept of "Complex is Simple". Design for function and strength.

Design detailing- Material selection, Design visualization- Solid modelling; Detailed 2D part drawings; Tolerance; Use of standard items in design; Research needs in design; Energy needs of the design, both in its realization and in the applications.

Project: An exercise in the detailed design of any two aircraft components

MODULE 3: PROTOTYPING OF AIRCRAFT COMPONENTS (4L+5P)

Prototyping- rapid prototyping; testing and evaluation of design; Design modifications; Freezing the design; Cost analysis.

Engineering the design – From prototype to product. Planning; Scheduling; Supply chains; inventory; handling; manufacturing/construction operations; storage; packaging; shipping; marketing; feed-back on design

Project: List out the standards organizations. Prepare a list of standard items used in aeronautical original equipment manufacturers. Develop any design with over 50% standard items as parts.

MODULE 4: QUALITY ASPECTS IN AIRCRAFT ENGINEERING (4L+5P)
Design for "X"; covering quality, reliability, safety, manufacturing/construction, assembly, maintenance, logistics, handling; disassembly; recycling; re-engineering etc. **Project:Example:** List out the design requirements(x) for designing a small Aircraft.
Module 5: USER CENTRED DESIGNS IN ENGINEERING (4L+5P)
Product centered and user centered design. Product centered attributes and user centered attributes. Bringing the two closer. ie, Aesthetics and ergonomics. Value engineering, Concurrent engineering, Reverse engineering in design; Culture based design; Architectural designs; Motifs and cultural background; Tradition and design; Study the evolution of Wheels; Printed motifs; Role of colours in design. Make sharp corners and change them to smooth curves-check the acceptance. Design as a marketing tool; Intellectual Property rights – Trade secret; patent; copy-right; trademarks; product liability. Group presentation of any such products covering all aspects that could make or mar it. **Project:** Examine the possibility of value addition for an existing product.

REFERENCE BOOKS

1	Balmer, R. T., Keat, W. D., Wise, G., and Kosky, P., Exploring Engineering, Third Edition: An Introduction to Engineering and Design - [Part 3 - Chapters 17 to 27], ISBN13: 978-0124158917 ISBN-10: 0124158919
2	Dym, C. L., Little, P. and Orwin, E. J., Engineering Design - A Project based introduction - Wiley, ISBN-978-1-118-32458-5
3	Eastman, C. M. (Ed.), Design for X Concurrent engineering imperatives, 1996, XI, 489 p. ISBN 978-94-011-3985-4 Springer
4	Haik, Y. And Shahin, M. T., Engineering Design Process, Cengage Learning, ISBN-13: 978-0-495-66816-9
5	Pahl, G., Beitz, W., Feldhusen, J. and Grote, K. H., Engineering Design: A Systematic Approach, 3rd ed. 2007, XXI, 617p., ISBN 978-1-84628-319-2
6	Voland, G., Engineering by Design, ISBN 978-93-325-3505-3, Pearson India

COURSE TITLE	INTRODUCTION TO DIGITAL SYSTEMS			CREDITS	3
COURSE CODE	EEB4101	COURSE CATEGORY	PC	L-T-P-S	3- 0- 0- 1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	To understand basic operation in digital systems and instruments.	1,3,5,12
2	To gain knowledge on basic functioning of sensors and display units.	1,3,5,12
3	To familiarize the concepts of signal processing and converting elements.	1,3,5,12
4	To acquire the knowledge of microcontrollers and applications	1,3,5,12
5	To attain the basic concepts of consumer electronics and communication devices.	1,3,5,12

Prerequisites : Physics and Mathematics

MODULE 1 – INTRODUCTION TO DIGITAL SYSTEMS (9L)

Analog& Digital signals - Need for digital instruments – Elements of digital instruments – Number systems: - Binary, Hexadecimal - Logic gates - Boolean algebra (Identities and Properties) - Digital controllers (ON-OFF).

Suggested Reading: Basics of number systems.

MODULE 2 –SENSORS AND DISPLAYS (9L)

Sensors and Transducers –Classification, Potentiometer, Strain Gauge, Piezoelectric Sensor, Linear Variable Differential Transformer, Resistance temperature detectors (RTD), Thermocouples, Tactile transducers - Displays: - Light Emitting Diode (including OLED) displays.

Suggested Reading: Primary sensing elements, introduction to displays.

MODULE – 3 : SIGNAL CONDITIONING CIRCUITS (9L)

D.C. Bridge- Unbalanced, Push-Pull configuration, Operational amplifiers- Inverting, Non-Inverting, Instrumentation Amplifier, Active filters: - Low pass, High pass - Analog to Digital Converter – Successive Approximation, Digital to Analog Converter - Weighted Resistor.

Suggested Reading: Basic network theorems.

MODULE – 4 :INTRODUCTION TO MICRO CONTROLLERS (9L)

Introduction: Memory types, peripheral devices- Microcontroller (8 bit), Architecture, Graphics Processing Unit (GPU) - Applications: -Interfacing of Digital Input/Output, Analogue Input/Output, Display. Introduction to Programmable Logic Controller (PLC) and PID (Proportional + Integral + Derivative) Controller.

Suggested Reading: Hobby electronics with Microcontroller interface.

MODULE 5 – CONSUMER ELECTRONICS AND COMMUNICATION SYSTEM (9L)

Consumer Electronics: Television, Mobile Phones, Air conditioners, Refrigerators, Washing Machine. (Block diagram approach only.)

Communication System: Satellite communication, Global Positioning Systems, Global System for Mobile. (Block diagram approach only.)

Suggested Reading: Consumer Electronics User Manuals.

LAB / MINI PROJECT/FIELD WORK	
Field trip to consumer electronics industry.	
TEXT BOOKS	
1	Digital Fundamentals, Thomas l. Floyd, 11th edition, Pearson 2014.
2	Op-amps and Linear Integrated Circuits,Ramakant A. Gayakwad,4th edition,Prentice Hall,2015.
3	Electronic Instrumentation and Measurements, David A. Bell, Oxford University Press, 2013.
4	The 8051 Microcontroller And Embedded Systems Using Assembly And C, SepehrNaimi, SarmadNaimi, Muhammad Ali Mazidi, Second edition, 2017.
5	Programmable Logic Controllers, Frank D. Petruzella, McGraw-Hill Education, 2016.
REFERENCE BOOKS	
1.	Digital Logic and Computer Design, M. Morris Mano, Prentice-Hall, 2016
2.	Linear Integrated Circuits, Roy Choudhury, New Age International Publishers, 4th edition, 2011
3.	C and 8051, Thomas W. Schultz, Thomas W. Schultz Publishers, 4th edition,2008
4.	Consumer Electronics, S.P Bali, Pearson Education Asia Pvt., Ltd., 2008 Edition
5.	Global Mobile Satellite Communications Applications (For Maritime, Land and Aeronautical Applications Volume 2), 2nd edition, Springer, 2018
E BOOKS	
1	http://www.ee.iitm.ac.in/~giri/pdfs/EE4140/textbook.pdf
2	https://electronics.howstuffworks.com/home-audio-video-channel.htm
MOOC	
1	http://nptel.ac.in/courses/106108099/Digital%20Systems.pdf
2	http://nptel.ac.in/courses/112103174/pdf/mod2.pdf
3	http://www.nptel.ac.in/courses/Webcourse-contents/IISc-BANG/Microprocessors%20and%20Microcontrollers/pdf/Teacher_Slides/mod3/M3L6.pdf
4	http://nptel.ac.in/courses/108105063/pdf/L-09(SS)(IA&C)%20((EE)NPTEL).pdf
5	http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/microcontrollers/micro /ui/Course_home2_5.html

COURSE TITLE	ENGINEERING IMMERSION LAB			CREDIT	0.5
COURSE CODE	GEA4131	COURSE CATEGORY	BS	L-T-P-S	0-0-2-2
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	Upon successful completion of this course the student should be able to Identify and use of tools, Types of joints used in welding, carpentry and plumbing operations.	1,2,3,4,5,6,9,12
2	Have hands on experience on basic fabrication techniques such as carpentry and plumbing practices.	1,2,3,4,5,6,9,12
3	Have hands on experience on basic fabrication techniques of different types of welding and basic machining practices.	1,2,3,4,5,6,9,12

SLOT X: LIST OF EXPERIMENTS

I. MECHANICAL ENGINEERING WORKSHOP

1. Welding: Arc welding: Butt joints
2. Lap joints.
3. Machining: Facing
4. Turning

II. AUTOMOBILE ENGINEERING

1. Dismantling and Studying of two stroke gasoline engine.
2. Assembling of two stroke gasoline engine.
3. Dismantling and Studying of four stroke gasoline engine
4. Assembling of four stroke gasoline engine.

III. AERONAUTICAL ENGINEERING

1. Study of Flow Pattern around Various Objects.
2. Force measurement on Aircraft Model
3. Determination of Young's Modulus for Aluminum Cantilever Beam
4. Binary Addition & Subtraction using Microprocessor

IV. CIVIL ENGINEERING

1. Plumbing- Basic Pipe Connection using valves, couplings and elbows.
2. Carpentry – Sowing, Planning and making common Joints.
3. Bar Bending
4. Construction of a 50 cm height brick wall without mortar using English Bond.

SLOT Y: LIST OF EXPERIMENTS

V.ELECTRICAL ENGINEERING

1. Study of tools and accessories.
2. Study of cables.
3. Staircase wiring, Tube light and Fan connection.
4. Measurement of energy using single phase energy meter.

VI. ELECTRONICS ENGINEERING

1. Study of Active and Passive Components.
2. Study of Logic Circuits.

3. Making simple circuit using Electronic Components.
4. Measuring of parameters for signal using CRO.

VII. COMPUTER SCIENCE

1. Troubleshooting different parts of the computer peripherals, Monitor, Keyboard & CPU.
2. Installation of various operating systems, their capabilities, Windows, Unix, Linux.
3. Installation of commonly used software like MS Office
4. Assembling digital computer.

VIII. MECHATRONICS ENGINEERING

1. Study of Key Elements of Mechatronics Systems
2. Sensors – Load Cell, Thermocouple
3. Actuators – Linear & Rotary Actuators
4. Interfacing & Measurements – Virtual Instrumentation

REFERENCE

1	Jeyapoovan T and Saravanapandian M., Engineering practices lab manual, 4th Edition, Vikas publishing House, New Delhi, 2015.
2	Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements ofWorkshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters andpublishers private limited, Mumbai.
3	Ibrahim Zeid, CAD/CAM Theory and Practice, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2011
4	Robert Quesada, Jeyapoovan T., Computer Numerical Control Machining and Turning Centers, Pearson Education, New Delhi, 2006

METHOD OF ALLOCATION FOR ENGINEERING IMMERSION LAB

SLOT X : MECH, AERO, AUTO, CIVIL EXPERIMENTS

SLOT Y : EEE, ELECTRONICS, CSE, MECHATRONICS EXPERIMENTS

- EVERY CLASS OF
  - GROUP A (AERO, AUTO, MECH, MCT, CHEM, BIO, CIVIL
  - GROUP B (CSE, IT, ECE, EEE, AEROSPACE)

GETS DIVIDED INTO 4 SUB - GROUPS NAMELY a, b, c, d -- EACH CONSISTING OF 15 TO 20 STUDENTS MAX.

- FOR EXAMPLE: **GROUP A STUDENTS WILL OCCUPY SLOT X**
  - WEEK 1 : SLOT X ---
    - ✓ a – MECH; b – AUTO; c – AERO ; d – CIVIL
  - WEEK 2 : SLOT X ---
    - ✓ b – MECH; c – AUTO; d – AERO ; a – CIVIL
- THE ABOVE SCHEDULE WILL BE ON ROTATION EVERY MONTH (ONE CYLCE PER MONTH)
- **GROUP B STUDENTS WILL OCCUPY SLOT Y**
  - WEEK 1 : SLOT Y ---
    - ✓ a – EEE; b – ECE; c – CSE ; d – MCT
  - WEEK 2 : SLOT Y ---
    - ✓ b – EEE; c – ECE; d – CSE ; a – MCT

THE ABOVE SCHEDULE WILL BE ON ROTATION EVERY MONTH (ONE CYLCE PER MONTH)

COURSE TITLE	ENGINEERING PHYSICS LABORATORY (Common to all engineering branches)			CREDIT	1
COURSE CODE	PHA4131	COURSE CATEGORY	BS	L-T-P-S	0-0-2-0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1.	Ability to analyze material's elastic properties	1,2,3,4,6,12
2.	Ability to determine thermal conductivity of bad conductor	1,2,3,4,6,12
3.	Ability to measure coefficient of viscosity of liquids	1,2,3,4,6,12
4.	Ability to determine wavelength of laser	1,2,3,4,6,12
5.	Ability to describe V-I characteristics of diode	1,2,3,4,6,12

Prerequisites: Knowledge in basic physics practical at higher secondary level.

List of Experiments (Any Five Experiments)

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

TEXT BOOK

1. P. Mani, engineering Physics Practicals, Dhanam Publications, Chennai, 2005

REFERENCE BOOKS

1. Glenn V.Lo, Jesus Urrechaga - Aituna, Introductory Physics Laboratory Manual, Part-I, Fall 2005 Edition.
2. P. Kulkarni, Experiments in Engineering Physics Bachelor of Engineering and Technology, Edition 2015

E BOOK

1	http://www.aurora.ac.in/images/pdf/departments/humanities-and-sciences/engg-phy-lab-manual.pdf

COURSE TITLE	MATERIALS CHEMISTRY LABORATORY (Common to ALL branches of Engineering)			CREDITS	1
COURSE CODE	CYA4131	COURSE CATEGORY	BS	L-T-P-S	0-0-2-0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1.	Students learn to characterize basic properties of refractory ceramics	1,2,3,4,6,7,12
2.	On completion of this course, students learn to prepare resins and composites.	1,2,3,4,6,7,12
3.	Students learn to estimate metal ions present in samples using instrumental techniques.	1,2,3,4,6,7,12
4.	On completion of the course the students learn to develop adsorption isotherm.	1,2,3,4,6,7,12
5.	Students learn to find properties of lubricants and other oil samples.	1,2,3,4,6,7,12

Prerequisites: Knowledge in basic chemistry practical at higher secondary level.

LAB / MINI PROJECT/FIELD WORK

1. Construction of Phenol-Water Phase diagram.
2. Determination of viscosity of polymer using Ostwald Viscometer.
3. Preparation of urea-formaldehyde resin.
4. Determination of porosity of a refractory.
5. Determination of Apparent Density of porous solids.
6. Determination of Viscosity Index of lubricants.
7. Estimation of dye content in the effluent by UV-Visible spectrophotometry.
8. Determination of viscosity of oil using Red-Wood Viscometer.
9. Determination of Copper / iron content in the alloy by colorimetry.
10. Estimation of sodium and potassium ions by Flame Photometry.
11. Verification of Beer-Lambert's law using gold nanoparticles.
12. Determination of adsorption isotherm for acetic acid on activated charcoal.

REFERENCE BOOKS

1.	J. Mendham, R.C. Denney, J.D. Barnes and N.J.K. Thomas, Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition, Pearson Education, 2009
2.	D.P. Shoemaker and C.W. Garland, Experiments in Physical Chemistry, 8th edition, McGraw Hill, London, 2008
3.	S. Sumathi, Laboratory work book for Engineering Chemistry Practical, 2015
4.	Laboratory Manual of Testing Materials, William Kendrick Hatt and Herbert Henry Scofield, Andesite Press, 2017

E BOOKS

1.	http://www.erforum.net/2016/01/engineering-chemistry-by-jain-and-jain-pdf-free-ebook.html

MOOC

1	https://ocw.mit.edu/courses/chemistry/5-111-principles-of-chemical-science-fall-2008/video-lectures/lecture-32/
2	https://www.coursetalk.com/providers/coursera/courses/introduction-to-chemistry-1

SEMESTER – II

COURSE TITLE	ANALYTICAL MATHEMATICS (Except Aeronautical and Aerospace Engineering)			CREDITS	4
Course Code	MAA4116	Course Category	BS	L-T-P-S	3-0-2-0
CIE	60%			ESE	40%
LEARNING LEVEL	BTL:1- 4				

CO	COURSE OUTCOMES	PO
1.	Competent to evaluate surface and volume integrals.	1,2,4,12
2.	Able to perform vector operations and interpret the results geometrically.	1,2,4,12
3.	Skilled to solve the system of ordinary differential equations using Laplace Transform	1,2,4,12
4.	Proficient to know that any periodic function satisfying Dirichlet's conditions can be expressed as a Fourier series	1,2,4,12
5.	Able to understand complex variable theory, applications of analytic function and harmonic conjugate.	1,2,4,12

Prerequisites : Nil

MODULE 1:MULTIPLE INTEGRALS (10L+2P)

Double integration – Cartesian and polar co-ordinates – Change of order of integration. Area as a double integral – Triple integration in Cartesian coordinates – Volume as a triple integral – Change of variables between Cartesian and polar coordinates.

Suggested Reading: Line Integrals

Lab: Area and Volume of double integration and triple integration.

MODULE 2:VECTOR CALCULUS (10L+2P)

Gradient, Divergence and Curl – Unit normal vector, Directional derivative – angle between surfaces– Solenoidal and Irrotationalvector fields.Green's theorem - Gauss divergence theorem and Stoke's theorem (without proof) – Verification and evaluation of the above theorems - Simple applications to regions such as square, rectangle, triangle, cuboids and rectangular parallelopipeds.

Suggested Reading: Basics of Vectors

Lab: Area using Green's theorem and Volume using Gauss divergence theorem

MODULE 3:LAPLACE TRANSFORMS (10L+2P)

Laplace transform – Conditions of existence – Transform of elementary functions – properties – Transforms of derivatives– Initial and final value theorems – Transform of periodic functions. Inverse Laplace transforms using partial fraction and convolution theorem. Solution of linear ODE of second order with constant coefficients.

Suggested Reading:Basics of Transform

Lab:Finding Laplace and Inverse Laplace Transform of Elementary Functions, Solutions of Ordinary differential equations using Laplace transform

MODULE 4: FOURIER SERIES (10L+2P)	
Dirichlet's Conditions – General Fourier Series – Odd and even functions – Half range sine and cosine series –Harmonic Analysis. **Suggested Reading**:Basics of series **Lab: Fourier series Expansion of simple functions, Harmonic Analysis**	
MODULE 5: COMPLEX VARIABLES (10L+2P)	
Functions of a complex variable – Analytic function – Cauchy - Riemann equations (Statement only) – Properties of analytic function (Statement only) – Construction of Analytic functions by Milne – Thomson method. **Suggested Reading**: Complex Numbers **Lab:** Complex Numbers	
LAB/MINI PROJECT/FIELD WORK	
Theory with practical classes	
TEXT BOOKS	
1	Kreyszig Erwin, "Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2	A.P.Santhakumaran, P.Titus, Engineering Mathematics - II, NiMericPublications,Nagercoil, 2012
3	Chandrasekaran A, Engineering Mathematics- II, Dhanam Publication, 2014
4	Raj Kumar Bansal,Ashok Kumar Goel, Manoj Kumar Sharma, "MATLAB and its Applications in Engineering", Pearson Publication, Second Edition, 2016.
REFERENCE BOOKS	
1.	Sastry, S.S, —Engineering Mathematics", Vol. I & II, PHI Learning Pvt. Ltd, 4thEdition, New Delhi, 2014
2.	Wylie, R.C. and Barrett, L.C., —Advanced Engineering Mathematics —Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.
3.	Dean G. Duffy., "Advanced Engineering Mathematics with MATLAB", CRC Press, Third Edition 2013.
E BOOKS	
1	http.// nptel.ac.in/courses/122104017/28
2	https://www.khanacademy.org/.../double-integrals.../double-integral.
3	nptel.ac.in/courses/115101005/downloads/lectures-doc/Lecture-1.pdf
4	nptel.ac.in/syllabus/122104017/
5	nptel.ac.in/courses/111105035/22
6	nptel.ac.in/syllabus/111103070/
MOOC	
1.	https://www.edx.org/course/introduction-engineering-mathematics-utarlingtonx-engr3-0x

COURSE TITLE	ENGINEERING MATERIALS (Common to ALL Branches of Engineering)			CREDITS	3
COURSE CODE	CYA4101	COURSE CATEGORY	BS	L-T-P-S	3-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	Student will be able to - Suggest suitable metals for alloying.	1,2,3,4,6,7,12
2	Identify the materials apt for engineering applications.	1,2,3,4,6,7,12
3	Select high temperature materials for engineering applications.	1,2,3,4,6,7,12
4	Map the properties of nano materials with their applications.	1,2,3,4,6,7,12
5	Suggest suitable materials for electronic applications.	1,2,3,4,6,7,12

Prerequisites: Knowledge in fundamentals of chemistry at higher secondary level.

MODULE 1 – CRYSTAL STRUCTURE AND PHASE RULE (9L)

Basic Crystal Systems – Types, characteristics, examples – Space lattice, Unit cell – types – X-ray diffraction and crystal structure.

Basic terminology - Derivation of Gibbs Phase rule- Phase diagrams: One component system (water), Two component system –- Reduced phase rule: Simple Eutectic system, examples, Phase diagram: Ag-Pb system, Pb-Sn system – Applications of phase rule.

MODULE 2 – POWDER METALLURGY, INORGANIC MATERIALS AND COMPOSITES. (9L)

Steel – Composition, types, heat-treatment, Abrasives – Classification, Properties, Uses - Refractories – Classification, Properties, Applications. Glasses – Properties, Types, Specialty glasses.

Composites - Introduction - Definition – Constituents – Classification - Fiber-reinforced Composites –Types and Applications.

Powder Metallurgy – Preparation of metal/alloy– Advantages and limitations.

MODULE 3 – NANOMATERIALS AND MOLECULAR SIEVES (9L)

Introduction – Synthesis of Nanomaterials - Bottom-up and Top-down approaches – Methods of preparation – Sol-gel process, Gas-phase condensation, Chemical Vapour Deposition. Properties **–** Optical, Electrical, Magnetic, Chemical properties (introduction only). Characterization **–** FE-SEM, TEM (Principle and Applications only).

Zeolite Molecular sieves – composition, structure, classification - applications – ion exchange, adsorption, separation, laundry, catalysis.

MODULE 4 –MATERIALS FOR ELECTRONIC APPLICATONS (9L)

Liquid Crystals- Introduction – Characteristics – Classification- Thermotropic crystals- - Polymorphism in Thermotropic Liquid Crystals – Molecular arrangement in various states of Liquid Crystals, Lyotropic Liquid Crystals- Applications.

Conducting and Super conducting Organic electronic materials - Applications.

Engineering plastics: Polycarbonate – Properties and uses- Conducting Polymers: Classification, Intrinsic Conducting Polymers, Extrinsic Conducting Polymers, Applications - Biodegradable Polymers, examples and applications.

MODULE 5 – LUBRICANTS, ADHESIVES AND EXPLOSIVES (9L)	
Lubricants – Mechanism of Lubrication, Classification and Properties, Semi Solid Lubricants, Solid Lubricants, MoS_2 and Graphite - Adhesives – Development of Adhesive strength, Physical and Chemical factors influencing adhesive action, Classification of Adhesives – Epoxy Resin (Preparation, Properties and Applications). Explosives – Requisites, Classification, Precautions during storage – Rocket propellants – Requisites - Classification.	
LAB / MINI PROJECT/FIELD WORK	
NA	
TEXT BOOKS	
1.	P.C. Jain and Monicka Jain, Engineering Chemistry, Dhanpat Raj Publishing Company (P) Ltd, New Delhi – 2012
2.	Puri, Sharma and Pathania, Principles of Physical Chemistry, Vishal Publishing Co. Jalandar, 2004.
3.	Composite materials, K.K. Chawala, 3rd ed., (2012) Springer-Verlag, New York
4.	Nanocomposite Science and Technology, P. M. Ajayan, L. S. Schadler, P. V. Braun, (2003), Wiley-VCH Verlag GmbH Co. KGaA, Weinheim.
5.	Mechanics and Analysis of Composite Materials, V.V. Vasiliev and E.V. Morozov, (2001), Elsevier Science Ltd, The Boulevard, Langford Lane, Kidlington, Oxford OX5 lGB, UK.
E BOOKS	
1.	http://www.erforum.net/2016/01/engineering-chemistry-by-jain-and-jain-pdf-free-ebook.html
2.	https://abmpk.files.wordpress.com/2014/02/book_maretial-science-callister.pdf `
MOOC	
1	https://www.edx.org/course/materials-science-engineering-misisx-mse1x
2	https://www.mooc-list.com/tags/materials-science

COURSE TITLE	ENGINEERING PHYSICS (AERO, MECH, AUTO, CHEMICAL, BIOTECH, CIVIL)			CREDITS	3
COURSE CODE	PHA4101	COURSE CATEGORY	BS	L-T-P-S	3-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1.	Solve basic problems in mechanics and also understand the properties of matter.	1,2,3,4,6,12
2.	Have knowledge of acoustics and ultrasonics which would facilitate in acoustical design of buildings and also be able to employ ultrasonics as an engineering tool.	1,2,3,4,6,12
3.	Knowledge on fundamental concepts of Quantum physics	1,2,3,4,6,12
4.	Fundamental knowledge on semiconductors and discrete devices.	1,2,3,4,6,12
5.	Understand the concept, working and application of lasers and fiber optics.	1,2,3,4,6,12

Prerequisites: Knowledge in fundamentals of physics at higher secondary level.

MODULE 1 – PROPERTIES OF MATTER AND HEAT (9L)

Elasticity - types of moduli of elasticity - Young's modulus - 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.

Thermal conductivity – experimental determination of thermal conductivities of good and bad conductors – Forbe's method – theory and experiment – Lee's disc method for bad conductors

MODULE 2 – ACOUSTICS AND ULTRASONICS (9L)

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.

MODULE 3 –QUANTUM PHYSICS (9L)

Black body radiation- Planck's theory (derivation) – Deduction of Wien's displacement law and Rayleigh – Jean's law from Planck's theory – Compton effect – Theory and experimental verification – Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one dimensional box Extension to 3 dimension (no derivation)

MODULE 4 –CRYSTAL PHYSICS AND MAGNETISM (9L)

Crystal - 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.

Magnetic dipole moment - atomic magnetic moments- magnetic permeability and susceptibility -

Types of magnetism: diamagnetism - paramagnetism - ferromagnetism - antiferromagnetism – ferrimagnetism - domain structure – hysteresis - hard and soft magnetic materials – applications.	
MODULE 5 –PHOTONICS AND FIBRE OPTICS (9L)	
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 - fiber optic communication system.	
LAB / MINI PROJECT / FIELD WORK	
NA	
TEXT BOOKS	
1.	P.Mani, " Engineering Physics", Vol-I & II, Dhanam Publications, Chennai. (2011)
2.	Gaur R.K. and Gupta S.L., "Engineering Physics", 8th edition, Dhanpat Rai publications (P) Ltd., New Delhi. (2010)
REFERENCE BOOKS	
1.	Arthur Beiser, "Concepts of Modern Physics", Tata Mc Graw – Hill Publications. (2007)
2.	Rajendran V. Marikani A., "Applied Physics for engineers", 3rd edition, Tata Mc Graw –Hill publishing company Ltd., New Delhi. (2003)
E BOOKS	
1	https://www.bookyards.com/en/book/details/13921/Elements-Of-Properties-Of-Matter
2	http://iopscience.iop.org/book/978-1-6817-4585-5
3	https://www.springer.com/in/book/9783319206295
MOOC	
1	http://nptel.ac.in/courses/115106061/
2	http://nptel.ac.in/courses/117101054/12

COURSE TITLE	PROFESSIONAL ENGLISH AND SOFT SKILLS			CREDITS	3
COURSE CODE	ELA4101	COURSE CATEGORY	BS	L-T-P-S	1-1-2-1
CIA	60%			ESE	40%
LEARNING LEVEL	BTL - 6				

CO	COURSE OUTCOMES	PO
1	Understanding the importance of professional communication and applying the knowledge.	6,10,12
2	Integrate the knowledge of phonetics, enhancing the listening skills in formal and real-life situations, enhance pronunciation skills based on the knowledge of phonetics.	6,10,12
3	Construct appropriate sentences in English Language, applying grammatical rules and mastery in syntax. Develop reading skills and derive the contextual meaning, case studies and analyzing problems	6,10,12
4	Integrate creativity in the writing skills both in formal and informal situations, related to environment, society and multidisciplinary environments	6,7,10,12
5	Imbibing soft skills to excel in interpersonal skills essential for workplace	6,10,12

Prerequisites : Plus Two English-Intermediate Level

MODULE 1 – THE ELEMENTS OF COMMUNICATION (9L)

Importance of communication through English -Process of communication and factors that influence speaking- Importance of audience and purpose- Principles of Communication-comparing general communication and business communication-Professional Communication-barriers to communication –strategies to overcome communication barriers-formal and informal communication

Suggested Activities:

Self-introduction-short conversations-Situational communication-dialogue writing -Language Functions-analyse the speech and comment-distinguish formal and informal style of communication-using bias-free language- news reports.

Suggested Reading:

Rogerson, Trish Stott & Derek Utley.2011

Elements of Effective Communication: 4th Edition, Plain and Precious Publishing, USA, by Randal S. Chase (Author), Wayne Shamo (Author)

Effective Communication Skills, MTD Training & Ventus Publishing (e book)

MODULE 2 – AURAL –ORAL COMMUNICATION IN ENGLISH (9L)

Vowels- diphthongs- consonants - International Phonetic Alphabet (IPA) ; phonemic transcription (simple words)-syllable division and word stress –enunciation-GIE script(General Indian English)-neutral accent- sentence rhythm and weak forms - contrastive stress in sentences to highlight different words - intonation varieties of Spoken English : Standard Indian, American and British-Speaking to Communicate-speech acts - Language Patterns

(Note: This unit should be taught in a simple, non-technical manner, avoiding technical terms as far as possible).

Suggested activities: (Audio CD) Listen and repeat, listen to the sentences and fill in the blanks, Listening to passages and answering questions, marking the stressed syllable, phonemic script of simple words, sentence rhythm and intonation (rising tone and falling tone), short speeches. Individual presentations-dynamics of a group discussion

Suggested sources:

Cambridge IELTS

Professional Speaking Skills by Aruna Koneru, Oxford Press

Face to face series Cambridge University Press

Speaking Effectively, Cambridge University Press, Jeremy Comfort, Pamela

MODULE 3 - GRAMMAR AND DEVELOPMENT OF READING SKILLS (9L)

Noun Phrase, Verb Phrase, Tense and Aspect, Articles, Pronouns and determiners, Sentence Pattern, interrogative and negative sentences-subject verb agreement -Vocabulary-word formation: prefixes and suffixes, reading passages-inductive vs deductive reading-newspaper articles- comprehension passages –cloze reading-annotating-editing

Suggested Activities:

Identify the errors in sentences, grammar exercises, book reviews, mini project on suggested reading activity - reading technical passages based on students area of specialization answering questions- reading passage for identifying the contextual meaning

Suggested sources:

Skills for the TOEFL IBT Test, Collins

IELTS, Cambridge books

Practical English Usage by Michael Swan , Cambridge University Press

MODULE 4 - EFFECTIVE WRITING AND BUSINESS COMMUNICATION (9L)

Paragraph writing- topic sentence-connectives - process writing-Memoranda-Business letters-Resumes /Visumes and job applications-drafting a report-agenda and minutes of the meeting-ATR-project proposals-email etiquette- interpreting visual data(bar chart, pie chart, line graphs)

Suggested activities:

Writing short paragraph based on environment protection, societal issues, health, cultural contexts etc., identifying topic sentences, linking pairs of sentences, cause and effect exercises, formal letters, e mails, drafting project proposals, drafting agenda, minutes of the meeting

Suggested sources:

Cambridge Advanced English, Newspapers, library books, IELTS,IELTS Academic Writing 1,New Insights into IELTS, CUP

MODULE 5 – SOFT SKILLS (9L)

Introducing Soft Skills &Life Skills- Myers Briggs Type Indicator – the Big Five Model Personality - Employability Skills- Workplace Etiquette- Professional Ethics -Time Management-Stress Management- Lateral Thinking (De Bono's Six Thinking Hats) and Problem Solving Skills

Suggested Activities:

Mock interviews, GD's, short oral presentation, lateral thinking puzzles, Case analysis and self-study assignments, Worksheet activities.

Suggested Sources:

Soft Skills and Employability Skills by Sabina Pillai and Agna Fernandez, Cambridge University Press,

2018.
Soft Skills for Everyone by Jeff Butterfield, Cengage Learning
Education and personality development, K. Manoharan
English for Life and the Workplace through the LSRW&T skills
Lateral Thinking skills by Edward De Bono

TEXT BOOKS	
1.	An Introduction to Profession English and Soft Skills with audio CD by Dr. Bikram K. Das et al. Published by Cambridge University Press. 2009
REFERENCE BOOKS	
1	Soft Skills & Employability Skills by Sabina Pillai and Agna Fernandez published by Cambridge University Press 2018.
2	Embark, English for Undergraduates by Steve Hart et al, Cambridge University Press, 2016, edition
3	Skills for the TOEFL IBT Test, Collins, 2012 edition
4	Soft Skills for Everyone by Jeff Butterfield, Cengage Learning, 2010 edition
5	English for Life and the Workplace Through LSRW&T skills, by Dolly John, Pearson Publications, 2014 edition
6	Professional Speaking Skills by Aruna Koneru, Oxford Publications.
7	The official Cambridge guide to IELTS for Academic and General Training, Cambridge University Press, 2014 edition.
8	Cambridge BEC Vantage, Self-Study edition, Practice Tests, CUP, 2002
9	English for Business Studies, 3rd edition, Ian Mackenzie, Cambridge University Press
10	Education and Personality Development by Dr. P.K.Manoharan, APH Publishing Corporation,
11	Speaking Effectively by Jeremy Comfort et al, Cambridge University Press, 2011.
E BOOKS	
1	https://www.britishcouncil.in/english/courses-business
2	http://www.bbc.co.uk/learningenglish/english/features/pronunciation
3	http://www.bbc.co.uk/learningenglish/english/
4	http://www.antimoon.com/how/pronunc-soundsipa.htm
5	http://www.cambridgeenglish.org/learning-english/free-resources/write-and-improve/
6	Oneshopenglish.com
7	Breakingnews.com
MOOC	
1	https://www.mooc-list.com/tags/english
2	https://www.mooc-list.com/course/adventures-writing-stanford-online
3	http://www.cambridgeenglish.org/learning-english/free-resources/mooc/

COURSE TITLE	ENGINEERING GRAPHICS AND COMPUTER AIDED DESIGN			CREDITS	3
COURSE CODE	MEA4101	COURSE CATEGORY	BS	L-T-P-S	1- 1- 2- 1
CIA	60%			ESE	40%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	Understand drafting and computer aided drafting. Remember the commands used in AutoCAD to generate simple drawings.	1,3,5,10,12
2	Explain details in a drawing and apply the knowledge to solve simple problems involving straight lines, planes and solids	1,3,5,10,12
3	Understand and Visualize solid objects and apply AutoCAD software commands to generate the graphic models	1,3,5,10,12
4	Apply the 3D model commands to generate and solid object	1,3,5,10,12
5	Apply the viewing AutoCAD commands to generate top view, front view and additional or sectional views.	1,3,5,10,12
6	Student can able to develop any graphical model of geometrical and simple mechanical objects in AutoCAD software.	1,3,5,10,12

Prerequisites : Nil

MODULE 1: BASICS OF ENGINEERING GRAPHICS AND PLANE CURVES (12L)

Importance of graphics - BIS conventions and specifications - drawing sheet sizes - Lettering – Dimensioning - Scales. Drafting methods - introduction to Computer Aided Drafting – Computer Hardware – Workstation – Printer and Plotter – Introduction to software for Computer Aided Design and Drafting – Exposure to Solid Modelling software – Geometrical Construction-Coordinate Systems/Basic Entities – 3D printer.

Suggested Reading: Solid modeling Software commands

MODULE 2: VISUALIZATION, ORTHOGRAPHIC PROJECTIONS AND FREE HAND SKETCHING (15L)

Visualization concepts and Free Hand sketching: Visualization principles —Representation of Three Dimensional objects — Pictorial Projection methods - Layout of views- Free hand sketching of multiple views from pictorial views of objects. Drafting of simple Geometric Objects/Editing

General principles of presentation of technical drawings as per BIS - Introduction to Orthographic projections - Naming views as per BIS - First angle projection method. Conversion to orthographic views from given pictorial views of objects, including dimensioning – Drafting of Orthographic views from Pictorial views.

Suggested Reading: CAD software commands for sketching a drawing

MODULE 3: GEOMETRICAL MODELING ISOMETRIC VIEWS AND DEVELOPMENT OF SURFACES (15L)

Principles of isometric projection and solid modelling. Isometric drawing – Iso Planes and 3D Modelling commands. Projections of Principal Views from 3-D Models. Solid Modelling – Types of modelling - Wire frame model, Surface Model and Solid Model – Introduction to graphic software for solid modelling. Development of Surfaces.

Suggested Reading: Surface modeling and solid modeling commands

MODULE 4: COMPUTER AIDED DESIGN AND DRAFTING (15L)
Preparation of solid models of machine components like slide block, solid bearing block, bushed bearing, gland, wall bracket, guide bracket, shaft bracket, jig plate, shaft support (open type), vertical shaft support etc using appropriate modelling software. 2D views and sectional view, computer aided drafting and dimensioning. Generate 2D drawing from the 3D models – generate and develop the lateral surfaces of the objects. Presentation Techniques of Engineering Drawings – Title Blocks – Printing/Plotting the 2D/3D drawing using printer and printing solid object using 3D printer. **Suggested Reading**: CAD commands for modeling and views generation
Module 5: SIMPLE DESIGN PROJECTS - COMPUTER AIDED DESIGN AND DRAFTING (15L)
Creation of engineering models and their presentation in standard 2D form, 3D Wire-Frame and shaded solids, meshed topologies for engineering analysis, tool-path generation for component manufacture, geometric dimensioning and tolerancing. Use of solid-modelling software for creating associative models at the components and assembly levels in their respective branch of engineering like building floor plans that include: windows, doors, fixtures such as WC, Sink, shower, slide block, etc. Applying colour coding according to drawing practice. **Suggested Reading**: CAD commands for modeling and views generation

TEXT BOOKS	
1	Jeyapoovan T, Engineering Drawing and Graphics Using AutoCAD, 7th Edition, Vikas Publishing House Pvt Ltd., New Delhi, 2016.
REFERENCE BOOKS	
1	Introduction to AutoCAD – 2D and 3D Design, A.Yarmwood, Newnes Elsevier, 2011
2	Engineering Drawing and Graphic Technology-International Edition, Thomas E. French, Charles J. Vierck, Robert J. Foster, McGraw-Hill, 2014
3	Engineering Drawing and Design, Sixth Edition, C. Jensen, J.D. Helsel, D.R. Short, McGraw-Hill, 2012
4	Technical Drawing-Fourteenth Edition, F. E. Giesecke, A. Mitchell, H. C. Spencer, I.L. Hill, J.T. Dygdon, J.E., Novak, Prentice-Hall, 2012,
5	Bhatt N.D and Panchal V.M, Engineering Drawing: Plane and Solid Geometry, Charotar Publishing House, 2017.
6	Warren J. Luzadder and Jon. M. Duff, Fundamentals of Engineering Drawing, Prentice Hall of India Pvt. Ltd., Eleventh Edition, 2016.
E BOOKS	
1	http://keralatechnologicaluniversity.blogspot.in/2015/06/engineering-graphics-j-benjamin-pentex-free-ebook-pdf-download.html
2	http://keralatechnologicaluniversity.blogspot.in/2015/06/engineering-graphics-p-i-varghese.html
MOOC	
1	http://nptel.ac.in/courses/112103019/
2	http://nptel.ac.in/courses/105104148/

COURSE TITLE	SUSTAINABLE ENGINEERING SYSTEMS (Common to ALL Branches of Engineering)			CREDITS	2
COURSE CODE	GEA4102	COURSE CATEGORY	PC	L-T-P-S	2-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1.	Students learn the principles of sustainability with case studies.	2,3,6,7,8,9,10,12
2.	Students will be able to understand assessing technologies and their impact on environment.	2,3,6,7,8,9,10,12
3	To learn the concept of Green Engineering and to apply in their projects at higher semesters.	2,3,6,7,8,9,10,12
4.	Management of natural resources and waste management from various types of industries.	2,3,6,7,8,9,10,12
5.	Students learn water technology and behavioral aspects of humans.	2,3,6,7,8,9,10,12

Prerequisites: Knowledge in fundamentals of chemistry at higher secondary level.

MODULE 1 – PRINCIPLES OF SUSTAINABLE SYSTEMS (5L)

Sustainability Definitions - Principles of Sustainable Design, Sustainable Engineering -Frameworks for Applying Sustainability Principles - Summary & Activities.

MODULE 2 – TECHNOLOGY DEVELOPMENT AND LIFECYCLE ASSESSMENT (5L)

Technology as a part of anthropogenic environment - Technology readiness levels (TRL) – technical metrics - Emerging, converging, disruptive technologies - Life Cycle Assessment (LCA) methodology - Summary & Activities.

MODULE 3 – GREEN ENGINEERING (5L)

Principles of Green Engineering - Frameworks for assessment of alternatives - Green Engineering examples - Multifunctional Materials and Their Impact on Sustainability - Summary & Activities.

MODULE 4 – RESOURCE MANAGEMENT TECHNOLOGIES (5L)

Waste management purpose and strategies - Recycling: open-loop versus closed-loop thinking - Recycling efficiency - Management of food waste and composting technologies - E-waste stream management - Reuse and redistribution programs - LCA approach to waste management systems - Summary and Activities.

MODULE 5 – SUSTAINABLE WATER AND WASTEWATER SYSTEMS (5L)

Water cycle - Water conservation and protection technologies - Water treatment systemsMetrics for assessment of water management technologies-Summary & Activities.

MODULE 6 - BEHAVIORAL ASPECTS AND FEEDBACKS (5L)

Collaborative Decision Making - Role of Community and Social Networking - Human Factor in Sustainability Paradigm - Summary & Activities.

TEXT BOOKS	
1.	Vanek, F.M., and L.D. Albright, Energy Systems Engineering. Evaluation and Implementation, McGraw Hill, 2008.
2.	C.U. Becker, Sustainability Ethics and Sustainability Research, Springer 2012.
3.	J.B. Guinee et al., Life Cycle Assessment: Past, Present, and Future, Environ. Sci. Technol., 2011, 45, 90-96.
4.	Anastas, P.T., Zimmerman, J.B., Innovationsin Green Chemistry and Green Engineering, Springer 2013.
5.	Solid Waste Technology & Management, Volume 1 & 2, Christensen, T., Ed., Wiley and Sons., *2010.*
6.	Sterman, J.D., in Sustainability Science: The Emerging Paradigm, Weinstein, M.P. and Turner, R.E. (Eds.), Springer Science+Business Media, LLC 2012.
E BOOKS	
1.	David T. Allen, David R. Shonnard, Sustainable Engineering Concepts, Design and Case Studies, Pearson Education, December 2011. (ISBN: 9780132756587)
2.	Gerald Jonker Jan Harmsen, Engineering for Sustainability 1st Edition, A Practical Guide for Sustainable Design, Elsvier 2012. (**ISBN:** 9780444538475).
MOOC	
1.	https://www.coursera.org/learn/sustainability
2.	https://www.academiccourses.com/Certificate/Sustainability-Studies/India/
3.	https://onlinecourses.nptel.ac.in/noc18_ce08/preview
4.	https://www.coursera.org/learn/ecosystem-services

COURSE TITLE	PROBLEM SOLVING USING C			CREDITS	3
COURSE CODE	CSA4101	COURSE CATEGORY	PC	L-T-P-S	2-0-2-0
CIA	60%			ESE	40%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
Upon completion of this course, the students will be able to		
1	Describe the basics of digital computer and programming languages.	1,2,8,12
2	Demonstrate problem solving techniques using flowchart, algorithm/pseudo code to solve the given problem.	1,2,3,5,12
3	Design and Implement C program using Control Statements and Functions.	1,2,3,5,9,10,12
4	Design and Implement C program using Pointers and File operations.	1,2,3,12
5	Identify the need for embedded C in real-time applications.	1,2,6,12

Prerequisites: Nil

MODULE 1 – PROGRAMMING LANGUAGES AND PROBLEM SOLVING TECHNIQUES (6L+6P)

Introduction – Fundamentals of digital computers - Programming languages -Programming Paradigms – Types of Programming Languages – Language Translators – Problem Solving Techniques: Algorithm – Flow Chart - Pseudo code.

Practical Component:

Drawing Flowcharts using E- Chart & Writing pseudo code for the following problems

(i) Greatest of three numbers

(ii) Sum of N numbers

(iii) Computation of nCr

MODULE 2: FUNDAMENTALS OF C (6L+6P)

Evolution of C -Why C language - Applications of C language - Data Types in C – Operators and Expressions – Input and Output statements in C – Decision Statements – Loop Control Statements.

Practical Component:

(i) Program to illustrate arithmetic and logical operators

(ii) Program to read and print data of different types

(iii) Program to calculate area and volume of various geometrical shapes

(iv) Program to compute biggest of three numbers

(v) Program to print multiplication table

(vi) Program to convert days to years, months and days

(vii) Program to find sum of the digits of an integer.

MODULE 3: FUNCTIONS, ARRAYS AND STRINGS (6L+6P)

Functions – Storage Class – Arrays – Strings and standard functions - Pre-processor Statements.

Practical Component:

(i) Program to compute Factorial, Fibonacci series and sum of n numbers using recursion

(ii) Program to compute sum and average of N Numbers stored in an array

(iii) Program to sort the given n numbers stored in an array

(iv) Program to search for the given element in an array
(v) Program to do word count
(vi) Program to insert a substring in a string
(vii) Program to concatenate and compare two strings
(viii) Program using pre-processor statements

MODULE 4: POINTERS, STRUCTURES AND UNION (6L+6P)

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

Practical Component:

(i) Program to compute sum of integers stored in a 1-D array using pointers and dynamic memory allocation
(ii) Program to read and print records of a student/payroll database using structures
(iii) Program to simulate file copy
(iv) Program to illustrate sequential access file
(v) Program to illustrate random access file

MODULE 5: INTRODUCTION TO EMBEDDED C (6L+6P)

Structure of embedded C program - Data Types - Operators - Statements - Functions - Keil C Compiler.

Practical component:

Simple programs using embedded C

LAB / MINI PROJECT / FIELD WORK

NA

TEXT BOOKS

1.	Jeyapoovan T, “Fundamentals of Computing and Programming in C”, Vikas Publishing house, 2015.
2.	Mark Siegesmund, "Embedded C Programming", first edition, Elsevier publications, 2014.

REFERENCE BOOKS

1.	Ashok Kamthane, “Computer Programming”, Pearson Education, 7th Edition, Inc 2017.
2.	Yashavant Kanetkar, “Let us C”, 15th edition, BPP publication, 2016.
3.	S.Sathyalakshmi, S.Dinakar, “Computer Programming Practicals – Computer Lab Manual”, Dhanam Publication, First Edition, July 2013.

E BOOKS

1.	https://en.wikibooks.org/wiki/C_Programming

MOOC

1.	https://onlinecourses.nptel.ac.in/noc18-cs10/preview
2.	http://nptel.ac.in/courses/106105085/2
3.	https://www.udemy.com/c-programming-for-beginners/
4.	https://www.coursera.org/specializations/c-programming

COURSE TITLE	INTRODUCTION TO DIGITAL SYSTEMS			CREDITS	3
COURSE CODE	EEB4101	COURSE CATEGORY	PC	L-T-P-S	3- 0- 0- 1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	To understand basic operation in digital systems and instruments.	1,3,5,12
2	To gain knowledge on basic functioning of sensors and display units.	1,3,5,12
3	To familiarize the concepts of signal processing and converting elements.	1,3,5,12
4	To acquire the knowledge of microcontrollers and applications	1,3,5,12
5	To attain the basic concepts of consumer electronics and communication devices.	1,3,5,12

Prerequisites : Physics and Mathematics

MODULE 1 – INTRODUCTION TO DIGITAL SYSTEMS (9L)

Analog& Digital signals - Need for digital instruments – Elements of digital instruments – Number systems: - Binary, Hexadecimal - Logic gates - Boolean algebra (Identities and Properties) - Digital controllers (ON-OFF).

Suggested Reading: Basics of number systems.

MODULE 2 –SENSORS AND DISPLAYS (9L)

Sensors and Transducers –Classification, Potentiometer, Strain Gauge, Piezoelectric Sensor, Linear Variable Differential Transformer, Resistance temperature detectors (RTD), Thermocouples, Tactile transducers - Displays: - Light Emitting Diode (including OLED) displays.

Suggested Reading: Primary sensing elements, introduction to displays.

MODULE – 3 : SIGNAL CONDITIONING CIRCUITS (9L)

D.C. Bridge- Unbalanced, Push-Pull configuration, Operational amplifiers- Inverting, Non-Inverting, Instrumentation Amplifier, Active filters: - Low pass, High pass - Analog to Digital Converter – Successive Approximation, Digital to Analog Converter - Weighted Resistor.

Suggested Reading: Basic network theorems.

MODULE – 4 :INTRODUCTION TO MICRO CONTROLLERS (9L)

Introduction: Memory types, peripheral devices- Microcontroller (8 bit), Architecture, Graphics Processing Unit (GPU) - Applications: -Interfacing of Digital Input/Output, Analogue Input/Output, Display. Introduction to Programmable Logic Controller (PLC) and PID (Proportional + Integral + Derivative) Controller.

Suggested Reading: Hobby electronics with Microcontroller interface.

MODULE 5 – CONSUMER ELECTRONICS AND COMMUNICATION SYSTEM (9L)

Consumer Electronics: Television, Mobile Phones, Air conditioners, Refrigerators, Washing Machine. (Block diagram approach only.)

Communication System: Satellite communication, Global Positioning Systems, Global System for Mobile. (Block diagram approach only.)

Suggested Reading: Consumer Electronics User Manuals.

LAB / MINI PROJECT/FIELD WORK

Field trip to consumer electronics industry.

TEXT BOOKS	
1	Digital Fundamentals, Thomas l. Floyd, 11th edition, Pearson 2014.
2	Op-amps and Linear Integrated Circuits, Ramakant A. Gayakwad, 4th edition, Prentice Hall, 2015.
3	Electronic Instrumentation and Measurements, David A. Bell, Oxford University Press, 2013.
4	The 8051 Microcontroller And Embedded Systems Using Assembly And C, SepehrNaimi, SarmadNaimi, Muhammad Ali Mazidi, Second edition, 2017.
5	Programmable Logic Controllers, Frank D. Petruzella, McGraw-Hill Education, 2016.
REFERENCE BOOKS	
1	Digital Logic and Computer Design, M. Morris Mano, Prentice-Hall, 2016
2	Linear Integrated Circuits, Roy Choudhury, New Age International Publishers, 4th edition, 2011
3	C and 8051, Thomas W. Schultz, Thomas W. Schultz Publishers, 4th edition,2008
4	Consumer Electronics, S.P Bali, Pearson Education Asia Pvt., Ltd., 2008 Edition
5	Global Mobile Satellite Communications Applications (For Maritime, Land and Aeronautical Applications Volume 2), 2nd edition, Springer, 2018
E BOOKS	
1	http://www.ee.iitm.ac.in/~giri/pdfs/EE4140/textbook.pdf
2	https://electronics.howstuffworks.com/home-audio-video-channel.htm
MOOC	
1	http://nptel.ac.in/courses/106108099/Digital%20Systems.pdf
2	http://nptel.ac.in/courses/112103174/pdf/mod2.pdf
3	http://www.nptel.ac.in/courses/Webcourse-contents/IISc-BANG/Microprocessors%20and%20Microcontrollers/pdf/Teacher_Slides/mod3/M3L6.pdf
4	http://nptel.ac.in/courses/108105063/pdf/L-09(SS)(IA&C)%20((EE)NPTEL).pdf
5	http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/microcontrollers/micro/ui/Course_home2_5.html

COURSE TITLE	ENGINEERING AND DESIGN			CREDIT	3
COURSE CODE	AEB4101	COURSE CATEGORY	PC	L-T-P-S	3- 0- 0 -1
CIA	60%			ESE	40%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	Students will be able to appreciate the different elements involved in good designs and to apply them in practice when called for.	1,2,3,4,7,10,12
2	Students will be aware of the product oriented and user oriented aspects that make the design a success.	1,2,3,4,7,10,12
3	Students Will be capable to think of innovative designs incorporating different segments of knowledge gained in the course	1,2,3,4,7,10,12
4	Students will have a broader perspective of design covering function, cost, environmental sensitivity, safety and other factors other than engineering analysis.	1,2,3,4,7,10,12
5	Students learn economic and environmental Issues, trade aspects and IPR	1,2,3,4,7,10,12

Prerequisites : Nil

Module 1: INTRODUCTION TO AERONAUTICAL ENGINEERING DESIGN (7L+2P)

Design and its objectives; Design constraints, Design functions, Design means and Design from; Role of Science, Engineering and Technology in design; Engineering as a business proposition; Functional and Strength Designs. Design form, function and strength; How to initiate creative designs? Initiating the thinking process for designing a product of daily use. Need identification; Problem Statement; Market survey-customer requirements; Design attributes and objectives; Ideation; Brain storming approaches; arriving at solutions; Closing on to the Design needs.

Project: An Exercise in the process of design initiation. A simple problem is to be taken up to examine different solutions- Vehicle, Group Presentation and discussion**.**

MODULE 2: PROCESSES IN DESIGN FOR AERONAUTIC SYSTEM (7L+2P)

Design process- Different stages in design and their significance; Defining the design space; Analogies and "thinking outside of the box"; Quality function deployment-meeting what the customer wants; Evaluation and choosing of a design. Design Communication; Realization of the concept into a configuration, drawing and model. Concept of "Complex is Simple". Design for function and strength.

Design detailing- Material selection, Design visualization- Solid modelling; Detailed 2D part drawings; Tolerance; Use of standard items in design; Research needs in design; Energy needs of the design, both in its realization and in the applications.

Project: An exercise in the detailed design of any two automobile components

MODULE 3: PROTOTYPING OF AERONAUTICAL COMPONENTS (4L+5P)

Prototyping- rapid prototyping; testing and evaluation of design; Design modifications; Freezing the design; Cost analysis.

Engineering the design – From prototype to product. Planning; Scheduling; Supply chains; inventory; handling; manufacturing/construction operations; storage; packaging; shipping; marketing; feed-back on design

Project: List out the standards organizations. Prepare a list of standard items used in aeronautical original equipment manufacturers. Develop any design with over 50% standard items as parts.

MODULE 4: QUALITY ASPECTS IN AERONAUTICAL ENGINEERING (4L+5P)
Design for "X"; covering quality, reliability, safety, manufacturing/construction, assembly, maintenance, logistics, handling; disassembly; recycling; re-engineering etc. **Project:Example:** List out the design requirements(x) for designing a car.
MODULE 5: USER CENTRED DESIGNSIN AERONAUTICAL ENGINEERING (4L+5P)
Product centered and user centered design. Product centered attributes and user centered attributes. Bringing the two closer. Example: Motor Cycle and Car, Aesthetics and ergonomics. Value engineering, Concurrent engineering, Reverse engineering in design; Culture based design; Architectural designs; Motifs and cultural background; Tradition and design; Study the evolution of Wheels; Printed motifs; Role of colours in design. Make sharp corners and change them to smooth curves-check the acceptance. Design as a marketing tool; Intellectual Property rights – Trade secret; patent; copy-right; trademarks; product liability. Group presentation of any such products covering all aspects that could make or mar it. **Project:** Examine the possibility of value addition for an existing product.
REFERENCE BOOKS

1	Balmer, R. T., Keat, W. D., Wise, G., and Kosky, P., Exploring Engineering, Third Edition: An Introduction to Engineering and Design - [Part 3 - Chapters 17 to 27], ISBN13: 978-0124158917 ISBN-10: 0124158919
2	Dym, C. L., Little, P. and Orwin, E. J., Engineering Design - A Project based introduction - Wiley, ISBN-978-1-118-32458-5
3	Eastman, C. M. (Ed.), Design for X Concurrent engineering imperatives, 1996, XI, 489 p. ISBN 978-94-011-3985-4 Springer
4	Haik, Y. And Shahin, M. T., Engineering Design Process, Cengage Learning, ISBN-13: 978-0-495-66816-9
5	Pahl, G., Beitz, W., Feldhusen, J. and Grote, K. H., Engineering Design: A Systematic Approach, 3rd ed. 2007, XXI, 617p., ISBN 978-1-84628-319-2
6	Voland, G., Engineering by Design, ISBN 978-93-325-3505-3, Pearson India

COURSE TITLE	ENGINEERING MECHANICS			CREDITS	3
COURSE CODE	AEB4116	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
1	Effectively use the free body diagrams of basic structural elements to design structures to meet design requirements	1,2,5
2	Demonstrate the ability to draw free body diagrams and calculate the forces in simple structures using hand calculation	1,2,3, 5
3	Calculate the area moment of inertia of structural members.	1,2, 3
4	Understand the dynamics of particle	1,2,4,5
5	Understand load paths in structures and demonstrate a knowledge of statics and dynamics of particles and rigid bodies	1,2, 3

Prerequisites : Engineering Physics

MODULE 1: STATICS OF PARTICLES **12 (9L + 3T)**

Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles, Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors. Equilibrium of a Particle, Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

MODULE 2: EQUILIBRIUM OF RIGID BODIES **12 (9L + 3T)**

Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point, Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple, Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force - Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions, Reactions at Supports and Connections.

MODULE 3: DISTRIBUTED FORCES **12 (9L + 3T)**

Centroids of lines and areas of symmetrical and unsymmetrical shapes, Determination of Centroids by Integration, Theorems of Pappus-Guldinus, Distributed Loads on Beams, Center of Gravity of a Three Dimensional Body, Centroid of a Volume, Composite Bodies, Determination of Centroids of Volumes by Integration. Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration, Polar Moment of Inertia, Radius of Gyration of an Area, Parallel-Axis Theorem, Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates, Determination of the Moment of Inertia of a Three Dimensional Body by Integration

MODULE 4: DYNAMICS OF PARTICLE **12 (9L + 3T)**

Kinematics, Rectilinear Motion and Curvilinear Motion of Particles. Kinetics, Newton's Second Law of Motion, Equations of Motions , Dynamic Equilibrium, Energy and Momentum Methods - Work of a Force , Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact, Method of Virtual Work, Work of a Force, Potential Energy, Potential Energy and Equilibrium

MODULE 5: FRICTION AND RIGID BODY DYNAMICS	12 (9L + 3T)
Laws of Dry Friction. Coefficients of Friction, Angles of Friction, Wedges, Wheel Friction, Rolling Resistance, Ladder friction, Translation and Rotation of Rigid Bodies, Velocity and acceleration, General Plane motion.	
LAB / MINI PROJECT / FIELD WORK	
TEXT BOOKS	
1	F.P. Beer and E.R. Johnson Jr., "Vector Mechanics for Engineers", McGraw-Hill Education (India) Pvt. Ltd. 10th Edition, 2013.
REFERENCE BOOKS	
1	R.C. Hibbeller, Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
2	J.L. Meriam and L.G. Karige, Engineering Mechanics: Statics (Volume I) and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.
3	P. Boresi and J. Schmidt, Engineering Mechanics: Statics and Dynamics, 1/e, Cengagelearning, 2008.
4	Irving H. Shames, G. Krishna Mohana Rao, Engineering Mechanics - Statics and Dynamics, Fourth Edition – PHI / Pearson Education Asia Pvt. Ltd., 2006.
5	Vela Murali, "Engineering Mechanics", Oxford University Press (2010)
6	J.E. Shigley, "Applied Mechanics of Materials", International Student Edition, McGraw Hill Koyakusha Limited, 2000.
E BOOKS	
1	https://www.scribd.com/doc/59446893/A-Textbook-of-Engineering-Mechanics-by-R-K-Bansal
2	https://books.google.co.in/books/about/Engineering_Mechanics.html?id=4wkLl4NvmWAC
MOOC	
1	http://nptel.ac.in/courses/122104015/
2	http://nptel.ac.in/courses/112103109/

COURSE TITLE	PRINCIPLES OF FLIGHT (Common to Aeronautical and Avionics)			CREDITS	3
COURSE CODE	AEB4117	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	Knowledge on history of aircraft & developments over the years	1,5,6
2	Understanding about classifications of aircrafts and control systems	3,5,6
3	Idea about the basic concepts and physics behind flight	2,3,6
4	Knowledge about construction and structure of Airplane components	1,4
5	Learnt about different types of engines used in Airplanes & Rocket	5,6

Prerequisites : Engineering Physics

MODULE 1: HISTORICAL EVOLUTION **6**

Historical Evolution of Aircrafts – Before and After Wright Brothers, Biplanes and Monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

MODULE 2: AIRCRAFT CONFIGURATIONS **9**

Classification of Aircrafts – Aerostats & Aerodynes, Aeroplane - Parts of Aeroplane - Classification of Aeroplane (Based on purpose & Mach) - Axis System - Primary & Secondary Control Surfaces , Introduction to Unconventional Configurations.

Conventional control, Powered control, Basic instruments for flying, Typical systems for control Actuation

MODULE 3: INTRODUCTION TO PRINCIPLES OF FLIGHT **12**

Physical properties and structure of the atmosphere, Temperature, pressure and altitude Relationships, Bernoulli's Principle, Coanda Effect, Forces acting on Airplane, Airfoil – nomenclature & types, Generation of lift, Drag, moment, Evolution of lift, drag and moment, Factors governing lift and drag, Manoeuvres.

MODULE 4: INTRODUCTION TO AIRPLANE STRUCTURES **9**

General types of Construction- Geodesic, Monocoque, Semi monocoque, Structure of Wing, Fuselage & Landing Gear, Materials used in aircraft Construction

MODULE 5: INTRODUCTION TO POWER PLANTS **9**

Basic ideas about piston and turbo engines, Use of propeller and jets for Thrust Production. Comparative merits, Principles of operation of rocket,Types of rockets engines and typical applications

TEXT BOOKS

1. Anderson, J.D., *"Introduction to Flight",* McGraw-Hill, 1995.
2. Richard S. Shevell, *" Fundamentals of Flight",* Pearson Education,2nd Edition – 2004
3. Pallet, E.H.J.,*"Aircraft Instruments & Principles",* Pitman & Co 1933

REFERENCE BOOKS

1. Kermode, A.C., *"Flight without Formulae*", McGraw-Hill, 1997.
2. Lalit Gupta and O P Sharma, *"Fundamentals of Flight Vol-I to Vol-IV",* Himalayan Books, 2006
3. Ian Moir, Allan Seabridge, *"Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration"*, John Wiley & Sons, 2011

E BOOKS

1. http://airspot.ru/book/file/73/hull_airplane_flight_mechanics.pdf

2	https://fas.org/irp/doddir/army/fm3-04-203.pdf
3	http://ae.sharif.edu/~iae/Download/Introduction%20to%20flight.pdf
4	http://www-pw.physics.uiowa.edu/~dag/lectures/Flight_Dec12-2003.pdf
TUTORIAL LINK	
1	https://www.educba.com/course/elements-of-aeronautics/
2	https://www.udemy.com/airplane-engineering-from-zero-to-100-for-everyone/
3	https://www.edx.org/course/introduction-to-aeronautical-engineering

COURSE TITLE	**AERO MODELLING LAB (Common to Aeronautical, Aerospace and Avionics)**			**CREDITS**	**1**
COURSE CODE	**AEB4131 / ASB4131**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**0-0-2-2**
CIA	**80%**			**ESE**	**20%**
LEARNING LEVEL	**BTL-3**				

CO	**COURSE OUTCOMES**	**PO**
1	Know wood crafting and the technology of new materials	1,5,6,8
2	Understand aerodynamics, designing, electronics and technology	3, 5, 6
3	Design, fabricate and fly models	2, 3,6,8

Prerequisites : Nil

LIST OF EXPERIMENTS **(30 Hrs)**

1. Introduction to wing plan forms and Aerofoils
2. Module -1

   Introduction to Gliders & its Design calculation.
3. Module -2

   Design & Fabrication of powered & Un-powered Gliders.
4. Module -3

   1) Simulation of RC plane using simulators

   2) Design calculation of RC plane

COURSE TITLE	ENGINEERING IMMERSION LAB			CREDIT	0.5
COURSE CODE	GEA4131	COURSE CATEGORY	BS	L-T-P-S	0-0-2-2
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	Upon successful completion of this course the student should be able to Identify and use of tools, Types of joints used in welding, carpentry and plumbing operations.	1,2,4,6,12
2	Have hands on experience on basic fabrication techniques such as carpentry and plumbing practices.	1,2,4,6,12
3	Have hands on experience on basic fabrication techniques of different types of welding and basic machining practices.	1,2,4,6,12

SLOT X -LIST OF EXPERIMENTS

I. MECHANICAL ENGINEERING WORKSHOP

5. Welding: Arc welding: Butt joints
6. Lap joints.
7. Machining: Facing
8. Turning

II. AUTOMOBILE ENGINEERING

5. Dismantling and Studying of two stroke gasoline engine.
6. Assembling of two stroke gasoline engine.
7. Dismantling and Studying of four stroke gasoline engine
8. Assembling of four stroke gasoline engine.

III. AERONAUTICAL ENGINEERING

5. Study of Flow Pattern around Various Objects.
6. Force measurement on Aircraft Model
7. Determination of Young's Modulus for Aluminum Cantilever Beam
8. Binary Addition & Subtraction using Microprocessor

IV. CIVIL ENGINEERING

5. Plumbing- Basic Pipe Connection using valves, couplings and elbows.
6. Carpentry – Sowing, Planning and making common Joints.
7. Bar Bending
8. Construction of a 50 cm height brick wall without mortar using English Bond.

SLOT Y -LIST OF EXPERIMENTS

V.ELECTRICAL ENGINEERING

5. Study of tools and accessories.
6. Study of cables.
7. Staircase wiring, Tube light and Fan connection.
8. Measurement of energy using single phase energy meter.

VI. ELECTRONICS ENGINEERING

5. Study of Active and Passive Components.
6. Study of Logic Circuits.
7. Making simple circuit using Electronic Components.
8. Measuring of parameters for signal using CRO.

VII. COMPUTER SCIENCE

5. Troubleshooting different parts of the computer peripherals, Monitor, Keyboard & CPU.
6. Installation of various operating systems, their capabilities, Windows, Unix, Linux.
7. Installation of commonly used software like MS Office
8. Assembling digital computer.

VIII. MECHATRONICS ENGINEERING

5. Study of Key Elements of Mechatronics Systems
6. Sensors – Load Cell, Thermocouple
7. Actuators – Linear & Rotary Actuators
8. Interfacing & Measurements – Virtual Instrumentation

REFERENCE BOOKS

1	Jeyapoovan T and Saravanapandian M., Engineering practices lab manual, 4th Edition, Vikas publishing House, New Delhi, 2015.
2	Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of Workshop Technology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
3	Ibrahim Zeid, CAD/CAM Theory and Practice, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2011
4	Robert Quesada, Jeyapoovan T., Computer Numerical Control Machining and Turning Centers, Pearson Education, New Delhi, 2006

METHOD OF ALLOCATION FOR ENGINEERING IMMERSION LAB

SLOT X : MECH, AERO, AUTO, CIVIL EXPERIMENTS

SLOT Y : EEE, ELECTRONICS, CSE, MECHATRONICS EXPERIMENTS

- EVERY CLASS OF
  - GROUP A (AERO, AUTO, MECH, MCT, CHEM, BIO, CIVIL
  - GROUP B (CSE, IT, ECE, EEE, AEROSPACE)

GETS DIVIDED INTO 4 SUB - GROUPS NAMELY a, b, c, d -- EACH CONSISTING OF 15 TO 20 STUDENTS MAX.

- FOR EXAMPLE: **GROUP A STUDENTS WILL OCCUPY SLOT X**
  - WEEK 1 : SLOT X ---
    - ✓ a – MECH; b – AUTO; c – AERO ; d – CIVIL
  - WEEK 2 : SLOT X ---
    - ✓ b – MECH; c – AUTO; d – AERO ; a – CIVIL
- THE ABOVE SCHEDULE WILL BE ON ROTATION EVERY MONTH (ONE CYLCE PER MONTH)
- **GROUP B STUDENTS WILL OCCUPY SLOT Y**
  - WEEK 1 : SLOT Y ---
    - ✓ a – EEE; b – ECE; c – CSE ; d – MCT
  - WEEK 2 : SLOT Y ---
    - ✓ b – EEE; c – ECE; d – CSE ; a – MCT
- THE ABOVE SCHEDULE WILL BE ON ROTATION EVERY MONTH (ONE CYLCE PER MONTH)

COURSE TITLE	ENGINEERING PHYSICS LABORATORY (Common to all engineering branches)			CREDIT	1
COURSE CODE	PHA4131	COURSE CATEGORY	BS	L-T-P-S	0-0-2-0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1.	Ability to analyze material's elastic properties	1,2,3,4,6,12
2.	Ability to determine thermal conductivity of bad conductor	1,2,3,4,6,12
3.	Ability to measure coefficient of viscosity of liquids	1,2,3,4,6,12
4.	Ability to determine wavelength of laser	1,2,3,4,6,12
5.	Ability to describe V-I characteristics of diode	1,2,3,4,6,12

Prerequisites: Knowledge in basic physics practical at higher secondary level.

List of Experiments (Any Five Experiments)

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

TEXT BOOK

1.	P. Mani, engineering Physics Practicals, Dhanam Publications, Chennai, 2005

REFERENCE BOOKS

1.	Glenn V.Lo, Jesus Urrechaga - Aituna, Introductory Physics Laboratory Manual, Part-I, Fall 2005 Edition.
2.	P. Kulkarni, Experiments in Engineering Physics Bachelor of Engineering and Technology, Edition 2015

E BOOK

1	http://www.aurora.ac.in/images/pdf/departments/humanities-and-sciences/engg-phy-lab-manual.pdf

COURSE TITLE	MATERIALS CHEMISTRY LABORATORY (Common to ALL branches of Engineering)			CREDITS	1
COURSE CODE	CYA4131	COURSE CATEGORY	BS	L-T-P-S	0-0-2-0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1.	Students learn to characterize basic properties of refractory ceramics	1,2,3,4,6,7,12
2.	On completion of this course, students learn to prepare resins and composites.	1,2,3,4,6,7,12
3.	Students learn to estimate metal ions present in samples using instrumental techniques.	1,2,3,4,6,7,12
4.	On completion of the course the students learn to develop adsorption isotherm.	1,2,3,4,6,7,12
5.	Students learn to find properties of lubricants and other oil samples.	1,2,3,4,6,7,12

Prerequisites: Knowledge in basic chemistry practical at higher secondary level.

LAB / MINI PROJECT/FIELD WORK

1. Construction of Phenol-Water Phase diagram.
2. Determination of viscosity of polymer using Ostwald Viscometer.
3. Preparation of urea-formaldehyde resin.
4. Determination of porosity of a refractory.
5. Determination of Apparent Density of porous solids.
6. Determination of Viscosity Index of lubricants.
7. Estimation of dye content in the effluent by UV-Visible spectrophotometry.
8. Determination of viscosity of oil using Red-Wood Viscometer.
9. Determination of Copper / iron content in the alloy by colorimetry.
10. Estimation of sodium and potassium ions by Flame Photometry.
11. Verification of Beer-Lambert's law using gold nanoparticles.
12. Determination of adsorption isotherm for acetic acid on activated charcoal.

REFERENCE BOOKS

1.	J. Mendham, R.C. Denney, J.D. Barnes and N.J.K. Thomas, Vogel's Textbook of Quantitative Chemical Analysis, 6th Edition, Pearson Education, 2009
2.	D.P. Shoemaker and C.W. Garland, Experiments in Physical Chemistry, 8th edition, McGraw Hill, London, 2008
3.	S. Sumathi, Laboratory work book for Engineering Chemistry Practical, 2015
4.	Laboratory Manual of Testing Materials, William Kendrick Hatt and Herbert Henry Scofield, Andesite Press, 2017

E BOOKS

1.	http://www.erforum.net/2016/01/engineering-chemistry-by-jain-and-jain-pdf-free-ebook.html

MOOC

1	https://ocw.mit.edu/courses/chemistry/5-111-principles-of-chemical-science-fall-2008/video-lectures/lecture-32/
2	https://www.coursetalk.com/providers/coursera/courses/introduction-to-chemistry-1

SEMESTER – III

COURSE TITLE	PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS (Common For all Department)			CREDITS	4
Course Code	MAA4201	Course Category	BS	L-T-P-S	3-1-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL: 1-4				

CO	COURSE OUTCOMES	PO
1.	Able to formulate and solve some of the physical problems involving partial differential equations	1,2,3,4,5,12
2.	Skilled to classify and solve the Wave and Heat equations	1,2,3,4,5,12
3.	Able to classify and solve two dimensional heat equations.	1,2,3,4,5,12
4.	Able to solve problems related to engineering applications by using Fourier Transform techniques.	1,2,3,4,5,12
5.	Able to understand the discrete transform applied to engineering problems.	1,2,3,4,5,12

Prerequisites : Nil

MODULE 1: PARTIAL DIFFERENTIAL EQUATIONS (9L+3T)

Formation of partial differential equations by elimination of arbitrary constants, arbitrary functions – Solution of standard types of first order partial differential equations – Lagrange's linear equation – Linear partial differential equations of second order with constant coefficients.

Suggested Reading: Partial Differentiation

MODULE 2: ONE DIMENSIONAL WAVE AND HEAT FLOW EQUATION (9L+3T)

Classification of second order linear partial differential equations – Solutions of one dimensional wave equation (without proof) – One dimensional heat flow equation (without proof) and application in string and rod problems.

Suggested Reading: Partial Differential Equations, Half range sine series.

MODULE 3: TWO DIMENSIONAL HEAT FLOW EQUATION (9L+3T)

Steady state solution of two dimensional heat equations and applications in finite plates and infinite plates problems.

Suggested Reading: Partial Differential Equations, Half range sine series.

MODULE 4: FOURIER TRANSFORM (9L+3T)

Fourier Integral Theorem (without proof) – Fourier transform pair – Sine and Cosine transforms – Properties – Transforms of Simple functions – Convolution theorem – Parseval's identity.

Suggested Reading: Basic integration.

MODULE 5: Z-TRANSFORM AND DIFFERENCE EQUATIONS (9L+3T)

Z-Transform – Elementary Properties – Inverse Z-Transform – Convolution theorem – Formation of Difference equations – Solution of difference equations using Z-Transform

Suggested Reading: Basic calculus

LAB/MINI PROJECT/FIELD WORK

Theory only

TEXT BOOKS	
1	P. Sivarama Krishna Das, C. Vijayakumari., “Transforms and partial differential equations”, Pearson Publication, 2016.
2	Grewal. B.S., "Higher Engineering Mathematics", 42nd Edition, Khanna Publishers, Delhi, 2012.
3	Chandrasekaran A, “A Text Book of Transforms and Partial Differential Equations”, Dhanam Publication, 2015
REFRENCE BOOKS	
1.	Bali.N.P and Manish Goyal, "A Textbook of Engineering Mathematics", 7th Edition, Laxmi Publications Pvt Ltd , 2007.
2.	Datta.K.B., "Mathematical Methods of Science and Engineering", Cengage Learning India Pvt Ltd, Delhi, 2013.
3.	Veerarajan. T., "Transforms and Partial Differential Equations", Tata McGraw Hill Education Pvt. Ltd., New Delhi, Second reprint, 2012.
E BOOKS	
1	nptel.ac.in/courses/122107037/
2	nptel.ac.in/courses/122107037/22
MOOC	
1	https://www.mooc-list.com/tags/laplace-transforms
2	https://www.edx.org/course/introduction-differential-equations-bux-math226-1x-1

COURSE TITLE	SOLID MECHANICS (Common to Aeronautical, Aerospace and Avionics)			CREDITS	4
COURSE CODE	AEB4201	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
1	Find the elongation, stress, strain, Elastic constants, Strain energy and thermal stresses for bars.	1,2,3,8,12
2	Calculate reaction forces for various beams. Differentiate between cantilever and simple support beams and to draw shear force and bending moment diagrams for various load cases. Also, find bending stresses and shear stresses for different beams with different cross sections.	1,2,3, 4,8,12
3	Find the deflection of different types of beams using various methods such as Double integration method, McCauley's method, Area moment method and Conjugate beam method.	1,2,3,4,8,12
4	Distinguish between bending & twisting moment. Also to find out shear stresses for solid & hollow shafts and deflection of helical springs.	1,2,3,8,12
5	Understand Hoop stress and longitudinal stress for thin cylinders and spheres to find the failure stresses.	1,4, 8,12

Prerequisites: ENGINEERING MECHANICS

MODULE 1: BASIC AND AXIAL LOADINGS **9**

Stress and Strain, Hooke's Law, Stress-strain relation, 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, Strain energy, Castigliano's theorem, Strain energy of axially loaded bar and deformation using energy method.

MODULE 2: STRESSES IN BEAMS **9**

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, Composite beams.

MODULE 3: DEFLECTION OF BEAMS **9**

Deflection of beams using Double integration method, McCauley's method, Area moment method, Conjugate beam method and Energy method. Principle of superposition, Maxwell reciprocal theorem

MODULE 4: SHAFT AND SPRINGS **9**

Torsion of circular shafts - shear stresses and twist in solid and hollow circular shafts, Torsion of non-circular shafts, Saint Venant's theory, Prandtl's stress function approach, Leaf and helical springs.

MODULE 5: BI-AXIAL STRESSES **9**

Stresses in thin circular cylinder and spherical shell under internal pressure, volumetric Strain. Combined bi-axial loading, Principal Stresses andmaximum Shear Stresses - Analytical and Graphical methods. Various failure theories; Maximum Stress theory, Maximum Strain Theory, Maximum Shear Stress Theory, Distortion energy Theory, Maximum Strain energy theory and Application to Structural problems.

LAB / MINI PROJECT / FIELD WORK	
NA	
TEXT BOOKS	
1	R. K. Bansal, “A Text Book of Strength of Materials”, Sixth Edition, Lakshmi Publications Pvt. Limited, New Delhi, 2012.
2	R.K. Rajput,” Strength of materials”, Seventh Edition ,S. Chand Limited, 2018.
3	W.A Nash and M. Potter, “Strength of Materials", Schaum's Outline Series, McGraw Hill International Edition, Sixth Edition, 2013.
4	S. Timoshenko and D.H. Young "Elements of strength materials Vol. I and Vol. II", T. Van Nostrand Co-Inc Princeton-N.J. 1990.
REFERENCE BOOKS	
1	1.Parviz Ghavami, “Mechanics of Materials: An Introduction to Engineering Technology”, First Edition, Springer International Publishing, 2015.
2	2.Vitor Dias da Silva, " Mechanics and Strength of Materials”, First Edition, Springer-Verlag Berlin Heidelberg, 2006.
3	3.Egor P. Popov., “Engineering mechanics of solids”, Second edition, Pearson Education India, 2015.
4	James M. Gere, “Mechanics of Materials”, Eighth Edition, Brooks/Cole, USA, 2013.
5	J. E Shigley, “Applied Mechanics of Materials”, International Student Edition, McGraw Hill Koyakusha Limited, 2000.
E BOOKS	
1	http://www.springer.com/in/book/9783319061870
2	http://www.springer.com/in/book/9780278000520
MOOC	
1	https://onlinecourses.nptel.ac.in/noc17_ae04
2	http://nptel.ac.in/courses/101104067/

COURSE TITLE	AERO -THERMODYNAMICS (Common to Aeronautical, Aerospace and Avionics)			CREDIT	3
COURSE CODE	AEB4202	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL 3				

CO	COURSE OUTCOMES	PO
1.	Effectively use the basic concepts of thermodynamics and its Ist law of Thermodynamics	1,2,3,8,12
2.	Effectively use the laws of thermodynamics for basic calculations.	1,2,3, 4,8,12
3.	Able to analyse various gas power cycles.	1, 2, 3, 4, 8, 12
4.	Able to calculate the power developed from steam as the working medium.	1, 2, 3, 8, 12
5.	Calculate the cooling load required for human comfort.	1, 4, 8, 12

Prerequisites : Nil

MODULE 1: FIRST LAW OF THERMODYNAMICS 9

Basic Concepts of Thermodynamics, The First Law for closed systems. Work and heat during cyclic and non-cyclic processes. Specific heats, internal energy and enthalpy for ideal gases. The First Law for open systems. The steady flow energy equation. Application to boiler, nozzles, throttles, turbines and heat exchangers.

MODULE 2: SECOND LAW OF THERMODYNAMICS 9

Definition of the heat engine and cycle efficiency. The Carnot heat engine, Reversed heat engines (heat pump and refrigerator) and coefficient of performance. Second law of thermodynamics Statements, reversibility, causes of irreversibility, Carnot cycle, Clausius inequality, Definition of entropy and its use in engineering thermodynamics. Entropy change in isothermal, adiabatic processes, Isentropic processes. Compressors and its classification.

MODULE 3: AIR STANDARD CYCLES 9

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

MODULE 4: STEAM AND VAPOR POWER CYCLE 9

Properties of steam - Carnot cycle for steam and ideal efficiency. Rankine cycle with dry, saturated and super-heated steam. Modified Rankine, Reheat and Regenerative cycles.

MODULE 5: REFRIGERATION AND AIR CONDITIONING 9

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

TEXT BOOKS

Nag, P. K, “Engineering Thermodynamics”, 5th Edition, Tata McGraw Hill, New Delhi, 2013.

Yunus A. Cengel and Michael A. Boles, “Thermodynamics an engineering approach”, seventh edition, Mc Graw Hill Higher education, 2011.

REFERENCES
1. Michael Moran, J., and Howard Shapiro, N., "Fundamentals of Engineering Thermodynamics", 4th Edition, John Wiley & Sons, New York, 2010. 2. Rayner Joel, "Basic Engineering Thermodynamics", 5th Edition, Addison Wesley, New York, 2016. 3. Holman, J. P., "Thermodynamics", 4th Edition Tata McGraw Hill, New Delhi, 2015. 4. Rathakrishnan. E, "Fundamentals of Engineering Thermodynamics", Prentice – Hall, India, 2005.
E-BOOKS
https://docs.google.com/file/d/0B7OQo6ncgyFjZTdUWEItdHRGbHc/edit
https://www.google.co.in/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0ahUKEwjG2q_tuY7aAhVLNo8KHXOEAq4QFggmMAA&url=http%3A%2F%2Fmech.at.ua%2FHolmanICS.pdf&usg=AOvVaw25_sWmrrjfGsmChWTJcF4k
https://books.google.co.in/books?id=GiLYEwSDLqsC&printsec=frontcover#v=onepage&q&f=false
MOOC
https://www.edx.org/course/thermodynamics-iitbombayx-me209-1x-1
https://www.coursera.org/learn/thermodynamics-intro
COURSEWARE LINK
https://onlinecourses.nptel.ac.in/noc18_ch03/preview
TUTORIAL LINK
https://onlinecourses.nptel.ac.in/noc18_ch03/preview

COURSE TITLE	FLUID MECHANICS AND MACHINERY (Common to Aeronautical, Aerospace and Avionics)			CREDIT	3
COURSE CODE	AEB4203	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL 3				

CO	COURSE OUTCOMES The student will be able to	PO
1	Distinguish different types of fluid, properties and their behaviour under various conditions	1,2,3
2	Apply scientific method strategies to fluid mechanics: analyse qualitatively and quantitatively the problem situation, propose hypotheses and solutions	1,2,3, 4
3	Formulate and analyse problems related to calculation of forces in fluid structure interaction.	1,2,3, 4
4	Gain knowledge on working Principles of Various hydraulic turbines and solve their basic problems	1,2,3,4
5	Acquire knowledge on working Principles of centrifugal & reciprocating pumps and solve their basic problems	1,2,4

Prerequisites : Physics and Engineering Mathematics

MODULE 1: BASIC CONCEPTS AND PROPERTIES **9**

Fluid – definition, distinction between solid and fluid - Units and dimensions - Properties of fluids - viscosity, relationship between stress and strain rate for Newtonian fluids, incompressible and compressible flows, Hydrostatics: Buoyancy, forces on submerged bodies. Pressure measurements by manometers and pressure gauges.

MODULE 2: FLIUD KINEMATICS AND FLUID DYNAMICS **9**

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 - Eulerian and Lagrangian description of fluids motion, concept of local and convective accelerations, Flow measurements: Basic ideas of flow measurement using venturimeter, pitot-static tube and orifice plate.

MODULE 3: DIMENSIONAL ANALYSIS AND FLUID FLOW **9**

Dimensional analysis: Rayleigh method and Buckingham's π theorem- applications- Concept of geometric, kinematic and dynamic similarity, Non-dimensional parameters and their physical significance

Fluid Flow: Fully developed pipe flow, friction factor and Darcy-Weisbach relation (flow through pipes, head losses in pipes). Boundary layer flows, boundary layer thickness, and boundary layer separation.

MODULE 4: HYDRAULIC TURBINES **9**

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.

Turbomachinery: Pelton wheel, Francis and Kaplan turbines - impulse and reaction principles, velocity diagram and performance

MODULE 5: HYDRAULIC PUMPS **12**

Pumps: Definition and classifications - Centrifugal pump: Classifications, working principles, velocity triangles, specific speed, efficiency and performance curves. Reciprocating pump: classification,

working principles, indicator diagram, performance curves - cavitation in pumps, working principles of gear and vane pumps(descriptive only)	
TEXT BOOKS	
1.White, Frank M. Fluid Mechanics. 7th ed. McGraw-Hill, 2010. ISBN: 9780077422417 2.S K Som, G Biswas,Suman Chakraborty, Introduction to Fluid Mechanics and Fluid machines, Tata McGraw Hill Edition, 2017 3.A Textbook of Fluid Mechanics and Hydraulic Machines by R.K. Bansal , Lakshmi Publications Pvt. Limited, New Delhi, 2010.	
REFERENCES	
1	Kumar, K.L., "*Engineering Fluid Mechanics"*, 8th Edition, S. Chand, New Delhi, 2008..
2	Munson, Bruce R., Young, Donald F., Okiishi, Theodore H., Huebsch, Wade W. "*Fundamentals ofFluid Mechanics"*, Seventh Edition, John Wiley & Sons, Inc. 2016
E-BOOKS	
1	http://www.engineering108.com/pages/Mechanical_Engineering/FM/Fluid_Mechanics_ebooks-free-download.html
2	http://royalmechanicalbuzz.blogspot.in/2014/11/textbook-of-fluid-mechanics-by-r-k.html
MOOC	
1	https://ecourses.ou.edu/cgi-bin/ebook.cgi?topic=me
2	https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-01-unified-engineering-i-ii-iii-iv-fall-2005-spring-2006/fluid-mechanics/
COURSEWARE LINK	
1	https://nptel.ac.in/courses/112105171/
TUTORIAL LINK	
1	https://sites.google.com/a/hindustanuniv.ac.in

COURSE TITLE	PROFESSIONAL ETHICS AND LIFE SKILLS			CREDITS	2
COURSE CODE	GEA4216	COURSE CATEGORY	BS	L-T-P-S	2-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL - 3				

CO	COURSE OUTCOMES	PO
1	An understanding of business ethics, levels, myths, use and train oneself to be ethical.	6,8,12
2	Knowledge on Ethical principles, reasoning, roles & responsibilities.	6,8,12
3	An understanding of stake holder theory, Individual and corporate responsibilities towards stake holders.	6,8,12
4	Understanding on Corporate responsibilities towards Product Safety & Reliability and environment friendly approach.	6,8,12
5	Understanding between the Employee & Corporate on responsibilities on aspects of contracts, equal opportunity , Affirmative action, sexual harassment etc.,	6,8,12

Prerequisites :Nil

MODULE 1 - HUMAN VALUES (6L)

Definition of ethics-Morals values and ethics – integrity-Work ethics- Service learning-Civic virtue-Respect for others-Caring-Sharing-Honesty-Courage-Valuing time-Cooperation-Commitment-Empathy-Self-confidence-Character-Spirituality-Introduction to Yoga and meditation for professional excellence and stress management.

Suggested Reading: Case study of Discovery failure

MODULE 2 - ENGINEERING ETHICS (6L)

Senses of 'Engineering Ethics' – Variety of moral issues – 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.

Suggested Reading: Study the Bhopal gas tragedy

MODULE 3- SAFETY, RESPONSIBILITIES AND RIGHTS (6L)

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination.

Suggested Reading: Chernobyl explosion, Nuclear and thermal power plant issues

MODULE 4 - LIFE SKILLS (6L)

Definition, Relevance, Types of values, changing concepts of values-aims and values of value education- basic etiquette-morals and values in life-dealing with people. Personal values – Self – Strengths (self-confidence, self-assessment, self-reliance, self-discipline, determination, self-restraint, contentment, humility, sympathy and compassion, gratitude, forgiveness) Weaknesses

Suggested Reading: Influences - Peer pressure, familial and societal expectations, media

MODULE 5 - SOCIETIES IN PROGRESS (6L)	
Definition of society; Units of society; Communities – ancient and modern – Agents of change – Sense of survival, security, desire for comfort and ease sense of belonging, social consciousness and responsibility **Suggested Reading**: Personal value and professional value of Engineers on societies perception	
LAB / MINI PROJECT / FIELD WORK	
NA	
TEXT BOOKS	
1	Subramanian R., Professional ethics, Oxford University press
REFERENCE BOOKS	
1	Megan J. Murphy (Editor), Lorna Hecker (Editor), Ethics and Professional Issues in Couple and Family Therapy
2	Andrew Belsey (Editor), Ruth Chadwick (Editor), Ethical Issues in Journalism and the Media (Professional Ethics)
3	Warwick Fox (Editor), Ethics and the Built Environment (Professional Ethics)
4	RuchikaNath, Value Education, APH Publishing Corporation, New Delhi, 2012
5	Manoharan P.K., Education and Personality Development, APH Publishing Corporation, New Delhi, 2012
E BOOKS	
1	https://www.bkconnection.com/static/Business_Ethics_EXCERPT.pdf
2	https://bookboon.com/en/business-ethics-ebook
MOOC	
1	https://www.mooc-list.com/course/global-impact-business-ethics-coursera

COURSE TITLE	FLUID MECHANICS AND MACHINERY LAB (Common to Aeronautical, Aerospace and Avionics)			CREDIT	1
COURSE CODE	AEB4231	COURSE CATEGORY	PC	L-T-P-S	0-0-3-0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL 3				

CO	COURSE OUTCOMES The students should be able to	PO
1	Determine the coefficient of discharge of orifice meter and venturimeter.	1, 2, 3, 8, 9,12,
2	Determine the friction factor of given set of pipes when there is change in pressure& Calculate the rate of flow using Rotameter	1, 2, 3, 4, 8, 9,12
3	Conduct experiments and draw the characteristics curves of Francis turbine and Kaplan turbine and also can find the efficiency of the turbine.	1, 2, 3, 4, 8, 9,12
4	Conduct experiment and draw the characteristics curves of Pelton wheel.	1, 2, 3, 8,9, 12
5	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.	1, 4, 8, 9,12

Prerequisites : Nil

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 EQUIPMENT

Sl. No	Details of Equipment	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

COURSE TITLE	SOLID MECHANICS LABORATORY (Common to Aeronautical, Aerospace and Avionics)			CREDIT	1
COURSE CODE	AEB4232	COURSE CATEGORY	PC	L-T-P-S	0-0-3-0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL 3				

CO	COURSE OUTCOMES	PO
1	Determine the hardness of the material	1,2,3,8,9,12
2	Determine the yield load, ultimate load and Young's modulus of the mild steel rod.	1,2,3, 4,8,9,12
3	Determine the modulus of rigidity of the mild steel rod.	1,2,3,8,9,12
4	Determine the impact energy stored in the material.	1,2,3, 5,8,9,12
5	Determine the deflection and stiffness of the spring.	1,2,3,7,9,12
6	Determine the failure strength under compression load.	1,2,3, 5,8,9,12
7	Determine the young's modulus of aluminium using Mechanical and Electrical extensometers.	1,2,3,8,9,12
8	Verify the Maxwell reciprocal theorem and Principle of Superposition.	1,2,3,9,12

Prerequisites : Nil

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. Testing of springs
6. Block Compression Test
7. Determination of young's modulus of Aluminium using Mechanical extensometers
8. Determination of young's modulus of Aluminium using Electrical extensometers
9. Maxwell reciprocal theorem and Principle of Superposition
10. Deflection of beams

COURSE TITLE	THERMODYNAMICS LAB (Common to Aeronautical, Aerospace and Avionics)			CREDIT	1
COURSE CODE	AEB4233	COURSE CATEGORY	PC	L-T-P-S	0-0-3-0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL 3				

CO	COURSE OUTCOMES The students will be able to	POs
1	understand the 4 stroke engine cycle and performance	1,2,3,8,9,12
2	clearly understand the port timing mechanism and valve timing mechanism of stroke engine	1,2,3, 4,8,9,12
3	get a clear idea about effectiveness of a parallel flow heat exchanger	1,2,3,8,9,12
4	get a clear idea about effectiveness of a counter flow heat exchanger	1,2,3, 5,8,9,12
5	understand the viscosity effects in a given fluid flow	1,2,3,7,9,12
6	carry COP test on a vapour compression refrigeration test rig	1,2,3, 5,8,9,12
7	carry COP test on a vapour compression A/C test rig	1,2,3,8,9,12
8	can clearly understand the performance of a Gas Turbine Engine	1,2,3,8,9,12

Prerequisites : Nil

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 Equipment	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
1.	4 stroke twin cylinder diesel engine	1	1

SEMESTER IV

COURSE TITLE	NUMERICAL METHODS (Department of Aeronautical, Aerospace, Bio Tech, Chemical, EEE,EIE)			CREDITS	4
COURSE CODE	MAA4217	COURSE CATEGORY	BS	L-T-P-S	3-1-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL 4				

CO	COURSE OUTCOMES	PO
1.	Able to obtain successively better approximation to the roots of a real-valued function	1,3 5,6
2.	Able to familiarise the process of approximating a given function	1,3, 6
3.	Able to understand numerical differentiation and integration	1, 5,6
4.	Able to solve initial value problems	1,3 5,6
5.	Able to solve boundary value problems	1,3, 6

Prerequisites : Nil

MODULE 1:SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS (10L+2P)

Solution of algebraic and transcendental equations: Method of false position – Newton's method – Fixed point iteration method – Solution of linear system of Gaussian elimination and Gauss-Jordan methods – Iterative methods: Gauss Jacobi and Gauss – Seidel methods- Inverse of a matrix by Gauss-Jordan method. Eigenvalue of a matrix by power method.

Suggested Reading: System of equations

MODULE 2:INTERPOLATION AND APPROXIMATION (10L+2P)

Lagrangian Polynomials – Divided difference – Newton forward and backward difference method – Cubic Spline interpolation.

Suggested Reading: Relations and functions

MODULE 3:NUMERICAL DIFFERENTIATION AND INTEGRATION (10L+2P)

Derivatives from difference table – Divided difference and finite difference – Numerical integration by Trapezoidal and Simpson's 1/3 and 3/8 rules – Romberg's method – Two and three point Gaussian quadrature formula – Double integrals using trapezoidal and Simpson's rules.

Suggested Reading: Basic differentiation and integration

MODULE 4: NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS (10L+2P)

Single step Methods: Taylor Series method –Euler and Modified Euler method – Fourth order Runge-Kutta method for solving first and second order differential equations - Multistep method: Milne's and Adam's predictor and corrector methods.

Suggested Reading: Ordinary Differential Equations

MODULE 5:BOUNDARY VALUE PROBLEMS (10L+2P)	
Finite difference solution for the second order ordinary differential equations. Finite difference solution for one dimensional heat equation by implicit and explicit methods – one dimensional wave equation and two dimensional Laplace and Poisson equations. Suggested Reading: Partial Differential Equations	
LAB/MINI PROJECT/FIELD WORK	
Theory with practical classes	
TEXT BOOKS	
1	Numerical Methods 3rd Edition by K. Gunavathi, P. Kandasamy, K. Thilagavathy, 2006
2	Gerald, C.F, and Wheatley, P.O, “Applied Numerical Analysis”, Sixth Edition, Pearson Education Asia, New Delhi, 2002.
3	Grewal. B.S., and Grewal. J.S., " Numerical methods in Engineering and Science", Khanna Publishers, New Delhi, 9th Edition, 2007.
REFERENCE BOOKS	
1.	Chapra. S.C., and Canale. R.P, "Numerical Methods for Engineers", 5th Edition, Tata McGraw Hill, New Delhi, 2007
2.	Gerald. C.F., and Wheatley. P.O. "Applied Numerical Analysis" Pearson Education, Asia, New Delhi, 2006.
3.	Jaankiusalaas, Numerical methods with engineering with Python 3, January 2013 Edition, Cambridge Press
E BOOKS	
http://nptel.ac.in/courses/112106061/Module_2/Lecture_2.2.pdf http://www.nptel.ac.in/courses/122104018/node109.html http://nptel.ac.in/courses/122107036/35	
MOOC	
https://www.mooc-list.com/course/numerical-methods-engineers-saylororg	

COURSE TITLE	AIRCRAFT STRUCTURAL MECHANICS			CREDITS	4
COURSE CODE	AEB4216	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES At the end of the course , the students should be able to	PO
1	Analyse the truss structure and find forces acting in the individual members deflections of the truss with the nature using different methods.	1,2,8
2	Calculate the reaction forces for indeterminate beams. Should be able to draw shear force and bending moment diagrams for indeterminate beams using different methods.	1,2,3,4,8
3	Calculate the bending stresses in unsymmetrical sections using different methods.	1,2,3,4,8
4	Calculate crippling load of columns and beam columns with various end conditions using Euler's method and Rankine's formula.	1,2,8
5	Analyse the buckling and crippling characteristics of rectangular shear panels.	1,2,3,4,8

Prerequisites : SOLID MECHANICS

MODULE 1: STATICALLY DETERMINATE STRUCTURES **12 (9L + 3T) + 6P**

Statically determinate and indeterminate systems, analysis of plane truss; method of joints, method of sections, analysis of space truss and plane frames, Principle of virtual work, Deflection of truss, frame and rings using unit load method

MODULE 2: STATICALLY INDETERMINATE STRUCTURES **12 (9L + 3T) +6P**

Shear force and bending moment of fixed-fixed beam, Propped cantilever beam, Continuous beam, Clapeyron's Three Moment Equation, Moment Distribution Method. Deflection of indeterminate beams using energy method and unit load method

MODULE 3: UNSYMMETRICAL BENDING **12 (9L + 3T)+6P**

Bending stresses in beams of unsymmetrical sections, Bending of symmetric sections with Skew loads, Principal axis method, Neutral axis method, Generalized K method

MODULE 4: BUCKLING OF COLUMNS **12 (9L + 3T)+6P**

Columns with various end conditions, Euler's Column curve, inelastic buckling, Rankine's formula, Column with initial curvature, Eccentric loading, South well plot, Beam column

MODULE 5: BUCKLING AND CRIPPLING OF PANELS **12 (9L + 3T)+6P**

Bending of thin plates, 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 sheet width, inter rivet and sheet wrinkling failures

TEXT BOOKS

1. T.M.G. Megson, "Aircraft Structures for Engineering Students", Fifth edition, Butterworth-Heinemann, 2012.
2. D.J. Peery, "Aircraft Structures", Dover Publications Inc., 2011.
3. E.H. Bruhn. 'Analysis and Design of Flight Vehicles Structures', Tri-state off- set company, USA, 1985.
4. 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	B.K. Donaldson, "Analysis of Aircraft Structures - An Introduction", Second edition, Cambridge University Press, 2012.
2	Howard D Curtis, 'Fundamentals of Aircraft Structural Analysis', WCB- McGraw Hill, 1997.
3	R.M. Rivello, "Theory and Analysis of Flight Structures", McGraw Hill, 1993.
E-BOOKS	
1	http://www.freeengineeringbooks.com/AeroSpace/Aircraft-Structures-Books.php
2	http://libguides.hcc.hawaii.edu/aero
3	http://www.jdrr.yolasite.com/resources/Aeronautical_Engineering/BOOKS/Aircraft%20Structures%20by%20Megson%20-%20Book.pdf
MOOC	
1	http://nptel.ac.in/courses/112107147/
2	https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-20-structural-mechanics-fall-002/index.html.
3	http://www.colorado.edu/engineering/CAS/courses.d/Structures.d/Home.html
COURSEWARE LINK	
https://sites.google.com/a/hindustanuniv.ac.in/sas-ramajeyathilagam-solid_mechanics/academics/btech/aircraft-structures-i	

COURSE TITLE	AIRCRAFT PROPULSION (Common to Aeronautical and Avionics)			CREDITS	4
COURSE CODE	AEB4217	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-III				

CO	COURSE OUTCOMES At the end of this course students should be able to	PO
1	Understand the details of gas turbine engine components and physical processes involved in the operation of gas turbine engines.	1,2,8,12
2	Perform integration of an engine inlet and nozzle as well as to understand the methods to size and design the components	1,2,3,4,8,12
3	Understand the principal design parameters and constraints that set the performance of combustion chamber	1,2,3,4,8,12
4	Describe the energy exchange processes that underlie the working of compressor and to use velocity triangles to estimate the performance of a compressors	1,2,8,12
5	Describe the energy exchange processes that underlie the workings of turbine and to be able to use velocity triangles with the Euler Turbine Equation to estimate the performance of a turbine stage	1,2,3,4,8,12

Prerequisites: Aero Thermodynamics

MODULE 1: FUNDAMENTALS OF GAS TURBINE ENGINES **12 (9L + 3T)**

Illustration of working of gas turbine engine - Thrust equation - Factors affecting thrust - Effect of pressure, velocity and temperature changes of air entering compressor – Methods of thrust augmentation - performance characteristics.

MODULE 2: INLETS AND NOZZLESFORJETENGINES **12 (9L + 3T)**

Internal flow and Stall in subsonic inlets- Diffuser Performance – Supersonic inlets-Starting problem on supersonic inlets-Shock swallowing by area variation-Modes of inlet operation.- Isentropic flow through nozzle – Flow through convergent nozzle & C-D nozzle – thrust reversal – thrust vectoring.

MODULE 3: COMBUSTION CHAMBERS **11 (9L + 2T)**

Classification of combustion chambers-Important factors affecting combustion chamber design-Combustion process-Combustion chamber performance-Flame tube cooling-Flame stabilization.

MODULE 4: COMPRESSORS **12 (9L + 3T)**

Types of compressors, Centrifugal compressor – working principle – Velocity triangle – work done. Axial compressor – working principle – Velocity triangle - Work done, Centrifugal and Axial compressor performance characteristics.

MODULE 5: TURBINES **13 (10L + 3T)**

Principle of operation of axial flow turbines, Work done and pressure rise, Velocity diagrams, degree of reaction, Performance characteristics of axial flow turbine, turbine blade cooling methods, basic blade profile design considerations, matching of compressor and turbine.

TEXT BOOKS

Cohen,H.Rogers,G.F.C.andSaravanamuttoo,H.I.H."GasTurbineTheory",Longman,2008

REFERENCES

1	Hill,P.G.&Peterson,C.R."Mechanics&ThermodynamicsofPropulsion"Addison-WesleyLongman INC, 2014
2	V Ganesan, “Gas Turbines”,McGraw-Hill Education, 2010

3	Mathur,M.L and Sharma,R.P, "Gas Turbine Jet and Rocket Propulsion", Standard Publishers &Distributors,Delhi,2014
MOOC	
1	http://nptel.ac.in/courses/101101001/
2	http://nptel.ac.in/courses/101101002/
3	http://nptel.ac.in/courses/101104019/
4	http://nptel.ac.in/courses/101106033/

COURSE TITLE	**AIRCRAFT SYSTEMS AND INSTRUMENTATION (Common to Aeronautical and Avionics)**			**CREDITS**	**3**
COURSE CODE	**AEB4219**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-1**
CIA	**50%**			**ESE**	**50%**
LEARNING LEVEL	**BTL-3**				

CO	**COURSE OUTCOMES At the end of this course, students will be able to**	**PO**
1	Understand the concepts of aircraft mechanical and electrical control system.	1,2,5,6
2	Apply the working principle hydraulic system for a modern aircraft and explain its function in detail	1,2,3,5,6
3	Understand the working piston & gas turbine engines and the purpose of each system	1,2,3,6
4	Understand the working of air-conditioning system & Fire protection system.	1,4,5,6
5	Remember the working principle of aircraft instruments and engine instruments in detail.	2,3,5,6

Prerequisites :Principles of flight

MODULE 1: AIRPLANE CONTROL SYSTEMS **9L**

Conventional Systems - Power assisted and fully powered flight controls - Power actuated systems – Engine control systems - Push pull rod system, flexible push pull rod system - Digital fly by wire systems

MODULE 2: AIRCRAFT SYSTEMS **9L**

Hydraulic systems - Study of typical workable system - components - Hydraulic system controllers - Modes of operation - Pneumatic systems - Advantages - Working principles - Typical Air pressure system – Brake system - Typical Pneumatic power system - Components, Landing Gear systems - Classification – Shock absorbers - Retractive mechanism.

MODULE 3: ENGINE SYSTEMS **9L**

Fuel systems for Piston and jet engines, - Components of multi engines. lubricating systems for piston and jet engines - Starting and Ignition systems - Typical examples for piston and jet engines.

MODULE 4: AUXILLIARY SYSTEM **6L**

Air conditioning-Pressurization systems- Oxygen systems - Fire protection systems, De-icing and anti-icing systems.

MODULE 5: AIRCRAFT INSTRUMENTS **12L**

Flight Instruments and Navigation Instruments – Gyroscope - Accelerometers, Air speed Indicators – TAS, EAS- Mach Meters - Altimeters - Principles and operation - Study of various types of engine instruments - Tachometers - Temperature gauges - Pressure gauges - Operation and Principles- Communication and Navigation Systems Instrument landing systems.

TEXT BOOKS	
1	David A Lambardo*., "Aircraft Systems*", Tata McGraw-Hill, second edition 2009.
2	S. Nagabhushana **,"***Aircraft Instrumentation and Systems"* I K International Publishing House Pvt .Ltd 2010
REFERENCES	
1	Ian Moir, Allan Seabridge "Aircraft Systems: Mechanical, Electrical, and Avionics Subsystems Integration "third edition,2008 John Wiley And Sons,Ltd.
2	Pallet, E.H.J., *"Aircraft Instruments & Principles and applications",* second edition copyright 2009 by arrangement with Pearson Education Ltd, United Kingdom.
E-BOOKS	
1	https://www.ebooks.com/2655150/aircraft-systems/binns-chris/
MOOC	
1	https://nptel.ac.in/courses/101104071/
COURSEWARE LINK	
https://sites.google.com/a/hindustanuniv.ac.in/gowrishankar/asi	

COURSE TITLE	LOW SPEED AERODYNAMICS (Integrated with Lab) (Common to Aeronautical and Avionics)			CREDITS	4
COURSE CODE	AEB4218	COURSE CATEGORY	PC	L-T-P-S	3-0-2-1
CIA	60%			ESE	40%
LEARNING LEVEL	BTL-3				

Aim of The Course

To provide student with a fundamental knowledge and understanding of Incompressible low speed aerodynamics by learning in depth about the inviscid, incompressible, Irrational aerodynamics and Boundary layer theory.

CO	COURSE OUTCOMES	PO
1.	Understand the three basic fundamental equations in aerodynamics	1,2,3 5,6,12
2.	understand the Study of two dimensional flows in aerodynamics (elementary flows) and their combinations	1,2,3, 6, 12
3.	To understand Joukowski transformation and its application to fluid flow problems, Kutta condition, Blasius theorem(Conformal transformation)	1, 2,5,6,12
4.	Understand airfoil and wing theory(Infinite vs Finite wing theory)	1, 2,3 5,6,12
5.	Understand the real time viscous flow and Boundary Layer behaviour	1,2,3, 6 ,12

Prerequisites : Fluid Mechanics And Machinery

MODULE 1: REVIEW OF BASIC FLUID MECHANICS **12 (9L + 3T)**

Continuity, momentum and energy equations. Aerodynamic forces and Moments

Lab: 1.Calibration of subsonic wind tunnel.

MODULE 2: TWO DIMENSIONAL FLOWS **12 (9L + 3T)**

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 fluid flows. KuttaJoukowski's theorem. D' Alembert Paradox, Magnus effects.

Lab:

1. Pressure distribution over smooth and rough cylinder.
2. Pressure distribution over symmetric airfoil.

MODULE 3: CONFORMAL TRANSFORMATION **12 (9L + 3T)**

Joukowski transformation and its application to fluid flow problems.

MODULE 4:AIRFOIL AND WING THEORY **12 (9L + 3T)**

Airfoils Nomenclature and NACA series,Airfoil Characteristics, Vortex sheet, Kelvin Circulation theoremThin aerofoil theory and its applications. Introduction to Finite wing, Downwash and Induced Drag, Biot -Savart law and Helmhotz's theorems, Horse shoe vortex ,Prandtl's Classical Lifting line theory and its limitations

Lab:

1. Pressure distribution over cambered airfoil& thin airfoils
2. Force measurement using wind tunnel balance.
3. Supersonic wind tunnel calibration and flow visualization with Schlieren system.

MODULE 5:VISCOUS FLOW **12 (9L + 3T)**

Newton's law of viscosity, Boundary Layer, displacement, Momentum and Energy thickness, Flow Separation, Methods to delay Flow SeparationFlow over a flat plate, Blasius solution, Navier-Stokes equation,

Lab:

1. Flow over a flat plate at different angles of incidence

2. Flow visualization studies in low speed flow over cylinders **3.** Flow visualization studies in low speed flow over airfoil with different angle of incidence
REFERENCES
1. L J Clancy,"*Aerodynamics"* Paperback 2006 2. Frank M White,"*Fluid Mechanics in S.I Units"* Paperback 2017
E-BOOKS
1. http://soaneemrana.org/onewebmedia/Aerodynamics---Houghton&Carpenter.pdf
2. http://www.engbrasil.eng.br/artigos/art19.pdf
MOOC
1. https://www.mooc-list.com/course/16101x-introduction-aerodynamics-edx 2. http://nptel.ac.in/syllabus/101105059/ 3. http://nptel.ac.in/courses/112105171/1 4. http://nptel.ac.in/courses/112104118/
COURSEWARE LINK
https://sites.google.com/a/hindustanuniv.ac.in/dilip-a-shah-aerodynamics/

LIST OF EQUIPMENT

Sl. No.	Items	Quantity	Experiment No.
1.	Wind Tunnel test section size around300 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 with20 – 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 Probes	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	1 No.	9,10
15.	Schlieren System	1 No.	9,10

COURSE TITLE	AIRCRAFT SYSTEMS LAB (Common to Aeronautical and Avionics)			CREDIT	1
COURSE CODE	AEB4241	COURSE CATEGORY	PC	L-T-P-S	0-0-3-0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	Have hands on experience of the aircraft jacking up without any damage to men equipment.	1,3,4,6
2	Carry out aircraft levelling as per procedure.	1,3,4,6
3	Have hands on experience on the various checks to be carried out to ensure the alignment of control surfaces	1,2,3,4,6
4	Carryout aircraft symmetry check, as per procedure	1,3,4,6
5	Have hands on experience of the flow test and pressure test on hydraulic hoses.	1,3,4,6
6	Have hands on experience of Functional Test" to adjust operating pressure of oleo struts	1,3,4,6
7	Have hands on experience of Bleeding and Assembly / disassembly of disc wheel brake units.	1,3,4,6
8	Understanding of Maintenance and rectification of snags in hydraulic systems.	1,2,3,4,5,6,7

LIST OF EXPERIMENTS

1. Aircraft "Jacking Up" procedure.
2. Aircraft "Levelling" procedure.
3. Control System "Rigging check" procedure.
4. Aircraft "Symmetry Check" procedure.
5. “Flow test" to assess of filter element clogging.
6. “Pressure Test" To assess the Leakage of hydraulic hoses.
7. “Functional Test" to adjust operating pressure of oleo struts
8. "Brake Torque Load Test/bleeding" on wheel brake units.
9. Assembly/disassembly of multi disc wheel brake units.
10. Maintenance and rectification of snags in hydraulic systems.

TOTAL HOURS : 45

REFERENCES

1. AC 65-15A - Airframe &Powerplant Mechanics – Airframe hand book
2. AMT Airframe Handbook Volume 1 (full version) (FAA-H-8083-31) *Aircraft Maintenance* and Repair, Seventh Edition, by Michael J Kroes, William A Watkins, Frank Delp, Ronald Sterkenburg

E-SOURCE

1. https://onlinecourses.nptel.ac.in/noc18_ae03/preview
2. https://nptel.ac.in/courses/101104071/

COURSE TITLE	COMPUTER AIDED MODELLING LAB (Common to Aeronautical, Aerospace and Avionics)			CREDIT	1
COURSE CODE	AEB4242	COURSE CATEGORY	PC	L-T-P-S	0-0-3-1
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-III				

CO	COURSE OUTCOMES	PO
1	Understand the basic tools and commands of Solid works	1,2,12
2	Model Aircraft Structural Members	1,3,4,6
3	Design &modelling of typical wing surface using Aerofoil co-ordinates.	1,2,3,4,6
4	Layout of typical fuselage structure	1,3,4,6
5	Model a typical aircraft wing.	1,3,4,6
6	Model a typical fuselage structure	1,3,4,6
7	Model a typical landing gear	1,3,4,6
8	Draft a typical Landing Gear	1,2,3,4,5,6,7

Prerequisites : Nil

LIST OF EXPERIMENTS

1. Introduction to Solid works
2. Modelling of Aircraft Structural Members.
3. Modelling of Wing Surface using Aerofoil coordinates (Global System).
4. Modelling of Aircraft Wing with Structural Members.
5. Modelling of Turbojet Engine (Two Stage Axial Flow Compressor, Annular Combustion Chamber and Single Stage Turbine).
6. Modelling and Assembly of Aircraft Landing Gear.
7. Drafting of Aircraft Landing Gear.

LIST OF EQUIPMENT

S.No	Equipment	Quantity	Experiments No.
1	Computer and modelling software	i5- IV gen (8 GB RAM) PC's, - 40 Nos. License of Software(Auto CAD, Solid Works) – 40 Nos.	1 - 8

SEMESTER V

COURSE TITLE	OPTIMIZATION TECHNIQUES (EXCEPT CSE AND MECHATRONICS)			CREDITS	4
COURSE CODE	MAA4301	COURSE CATEGORY	BS	L-T-P-S	3-1-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL :1-4				

CO	COURSE OUTCOMES	PO
1.	Able to formulate engineering problems as mathematical optimization problems.	1,2,3,4,5,12
2.	Skilled to apply the concept of linear and nonlinear programming problem to the engineering problem	1,2,3,4,5,12
3.	Competent to apply the concept of integer programming problem to the engineering problem	1,2,3,4,5,12
4.	Proficient to recognize the solution for assignment problem and transportation problem for optimal solution.	1,2,3,4,5,12
5.	Able to understand the designs of networks	1,2,3,4,5,12

Prerequisites : Nil

MODULE 1: INTRODUCTION TO OPTIMIZATION (9L+3T)

Introduction to operations research – objective – scope of OR – Limitations of OR – Introduction and formulation of linear programming – Solving LPP using Graphical method.

Suggested Reading: Basics of inequalities

MODULE 2: LINEAR PROGRAMMMING PROBLEM (9L+3T)

Solving LPP using simplex method – Big-M method – Two phase method – conversion of primal to dual.

Suggested Reading: System of equations

MODULE 3: INTEGER PROGRAMMING (9L+3T)

Integer programming – Cutting plane method – Gomory's Mixed integer method – Branch and Bound method

Suggested Reading: System of equations

MODULE 4: ASSIGNMENT AND TRANSPORTATION PROBLEM (9L+3T)

Hungarian Method – Maximization and unbalanced assignment problem – Basic feasible solution of transportation problem – Modi method – Degeneracy – Unbalanced Transportation problem.

Suggested Reading: Arithmetic Calculation

MODULE 5: PERT AND CPM (9L+3T)

Network diagram – Representation – Labeling – CPM – PERT probabilities of CPM – PERT probabilities of project duration.

Suggested Reading: Basics of graphs

TEXT BOOKS	
1	Chandrasekaran A, "A Text book of Operation Research", Dhanam Publications, Chennai, 2017
2	V. Sundaresan, K. S. Ganapathy Subramanian, K. Ganesan, "Resource Management Techniques", A. R. Publications, 2004
3	S. D. Sharma, "Operation Research", Kedarnath Ramnath & Co, 2002
REFERENCE BOOKS	
1	Hamdy A. Taha, "Operations Research: An Introduction (9th Edition)", Prentice Hall, 2010
2	D S Hira & Prem Kumar Gupta**, "**Introduction to Operations Research**",** S. Chand Publishing, 2012
E BOOKS	
1	http://nptel.ac.in/courses/112106134/1
2	https://onlinecourses.nptel.ac.in/noc17_mg10/preview
MOOC	
1.	https://www.edx.org/course/operations-management-iimbx-om101-1x

COURSE TITLE	COMPOSITE MATERIALS AND STRUCTURES			CREDIT	3
COURSE CODE	AEB4333	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL :1-4				

CO	Course Outcomes The students will be able to	PO
1	identify and differentiate amongst various types of composite materials and their constituents.	1,3,5,6,7
2	analyse the composite materials using micromechanics and macro mechanics approach.	1,2,3,6,7
3	analyse composite laminates using Classical Lamination theory.	1,2,4,5,6,7
4	understand the basic design concepts of sandwich construction and Materials used for sandwich construction ,Failure modes of sandwich panels.	1,3,5,6,7
5	know various fabrication processes of composite materials. Manufacturing techniques of fibres - Types of resins and properties and applications	1,3,6,7

Prerequisites : Aircraft Materials & Solid Mechanics

MODULE 1: STRESS AND STRAIN RELATION	9
Introduction, Classification and Application to composite materials Generalised Hooke's Law - Elastic constants for anisotropic, orthotropic and isotropic materials.	
MODULE 2: METHOD OF ANALYSIS	**9**
Micro mechanics - Mechanics of materials approach, elasticity approach to determine material properties - Macro Mechanics - Stress-strain relations with respect to natural axis, arbitrary axis.	
MODULE 3: LAMINATE PLATES	**9**
Governing differential equation for a general laminate, Stacking sequences in laminate - Failure criteria for composites.	

MODULE 4: SANDWICH STRUCTURES	9
Basic design concepts of sandwich construction - Failure modes of sandwich panels – Application and testing of sandwich structures.	
MODULE 5: FABRICATION PROCESS	**9**
Various Open and closed mould processes. Manufacture of fibres - Types of resins and properties and applications - Netting analysis.	

TEXT BOOKS

1	Calcote, L R. "The Analysis of laminated Composite Structures", Von - Nostrand Reinhold Company, New York 1991.
2	Jones, R.M., "Mechanics of Composite Materials", 2nd Edition McGraw-Hill, 1999.
3	Ronald F.Gibson., “Principles of composite material and mechanics” 2nd Edition Taylor and Francis group 2007.

REFERENCE BOOKS

1. Krishan K. Chawla., “Composite Materials: Science and Engineering”, Springer science media New York 2012
2. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites", John Wiley and sons.Inc., New York, 1995.
3. Lubin, G., "Handbook on Advanced Plastics and Fibre Glass", Von Nostrand Reinhold Co., New York, 1991
4. Lalit Gupta., “ Advanced Composite materials”, Himalayan books, Revised Edition, 2005

E BOOKS

1. https://www.springer.com/in/book/9780387743646
2. http://www.engbrasil.eng.br/artigos/art19.pdf

MOOC

1. https://www.mooc-list.com/tags/composite-structures
2. http://nptel.ac.in/courses/112104168/
3. http://nptel.ac.in/downloads/101104010/
4. http://nptel.ac.in/courses/101104010/

COURSE TITLE	ADVANCED PROPULSION (Common to Aeronautical and Avionics)			CREDIT	3
COURSE CODE	AEB4303	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	Course Outcomes The students should be able to	POs
1.	Understand the operating principle of ramjet, combustion and its performance.	1,2,3,4,8,12
2.	Emphasize the rocket operating principles, Rocket staging, Rocket nozzle classifications and performance of rockets	1,2,3,4,8,12
3.	compute in detail about solid propellant rockets and the various types of propellants used with their grain structure and their burning rates	1,2,3,4,7,8
4.	Understand in detail about liquid propellant rockets and the various types of propellants used& how to cool the liquid rocket	1,2,3,4,5,7,8,12
5.	Apply and understand about electric, ion rockets, basics of solar sails and its operating principle	1,2,3,4,5,8,12

Prerequisites : Aerothermodynamics & Jet Propulsion

MODULE 1: RAMJET PROPULSION **12 (9L + 3T)**

Operating principle-Subcritical, critical and supercritical operation-Combustion in ramjet Engine-Ramjet performance - Sample ramjet design calculations, Scramjet combustion, Turbulence mixing - Numerical problems.

MODULE 2: FUNDAMENTALS OF ROCKET PROPULSION **12 (9L + 3T)**

Operating principle-Thrust of Rocket ,Specific impulse of a rocket– Types of rockets - Rocket Staging – Rocket nozzle classification-Numerical Problems.

MODULE 3: SOLID PROPELLANT ROCKETS **13 (10L + 3T)**

Solid propellant rockets-Selection criteria of solid propellants-Important hardware components of solid rockets-Propellant grain design considerations – combustion of solid propellants.

MODULE 4: LIQUID PROPELLANT ROCKETS **12 (9L + 3T)**

Liquid propellant rockets-Selection of liquid propellants– Injectors –Thrust control in liquid rockets-Cooling in liquid rockets- hybrid rockets.

MODULE 5: ADVANCED PROPULSION TECHNIQUES **11 (8L + 3T)**

Electric rocket propulsion–Electrostatic, Electro thermal, Electromagnetic thrusters – Ion propulsion - Nuclear propulsion techniques-Solar sail

TEXT BOOKS

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 8th Edition, 2010.
2. Hill P.G. &Peterson,C.R. "Mechanics & Thermodynamics of Propulsion" Addison-Wesley Longman INC,2010.

REFERENCE BOOKS

1. Cohen,H.,Rogers,G.F.C.andSaravanamuttoo,H.I.H.,"GasTurbineTheory",LongmanCo., ELBS Ed.,2008.

2. Gorden,C.V.,"Aerothermodynamicsof Gas Turbine and Rocket Propulsion",AIAA Education Series, NewYork, 1991
3. Mathur, M., and Sharma, R.P., "Gas Turbines and Jet and Rocket Propulsion", Standard Publishers,NewDelhi,1988
4. Mathur,M.L. and Sharma,R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers & Distributors, Delhi,1999..

MOOC

1. http://nptel.ac.in/courses/101106033/
2. http://nptel.ac.in/courses/101101001/
3. http://nptel.ac.in/courses/101101002/

TUTORIAL LINK:

https://sites.google.com/a/hindustanuniv.ac.in/propulsion-ii/home

COURSE TITLE	AIRCRAFT STRUCTURES (Integrated with lab) (Common to Aeronautical and Avionics)			CREDIT	4
COURSE CODE	AEB4302	COURSE CATEGORY	PC	L-T-P-S	3-0-2-1
CIA	60%			ESE	40%
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES At the end of the course , the students should be able to	PO
1	Analyse the thin walled sections and able to calculate shear flow and shear centre.	1,2,3,4,8,12
2	Compute the flexural and torsional shear flow in closed sections.	1,2,3,4,8,9,12
3	Understand load paths and demonstrate the knowledge of structural behaviour in fuselage and wing structures	1,2,3,4,8,9,12,
4	Calculate the stresses in wing, fuselage, wing spar, attachments	1,2,3,4,5,8,9,12
5	Differentiate and analyse the types of aircraft fittings, bolt fittings, Riveted connections and their failures.	1,2,3,4,5,8,9,12

Prerequisites : Solid Mechanics & Aircraft Structural Mechanics

MODULE 1: SHEAR FLOW IN OPEN SECTIONS **12 (10L + 2P)**

Thin walled beams, Concept of shear flow and shear centre, Elastic axis. Shear flow in single and multi-cell under bending with walls effective and ineffective, one axis of symmetry, unsymmetrical beam sections. Structural constraint, Shear stress distribution in constrained open sections

Lab: 1.Locate Shear Centre for open section

MODULE 2: SHEAR FLOW IN CLOSED SECTIONS **12 (9L + 3P)**

Bredt - Batho formula, Shear flow in single and multi – cell closed structures under bending and torsion with walls effective and ineffective in bending, approximate methods, Shear stress distribution in constrained closed sections, Warping of beams due to torsion, Shear lag of different constrained beams

Lab:

1. Locate Shear Centre for closed section
2. 3.Determination of Principal axis of Unsymmetrical beams

MODULE 3: ANALYSIS OF WINGS AND FUSELAGE **12 (9L + 3P)**

Basics of aircraft components and functions of parts, Construction concepts for fuselage, wing, control surfaces and tail plane. Analysis of fuselage structures for bending, shear and torsional loads. Analysis of fuselage frames, cut outs in fuselages. Analysis of multi-cell wing structures for bending, shear and torsional loads. Method of successive approximation, analysis of ribs, cut outs in wings.

Lab:

1. Column testing
2. 5.Vibrations of beams

MODULE 4: ANALYSIS OF WING SPAR **12 (9L + 3P)**

Types of spar construction, diagonal tension concept, semi-diagonal tension concept, design of spar web: shear resistant, diagonal tension, semi-diagonal tension web. Analysis of parallel and tapered spar cab

Lab:

1. Wagner beam – Tension field beam
2. Constant Strength Beam
3. Beam Subjected to complex loading

MODULE 5: AIRCRAFT FITTINGS AND CONNECTIONS **12 (9 L + 3 P)**

Types of aircraft fittings, Wing to spar attachments, Single bolt fittings, Multi-bolt fittings, Bolt group analysis, Shear, bending and tensile failures of bolts, Analysis of lugs to normal and oblique loadings. Riveted connections and strength of rivets.

Lab:

1. Find stresses in circular discs and beams using photo-elastic techniques
2. Determination of stress concentration factor of tensile strip with central circular hole

TEXT BOOKS

1. T.M.G. Megson, “Aircraft Structures for Engineering Students”, Fifth edition, Butterworth-Heinemann, 2012.
2. E.H. Bruhn, “Analysis and Design of Flight Vehicles Structures”, Tri-state off- set company, USA, 1985.
3. D.J. Peery and J.J. Azar, “Aircraft Structures”, 2nd edition, McGraw – Hill, N.Y., 1999.
4. S. Timoshenko and D.H. Young, “Elements of strength materials Vol. I and Vol. II"., T. Van Nostrand Co-Inc Princeton-N.J. 1990.

REFERENCE BOOKS

1. B.K. Donaldson, "Analysis of Aircraft Structures - An Introduction", Second edition, Cambridge University Press, 2012.
2. Howard D Curtis, ‘Fundamentals of Aircraft Structural Analysis’, WCB- McGraw Hill, 1997.
3. R.M. Rivello, “Theory and Analysis of Flight Structures”, McGraw Hill, 1993.

E BOOKS

1. https://www.researchgate.net/publication/258630500_Aerospace_Structures_for_Engineers

2. http://www.jdrr.yolasite.com/resources/Aeronautical_Engineering/BOOKS/Aircraft%20Structures%20by%20Megson%20-%20Book.pdf
MOOC
https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-20-structural-mechanics-fall-2002/
COURSEWARE LINK
https://sites.google.com/a/hindustanuniv.ac.in/eselumalai/aircraft-structures-2

COURSE TITLE	**COMPRESSIBLE AERODYNAMICS (Common to Aeronautical and Avionics)**			**CREDIT**	**4**
COURSE CODE	**AEB4304**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-1-0-1**
CIA	**50%**			**ESE**	**50%**
LEARNING LEVEL	**BTL-3**				

CO	**Course Outcomes** The Student will be able to:	**PO**
1	Understand and derive the one dimensional compressible flow equations	1,2,3 5,6,12
2	Understand the normal, oblique shocks, expansion waves and calculate the various flow properties across these waves	1, 2,3, 6, 12
3	Develop the linearized differential equations of motion for steady compressible flows and different compressibility corrections	1, 2, 5,6, 12
4	Understand the different air foil/wings design in high speed flows	1, 2,3 5,6, 12
5	To classify different types of high speed wind tunnels and their operations and also different optical technique for supersonic flow visualization	1, 2,12

Prerequisites : Fluid Mechanics & Low Speed Aerodynamics

MODULE 1: 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	
MODULE 2: NORMAL, OBLIQUE SHOCKS AND EXPANSION WAVES	**15**
Prandtl equation and Rankine - Hugoniot 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.	
MODULE 3: DIFFERENTIAL EQUATIONS OF MOTION FOR STEADY COMPRESSIBLE FLOWS	**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.	

MODULE 4: AIRFOIL IN HIGH SPEED FLOWS	12
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.	
MODULE 5: 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.	
TEXT BOOKS	
1. Rathakrishnan, E., "Gas Dynamics", Prentice Hall of India, 2012.	
REFERENCE BOOKS	
1. Anderson Jr., D., - "Modern compressible flows", McGraw-Hill Book Co., New York 2012. 2. Shapiro, A.H., "Dynamics and Thermodynamics of Compressible Fluid Flow", Ronold Press. 3. Zucrow, M.J. and Anderson, J.D., "Elements of gas dynamics", McGraw-Hill Book Co., New York.	
E BOOKS	
1. https://open.umn.edu/opentextbooks/textbooks/fundamentals-of-compressible-flow-mechanics 2. https://allbookserve.org/downloads/modern_compressible_flow_solution_manual.pdf 3. http://www.momentumpress.net/books/introduction-compressible-flow	
MOOC	
1. https://nptel.ac.in/syllabus/112106056/ **2.** https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-120-compressible-flow-spring-2003/ **3.** http://scpd.stanford.edu/search/publicCourseSearchDetails.do?method=load&courseId=11396	
COURSEWARE LINK	
1. https://sites.google.com/a/hindustanuniv.ac.in/dilip-a-shah-aerodynamics/	

COURSE TITLE	PROPULSION LAB (Common to Aeronautical, and Avionics)			CREDIT	1
COURSE CODE	AEB4331	COURSE CATEGORY	PC	L-T-P-S	0-0-3-0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-3				

CO	Course Outcome The students should be able to:	PO
1	Gain knowledge about the various systems of aircraft piston engine, jet engines and show the systems on the engines available in the Lab	1,2,9,12
2	Understand the concept of forced convective heat transfer and perform experiment on the heat transfer apparatus	1,3,4,9,6
3	Understand the concept of free convection heat transfer and perform experiment on the heat transfer apparatus	1,2,3,4,6,9
4	Apply the cascade arrangement of a model axial compressor blade row	1,3,4,9
5	Compute the heat of combustion of aviation fuel is found out using given set up	1,3,4,6,7,9
6	Apply the concept of Combustion performance in a jet engine combustion chamber	1,3,4,5,9
7	Carry out experiments on free jet	1,3,4,6,9
8	Carry out experiments on wall jet	1,3,4,6,9

LIST OF EXPERIMENTS

1. Assembly of an aircraft piston engine and jet engines and its components
2. Determination of convective heat transfer coefficient by natural convection
3. Determination of convective heat transfer coefficient by Forced convection
4. Cascade testing of a model of axial compressor blade row
5. Determination of heat of combustion of aviation fuel
6. Combustion performance studies in a jet engine combustion chamber
7. Characteristic plots of a free jet through a non-circular / circular orifice
8. Characteristic plots of a wall jet through a non-circular / circular orifice

TOTAL HOURS - 45

LIST OF EQUIPMENTS

Sl. No	Equipment	Qty	Experiments No.
1	Piston engines	2	1
2	Jet Engine /Engine model	1	1
3	Forced Convective apparatus	3	3
4	Free Convective apparatus	3	2
5	Bomb calorimeter	2	5
6	Free jet Apparatus	2	7
7	wall jet Apparatus	1	8
8	Combustion performance Set-up	1	6
9	Cascade Testing Set-up	1	4

COURSE TITLE	COMPOSITE MATERIALS AND STRUCTURES LABORATORY (Common to Aeronautical and Avionics)			CREDIT	1
COURSE CODE	AEB4333	COURSE CATEGORY	PC	L-T-P-S	0-0-3-0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL 3				

CO	COURSE OUTCOMES The students should be able to:	PO
1	fabricate the laminate plate using various manufacturing techniques.	1,2,4,7,9
2	calculate the density and constitute fraction of the fabricated composite panel.	1,3,4,6,9
3	evaluate the specimen as per the ASTM procedure for various mechanical characteristics.	1,2,3,4,6,9
4	evaluate the composite panel for low velocity projectile impact response	1,3,4,6,9
5	determine the buckling characteristics of composite panel.	1,3,4,6,9

LIST OF EXPERIMENTS

1. Fabrication of Composite plate using Hand layup method.
2. Fabrication of Composite plate using Vacuum infusion method.
3. Fabrication of Composite plate using Compression Moulding Technique.
4. Measurement of major constituent fraction by Burnout method using Muffle furnace.
5. Carry out the tensile test of the prepared composite specimen as per the ASTM procedure.
6. Carry out three-point bending test of the composite specimen as per ASTM procedure.
7. Carry out shear test of the composite specimen as per ASTM procedure.
8. Perform single lap joint strength test as per the ASTM procedure.
9. Perform double lap joint strength test as per the ASTM procedure.
10. Perform double strap butt joint strength test as per the ASTM procedure.
11. Perform the low velocity projectile impact test.
12. Determine the critical buckling loads for given specimen using Buckling Test.

TOTAL HOURS - 45

LIST OF EQUIPMENTS

Sl.No	Items	Quantity	Experiment No.
1	Compression molding machine (50 Ton capacity)	1	3
2	Vacuum Infusion technique	1	2
3	Muffle furnace (1.5 KW)	1	4
4	UPS/Invertor (2 kVA) – 2 Batteries for uninterrupted supply of power to vacuum pump	1	2,5
5	Vertical band saw cutter (500*500mm)- Bed size	1	5,6,7,8,9,10,11
6	Ultrasonicator (50 Hz)	1	1,2,3
7	Universal Testing Machine	1	5,6,7,8,9,10
8	Projectile Impactor (Internally fabricated)	1	11

COURSE TITLE	COMPUTER AIDED MODELLING PROJECT (Common to Aeronautical, Aerospace and Avionics)			CREDIT	1
COURSE CODE	ATB4332	COURSE CATEGORY	PC	L-T-P-S	0-0-2-0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	Understand and able to model aircraft wing	1,2,4,5,9,11
2	Apply and model aircraft fuselage	1,3,4,5,6,9,11
3	Understand and able to model aircraft empennage	1,2,3,4,5,6,9,11
4	Apply and model engine	1,3,4,5,6,9,11
5	Model aircraft landing gear	1,3,4,5,6,9,11
6	Assemble aircraft major components	1,3,4,5,9,11

LIST OF EXPERIMENTS

1. Modelling of typical Aircraft Wing with Structural Members.
2. Modelling of typical Aircraft Fuselage with Structural Members.
3. Modelling of typical Aircraft Empennage.
4. Modelling of typical Turbojet Engine.
5. Modelling and Assembly of typical Aircraft Landing Gear.
6. Assembly of all the above modules.

TOTAL HOURS - 30

LIST OF EQUIPMENT

S. No	Equipment	Quantity	Experiments No.
1	Computer and modelling software	i5 IV gen (8 GB RAM) PC's, - 40 Nos.	1 - 8
		License of Software(Auto CAD, Solid Works) – 40 Nos.	

SEMESTER – VI

COURSE TITLE	BUSINESS ECONOMICS			CREDITS	2
COURSE CODE	GEA4304	COURSE CATEGORY	BS	L-T-P-S	2-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL 2				

CO	COURSE OUTCOMES	PO
1	Demonstrate an understanding the introduction of economics	1
2	Demonstrating to know knowledge about cost analysis	5
3	Able to build knowledge about consumer's and producer's behavior	3
4	Enabling to know about budget	6
5	Educate about financial services	5

Prerequisites : Basic Economics

MODULE – 1: INTRODUCTION TO ECONOMICS **6**

Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics

MODULE – 2: COST ANALYSIS **6**

Types of Cost, Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis, Economies of Scale Cost Classification

MODULE – 3: CONSUMER'S AND PRODUCER'S BEHAVIOUR **6**

Consumer Behavior: Law of Diminishing Marginal utility – Equimarginal Utility – Consumer's Equilibrium - Indifference Curve – Production: Law of Variable Proportion – Laws of Returns to Scale – Producer's equilibrium – Economies of Scale Cost Classification

MODULE – 4: BUDGET **6**

Process of budgeting in India –classification of budgets trends – evaluation systems – types of deficits – fiscal policy – indicators –– taxation – centre, state and local – public debt and management.

MODULE – 5: FINANCE **6**

Basics of finance and financial environment – instruments of financial markets – financial intermediation – investment banking and brokerage services – securities – types of securities – market for securities – how and where traded – initial public offering (IPO) – secondary markets – trading on exchanges and trading with margins.

TEXT BOOKS

1. S.Shankaran, Business Economics - Margham Publications.
2. H.L. Ahuja, Business Economics – Micro & Macro - Sultan Chand & Sons - New Delhi – 55.

REFERENCE BOOKS

1. S.A.Ross, R.W.Westerfield, J.Jaffe and Roberts: Corporate Finance, McGraw-Hill.
2. Joseph E Stiglitz: Economics of the Public Sector.

ONLINE SOURCES

1. https://sites.google.com/site/readbookpdf7734/pdf-download-business-economics-by---mark-taylor-read-online
2. https://bookboon.com/en/economics-ebooks

COURSE TITLE	AIRCRAFT PERFORMANCE, STABILITY & CONTROL (Common to Aeronautical and Avionics)			CREDITS	3
COURSE CODE	AEB4317	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL- 3				

CO	COURSE OUTCOMES The students will be able to	PO
1	Gain knowledge about the forces and moments that are acting on an aircraft, the different types of drag, drag polar, ISA, variation of thrust, power, SFC with velocity and altitude.	1,5,6
2	Understand about performance in level flight, minimum drag and power required, climbing, gliding and turning flight, v-n diagram and load factor.	1,2,3,4,5, 6
3	Acquire the knowledge about degrees of stability, stick fixed and stick free stability, stability criteria, effect of fuselage and CG location, stick forces, aerodynamic balancing.	1,2,3,4,6
4	Understand about lateral control, rolling and yawing moments, static directional stability, rudder and aileron control requirements and rudder lock.	1,2,4,5, 6
5	Understand about lateral and directional dynamic stability	1,2,3,4,5,6

Prerequisites :COMPRESSIBLE AERODYNAMICS

MODULE 1: DRAG ON THE AIRPLANE **12 (9L + 3T)**

International Standard Atmosphere - Forces and moments acting on a flight vehicle - Equation of motion of a rigid flight vehicle - Different types of drag - Drag polars of vehicles from low speed to high speed - Variation of thrust, power and SFC with velocity and altitudes for air breathing engines and rockets - Power available and power required curves.

MODULE 2: AIRCRAFT PERFORMANCE **12 (9L + 3T)**

Performance of airplane in level flight - Maximum speed in level flight - Conditions for minimum drag and power required - Range and endurance - Climbing and gliding flight (Maximum rate of climb and steepest angle of climb, minimum rate of sink and shallowest angle of glide) -Turning performance (Turning rate, turn radius). Bank angle and load factor, Limitations of pull up and push over, V-n diagram and load factor.

MODULE 3: STATIC LONGITUDINAL STABILITY **12 (9L + 3T)**

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

MODULE 4: LATERAL AND DIRECTIONAL STABILITY **12 (9L + 3T)**

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.

MODULE 5: DYNAMIC STABILITY	12 (9L + 3T)
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.	

TEXT BOOKS

1. Nelson, Robert C. “Flight stability and Automatics Control” McGraw Hill , 1989
2. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley &Son:,Inc, New York, 1949.
3. Perkins, C.D." Stability and Control", Elsevier, 2014.

REFERENCE BOOKS

1. Etkin, B., "Dynamics of Flight Stability and Control", Edn. 2, John Wiley, New York, 2015.
2. McCormickBarnes "Aerodynamics Aeronautics and Flight Mechanics “, WileyIndia,2010
3. Dommasch, D.O., Shelby, S.S., and Connolly, T.F., "Aeroplane Aero dynamics", Third Edition, 1952
4. Issac Pitman, London, 1911.4. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 1991

E BOOKS

1. https://web0615.students.flatironschool.com/0iw4rr315u14/02-celine-leuschke/read-9787118091236-launch-vehicle-flight-dynamics-and-guidance-chin.pdf

MOOC

1. https://ecourses.ou.edu/cgi-bin/ebook.cgi?topic=me
2. http://nptel.ac.in/courses/101106042/1
3. https://nptel.ac.in/courses/101106041/
4. https://nptel.ac.in/courses/101106043/

COURSEWARE LINK

https://sites.google.com/a/hindustanuniv.ac.in/sas-aerodynamics-flight

TUTORIAL LINK

https://sites.google.com/a/hindustanuniv.ac.in/dynamics/academics/btech/flight dynamics/

COURSE TITLE	CONTROL THEORY (Common to Aeronautical, Aerospace and Avionics)			CREDIT	3
COURSE CODE	AEB4318	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES At the end of this course, students will be able to	PO
1	Apply systems theory to complex real world problems in order to obtain models that are expressed using differential equations, transfer functions, and state space equations	1,5,6
2	Predict system behavior based on the mathematical model of that system where the model may be expressed in time or frequency domain	3, 5, 6
3	Analyze the behavior of closed loop systems using tools such as root locus, Routh Hurwitz, Bode, Nyquist, and Matlab	2, 3,5,6
4	Design controllers using classical PID methods, root locus methods, and frequency domain methods.	1,4,5,6
5	Devise a safe and effective method of investigating a system identification problem in the lab	2,3,5,6

Prerequisites : Engineering mathematics

MODULE 1: MATHEMATICAL MODELLING OF CONTROL SYSTEMS 12 (9L + 3T)

Introduction

- History of Automatic Control
- Control Engineering Practice
- The Future Evolution of Control Systems
- Engineering Design
- Mechatronic Systems
- Control System Design
- Transfer function
- Mathematical modelling of mechanical systems
- Mathematical modelling of Electrical systems.
- Transformation of mathematical models with MATLAB

MODULE 2: MATHEMATICAL MODELLING OF HYDRAULIC, PNEUMATIC AND THERMAL SYSTEMS 12(9L + 3T)

- Pneumatic systems: Pressure systems, pneumatic nozzle – flapper Amplifiers, pneumatic relays, pneumatic proportional controllers, pneumatic actuating valves.
- Hydraulic systems: Hydraulic servo system, Hydraulic proportional controller, dashpot.
- Thermal systems

MODULE 3: TRANSIENT AND STEADY-STATE RESPONSE ANALYSES 12 (9L + 3T)

- Definition: Transient and steady state response

- Input signals
- First order system with unit step response
- Second order system with unit step response for un-damped, critical damped, overdamped and underdamped cases.
- Higher order system.
- Routh's stability criterion
- Steady-state errors in unit feedback control systems.
- Transient – Response analysis with MATLAB

MODULE 4: CONTROL SYSTEMS ANALYSIS AND DESIGN BY THE ROOT-LOCUS METHOD 12 (9L + 3T)

- Introduction
- Root-locus plot
- Lead compensation
- Lag Compensation
- Plotting Root loci with MATLAB

MODULE 5: CONTROL SYSTEMS ANALYSIS AND DESIGN BY THE FREQUENCY- RESPONSE METHOD 12 (9L + 3T)

- Introduction
- Bode plot: Concepts and construction
- Lead and lag compensation technique based on the frequency-response approach.
- Experimental problem using MATLAB

TEXT BOOKS

Modern Control Engineering by Katsuhiko Ogata, 5th Edition, Prentice Hall of India.(2010)

REFERENCE BOOKS

1. Modern Control System by Richarc C. Drof and Robert H. Bishop,13th Edition Pearson Int.(2017)
2. Automatic Control Systems by Benjamin C.Kuo, 9th Edition, FaridGolnaraghi, John Wiley & Sons(2014).
3. Control Systems Engineering by Nagrath and Gopal New Age Publication (2001)
4. Feedback and Control Systems by Joseph J Distefano 2nd Edition TMH (2011)

E-BOOKS

1. Glad, T., Ljung, L. (2000). Control Theory. London: CRC Press.
2. https://www.taylorfrancis.com/books/9781482268164

MOOC

1 https://www.edx.org/course/introduction-control-system-design-first-mitx-6-302-0x
2.https://onlinecourses.nptel.ac.in/noc18_ee41/preview

COURSE TITLE	CIVIL AVIATION REQUIREMENT-I			CREDIT	3
COURSE CODE	AEB4319	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES At the end of this course, students will be able to	PO
1	Should be able to have the knowledge of Indian Aircraft Rules 1937 and related publication	1,6,8
2	Should be able to have the knowledge CAR series B and C (MEL, cockpit and emergency check list and Defects rectification and analysis)	1,2,6,8,10
3	Should be able to have the knowledge CAR series E for approval of organizations: in various categories and CAR series M	1,2, 6,8,10
4	Should be able to have the knowledge CAR145, CAR -21 Type certificate and Noise certificate	1,2,6,8,10
5	Should be able to have the knowledge C.A.R. series F airworthiness and continued airworthiness, Registration / deregistration of aircraft, Micro light and Hot air balloons, Issue/Renewal and Suspension of Special Certificate of Airworthiness	1,2, 6,8,10

Prerequisites : Nil

MODULE 1: INDIAN AIRCRAFT RULES 1937 AND RELATED PUBLICATIONS **9**

Knowledge of aircraft act, 1934, aircraft rules, 1937 as far as they related to airworthiness and safety of aircraft. Knowledge of civil airworthiness requirements, aeronautical information circulars, aeronautical information publications- (relating to airworthiness), advisory circulars & A.M.E. notices (NOTAMS) by DGCA

MODULE 2: C.A.R. SERIES“B "and “C" **9**

C.A.R. series “B” – Minimum Equipment List (MEL), preparation and use of cockpit check list and emergency check list.

C.A.R. series ‘C’ – Defect recording, reporting, investigation, rectification and analysis

MODULE 3 : C.A.R. SERIES “E" **9**

C.A.R. Series E – approval of organizations: Approval in categories E & G;CAR M- Objective, Definitions, Continuing Airworthiness Requirement.

MODULE 4: C.A.R. SERIES **9**

CAR145-General, Scope, Terms of Approval, Facility Requirement, Personnel Requirement, Certifying Staff, Safety and Quality policy, maintenance procedures and quality system.

CAR -21, Type certificate, Noise certificate,

MODULE 5: C.A.R. SERIES “F " **9**

C.A.R. Series “F” airworthiness and continued airworthiness:

Procedure relating to Registration / deregistration of aircraft, , Issue/validation and suspension of Certificate of Airworthiness, Special Flight permits, Airworthiness requirements for Gliders , Design, Manufacture, Registration and Operation of Micro light Aircraft., Requirements for manufacture, registration and airworthiness control of hot air balloons, Age of Aircraft to be imported for Scheduled / Non-Scheduled including Charter, General Aviation and other Operations, Issue/Renewal and Suspension of Special Certificate of Airworthiness

TEXT BOOKS

1. Aircraft manual (India) volume – latest edition, the English book store, 17-l, Connaught circus,

New Delhi. 2. Civil aviation requirements with latest amendment (section 2 airworthiness) – published by DGCA, the English book store, 17-l, Connaught circus, New Delhi.
REFERENCE BOOKS
1. Aeronautical information circulars (relating to airworthiness) from DGCA. 2. Advisory circulars from DGCA.
E BOOKS
http://dgca.nic.in/rules/car-ind.htm
MOOC
1. https://onlinecourses.nptel.ac.in/noc19_ae02/preview cari 2. https://www.mooc-list.com/search/node/civil%20aviation
COURSEWARE LINK
1.https://sites.google.com/a/hindustanuniv.ac.in/cska/home 2.https://sites.google.com/a/hindustanuniv.ac.in/car-i/
TUTORIAL LINK
https://sites.google.com/a/hindustanuniv.ac.in/cska/home

COURSE TITLE	**AIRCRAFT DESIGN PROJECT-I (Common to Aeronautical and Avionics)**			**CREDIT**	**1**
COURSE CODE	**AEB4341**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**0-0-3-1**
CIA	**80%**			**ESE**	**20%**
LEARNING LEVEL	**BTL-3**				

CO	**Course Outcomes The students should be able to:**	**PO**
1	Compare different types of airplanes and their specifications and performance details with reference to the design work under taken.	1,2,3,5,6,9,10
2	Perform Preliminary weight estimation, Selection of design parameters, power plant selection, aerofoil selection, fixing the geometry of Wing, tail, control surfaces Landing gear selection.	1,2,3,5,6,9,10
3	Prepare the layout drawing, construction of balance and three view diagrams of the airplane under consideration.	1,2,3,5,6,9,10

LIST OF EXPERIMENTS

1. Comparative studies of different types of airplanes and their specifications and performance details with reference to the design work under taken.
2. Preliminary weight estimation, Selection of design parameters, power plant selection, aerofoil selection, fixing the geometry of Wing, tail, control surfaces Landing gear selection.
3. Preparation of layout drawing, construction of balance and three view diagrams of the airplane under consideration.
4. Drag estimation, Performance calculations, Stability analysis and V-n diagram

TOTAL HOURS - 45

COURSE TITLE	COMPUTATIONAL MECHANICS LAB (Common to Aeronautical, Aerospace and Avionics)			CREDIT	1
COURSE CODE	AEB4342	COURSE CATEGORY	PC	L-T-P-S	0-0-3-1
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES The students should be able to:	PO
1	Familiarize with computational fluid dynamics software tools	1,5,6
2	Familiarize with structural analysis software tools	3,5, 6
3	Employ these tools in Aerospace applications	2, 3,5,6
4	Expose themselves to different simulation techniques of wings & structures	1, 3,5,6
5	interpolate the simulation results with experimental results	2, 3,5,6

LIST OF EXPERIMENTS

1. Simulation of flow over a circular cylinder (in-viscous and Viscous Flows)
2. Simulation of flow over an airfoil for various angle of attack
3. Simulation of supersonic flow over a wing of biconvex cross section
4. Hot flow simulation through an axial flow turbine blade passage
5. Simulation of flow through subsonic and supersonic diffusers
6. Structural analysis of a tapered wing
7. Structural analysis of a fuselage structure
8. Structural analysis of a landing gear
9. Structural analysis of cut outs
10. Analysis of composite laminate structure

TOTAL HOURS - 45

REFERENCE

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Software Packages: (30 License Each)

- CATIA/ Pro-E
- Ansys (Full Package)

Hardware Requirements:

- Workstation 1 Nos.
- Computer 30 Nos.
- Printer 1 Nos
- UPS

COURSE TITLE	COMPREHENSION (Common to Aeronautical, Aerospace and Avionics)			CREDIT	1
COURSE CODE	AEB4343	COURSE CATEGORY	PC	L-T-P-S	1-0-2-0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-3				

Goal:

To encourage the students to comprehend the knowledge acquired from the first semester to Sixth semester of B.Tech Degree Course through periodic exercise.

SEMESTER VII

COURSE TITLE	AVIONICS (COMMON TO AERONAUTICAL AND AVIONICS)			CREDITS	3
COURSE CODE	AEB4401	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOME At the end of this course, students will be able to	PO
1	Use his general awareness for design and fabrication of modern aircraft cockpit. Appreciate the need for avionics and Role of avionics with real time application using ARM architecture	1, 2, 5, 12
2	Identify various systems inside the cockpits in real time and understand the process of interfacing with the computer and external world.	1, 2, 3, 12
3	Identify the real time applications of Data bus in aircraft with a study of data acquisition and communication between systems.	1, 2, 3, 4, 5, 12
4	Understand navigation, communication and control systems with their applications.	1, 2, 12
5	Understand the needs for evaluation of systems in the design of hardware and software with the use of modern tools and practices. Testing and application of standards in the design of various systems.	1, 2, 3, 5, 6, 8, 12

Prerequisites : Nil

MODULE 1: AVIONICS SYSTEMS AND PROCESSORS	**10**
Avionics sub-systems and design drivers, need for avionics in various fields, design and development process, RISC Processor – PIC architecture, Interrupts, Instruction format, Addressing Modes, Instruction Set, ARM Architecture – Instruction set, Thumb Instruction set, Exception Handling.	
MODULE 2: DISPLAYS AND I/O DEVICES	**10**
Trends in display technology, Alphanumeric displays, character displays etc., Civil and Military aircraft cockpits, MFDs, MFK, HUD, HDD, HMD, DVI, HOTAS, Synthetic and enhanced vision, situation awareness, Panoramic/big picture display, human and physical interfaces with using PIC processor.	
MODULE 3: DATA BUSES, DATA ACQUSITION AND INTEGRATION	**9**
MIL-STD-1553B, ARINC-429, ARINC-629, AFDX and its Elements, Integrated avionics system, PIC – Role of process – in Data acquisition, data transfer, Connectivity and networks.	
MODULE 4: COMMUNICATION NAVIGATION AND CONTROL	**8**
Communication – Types of Navigation – INS – GPS, FBL, Autopilot Concepts – Autopilot Function – Flight Director – Follow Route – Fly Heading – Maintain Altitude, Electronic Warfare.	
MODULE 5: ASSESSMENT AND VALIDATION	**8**
Qualitative evaluating system, Civil Aviation Certification, Hardware analysis techniques, DO-160, MIL-STD-810, EMI, CASE tools, DO – 178, DO-STD-2167 & 2168, Use of Ada, MIL-STD-1750.	

TEXT BOOKS

1. R.P.G. Collinson, "Introduction to Avionics", 3rd edition, Springer, 2011.
2. Cary R. Spitzer, " Digital Avionics Systems: Principles and Practices", 2nd edition, McGraw-Hill, 1992.
3. Ian Moir, Allan Seabridge, “Design and Development of Aircraft Systems”, 2nd Edition, John Wiley & Sons, 2013.
4. Raj Kamal, "Microcontrollers –Architecture, Programming, Interfacing System Design”, Dorling Kindersley India Pvt. Ltd., 2012.

REFERENCE BOOKS

1. Mohamed Rafiquzzaman, “Microcontroller Theory and Applications with the PIC18F” Wiley, 2018.
2. Nicolas K. Haddad, “Microcontroller System Design Using PIC18F Processors” IGI Global, 2017.
3. Ian Moir, Allan Seabridge, Malcolm Jukes, “Civil Avionics Systems” 2nd Edition, John Wiley & Sons, 2013.
4. Middleton, D.H., Ed., "Avionics Systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1919.
5. Cary Spitzer, Uma Ferrell, Thomas Ferrell, “Digital Avionics Handbook”,3rd Edition, CRC Press, 2017.
6. Brain Kendal, "Manual of Avionics", The English Book House, 3rd Edition, New Delhi, 1993.
7. John R. Newport, “Avionic Systems Design”,CRC Press, Aug-1994.
8. Tim Wilmshurst, "Designing Embedded Systems with PIC Microcontrollers-Principles and Applications", Newnes Publications, 2007.
9. Advanced Avionics Handbook, FAA-H-8083-6, U.S. Department of Transportation – FAA, 2009.

E BOOKS

1. https://www.faa.gov/regulations_policies/handbooks_manuals/aviation/advanced_avionics_handbook/
2. https://www.scribd.com/document/266128579/Avionics-Navigation-Systems-Second-Edition

MOOC

1. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-682-prototyping-avionics-spring-2006/lecture-notes/
2. http://www.aea.net/training/
3. https://www.kilroyscollege.ie/course.php?courseid=21

COURSE TITLE	AERO ENGINE MAINTENANCE & REPAIR (Integrated with lab)			CREDIT	5
COURSE CODE	AEB4403	COURSE CATEGORY	PC	L-T-P-S	3-0-2-1
CIA	60%			ESE	40%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES The students will be able to	PO
1.	Describe the function of each component in piston engines and its materials.	1,6
2	Inspect the engine, carry out various maintenance checks on aircraft piston engines and troubleshoot	1,5,6
3	Overhaul the piston engine and rectify if any malfunction is found	1,5,9
4	Describe the types and function of each component in gas turbine engine and should be able to troubleshoot and rectify malfunction in gas turbine engines	1,2,4
5	Overhaul and balance gas turbine engine and its components.	1,3,5,9
6	Describe the detail procedure for gas turbine engine, health monitoring	2,3

Prerequisites :PRINCIPLES OF FLIGHT

MODULE 1: AIRCRAFT ENGINE AND ITS COMPONENTS **6 (4L + 2P)**

- Piston Engine - Types - Principles of operation - Function of components - Materials used - Starting procedures.
- Jet Engine - Types - Principles of operation - Functions of components - Materials used- Starting procedures.
- Experiments:
  - Piston Engine – Identification of Components
  - Jet Engine - Identification of Components

MODULE 2: INSPECTION OF PISTON ENGINES **12 (8L + 4P)**

- Inspection - maintenance - Daily and routine checks- Compression testing of cylinders - Special inspection schedules - Inspection of all engine components- Engine fuel system, control and exhaust systems - Engine mount and super chargers - Checks and inspection procedures and Troubleshooting-Symptoms of failure - Fault diagnostics.
- Experiments:
  - Disassembly of Piston Engine and Its Components
  - Cleaning and visual Inspection of Piston Engine components

MODULE 3: OVERHAULING OF PISTON ENGINE **14 (10L + 4P)**

- Tools and equipment requirements for various checks and alignment during overhauling - Tools for inspection - Tools for safety and for visual inspection - Methods and instruments for non-destructive testing techniques - Equipment for replacement of part and their repair. Engine testing: Engine testing procedures and schedule preparation -- Details of starting and operating procedures.
- Experiments:
  - Non - Destructive Testing checks
  - Re-Assembly Of Piston Engine And Its Components

MODULE 4:INSPECTION OF JET ENGINES **14 (10L + 4P)**

- Gas turbine engine inspection & checks - Use of instruments for online maintenance - Special

inspection procedures: Foreign Object Damage - Blade damage - etc.

- Maintenance procedures of gas turbine engines - Trouble shooting and rectification procedures - Component maintenance procedures - Systems maintenance procedures.
- Gas turbine testing procedures - test schedule preparation - Storage of Engines - Preservation and de-preservation procedures.
- Experiments:
  - Cleaning and visual inspection of engine components
  - Dimension check of components

MODULE 5: OVERHAULING OF JET ENGINE **14 (10L + 4P)**

- Engine Overhaul procedures - Inspections and cleaning of components - Repairs schedules for overhaul - Balancing of Gas turbine components. Trouble Shooting - Procedures for rectification - Condition monitoring of the engine on ground and at altitude - engine health monitoring and corrective methods. Details of starting and operating procedures
- Experiments:
  - Non - Destructive Testing checks
  - Re-AssemblyDisassembly of jet engine

TEXT BOOKS

- KROES & WILD, "Aircraft Power plants", 8th Edition - McGraw Hill, New York, 2014.
- Aviation Maintenance Technician Handbook–Power plant (Vol 1 & Vol 2)– FAA, 2012

REFERENCE BOOKS

- TURBOMECA, "Gas Turbine Engines", The English Book Store, New Delhi, 1993.
- UNITED TECHNOLOGIES PRATT & WHITNEY, "The Aircraft Gas turbine Engine and its Operation", (latest edition) The English Book Store, New Delhi.

E BOOKS

- http://www.ebook777.com/aircraft-maintenance-repair-seventh-edition/l
- http://libguides.hcc.hawaii.edu/aero

MOOC

- https://elearning.flightsafety.com/courses/maintenance/pwc-engine.html
- https://onlinecourses.nptel.ac.in/noc18_ae03

COURSE TITLE	AIRFRAME MAINTENANCE & REPAIR PRACTICES (Common to Aeronautical and Avionics)			CREDIT	3
COURSE CODE	AEB4402	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
CIA	50%			ESE	50%
LEARNING LEVEL	BTL- 3				

CO	COURSE OUTCOMES The students should be able to:	PO
1	Explain the welding, brazing process with the requirements of the process and significance of NDT	1, 2, 3,4
2	Understand the various maintenance practices in plastic and composite parts of aircraft	1, 2, 3
3	Understand the precautionary steps involved in rigging, jacking process.	1, 2, 3,4
4	Gain thorough understanding in parts, working methodology of basic aircraft systems.	1, 2, 3,4
5	Get a clear idea about safety practices and troubleshooting of an aircraft	1, 2, 3,7

Prerequisites : Nil

MODULE 1: WELDING IN AIRCRAFT STRUCTURAL COMPONENTS (10L)

Equipments used in welding shop and their maintenance - Ensuring quality welds - Welding jigs and fixtures - Soldering and brazing.

SHEET METAL REPAIR AND MAINTENANCE

Inspection of damage - Classification - Repair or replacement - Sheet metal inspection - N.D.T. Testing - Riveted repair design, Damage investigation - reverse technology.

MODULE 2: PLASTICS AND COMPOSITES IN AIRCRAFT (10L)

Review of types of plastics used in airplanes - Maintenance and repair of plastic components - Repair of cracks, holes etc., various repair schemes - Scopes.Inspection and Repair of composite components - Special precautions - Autoclaves.

MODULE 3: AIRCRAFT JACKING, ASSEMBLY AND RIGGING (8L)

Airplane jacking and weighing and C.G. Location. Balancing of control surfaces - Inspection maintenance. Helicopter flight controls. Tracking and balancing of main rotor.

MODULE 4: REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM (10L)

Trouble shooting and maintenance practices - Service and inspection. - Inspection and maintenance of landing gear systems. - Inspection and maintenance of air-conditioning and pressurisation system, water and waste system. Installation and maintenance of Instruments - handling – TestingInspection. Inspection and maintenance of auxiliary systems - Fire protection systems - Ice protection system - Rain removal system - Position and warning system - Auxiliary Power Units (APUs)

MODULE 5: SAFETY PRACTICES (9L)

Hazardous materials storage and handling, Aircraft furnishing practices - Equipment. Trouble shooting - Theory and practices.

TEXT BOOKS

Hazardous materials storage and handling, Aircraft furnishing practices - Equipment. Trouble shooting - Theory and practices.

REFERENCE BOOKS

1. LARRY REITHMEIR, "Aircraft Repair Manual", Palamar Books, Marquette, 1992.

2. BRIMM D.J. BOGGES H.E., "Aircraft Maintenance", Pitman Publishing corp. New York, 1940
MOOC
https://www.faasafety.gov/gslac/onlineresources.aspx?masterId=2
COURSEWARE LINK
https://onlinecourses.nptel.ac.in/noc18_ae03/preview

COURSE TITLE	**CIVIL AVIATION REQUIREMENT-II (Common to Aeronautical and Avionics)**			**CREDIT**	**3**
COURSE CODE	**AEB4404**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3 0 0 3**
CIA	**50%**			**ESE**	**50%**
LEARNING LEVEL	**BTL-3**				

CO	**COURSE OUTCOMES The students will be able to**	**PO**
1.	gain knowledge of CAR series H & I Aircraft fueling procedures and recording and collision avoidance system	1,6,8,10
2.	acquire knowledge of CAR series L& M , CAR66-Licensing procedure A M E and Mandatory Modifications/ Inspections	1, 6,8,10
3.	gain knowledge of CAR series O& R Manufacture, Registration and Operation of Powered Hang Gliders and installation of Communication, Navigation and Radar equipment	1, 6,8,10
4.	gain knowledge of CAR series T , Flight testing of aircraft for which a C of A had been previously issued	1, 6,8,10
5.	acquire knowledge of CAR series X ,Weight and balance control, Provision of Medical Supplies, furnishing materials, Flammability requirements for furnishing materials, Log Books and related aircraft documents , issue of taxy permit,	1,6 ,8,10

Prerequisites : Control Systems, Automotive Electricals and Electronics knowledge

MODULE 1: C.A.R. SERIES " H, & I " 9

Aircraft fuelling procedures, Aviation fuel at airport - Storage, handling and quality control, Aircraft equipment and instruments for flying training organisations and aerial work operations, Flight Data Recorders, Combination Recorders, Data-link Recorders, Airborne Image Recorders, Airborne Image Recording System and Aircraft Data Recording System , Cockpit voice recorders and Cockpit Audio Recording System, Ground Proximity Warning Systems (GPWS), Installation of Airborne Collision Avoidance System.

MODULE 2: C.A.R. SERIES " L& M" 9

CAR66-Licensing of Aircraft Maintenance Engineers, Procedure for renewal of AME's Licence, Issue of authorisation to Aircraft Maintenance Engineer's/Approved personnel, Approval of Flight Engineer Examiners and Check Flight Engineers, Procedure for issue/renewal/extension of Student Flight Engineer/Flight Engineer's licence, Validation of Foreign Licences of Aircraft Maintenance Engineers,Series M-Mandatory Modifications/ Inspections

MODULE 3: C.A.R. SERIES " O& R" 13	9
Manufacture, Registration and Operation of Powered Hang Gliders, Requirements for preparation of operations manual, Airworthiness and Maintenance Requirements for Cat II and Cat IIIA operations. Series 'R'- Installation of Communication, Navigation and Radar equipment, Installation of Mode 'A'/'C' and Mode 'S' Transponders,	
MODULE 4: C.A.R. SERIES " T "	**9**
C.A.R. series T: Flight testing of aircraft for which a C of A had been previously issued	
MODULE 5: CAR – X	**9**
C.A.R. series X – miscellaneous requirements: Weight and balance control of an aircraft, Provision of Medical Supplies in Aircraft, Use of furnishing materials in aircraft, Flammability requirements for furnishing materials to be used in aircraft, Aircraft Log Books, Document to be carried on board by Indian registered aircraft, Procedure for issue of taxy permit, Requirements for issue of taxy permit,	
TOTAL - 45	

TEXT BOOKS

- Aircraft manual (India) volume – latest edition, the English book store, 17-l, Connaught circus, New Delhi.
- Civil aviation requirements with latest amendment (section 2 airworthiness) – published by DGCA, the English book store, 17-l, Connaught circus, New Delhi.

REFERENCE BOOKS

- Aeronautical information circulars (relating to airworthiness) from DGCA.
- Advisory circulars from DGCA.

EBOOK

- http://dgca.nic.in/rules/car-ind.htm

MOOC

- https://www.mooc-list.com/search/node/civil%20aviation
- https://simandflight.com/2017/11/22/mooc-aircraft-maintenance

COURSEWARE LINK

- https://sites.google.com/a/hindustanuniv.ac.in/cska/home
- https://sites.google.com/a/hindustanuniv.ac.in/car-i/

TUTORIAL LINK

- https://sites.google.com/a/hindustanuniv.ac.in/cska/home

COURSE TITLE	AIRFRAME REPAIR LAB (Common to Aeronautical and Avionics)			CREDIT	1
COURSE CODE	AEB4432	COURSE CATEGORY	PC	L-T-P-S	0-0-3-0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES The student will be able to	PO
1	Understand TIG welding.	1,5,6
2	Perform the MIG welding.	3,5, 6
3	Do the riveted patch repair by manual and pneumatic	2, 3,6
4	Apply and form different shapes in sheet metal. .	1, 3,6
5	Apply the repair techniques of control cables	2, 3,6
6	Apply the repairing of nonmetallic window panels of Aircraft	3,5, 6
7	Understand the preparation of pipe ends for connecting components	2, 3,6

LIST OF EXPERIMENTS **TOTAL HOURS – 45**

1. Sheet Metal Forming.
2. Lap Joint by MIG Welding.
3. Butt Joint by TIG Welding.
4. Lap Joint by Riveting.
5. Butt Joint by Riveting.
6. Surface Patch Repair by Riveting (Using Pneumatic Gun).
7. Control cable inspection and repair.
8. Repair on Perspex glass panels.
9. Pipe flaring.
10. Composite Materials - Fabrication and Repair.

COURSE TITLE	AVIONICS LAB (Common to Aeronautical, Aerospace and Avionics)			CREDIT	1
COURSE CODE	AEB4431	COURSE CATEGORY	PC	L-T-P-S	0-0-3-0
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOME The students should be able to:	PO
1	Understand the functions of various instructions in RISC/ARM processor.	1, 2, 3, 10, 11, 12
2	Carry out data acquisition from various sensors on board.	1, 2, 6, 10, 11, 12
3	Perform the operation of actuation and alerting system.	1, 2, 6, 10, 11, 12
4	Execute data communication between analog and digital system.	1, 2, 10, 11, 12
5	Experiment how wireless protocol and interrupts used in data transfer.	1, 2, 6, 10, 11, 12
6	Understand the data transfer on MIL STD 1553B and AFDX data bus	1, 2, 10, 11, 12

LIST OF EXPERIMENTS **TOTAL HOURS - 45**

ARM / PIC microcontroller based experiments

1. Arithmetic and logical Operations using ARM and PIC.
2. Interfacing with temperature sensor to determine cabin temperature with PIC.
3. Interfacing with actuators to deflect the aircraft control surface with PIC.
4. Interfacing with sensor to determine altitude of flight with PIC.
5. Interfacing with temperature sensors to provide alarm in case of cabin fire with ARM.
6. Interfacing with ADC and DAC to communicate with external world devices with PIC.
7. Interfacing with LED and LCD and to provide indications in the cockpit with ARM and PIC.
8. Interfacing keyboard to provide input to the onboard computer PIC / ARM.
9. Implementing Zigbee protocol with ARM.
10. Interfacing memory and interrupts with ARM.

AVIONICS DATA BUSES

11. Study of Different Avionics Data Buses.
12. MIL-Std – 1553 Data Buses Configuration with Message transfer.
13. AFDX Configuration and message transfer.

LIST OF EQUIPMENTS

S.No.	Details of Equipment	Quantity	Experiment Nos.
1.	PIC Kit	10	1,2,3,4,6,7,8
2	ARM Kit	10	1,5,7,8,9,10
3	temperature sensors and alarm / buzzer	10	2,5,
4	Stepper motor actuation	10	3
5	Ultrasonic interface for range estimation	10	4
6	ADC and DAC interface	10	6
7	LED and LCD interface	10	7
8	keyboard interface	10	8
9	Xbee RF Module	10	9

10	Cathode Ray Oscilloscope	10	7,9
11	MIL-Std 1553B terminal	2	12
12	AFDX terminal	2	13
13	Computers	2 or 4	12,13

REFERENCES

1. Mohamed Rafiquzzaman, “Microcontroller Theory and Applications with the PIC18F” Wiley, 2018
2. Nicolas K. Haddad, “Microcontroller System Design Using PIC18F Processors” IGI Global, 2017.
3. William Hohl, Christopher Hinds, “ARM Assembly Language: Fundamentals and Techniques, Second Edition” CRC Press, 2016
4. Tammy Noergaard, “Embedded Systems Architecture: A Comprehensive Guide for Engineers and Programmers” 2nd edition, Newnes, 2013.
5. Raj Kamal, "Microcontrollers –Architecture, Programming, Interfacing System Design”, Dorling Kindersley India Pvt. Ltd., 2012.
6. Tim Wilmshurst, "Designing Embedded Systems with PIC Microcontrollers-Principles and Applications", Newnes Publications, 2007.
7. Muhammad Ali Mazidi, Rolin D. Mckinlay, Danny Causey ‘ PIC Microcontroller and Embedded Systems using Assembly and C for PIC18’, Pearson Education 2008

COURSE TITLE	AIRCRAFT DESIGN PROJECT-II (Common to Aeronautical and Avionics)			CREDIT	1
COURSE CODE	AEB4433	COURSE CATEGORY	PC	L-T-P-S	0-0-3-1
CIA	80%			ESE	20%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES The students should be able to:	POs
1	Detailed design of an aircraft fuselage – design of bulkheads and longerons – bending stress and shear flow calculations – buckling analysis of fuselage panels	1, 2, 3, 9,10
2	Design the control surfaces - balancing and maneuvering loads on the tail plane and aileron, rudder loads	1, 2, 6, 9,10
3	Design the wing-root attachment	1, 2, 4, 9,10

LIST OF EXPERIMENTS

1. Preliminary design of an aircraft wing – Shrenck's curve, structural load distribution, shear force, bending moment and torque diagrams
2. Detailed design of an aircraft wing – Design of spars and stringers, bending stress and shear flow calculations – buckling analysis of wing panels 3.
3. Preliminary design of an aircraft fuselage – load distribution on an aircraft fuselage
4. Detailed design of an aircraft fuselage – design of bulkheads and longerons – bending stress and shear flow calculations – buckling analysis of fuselage panels
5. Design of control surfaces - balancing and maneuvering loads on the tail plane and aileron, rudder loads
6. Design of wing-root attachment
7. Landing gear design 8. Preparation of a detailed design report with CAD drawings

TOTAL HOURS - 45

SEMESTER VIII

COURSE TITLE	PROJECT & VIVA - VOCE			CREDITS	8
COURSE CODE	AEB4441	COURSE CATEGORY	PC	L-T-P-S	0-0-24-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-5				

CO	COURSE OUTCOMES The students will be able to	PO
1	make comprehensive use of the technical knowledge gained from previous courses.	1,2,3,4,5,6,7,8,9,10,11,12
2	understand technologies concerned with the project.	1,2,3,4,5,6,7,8,9,10,11,12
3	apply project management skills (scheduling work, procuring parts and documenting expenditures and working within the confines of a deadline).	1,2,3,4,5,6,7,8,9,10,11,12
4	analyze, develop and demonstrate the proposed work	1,2,3,4,5,6,7,8,9,10,11,12
5	communicate technical information by means of ethical writing and presentation.	1,2,3,4,5,6,7,8,9,10,11,12

The Project Work shall be carried out in any of the Aeronautical Engineering areas such as Aircraft structures, Composite materials, Aerodynamics, Propulsion, Aircraft Maintenance and Avionics. Students shall work in convenient groups of not more than four members in a group. Every Project work shall have a Guide who is a member of the faculty of the Institute. During this period the students shall receive directions from the Supervisor/Project Coordinator for the progress of the Project Work.

The students shall give periodical presentations of the progress made in the Project Work. Each student shall finally produce a comprehensive report covering background information, literature survey, problem statement, Project work details and conclusions. This final report shall be typewritten form as specified in the guidelines.

LIST OF DEPARTMENTAL ELECTIVES – I (SEMESTER V)

COURSE TITLE	AIRCRAFT MATERIALS (Common to Aeronautical, Aerospace and Avionics)			CREDITS	3
COURSE CODE	AEC4251	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-5				

CO	COURSE OUTCOME At the end of this course, students should be able to	PO
1	Knowledge of the different material properties, defects and equipment, procedure to perform various destructive and non-destructive tests.	1,5,6
2	Knowledge of various strengthening and hardening mechanisms of materials	3, 5, 6
3	Knowledge of materials used in aircraft construction- Aluminium, Magnesium and Titanium, Steel, Copper alloys and Super alloys.	2, 3,6
4	Knowledge of composites, sandwich structures and adhesives	3,6

Prerequisites : Nil

MODULE 1: MECHANICAL BEHAVIOUR OF ENGINEERING MATERIALS **9**

Introduction to Materials - Atomic structure, Crystal structure, Imperfections in Solids – Point, Line, Surface, Volume Defects, Mechanical Properties of Materials– Elastic Deformation & Plastic Deformation, Stress and Strain Curves for Ductile & Brittle Materials, Types of Destructive testing – Tensile Test, Compressive test, Hardness Test (Brinell's, Rockwell"s, Vicker"s Hardness) and Impact testing (Izod&Charpy), Effect of notches,Bauchinger's effect, Flaw detection – NDT Methods.

MODULE 2: STRENGTHENING MECHANISMS IN MATERIALS **9**

Diffusion, Dislocation, Strengthening Mechanisms – Solid Solution Strengthening, Grain Boundary Strengthening, Hardening – Work Hardening, Precipitation Hardening, Secondary Hardening Process. Iron – Carbon Phase Diagram, Heat Treatment -Annealling, Tempering, Carburizing.

MODULE 3: FERROUS & NON FERROUS MATERIALS IN AIRCRAFT CONSTRUCTION **9**

Aluminium and its alloys: Classification - Properties – Heat treatment processes – Surface treatments. Application

Magnesium and its alloys: Classification - Cast and Wrought alloys – Heat treatment processes, Aircraft application.

Titanium and its alloys: Classification, Heat treatment processes, Welding Operations on Titanium.

Steels: Classification, Plain and low carbon steels, Structural applications, Heat treatment processes, Maraging Steels - Properties and Applications, Copper Alloys – Monel, K Monel

MODULE 4: COMPOSITES AND ADHESIVES **9**

Introduction to composites. Classifications on the basis of matrix and reinforcements. Laminated composites. Advantages and disadvantages. Applications of composite materials in Aerospace Industries. Sandwich Structures-Honeycomb structures – Methods of construction of honeycombs. Advantages of Bonded structure in airframes – Crack arresting – Weight saving – Technology of adhesive Bonding, Structural adhesive materials –Non -destructive tests for bonded joint.

MODULE 5: NANO MATERIALS AND MATERIAL CHARACTERIZATION **9**

Basic concepts of nano science and nano technology, nano fillers for polymer composites-graphene, fullerenes, CNT. Applications of nano materials. X-ray diffraction, neutron diffraction and electron

diffraction. Principles of SEM and TEM. Thermo-gravimetric Analysis (TGA) and Differential Scanning Calorimetry (DSC)
TEXT BOOKS
1. V Rajendran, "*Material Science*" Tata Mc Graw- Hill, New Delhi 2011 2. Titterton.G., Aircraft Materials and Processes, Pitman Publishing Co., 2004
REFERENCE BOOKS
1. V. RAGHAVAN, "Material Science & Engineering: A first course", Sixth Edition 2015. 2. "Advanced Composite Materials " ,Lalith Gupta 2006, Himalaya Book House, Delhi
E BOOKS
1. https://www.intechopen.com/books/solidification 2. https://www.intechopen.com/books/aluminium-alloys-recent-trends-in-processing-characterization-mechanical-behavior-and-applications 3. https://www.accessengineeringlibrary.com/browse/aircraft-materials-and-analysis
MOOC
1. https://onlinecourses.nptel.ac.in/noc18_me03/preview 2. http://nptel.ac.in/courses/113106032/16%20%20Properties%20and%20Applications%20of%20Materials.pdf

COURSE TITLE	**MEASUREMENTS AND INSTRUMENTATION (Avionics)**			**CREDITS**	**3**
COURSE CODE	**AEC4252**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
CIA	**50%**			**ESE**	**50%**
LEARNING LEVEL	**BTL-4**				

CO	**COURSE OUTCOME** **After learning the course the students should be able to:**	**PO**
1	Analyze the instruments errors and calibration.	1,2,3,4
2	Understand and determine problems in electrical and electronic instruments.	1,2,3
3	Applying various measurement and safety techniques for instruments	1,2,3,6,7
4	Understand the various flight data storage devices and display systems.	1,4,5,6,7
5	Application of sensors and transducers for data acquisition in aircraft.	1,2,5,6

Prerequisites : Nil

MODULE 1: INTRODUCTION	**9**
Functional elements of an instrument – Static and dynamic characteristics – Errors in measurement – Statistical evaluation of measurement data – Standards and calibration	
MODULE 2: ELECTRICAL AND ELECTRONICS INSTRUMENTS	**9**
Principle and types of analog and digital voltmeters, ammeters, multimeters – Single and three phase wattmeter's and energy meters – Magnetic measurements – Determination of B-H curve and measurements of iron loss – Instrument transformers – Instruments for measurement of frequency and phase.	

MODULE 3: BRIDGE MEASUREMENTS INSTRUMENT SAFETY	9
D.C & A.C potentiometers, D.C & A.C bridges, transformer ratio bridges, self-balancing bridges. Hazards and safety practices in aircraft - Interference & screening – Multiple earth and earth loops - Electrostatic and electromagnetic interference – Grounding techniques.	
MODULE 4: AIRCRAFT RECORDERS AND DISPLAY DEVICES	**9**
Magnetic disk and tape – Flight data Recorders, CVR, QAR, digital plotters and printers, CRT display, digital CRO, LED, LCD & dot matrix display – Data Loggers and aircraft displays.	
MODULE 5: TRANSDUCERS AND FLIGHT DATA ACQUISITION SYSTEMS	**9**
Classification of transducers – Selection of transducers – Resistive, capacitive & inductive transducers – Piezoelectric, Hall effect, optical and digital transducers – Elements of Flight data acquisition system – A/D, D/A converters – Smart sensors.	

TEXT BOOKS

1. A.K. Sawhney, 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2015.
2. J. B. Gupta, 'A Course In Electronics & Electrical Measurements And Instrumentation', S. K. Kataria& Sons, Delhi, 2008.
3. Doebelin E.O. and Manik D.N., Measurement Systems – Applications and Design, Special Indian Edition, Tata McGraw Hill Education Pvt. Ltd., 2007.

REFERENCE BOOKS

1. John G. Webster, HalitEren 'Measurement, Instrumentation, and Sensors Handbook: Two-Volume Set', edition 2 revised, CRC Press, 2018.
2. H.S. Kalsi, 'Electronic Instrumentation', Tata McGraw Hill, III Edition 2017.
3. D.V.S. Murty, 'Transducers and Instrumentation', Prentice Hall of India Pvt Ltd, II Edition 2010.
4. A.J. Bouwens, 'Digital Instrumentation', Tata McGraw Hill, 2001.
5. Ratandeep Singh "Aviation Management: Global and National Perspectives" Kanishka Publishers, 2009
6. Alan S. Morris and Reza Langari, 'Measurement and Instrumentation: Theory and Application', Second Edition, Academic Press, 2015.

E BOOKS

- https://nptel.ac.in/courses/112106139/pdf/1_1.pdf
- https://nptel.ac.in/courses/108105063/pdf/L-03(SS)(IA&C)%20((EE)NPTEL).pdf

MOOC

- https://swayam.gov.in/course/3764-industrial-instrumentation
- https://nptel.ac.in/syllabus/108106070/

COURSE TITLE	AEROSPACE DEVELOPMENTS IN INDIA			CREDITS	3
COURSE CODE	AEC4253	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	Understand the initial developments of space related activities	1,5,6
2	Understand the types of Launch vehicles and its purposes	3,5,6
3	Know the developments in and around the globe	2,3,6
4	Know the space programs of India	3,5,6
5	Know the future activities of Indian space community	1,5,6

Prerequisites : Nil

MODULE 1: HISTORY OF EARLY DEVELOPMENTS **9**

History of aviation - History of space flight, developments of space vehicle. Rocket propulsion-advance propulsion and its applications

MODULE 2: LAUNCH VEHICLES AND SPACECRAFTS **9**

General characteristics of Rocket engines, Launch vehicles and types of launch vehicle structures. Various systems in Launch vehicles. Satellites, types of like Pico, Nano, Micro, Small and commercial applications. Developments in Advanced materials and propulsion systems

MODULE 3: RECENT DEVELOPMENT IN AND AROUND WORLD **9**

Moon landing, Inter planetary mission like Mars. Space stations, Scientific experiments in space and space tourism.

MODULE 4: INDIAN DEVELOPMENT **9**

Early developments in Indian Space organization, Sounding Rocket, Satellite Launch vehicle, Polar Launch vehicle, GSLV, Reusable Vehicles. Inter planetary mission, Human space Mission

MODULE 5:FUTURE PLANS OF INDIA **9**

Developments of Heavy lift vehicles, Human space flight programs, Semi cryogenic engines, single stage orbit vehicles (SSTO) and two stage orbit vehicles (TSTO), Use of composite materials for space applications

TEXT BOOKS

1. Kermode, A.C., *"Flight without Formulae*", McGraw-Hill, 1997.
2. Lalit Gupta and O P Sharma, *"Fundamentals of Flight Vol-I to Vol-IV",* Himalayan Books, 2006

REFERENCE BOOKS

1. Anderson, J.D., *"Introduction to Flight",* McGraw-Hill, 8th Edition 2015.
2. Richard S. Shevell, *" Fundamentals of Flight",* Pearson Education,2nd Edition – 2004
3. Pallet, E.H.J.,*"Aircraft Instruments & Principles",* Pitman & Co 1993

COURSE TITLE	MECHANICS OF MACHINES (Common to Aeronautical, Aerospace and Avionics)			CREDITS	3
COURSE CODE	AEC4254	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL – 3				

CO	COURSE OUTCOMES The students should be able to :	PO
1	Understand the various mechanisms and its degree of freedom	1,5,6
2	Learn to find out the effect of centrifugal and initial tension in both drives and Condition for maximum power transmission	3, 5, 6
3	Learn to determine the speed and torque of the various types of gear geometry and also the follower motions of cam profile.	2, 3,6
4	Understand the concept of balancing in rotating mass and Balancing of radial V engine (reciprocating mass).	3,6
`5	Understand the Free, forced and damped vibrations and its force transmitted to supports	1,5,6

Prerequisites : ENGINEERING MECHANICS

MODULE 1:MECHANISMS **12 (9L + 3T)**

Machine - Structure – Kinematic link, pair and chain – Types of constrained motion – Kutzbach criteria - Grueblers criteria – Degrees of freedom – Inversion of mechanism – Four bar chain, single slider crank and Double slider crank mechanisms- Applications – Determination of velocity and acceleration in mechanisms by using relative method.

MODULE 2: FRICTION **12 (9L + 3T)**

Introduction –Types of friction- Friction between unlubricated and lubricated surfaces-Friction in screw and nut – Pivot and collar – plate and clutches –Belt (flat and V), rope drives and chain drives. Ratio of tensions – Effect of centrifugal and initial tension – Condition for maximum power transmission – Open and crossed belt drive.

MODULE 3: GEARING AND CAMS **12 (9L + 3T)**

Gear profile and geometry – Nomenclature of spur and helical gears – Gear trains: Simple, compound gear trains and epicylic gear trains - Determination of speed and torque - Cams – Types of cams – Design of profiles – Knife edged, flat faced and roller ended followers with and without offsets for various types of follower motions

MODULE 4: BALANCING **12 (9L + 3T)**

Static and dynamic balancing – Single and several masses in different planes –Balancing of reciprocating masses- primary balancing and concepts of secondary balancing – Single and multi-cylinder engines (Inline) – Balancing of radial V engine – direct and reverse crank method

MODULE 5: VIBRATION **12 (9L + 3T)**

Free, forced and damped vibrations of single degree of freedom systems – Force transmitted to supports – Vibration isolation – Vibration absorption – Torsional vibration of shaft – Single and multi-rotor systems – Geared shafts – Critical speed of shaft.

TEXT BOOKS

1. Rattan.S.S, "*Theory of Machines*", Tata McGraw–Hill Publishing Co, New Delhi, 4th Edition, 2014 6 tyhyu.
2. Ballaney.P.L, "*Theory of Machines",* Khanna Publishers, New Delhi, 2002.

REFERENCE BOOKS

1. Rao, J.S and Dukkipati, R.V, "*Mechanism and Machine Theory",* Second Edition, Wiley Eastern Ltd., 1992.
2. Malhotra, D.R and Gupta, H.C., *"The Theory of Machines*", SatyaPrakasam, Tech. India Publications, 1989.
3. Gosh, A. and Mallick, A.K., *"Theory of Machines and Mechanisms",* Affiliated East West Press, Edition: 3rd, 2006.
4. Shigley, J.E. and Uicker, J.J., *"Theory of Machines and Mechanisms",* McGraw-Hill, 4th Edition, 2014.
5. Burton Paul, "*Kinematics and Dynamic of Planer Machinery",* Prentice Hall.

E BOOKS

1. https://www.tutorialspoint.com/theory_of_machines/index.asp
2. https://www.btechguru.com/GATE--mechanical-engineering--theory-of-machines-video-lecture--23--189.html
3. https://mechanicalguru.in/theory-of-machine/

MOOC

1. https://ocw.mit.edu/courses/mechanical-engineering/
2. https://www.coursera.org/learn/machine-design1
3. http://nptel.ac.in/courses/112104121/1

Department Elective-II (Semester-VI)

COURSE TITLE	AIRCRAFT GENERAL ENGINEERING MAINTENANCE & PRACTICES			CREDITS	3
COURSE CODE	AEC4351	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	Explain about ground handling procedures and precautions, engine starting procedures.	1,5,6
2	Gain thorough understanding aboutthe ground servicing of sub systems in Aircraft	3, 5, 6
3	Understand the various shop safety Precautions, Environment cleanliness in an aircraft materials shop	2, 3,6
4	Get a clear idea about the FAA airworthiness regulations and the checklist involved in each inspection of aircraft	3,6
5	Explain about various tools used, terminology and specifications involved in Aircraft hardware selection and fluid line fittings.	1,5,6

Prerequisites : Nil

MODULE 1: AIRCRAFT GROUND HANDLING AND SUPPORT EQUIPMENT **10**

Mooring, jacking, leveling and towing operations - Preparation - Equipment - precautions - Engine starting procedures - Piston engine, turboprops and turbojets - Engine fire extinguishing - Ground power units.

MODULE 2: GROUND SERVICING OF VARIOUS SUB SYSTEMS **8**

Air conditioning and pressurization - Oxygen and oil systems - Ground units and their maintenance.

MODULE 3: MAINTENANCE OF SAFETY **5**

Shop safety - Environmental cleanliness - Precautions.

MODULE 4: INSPECTION **10**

Process - Purpose - Types - Inspection intervals - Techniques - Checklist - Special inspection - Publications, bulletins, various manuals - FAR Air worthiness directives - Type certificate Data Sheets - ATA specifications.

MODULE 5: AIRCRAFT HARDWARE, MATERIALS, SYSTEMS PROCESSES **12**

Hand tools - Precision instruments - Special tools and equipments in an airplane maintenance shop - Identification terminology - Specification and correct use of various aircraft hardware (i.e. nuts, bolts, rivets, screws etc.) - American and British systems of specifications - Threads, gears, bearings, etc. - Drills, tapes & reamers. - identification of all types of fluid line fittings. Materials, metallic and non-metallic - Plumbing Connectors - Cables - Swaging procedures, tests, Advantages of swaging over splicing.

TEXT BOOKS

KROES WATKINS DELP, "Aircraft Maintenance and Repair" - McGraw-Hill, New York 1993.

REFERENCE BOOKS

- A & P MECHANICS, "Aircraft hand Book" - F. A. A. Himalayan Book House, New Delhi, 1996.
- A & P MECHANICS, "General hand Book" - F. A. A. Himalayan Book House, New Delhi, 1996.

COURSE TITLE	FINITE ELEMENT METHOD (Common to Aeronautical, Aerospace and Avionics)			CREDITS	3
COURSE CODE	AEC4352	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50 %			ESE	50 %
LEARNING LEVEL	BTL- 3				

CO	COURSE OUTCOMES At the end of this course, students should be capable of	PO
1.	Effectively use basic structural elements to design structures to meet design requirements	3,5, 6
2.	Demonstrate the ability to analyze simple structures using finite element method	2, 3,6
3.	Understand and demonstrate the knowledge of structural behavior using FEM	3,6
4.	Formulation the stiffness, mass matrix for various finite elements	1,5,6

Prerequisites :SOLID MECHANICS,AEROSPACE STRUCTURAL MECHANICS

MODULE 1: INTRODUCTION TO FEM **9**

Introduction to finite element method, stiffness, mass, damping, formulation of FE equations and solution methods for static, dynamic and buckling analysis, Introduction to commercial software packages, pre and post processing

MODULE 2: APPROXIMATION TECHNIQUES AND 1D BAR ELEMENT **9**

Review of various approximate methods, strong and weak forms, Rayleigh-Ritz,Galerkin approximation, weighted residual method, Stiffness and Flexibility matrix for simple cases - Governing equation and convergence criteria, Stiffness matrix, mass matrix and load vector for 1D bar element in elasticity and heat transfer problems using classical and isoparametric formulation, assemblage of stiffness and mass matrices and load vectors

MODULE 3: BEAM AND FRAME ELEMENT **9**

Stiffness matrix formulation for beam and frame element using classical and iso-parametric approach, assemblage of stiffness matrix, mass matrix and load vectors. Deflection and stress analysis of beam, frame structures

MODULE 4: CONTINUUM ELEMENTS **9**

Plane stress, Plane strain and Axisymmetric problems, Stiffness matrix for CST Element and LST Element. Consistent and lumped load vectors. Use of area coordinates, Numerical integration. Application to elastic and heat transfer problems.

MODULE 5: PLATE AND SHELL ELEMENT **9**

Stiffness matrix derivation for plate bending element and general shell element using classical and isoparametric approach. Numerical integration in two dimensions

TEXT BOOKS

1. Tirupathi R. Chandrupatla and Ashok D. Belegundu, Introduction to Finite Elements in Engineering, Prentice Hall, 2002

2. S.S. Rao, "Finite Element Method in Engineering", Butterworth, Heinemann Publishing, 3rd Edition, 1998
3. K.J. Bathe and E.L. Wilson, "Numerical Methods in Finite Elements Analysis", Prentice Hall of India Ltd., 1983.
4. L.J. Segerlind, "Applied Finite Element Analysis", Second Edition, John Wiley and Sons Inc., NewYork, 1984.

REFERENCE BOOKS

1. Robert D. Cook, David S. Malkus, Michael E. Plesha and Robert J. Witt "Concepts and Applications of Finite Element Analysis", 4th Edition, John Wiley & Sons, 2002.
2. C.S. Krishnamurthy, "Finite Elements Analysis", Tata McGraw-Hill, 1987.Nostrand Co-Inc Princeton-N.J. 1990.
3. K.J. Bathe , " Finite element procedures" Prentice Hall of India Ltd., 2016.

E BOOKS

1. http://www.faadooengineers.com/threads/4169-Finite-Element-Analysis-Ebook-PDF-Download
2. http://ftp.demec.ufpr.br/disciplinas/TM310/livro/Finite%20Element%20Analysis,%20Theory%20and%20application%20with%20ANSYS,%.pdf

MOOC

1. http://nptel.ac.in/courses/112104116/
2. http://nptel.ac.in/courses/112104193/
3. https://ocw.mit.edu/courses/mechanical-engineering/2-092-finite-element-analysis-of-solids-and-fluids-i-fall-2009/

COURSE TITLE	WIND TUNNEL TECHNIQUES (Common to Aeronautical and Aerospace)			CREDITS	3
COURSE CODE	AEC4353	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES The student should able to:	PO
1	Use the Buckingham theorem for model testing.	3,5, 6
2	Clearly understand the working of different types of low and speed wind tunnels and water tunnels and their specifications.	2,3, 6
3	Know about horizontal buoyancy, flow angularities and other calibration parameters	3, 6
4	Know about aerodynamic measurements and three and six component external and internal balances for steady and unsteady force measurements.	1,5, 6
5	Get a clear idea about the surface and flow field flow visualization of incompressible and compressible flows	3,5, 6

Prerequisites: AERODYNAMICS

MODULE 1: PRINCIPLES OF MODEL TESTING **6**

Buckingham Theorem - Non-dimensional numbers - Scale effects, Types of similarities.

MODULE 2: WIND TUNNELS **10**

Classification - Special problems of testing in subsonic, transonic, supersonic and hypersonic speed regions –Water tunnels: Advantages, limitations and configurations for aeronautical and non-aeronautical applications – Layouts -Sizing, design parameters and loss estimation. Model making;Use of CFD in wind tunnel and water tunnel design.

MODULE 3: CALIBRATION OF WIND TUNNELS **8**

Test section speed - Horizontal buoyancy - Flow angularities - Turbulence measurements - Associated instrumentation - Calibration of low and high speed wind tunnels and water tunnels.

MODLE 4: WIND TUNNEL MEASUREMENTS **12**

Pressure, velocity and temperature measurements on and off model surfaces using conventional probes, fast response pressure transducer probes, thermal and optical anemometry - Temperature measurements; Pressure, temperature and shear stress sensitive paints; Model supports - Force measurements - Three component and six component balances - Internal balances.

MODLE 5: FLOW VISUALIZATION **9**

Surface and flow field visualization methods for wind tunnels and water tunnels; Optical methods of flow visualization - Photography techniques;Use of computers in wind tunnel operation, control, calibration, measurements and flow visualization.

TEXT BOOKS

1 Rathakrishnan E., “Instrumentation, Measurements, and Experiments in Fluids”, 2nd Ed., CRC Press, ISBN: 978131 5394862, CAT#KE37758, 520 pages, 2016.

2 Barlow Jewel B., William H. Rae and Alan Pope, “Low-Speed Wind Tunnel Testing”, 3rd Edition, Wiley, ISBN: 978-8-126-52568-3, 728 pages, 2010.

REFERENCE BOOKS

1 Discetti Stefano and Andrea Ianiro (Eds.), “Experimental Aerodynamics”, CRC Press, ISBN-

10: 1498704018,ISBN-13: 978-1498704014, 468 pages, 2017.

2 Pope Alan and Kenneth L. Goin, "High-Speed Wind Tunnel Testing", 1st Edition, Wiley, 1965. (Reprint edition: Robert E. Krieger Publishing Company, Malabar, Florida, 488 pages, 1978).

3 Goethert B., "Transonic Wind Tunnel Testing", Pergamon Press, 1961. Dover reprint 2007, ISBN 978-0486458816.

4 Russo Giuseppe P., "Aerodynamic measurements: From physical principles to turnkey instrumentation", Woodhead Publishing, ISBN-10: 1845699920, ISBN-13: 978-1845699925, 281 pages, 2011.

5 Tavoularis Stavros, "Measurement in Fluid Mechanics", Cambridge University Press, ISBN-10: 0521138396, ISBN-13: 978-0521138390, 370 pages, 2005.

6 Goldstein R. J. (Ed.), "Fluid Mechanics Measurements", 2nd ed., Taylor & Francis, ISBN-10: 156032306X, ISBN-13: 978-1560323068, 600 pages, 1996.

E BOOKS

1. https://www.scribd.com/doc/118591509/Lecture-Notes-on-Wind-Tunnel-TestingLecture Notes on Wind Tunnel Testing Uploaded by Aseem Taneja
2. https://www.scribd.com/document/352503625/High-Speed-Wind-Tunnel-Testing-Alan-Pope

MOOC

1. http://www.nptel.ac.in/courses/101106040
2. http://nptel.ac.in/courses/101103003 (Hypersonic Flows)

COURSE TITLE	PROGRAMMING IN ADA (Common to Aeronautical, Aerospace and Avionics)			CREDITS	3
COURSE CODE	AEC4354	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES	PO
1	Understand and apply the principles of Ada and encapsulation concept of object-oriented programming.	1,2,3,4,5
2	Analyze structure, types, Boolean loop and iteration in the data types of Ada.	1,2,3,4,5
3	Demonstrate the I/O capabilities, generics, packages and definition of Ada packages	1,2,3,4,5
4	Apply the concepts of parallel programming in the relevant field	1,2,3,4,
5	Execute the interface of Ada with other languages and learn the advanced concepts in Ada for further developments	1,2,3,4,5,11,12

Prerequisites : Nil

MODULE 1:OBJECT ORIENTED PROGRAMMING **9**

Overview- History of Ada -Inheritance, dynamic dispatching (polymorphism)- Encapsulation

MODULE 2: ADA DATA TYPES **9**

Basic Ada structures, program units, Ada structures, lexical elements, identifiers, numeric literals, character literals, Basic types- integer , float, Boolean, user defined types & rule types.Enumeration. Array, records, limited and private limited types, control structure- if, case, loop, loop iteration schemes, subprograms-declaration, parameter passing- local and global variables.

MODULE 3: ADA PACKAGES **9**

Declaration and bodies-packages-compilation units, I/O capabilities, Text file I/o, various text file, package command line options, child packages, exceptions - declarations, handling, generics definitions, formal parameters, visibility rules.

MODULE 4: PARALLEL PROGRAMMING **9**

Access types-declaration -unbounded types, unchecked deal location-task and protected types multitasking.

MODULE 5: INTERFACING WITH OTHER LANGUAGES **9**

Interfacing with C, Java vs. Ada, Ada applets, Java interfaces and aliased components- flight safety and Ada, recursion and efficiency, software inspection, debugging, Ada bindings, other Ada capabilities

TEXT BOOKS

1. Introduction to Ada Programming, Andrew Shvets, 2nd Edition, CreateSpace Independent Publishing Platform, 2018.
2. Alan Burns, Andy Wellings, ‘Analysable Real-time Systems: Programmed in Ada’, Createspace Independent Publishing Platform, 2016.
3. John W. McCormick, Frank Singhoff, JérômeHugues, ‘Building Parallel, Embedded, and Real-Time Applications with Ada’ Cambridge University Press, 2011.
4. Ada for experienced programmers-Habermann AN, Peary DE-Addison Wiley, 1983.
5. Ada in industry- Heibrunner s- Cambridge UniversityPress-1988.
6. Ada: Introduction & Ada reference manual- HegardH-Springer Verlag

REFERENCE BOOKS
1. Ada: Reference manual, Programming language-Spamgerverlag 2. Ada as a second language, Norman H.Cohen, McGraw Hill II edition, 1995. 3. Ada 95: Problem solving and program design, Michael B. Feildman, Elliot B. Koffman, Addison – Wesley, 1999. 4. Ada 95: The Craft of object oriented programming, John English I edition.
E-BOOKS
1. www.xplora.org/downloads/Knoppix/books/Ada_Programming.pdf 2. https://en.wikibooks.org/wiki/Ada_Programming 3. https://people.cs.kuleuven.be/~dirk.craeynest/ada-belgium/events/09/090207-fosdem/01-intro-ada.pdf
MOOC
1. http://university.adacore.com/courses/ 2. http://learnadanow.com/

COURSE TITLE	MEMS IN AEROSPACE APPLICATIONS (Avionics)			CREDITS	3
COURSE CODE	AEC4355	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	To understand the MEMS fabrication assembly and system integration	1,5,12
2	To gain knowledge on MEMs Transducers , sensors and actuators	1,5
3	To familiarize the concepts of INS and GPS and applications.	1,5,12
4	To acquire the knowledge of structural health monitoring (SHM) application for aerospace structures	1,5
5	To acquire the knowledge of future trends in spacecraft, satellite , propulsion systems.	1,5,12

Prerequisites :NA

MODULE 1: INTRODUCTION TO MEMS	9
Introduction - MEMS Fabrication Methods – Photolithography - Materials for Micromachining - Additive Films and Materials - Surface Micromachining - High-Aspect-Ratio-Micromachining - Assembly and System Integration - Packaging	
MODULE 2: MEMS TRANSDUCERS	**9**
Introduction - Mechanical Transducers - Mechanical Sensors - Mechanical Actuators - Radiation Transducers - Radiation Sensor - Radiation (Optical) Actuators – Thermal Transducers - Thermal Sensors - Thermal Actuators - Magnetic Transducers - Magnetic Sensors - Magnetic Actuators Chemical and Biological Sensors - Chemical Actuators - Microfluidic Devices	
MODULE 3: MEMS INERTIAL NAVIGATION SYSTEMS FOR AIRCRAFT	**9**
Introduction – Microfabrication - Integrated inertial navigation systems (INS) with global positioning system (GPS) - Application of an Inertial Navigation System to the Quad-rotor UAV using MEMS Sensors	

MODULE 4: MEMS FOR STRUCTURAL HEALTH MONITORING IN AIRCRAFT	9
Introduction- State-of-the-art structural health monitoring (SHM) application for aerospace structures - MEMS devices for embedded SHM - Conclusion and future trends	
MODULE 5: MEMS THRUSTERS FOR NANO- AND PICO-SATELLITES	**9**
Propulsion requirements- Miniaturizing propulsion systems - MEMS thrusters - Design considerations of MEMS thrusters - Future trends in spacecraft – small satellites - MEMS in spacecraft subsystems - MEMS in space science instrumentation.	
TEXT BOOKS	
1. Mems for Automotive and Aerospace Applications Hardcover – Jan 16 2013by Michael Kraft (Editor), Neil M White (Editor)	
REFERENCE BOOKS	
Title	MEMS: Fundamental Technology and Applications Devices, Circuits, and Systems
Editors	VikasChoudhary, Krzysztof Iniewski
Publisher	CRC Press, 2017
Title	Introduction to Microelectromechanical Systems EngineeringArtech House microelectromechanical systems (MEMS) seriesMicroelectromechanical systems series
Authors	NadimMaluf, Kirt Williams
Publisher	Artech House, 2004
Title	MEMS and Nanotechnology-Based Sensors and Devices for Communications, Medical and Aerospace Applications
Author	A. R. Jha
Edition	illustrated
E BOOKS	
1. https://books.google.co.in/books?isbn=144196018X 2. https://books.google.co.in/books?isbn=0070634459	
MOOC	
1. https://www.edx.org/course/micro-nanofabrication-mems-epflx-memsx-0 2. https://www.mooc-list.com/tags/mems 3. https://www.mooc-list.com/course/micro-and-nanofabrication-mems-edx	

LIST OF DEPARTMENT ELECTIVE – III (SEMESTER- VI)

COURSE TITLE	MICROPROCESSOR AND DIGITAL SYSTEMS (Avionics)			CREDITS	3
COURSE CODE	AEC4356	COURSE CATEGORY	PC	L-T-P-S	3-0-0-0
CIA	60%			ESE	40%
LEARNING LEVEL	BTL-4				

CO	COURSE OUTCOMES After learning the course the students should be able to:	PO
1	Understand operation of digital systems and design of combinational circuit design.	1, 2, 3, 9
2	Design of sequential circuit and understand the concepts of flip flop	1, 2, 3, 9
3	Learn the concepts of microprocessor and apply the programming skill to perform arithmetic and branching operations.	1, 2, 3, 9
4	Acquire the knowledge on interfacing with microprocessor and execute the interfacing process.	1, 2, 3, 9
5	Apply the concepts microprocessor and digital system by simple design of system.	1, 2, 3, 9, 10, 11

Prerequisites : Nil

MODULE 1 – COMBINATIONAL DIGITAL CIRCUITS (L-6,P-6)

Number system, Boolean, Sum of products and product of sums, Min-terms and Max-terms, Karnaugh map Minimization, Design of Half and Full Adders, Half and Full Subtractors, Multiplexer, Demultiplexer, Magnitude Comparator, Decoder, Encoder.

Lab:

1. Design of Adder and subtractor
2. Design of Multiplexer and demultiplexer
3. Design of Comparator
4. Design of Encoder and decoder

MODULE 2 –SEQUENTIAL DIGITAL CIRCUITS (L-5,P-4)

Flip flops – SR, JK, T, D, Analysis and design of clocked sequential circuits, Design of Counters, Shift registers.

Lab:

1. Study of flip flops
2. Design of a counter
3. Design of shift register

MODULE – 3 : MICROPROCESSORS (L-5,P-6)

Architecture of Intel 8085– Instruction Formats – Addressing Modes – Simple Assembly Language Programs – Arithmetic operations and loop-based programming.

Lab:

1. Addition and subtraction
2. Multiplication and division
3. Factorial and Fibonacci.
4. Sorting and finding largest or smallest number

MODULE – 4 : I/O INTERFACING (L-5,P-5)
Memory Interfacing and I/O interfacing - Parallel communication interface – Serial communication interface – D/A and A/D Interface – Keyboard /display controller **Lab**: 1. Keyboard and display interface 2. Switches and led interfacing 3. Wave generation using D/A 4. A/D interfacing
MODULE 5 – APPLICATIONS (L-3)
Microprocessor Applications in the field of aeronautical, Design a simple system as a mini project.
TEXT BOOKS
1. Ramesh Gaonkar, “Microprocessor Architecture, Programming and Applications with the 8085 “ Penram International Publishing; 6th edition (2013) 2. M. Morris Mano and Michael D. Ciletti, “Digital Design”, 5th Edition, Pearson, 2014 3. Krishna Kant, “Microprocessors And Microcontrollers : Architecture, Programming And System Design 8085, 8086, 8051, 8096” 2nd edition, PHI Learning Pvt. Ltd., 2014. 4. Anil K.Maini ”Digital Electronics”, Wiley, 2014.
REFERENCE BOOKS
1. A.Anand Kumar “Fundamentals of Digital Circuits”, 4th Edition, PHI Learning Private Limited, 2016. 2. Soumitra Kumar Mandal “ Digital Electronics”, McGraw Hill Education Private Limited, 2016. 3. DoughlasV.Hall, “Microprocessors and Interfacing, Programming and Hardware”,TMH,2012 4. A.K.Ray,K.M.Bhurchandi, "Advanced Microprocessors and Peripherals" 3rd edition, TataMcGrawHill, 2012
E-BOOK
1. https://www.nodia.co.in/image/catalog/2015/08/Digital-Electronics-sample-chapter.pdf 2. https://www.researchgate.net/profile/Dr_DK_Kaushik/publication/264005162_An_Introduction_to_Microprocessor_8085/links/53fb5d750cf2364ccc03d728/An-Introduction-to-Microprocessor-8085.pdf
MOOC
1. https://nptel.ac.in/courses/108107029/ 2. https://onlinecourses.nptel.ac.in/noc18_ee33/preview 3. https://www.coursera.org/learn/digital-systems

COURSE TITLE	HEAT TRANSFER (Common to Aeronautical, Aerospace)			CREDITS	3
COURSE CODE	AEC4357	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	LEARNING OUTCOME OF THE COURSE The students will be able to	PO
1	Apply principles of heat and mass transfer to engineering problems	1,2
2	Analyse and obtain solutions to problems involving various modes of heat transfer	1,2,3
3	Design heat transfer systems such as heat exchangers, fins, radiation shields etc.	2,3,4,5

Prerequisites : Aero Thermodynamics

MODULE 1: INTRODUCTION TO HEAT TRANSFER & STEADY STATE CONDUCTION. 9

Modes of Heat Transfer: Conduction: Fourier law of heat conduction-Thermal conductivity of solids, liquids and gases. Factors affecting thermal conductivity-Most general heat conduction equation in Cartesian, cylindrical and spherical coordinates. One dimensional steady state conduction with and without heat generation conduction through plane walls, cylinders and spheres-variable thermal conductivity conduction shape factor- heat transfer through corners and edges,Critical radius of insulation.

MODULE 2: UNIT II: CONDUCTION: ENERGY GENERATION, EXTENDED SURFACE & TRANSIENT CONDUCTION 9

Conduction with Thermal Energy Generation – Plane wall & radial systems, Heat Transfer from Extended Surfaces - Fins of Uniform Cross-Sectional Area, Fin Performance, Overall Surface Efficiency, Transient Conduction - The Lumped Capacitance Method, Large walls & long cylinders, Transient Conduction: Semi-infinite solids.

MODULE 3: UNIT III: CONVECTION: INTRODUCTION & FREE CONVECTION 9

Physical mechanism on convection, classification of fluid flows, Governing equation, velocity and thermal boundary layer, Empirical Correlations: External Free Convection Flows

MODULE 4: UNIT IV: FORCED CONVECTION 9

Laminar and turbulent convective heat transfer analysis in flows between parallel plates, Laminar and turbulent convective heat transfer analysis in flows over a flat plate, Laminar and turbulent convective heat transfer analysis in flows in a circular pipe. Heat Exchangers - LMTD,NTU Methods

MODULE 5: UNIT V: RADIATIVE HEAT TRANSFER 9

Nature of thermal radiation-definitions and concepts- monochromatic and total emissive power-Intensity of radiation- solid angle- absorptivity, reflectivity and transmissivity-Concept of black body- Planck' law- Kirchoff's law- Wein's displacement law-Stefan Boltzmann's law- black, gray and real surfaces-Heat exchange between black/gray surfaces- infinite parallel plates, equal and parallel opposite plates-perpendicular rectangles having common edge- parallel discs (simple problems using charts and tables). Radiation shields (no derivation).

TEXT BOOKS

1. Yunus A. Cengel&Afshin J. Ghajar, "Heat & Mass Transfer", fifth Edition, McGraw-Hill, 2014.
2. Sachdeva R C, Fundamentals of Engineering Heat and Mass Transfer, New Age Science Limited, 2009

3. R.K.Rajput. Heat and mass transfer, S.Chand& Co.,2015
4. Nag P K., Heat and Mass Transfer, McGraw Hill,2011
5. Kothandaraman, C.P., Fundamentals of Heat and Mass Transfer, New Age International, New Delhi, 2006

REFERENCE BOOKS

1. John H Lienhard, "A Heat Transfer Text Book", Dover publications inc, New York, 2011.
2. Theodore L. Bergman , Adrienne S. Lavine , Frank P. Incropera , David P. DeWitt, "Fundamentals of Heat and Mass Transfer", seventh Edition, John Wiley and Sons, New York, 2011
3. Sarma, P.K.,Rama Krishna, K. " Heat Transfer : A Conceptual Approach", New Age International publishers, eighth edition, 2006
4. Holman J P, Heat Transfer, McGraw Hill, 2011

DATA BOOK

C P Kothandaraman, Heat and mass transfer data book, New Age International Publishers, Eighth Edition, 2014

E BOOKS

http://web.mit.edu/lienhard/www/ahtt.html

MOOC

https://www.class-central.com/course/nptel-heat-transfer-10061

COURSEWARE LINK

https://sites.google.com/a/hindustanuniv.ac.in/stanleyaeroedu/subjects/heat-transfer

COURSE TITLE	BOUNDARY LAYER THEORY (Common to Aeronautical , Aerospace and Avionics)			CREDITS	3
COURSE CODE	AEC4358	COURSE CATEGORY	PE	L-T-P-S	3-0-0-0
CIA	40 %			ESE	60 %
LEARNING LEVEL	BTL- 4				

CO	COURSE OUTCOMES Student should able to:	PO
1	Know about the basic fundamentals of Different types of Boundary layer thickness	1,2,3 5,6,12
2	Understand the behaviour of the fluid flow under static condition	1, 2,3, 6, 12
3	Understand the basics of different types of flows such as laminar, turbulent and compressible. Incompressible, viscid and inviscid flow	1, 2, 5,6, 12
4	Know the basics of flow separation and boundary layer control	1, 2,3 5,6, 12
5	Know more about analytic techniques and wind tunnel experiments.	1, 2,12

Prerequisites : Fluid Mechanics , Low Speed Aerodynamics, Gas Dynamics

MODULE 1: BASIC CONCEPTS OF VISCOUS FLOWS **9**

Viscous flow characteristics, introduction to hydrodynamic andthermal boundary layer theory, governing equations with effect ofviscosity, flow over the flat plate at zero incidences, boundarylayer thickness, displacement thickness, momentum thickness,energy thickness, boundary layer equation and their generalproperties.

MODULE 2: SOLUTIONS TO BOUNDARY LAYER FLOWS **9**

Flat plate at zero angle of incidence, method of exact solution-Blassius solution to boundary layer problems,Approximate solutions – Von Karman solution to boundary layerflows over the flat plate, flow with pressure gradient, flow over acylinder, plane Couette flow, circular Couette flow betweenparallel plates.

MODULE 3: TRANSITION **9**

Pipe flow and flow over a flat plate, critical Reynolds number,turbulentsts, principles of theory of stability of Laminar flows,Summerfield equation, factors effecting transition, Laminar aerofoils.

MODULE 4: TURBULENT BAOUNDARY LAYERS **9**

Fundamentals of turbulent flow, Mean motion fluctuations, ReynoldsEquations, Reynolds stresses, wind tunnel turbulence, Prandtl'smixing length theory, velocity distribution laws.

MODULE 5: BOUN DARY LAYER CONTROL AND THERMAL BOUNDARY LAYER **9**

Need of boundary layer control, causes of boundary layerseparation, flow over the cylinder and aero foil for different flowconditions lead separationHeat transfer from heated surface. Heat transfer from cold surface,thermal boundary layer growth over the hot and cold surface, flowover the flat plate with different flow conditions with heat transfer,exact and approximate solutions to thermal boundary layer flows,relation between thermal and hydrodynamic boundary layertheories, Reynolds analogy andColburn analogy, non-dimensional numbers governing boundarylayer flows.

TEXT BOOKS

H Schlichting - Boundary-Layer TheoryPublished May 20th 2003 by Springer – available in Indian edition

REFERENCE BOOKS

1. J.O. Hinze -Turbulence: An Introduction to Its Mechanism and Theory 1959

2. Guy Métivier - Small Viscosity and Boundary Layer Methods: Theory, Stability Analysis, and Applications (Modeling and Simulation in Science, Engineering and Technology) 1st ed. 2004 Edition, Kindle Edition.

E BOOKS

1. https://www.springer.com/in/book/9783662529171
2. https://www.elsevier.com/books/boundary-layer-and-flow-control/lachmann/978-1-4832-1323-1

MOOC

1. https://nptel.ac.in/courses/105101082/31
2. https://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/FLUID-MECHANICS/ui/Course_home-9.htm

COURSE TITLE	CRYOGENIC PROPULSION (Common to Aeronautical and Aerospace)			CREDITS	3
COURSE CODE	AEC4359	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL – 3				

CO	COURSE OUTCOMES	PO
1	Understand the background of cryogenic technology and its applications.	1,2,3 5,6,12
2	Understand the properties of cryogenic materials and their production.	1, 2,3, 6, 12
3	Understand the different methods used for cryogenic insulation.	1,2, 5,6, 12
4	Understand the technique for storing cryogenics.	1, 2,3 5,6, 12
5	Understand the different cryogenic equipment's and their applications.	1, 2,12

Prerequisites : HEAT TRANSFER and AERO ENGINEERING THERMODYNAMICS

MODULE 1:INTRODUCTION TO CRYOGENIC ENGINEERING **9**

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

MODULE 2: PROPERTIES **9**

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

MODULE 3: CRYOGENIC INSULATION **9**

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

MODULE 4: 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.

MODULE 5: CRYOGENIC EQUIPMENT **9**

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.

TEXT BOOKS

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

REFERENCE BOOKS

1. 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.

E BOOKS

www.onlinelibrary.wiley.com/doi/10.1002/vipr.19980100419/full

COURSEWARE LINK

nptel.ac.in/downloads/112101004/

TUTORIAL LINK

nptel.ac.in/Clarify_doubts.php?subjectId=112101004

COURSE TITLE	EXPERIMENTAL STRESS ANALYSIS			CREDITS	3
COURSE CODE	AEC4360	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES At the end of this course, students should be able to	PO
1	Analyze instruments for measurements	1,5,6
2	Awareness of NDT methods.	3, 5, 6
3	Use strain gauge effectively	2, 3,6
4	Analyze photo elastic results	2, 3,6
5	Estimate the Interpretation of fringe pattern.	1,4,5, 6

Prerequisites : Nil

MODULE 1: MEASUREMENTS **4**

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

MODULE 2: EXTENSOMETERS **6**

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

MODULE 3: 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.

MODULE 4: 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.

MODULE 5: 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.

TEXT BOOKS

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

REFERENCE BOOKS

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.

LIST OF DEPARTMENT ELECTIVE-IV (SMESTER –VII)

COURSE TITLE	COMPUTATIONAL FLUID DYNAMICS			CREDITS	3
COURSE CODE	AEC4366	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL- 3				

CO	COURSE OUTCOMES	PO
1	At the end of this course, students will be able to Distinguish the flow phenomena in a flow field in correspondence with elliptic, parabolic and hyperbolic equations. Apply the steps involved in source and vortex panel methods. Gain knowledge on steps involved in grid generation methods.	1,2,3,5
2	Discretize flow governing equations in explicit and implicit formulations with knowledge on stability and numerical dissipation. Apply upwind discretization to a given flow problem.	1,2,3,5
3	Gain knowledge on strong and weak formulations including weighted residual, Galerkin and variational formulations of finite element technique and to implement the FEM solution for a given flow problem.	1,2,3,5
4	Gain knowledge on cell centered and cell vertex formulations of the numerical finite volume method and apply them with different time stepping schemes using central and upwind discretization for flow problems.	1,2,3,5
5	Able to solve the complex flow field problems with suitable turbulence models with detailed understanding of its physics.	2,3,5

Prerequisites : Fluid Mechanics and Machinery & Numerical Methods

MODULE 1: FUNDAMENTAL CONCEPTS **12**

Mathematical properties of Fluid Dynamics Equations - Elliptic, Parabolic and Hyperbolic equations- Initial and Boundary conditions - Well posed- ill Posed problems; Discretization of partial differential equations; Grid generation – Introduction, types of grids – structured, unstructured, single and multi-block grids, hybrid and adaptive grids; Meshless methods; Explicit finite difference methods of subsonic, supersonic and viscous flows- Implicit and explicit schemes; Source panel method - Vortex panel method

MODULE 2: 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.

MODULE 3: FINITE ELEMENT TECHNIQUES **8**

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.

MODULE 4: FINITE VOLUME TECHNIQUES	9
Finite Volume Techniques - Cell centered formulation - Lax – Wendroff 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 discretization - Treatment of derivatives.	
MODULE 5: FLOW FIELD ANALYSIS AND TURBULENCE MODELS	**8**
Pressure and Velocity corrections - Pressure correction equation; SIMPLE algorithm and its variants; PISO algorithms; Turbulence models – algebraic mixing length model, one and two equation models - High and low Reynolds number models.	

TEXT BOOKS

1. R.H. Pletcher, J.C. Tannehill, and D.A. Anderson, "Computational Fluid Mechanics and Heat Transfer", 3rd Edition, CRC Press - Taylor & Francis, 2013.
2. W. Versteeg and H. Malalasekara, "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", 2nd Edition, Pearson Education, 2010.

REFERENCE BOOKS

1. J. D. Anderson, "Computational Fluid Dynamics: The Basics with Applications", McGraw Hill Education, Indian Edition 2017
2. John F. Wendt (Editor), "Computational Fluid Dynamics: An Introduction", A Von Karman Institute Book, 3rd Edition. 2009
3. Suhas V Patankar, "Numerical Heat Transfer and Fluid Flow", CRC Press Paperback 2017.
4. K. Muralidhar and T. Sundararajan (Editors), "Computational Fluid Flow and Heat Transfer", 3rd Edition,
5. Narosa Publishing House, 2009
6. Klaus A. Hoffmann and Steve T. Chiang, "Computational Fluid Dynamics for Engineers", Vols. I, II and III, 4th
7. Edition, Engineering Education System, Wichita, KS, 67208-1078 USA, 2000
8. SedatBiringen and Chuen-Yen Chow, "An Introduction to Computational Fluid Mechanics by Example", 2nd Ed., John Wiley and Sons, New York, 2011
9. C. A. J. Fletcher, "Computational Techniques for Fluid Dynamics", Vols. I and II, 2nd Edition., Springer-Verlag, Berlin, 1990

E BOOKS

1. https://books.google.co.in/books?isbn=3540850562
2. https://books.google.co.in/books?isbn=0070016852
3. https://books.google.co.in/books?isbn=0081012446
4. https://books.google.co.in/books?isbn=1139446835

MOOC

1. https://nptel.ac.in/courses/112105045
2. www.engr.uky.edu/~acfd/me691-lctr-nts.pdf

COURSE TITLE	HIGH TEMPERATURE GAS DYNAMICS (Common to Aeronautical and Aerospace)			CREDITS	3
Course Code	AEC4367	Course Category	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES At the end of the course, students will be able to	PO
1	Acquire knowledge on high temperature flows and the associated gas equations and functions.	1, 2
2	Apply the basics of statistical thermodynamics to calculate the thermodynamic properties of gas species.	1,2,3,5
3	Acquire knowledge of the governing equations of inviscid high temperature equilibrium and non-equilibrium flows.	1,2,3,5
4	Distinguish the mechanism of thermal conduction and diffusion and calculate transport properties.	1,2,3
5	Acquire knowledge of the governing equations of viscous chemically reacting flows and apply parabolized Navier-Stokes equations for chemically reacting flows.	1,2,3,5

Prerequisites : Thermodynamics

MODULE 1: INTRODUCTION **8**

Importance of High-Temperature Flows, Nature of High-Temperature Flows, Chemical Effects in Air: The Velocity-Altitude Map, Thermodynamics of Chemically Reacting Gases, Kinetic theory of gases, Definition of Real Gases and Perfect Gases, Various Forms of the Perfect-Gas Equation of State, Collision Frequency and Mean Free Path, Velocity and Speed Distribution Functions, Classification of Gases, First Law of Thermodynamics, Second Law of Thermodynamics, Calculation of Entropy, Gibbs Free Energy, Heat of Reaction.

MODULE 2: STATISTICAL THERMODYNAMICS **10**

Introduction, Microstates &Macrostates, Boltzmann Distribution, Evaluation of Thermodynamic Properties in Terms of the Partition Function, Evaluation of the Partition Function in terms of T andV, Thermodynamic Properties for a Single Chemical Species, Calculation of the Equilibrium Constant, Chemical Equilibrium, Calculation of the Equilibrium Composition or High-Temperature Air, Thermodynamic Properties of an Equilibrium Chemically Reacting Gas, Equilibrium Properties of High-Temperature Air.

MODULE 3:INVISCID HIGH TEMPERATURE EQUILIBRIUM AND NON-EQUILIBRIUM FLOWS **10**

Introduction, Governing Equations for Inviscid High-Temperature Equilibrium Flow, Equilibrium Normal and Oblique Shock-Wave Flows, Equilibrium Quasi-One-Dimensional Nozzle Flows, Frozen and Equilibrium Flows: The Distinction, Equilibrium and Frozen Specific Heats, Equilibrium Speed of Sound, Equilibrium Conical Flow, Equilibrium Blunt-Body Flows.

Governing Equations for Inviscid, non-equilibrium flows, Non-equilibrium Normal and Oblique Shock-Wave Flows.

MODULE 4:TRANSPORT PROPERTIES IN HIGH TEMPERATURE GASES **8**

Introduction, Definition of Transport Phenomena, Transport Coefficients, Mechanism of Diffusion, Energy Transport by Thermal Conduction and Diffusion: Total Thermal Conductivity, Transport Properties for High-Temperature Air.

MODULE 5: VISCOUS HIGH TEMPERATURE FLOWS **9**

Introduction, Governing Equations for Chemically Reacting Viscous Flow, Alternate Forms of the Energy Equation, Boundary-Layer Equations for a Chemically Reacting Gas, Boundary Conditions:

Catalytic Walls, Boundary-Layer Solutions: Stagnation-Point Heat Transfer for a Dissociating Gas, Parabolized Navier-Stokes Solutions to Chemically Reacting Flows.
TEXT BOOKS
John D. Anderson Jr., "Hypersonic and High-Temperature Gas Dynamics", 2nd Edition, AIAA Education Series, 2006.
REFERENCE BOOKS
1. Tarit K. Bose, "High Temperature Gas Dynamics – An Introduction for Physicists and Engineers", 2nd Edition, Springer, 2014. 2. H.W. Liepmann and A Roshko, "Elements of Gas Dynamics", Dover Publications, 2001 3. John D. Anderson, "Modern Compressible Flow: with Historical Perspective", McGraw Hill Education, Indian Edition, 2017
E-BOOK
https://www.kobo.com/us/en/ebook/high-temperature-gas-dynamics
MOOC
https://nptel.ac.in/courses/101103003/44

COURSE TITLE	VIBRATION AND AEROELASTICITY			CREDITS	3
COURSE CODE	AEC4368	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL – 3				

CO	COURSE OUTCOMES The students should be able to:	PO
1	Understand the basics of vibrations and simple harmonic motion.	1,5,6
2	Differentiate types of vibrations according to dampness and particle motion	3, 5, 6
3	Clearly understand the need of a multi degree of freedom particle and its characteristics.	2, 3,6
4	Solve Rayleigh and Holzer method to find natural frequency of an object.	2, 3,6
5	Understand the formation of Aileron reversal, flutter and wing divergence.	1,5,6

Prerequisites : Nil

MODULE 1: BASIC NOTIONS **8**

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

MODULE 2: SINGLE DEGREE OF FREEDOM SYSTEMS **12**

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

MODULE 3: MULTI 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.

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

MODULE 4: APPROXIMATE METHODS **5**

Rayleigh's and Holzer Methods to find natural frequencies.

MODULE 5: ELEMENTS OF AEROELASTICITY **10**

Concepts - Coupling - Aero elastic instabilities and their prevention - Basic ideas on wing divergence, loss and reversal of aileron control - Flutter and its prevention.

TEXT BOOKS

1. TIMOSHENKO S., "Vibration Problems in Engineering"- John Wiley and Sons, New York, 1993.
2. FUNG Y.C., "An Introduction to the Theory of Aeroelasticity" - John Wiley & Sons, New York, 1995.

REFERENCE BOOKS

1. BISPLINGHOFF R.L., ASHELY H and HOGMAN R.L., "Aeroelasticity" - Addison Wesley Publication, New York, 1913.
2. TSE. F.S., MORSE, I.F., HUNKLE, R.T., "Mechanical Vibrations", - Prentice Hall, New York, 1914.
3. SCANLAN R.H. & ROSENBAUM R., "Introduction to the study of Aircraft Vibration & Flutter", John Wiley and Sons. New York, 1912.
4. BENSON H.TONGUE, "Principles of Vibration", OxfordUniversity Press, 2000.

COURSE TITLE	COMPOSITE MANUFACTURING, REPAIR AND MAINTENANCE			CREDITS	3
COURSE CODE	AEC4369	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	Fabricating the composite material using various methods	1,5,6
2	Assessing the damages in the composite materials.	3, 5, 6
3	Identifying the advanced repair techniques	2, 3,6
4	Knowing the issues in maintenance procedure in composite material.	2, 3,6

Prerequisites : Nil

MODULE 1: MANUFACTURING TECHNIQUES (10)

Definitions and applications, Lay-Up Methods for Fabrics and Tapes, Filament Winding Pultrusion, Resin Transfer Moulding Injection Moulding, Press Moulding, Vacuum Bonding, Autoclave Bonding.

MODULE 2: DAMAGE AND REPAIR ASSESSMENT (10)

Damage Types Sources of Mechanical Damage, Damage Mapping, Assessment of Damage Significance. Visual Inspection, Tap Test, Ultrasonic Inspection, X-Ray Methods, Eddy Current Inspection Thermography, Bond Testers, Moisture Meters, Interferometry/Shearography.

MODULE 3: REPAIR PROCEDURES (6)

Typical Repairs. Reserve factor, Disbonding Methods, Damage Removal, Surface Preparation of Composites-Repair Sanding and Ply Determination.

MODULE 4: ADVANCE REPAIR METHODS (6)

Selection of methods - Speed-tape, Resin Sealing, Potted Repairs, Bolted Doublers (Metal Plates) and Bonded Doublers (Composite Patches), Pre-Cured Doublers Versus Co-Cured Doublers Pre-Preg. Repairs, Scarfed and Stepped Lap Repairs.

MODULE 5: MAINTENANCE OF COMPOSITE COMPONENTS (13)

Safety Precautions-composite workshop, Care of tools, use of workshop materials, Maintenance Procedures - Maintenance Planning, stores procedures, maintenance inspection, Tools and consumables, including repair material for composite workshops, maintenance issues during the development of composite structures and the importance of providing maintenance information.

TEXT BOOKS

1. Keith B. Armstrong, L. Graham Bevan, William F. Cole. “Care and Repair of Advanced Composites”, SAE International; 2 edition, 2005. ISBN-10: 0768010624.
2. Advanced Composites 2nd (second) Edition by Foreman, Cindy published by Jeppesen (2002).

REFERENCE BOOKS

1. Lalit Gupta, “Advanced Composite Materials”, Himalaya Publishing House, 1998. ISBN-10: 8170020697
2. Murphy, John, “The Reinforced Plastics Handbook”, 2nd edition, Elsevier Advanced Technology, London, U.K., ISBN 1-85617-348-8, 1998.
3. Matthews, F.L., and Rawlings, R.D., “Composite Materials-Engineering and Science”, Chapman and Hall, London, U.K., ISBN 0-412-55960-9 (hardbound), ISBN 0-412-55970-6, 1994.
4. Aircraft Maintenance and Repair ByKroes, Watkin and Delph.
5. Aviation Maintenance Technician Hand book by FAA
6. A & P Technician Airframe Textbook, by Jeppesen, Current Edition.

COURSE TITLE	AIRCRAFT NAVIGATION SYSTEMS (Common to Aeronautical and Avionics)			CREDITS	3
COURSE CODE	AEC4370	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	Know the dynamics of the vehicle.	1,5,12
2	Appreciate the tools available for solving the problems in the vehicle dynamics	1,5,12
3	Appreciate the problems associated with the vehicle development	1,5,12
4	Use the various vehicle testing methods to extract the maximum performance	1,5,12

Prerequisites : Nil

MODULE 1: NAVIGATION SYSTEMS & SENSORS **6**

Introduction to aircraft navigation systems– Introduction to Inertial Sensors - Mechanical - Ring Laser gyro- Accelerometers, Fiber optic gyro – MEMS system, Multi-sensors navigation.

MODULE 2: INERTIAL NAVIGATION SYSTEMS **10**

INS components: transfer function and errors- Earth in inertial space - coriolis effect – INS Mechanization. Platform and Strap down – Navigation algorithms - INS system block diagram, Different co-ordinate systems – Transformation Techniques - Schuler Tuning - compensation errors - Gimbal lock - Initial calibration and Alignment Algorithms.

MODULE 3: NAVIGATION, TRACKING AND SAFETY SYSTEMS **11**

Different types of radio navigation- ADF, VOR, DME - Doppler – Hyperbolic Navigations -LORAN, DECCA and Omega – TACAN, ILS, MLS, GLS - Ground controlled approach system - surveillance systems-radio altimeter, TCAS, ATC transponder, Automatic dependent surveillance,Regional Navigation Systems- Distress and Safety- Cospas-Sarsat- Inmarsat Distress System- Location-Based service,Emergency locator transmitters.

MODULE 4: MISSILE AND UAV NAVIGATION **9**

Tactical Guidance Intercept Techniques, Proportional Navigation, Augmented and 3D Proportional Navigation, Optimal Control of Linear Feedback system, Way-point Navigation, UAV Control Stations, Path Planning,CollisionAvoidanceand Mid-air Collision (MAC) Avoidance.

MODULE 5: SATELLITE NAVIGATION & HYBRID NAVIGATION **9**

Introduction to Global Navigation Satellite Systems, Concepts of GPS, DGPS, Introduction to Kalman filtering-Estimation and mixed mode navigation Integration of GPS and INS-utilization of navigation systems in aircraft.

TEXT BOOKS

1. Mike Tooley, David Wyatt“Aircraft Communications and Navigation Systems”, 2nd edition, Routledge, 2018
2. Myron Kyton, Walfred Fried, ‘Avionics Navigation Systems’, John Wiley & Sons,2nd edition, 1997 2. Global Navigation Satellite Systems, Inertial Navigation, and Integration, 3rd EditionMohinder S. Grewal, Angus P. Andrews, Chris G. Bartone

3. Nagaraja, N.S. —Elements of Electronic Navigation‖, Tata McGraw-Hill Pub. Co., New Delhi, 2nd edition, 1975.

REFERENCE BOOKS

1. Reg Austin, Unmanned Aircraft Systems: UAVS Design, Development and Deployment, wiley, 2010.
2. George M. Siouris, Missile Guidance and Control Systems, Springer New York, 2010.
3. AntoniosTsourdos, Brian A White, MadhavanShanmugavel, Cooperative Path Planning of Unmanned Aerial Vehicles, wiley, 2010.
4. George M Siouris, 'Aerospace Avionics System; A Modern Synthesis', Academic Press Inc., 1993.
5. Albert Helfrick, 'Practical Aircraft Electronic Systems', Prentice Hall Education, Career & Technology, 1995.
6. Albert D. Helfrick, 'Modern Aviation Electronics', Second Edition, Prentice Hall Career & Technology, 1994. 6. Sen, A.K. & Bhattacharya, A.B. "Radar System and Radar Aids to Navigation", Khanna Publishers, 1988. 7. Slater, J.M. Donnel, C.F.O and others, "Inertial Navigation Analysis and Design", McGraw-Hill.

E- BOOKS

https://www.faa.gov/regulations_policies/handbooks_manuals/aircraft/amt_airframe_handbook/media/ama_Ch11.pdf

MOOC

http://nptel.ac.in/courses/101108056/

COURSE TITLE	AUTOPILOT SYSTEMS (Common to all)			CREDITS	3
COURSE CODE	AEC4371	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	After learning the course, the students should be able to: Apply linear algebra to complex real world problems in order to obtain models that are expressed using state space equation	1,5,6
2	Effectively derive the differential equations and transfer functions of longitudinal equation of motion of an aircraft.	3, 5, 6
3	Analyse the behaviour of longitudinal autopilot systems using tools like Matlab	2, 3,6
4	Effectively derive the differential equations and transfer functions of lateral equation of motion of an aircraft.	2, 3,6
5	Analyse the behaviour of lateral autopilot systems using tools like Matlab	1,4,5, 6

Prerequisites : Knowledge in Flight Control System and mathematic modelling of systems

MODULE 1: STATE SPACE ANALYSIS OF CONTROL SYSTEMS **10 (8L + 2T)**

State Variables; State-Space Representation of Electrical and Mechanical and Electromechanical Systems; State Space Representation of Nth Order Linear Differential Equation; Transformation to Phase Variable Canonical Form; Relationship Between State Equations and Transfer Functions; Characteristic Equation; Eigen Values and Eigen Vectors; Transformation to Diagonal Canonical Form; Jordan Canonical Form; Controllability Canonical Form; Observability Canonical Form; Decomposition of Transfer Function-Direct, Cascade and Parallel Decomposition; State Diagram; Solution of the Time-Invariant State Equation; State Transition Matrix and its Properties; Transfer Matrix; Transfer Matrix of Closed Loop Systems

MODULE 2: LONGITUDINAL DYNAMICS **8 (6L + 2T)**

Introduction -The Meaning of Velocities in a Moving Axis System Development of the Equations of Motion(Controls Locked) -Aircraft Attitude with Respect to the Earth - linearization and Separation of the Equations of Motion - Longitudinal Equations of Motion- Derivation of Equations for the Longitudinal Stability Derivatives Solution of the Longitudinal Equations(Stick Fixed) - Longitudinal Transfer Function for Elevator Displacement - Transient Response of the Aircraft- Effect of Variation of Stability Derivatives on Aircraft Performance.

MODULE 3: LONGITUDINAL AUTOPILOTS **9 (7L + 2T)**

Displacement Autopilot - Pitch Orientational Control System - Acceleration Control System - Glide Slope Coupler and Automatic Flare Control – Flight Path Stabilization - Vertical Gyro as the Basic Attitude Reference - Gyro Stabilized Platform as the basic Attitude Reference- Effects of Nonlinearities.

MODULE 4: LATERAL DYNAMICS **9 (7L + 2T)**

Lateral Equations of Motion- Derivation of Equations for the Lateral Stability Derivatives – Solution of Lateral Equations (Stick Fixed) - Lateral Transfer Function for Rudder Displacement- Lateral Transfer Function for Aileron Displacement - Approximate Transfer Functions- Transient Response of the Aircraft- Effect of Stability Derivative Variation

MODULE 5: LATERAL AUTOPILOTS **9 (7L + 2T)**

Introduction – Damping of the Dutch Roll – Methods of Obtaining Coordination - Discussion of Coordination Techniques - Yaw Orientational Control System- Other Lateral Autopilot Configurations – Tum Compensation - Automatic Lateral Beam Guidance - Nonlinear Effects

TEXT BOOKS	
John H. Blakelock, Automatic control of aircraft and missiles, Wiley India Pvt.Ltd.(2011)	
REFERENCE BOOKS	
Title	Aircraft Autopilot Design: Comparison of Classical and Modern Design Techniques
Author	Richard John Rosasco
Published	1990
Title	Multivariable Autopilot Design and Implementation for Tactical Missiles AD-a356 536
Contributors	Friedrich S. Kramer, Raytheon co tewksbury ma missile systems labs
Publisher	Raytheon Company tewksbury ma missile systems labs, 1998
Title	Nonlinear Problems in Aviation and Aerospace Stability and Control: Theory, Methods and Applications
Editor	S. Sivasundaram
Edition	illustrated
Publisher	CRC Press, 2000
E- BOOKS	
1. https://books.google.co.in/books?isbn=1420083147l	
2. https://books.google.co.in/books?isbn=3656960054	
MOOC	
1. shodhganga.inflibnet.ac.in/bitstream/10603/31658/9/09_chapter%204.pdf	
2. nptel.ac.in/syllabus/101106042/	
3. nptel.ac.in/courses/101108047/	

COURSE TITLE	HIGH TEMPERATURE MATERIALS (Common to Aeronautical, Aerospace)			CREDITS	3
COURSE CODE	AEC4372	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	Knowledge of creep behaviour, mechanisms and effect of different parameters like stress, temporary, strain rate on creep.	1,5,6
2	Knowledge of laws that would be beneficial in determining the rupture life of a component	3, 5, 6
3	Knowledge of various types of fracture and its occurrence.	2, 3,6
4	Knowledge of Oxidation and Corrosion, its interaction, transition and methods to combat hot corrosion.	2, 3,6
5	Knowledge of super alloys and other high temperature materials.	1,4,5, 6

Prerequisites : AIRCRAFT MATERIALS

MODULE 1: CREEP (9L)

Creep – Creep Strength, Creep Limit, Creep Curve - Stages of Creep, Creep Fracture, Factors influencing creep property of a material, Factors Affecting Creep – Temperature, Stress, Time, Grain Size, Mechanism of Creep – Diffusion Creep & Dislocation Creep, Metallurgical Factors Influencing Creep at High Temperature, Creep Test, Creep resistant materials.

MODULE 2: LAWS TO DETERMINE CREEP (9L)

Laws of Creep- Andrade's law, Logarithmic Law, Hyperbolic Law of Transient creep, Secondary creep law,Laws to determine rupture life of component – Larson –Miller Parameter, Monkman Grant Relationship, Creep Mechanism Maps.

MODULE 3: HIGH TEMPERATURE FRACTURE (9L)

Fracture – Types of Fracture –Ductile fracture, Brittle fracture, Shearing Fracture, Factors AffectingFracture, Fracture toughness, Griffith Theory of Brittle Fracture, Blue Brittleness, Orange Peel Effect, Cleavage Fracture, Micro void Coalescence and Dominant Void Growth Modes, Ductile to Brittle Transition (DBT), Bauchinger's effect.

MODULE 4: OXIDATION & CORROSION (11L)

Oxidation –Nature of Oxides formed on Metal Surface, Types of Corrosion, Kinetic laws of Oxidation – Parabolic rate law, Linear rate law and Logarithmic rate law, Pilling-Bedworth ratio, Corrosion – Types of Corrosion, Factors Influencing Corrosion, Fluxing Mechanisms – Acidic and Basic Fluxing, Effect of Alloying Element on Hot Corrosion, Corrosion Control - Methods to Combat Hot Corrosion.

MODULE 5: HIGH TEMPERATURE RESISTANT MATERIALS (7L)

Super Alloys – Cobalt Base, Nickel base, Iron Base. Ultra High Temperature Ceramics, Inter-metallics, Thermal Barrier Coatings, Hydrogen Embrittlement, Refractory Metals, Structural Heat Resistant Composites.

TEXT BOOKS
Norman E Dowling, “Mechanical Behaviour of Materials” Pearson Publisher, Fourth Edition, 2012. Jun-Shan Zhang, “High Temperature Deformation and Fracture of Materials”, First Edition, Woodhead Publishing, 2010.
REFERENCE BOOKS
J.Betten, “Creep Mechanics” Springer, 3rd Edition 2008.
E-BOOKS
1. https://books.google.co.in/books?id=e-51AgAAQBAJ&printsec=frontcover#v=onepage&q&f=false 2. https://www.crcpress.com/High-Temperature-Materials-and-Mechanisms/Bar-Cohen/p/book/9781138071544
MOOC
1. https://www.coursera.org/learn/materials-science/lecture/Fpo4U/mechanisms-for-creep-deformation **2.** https://www.doitpoms.ac.uk/tlplib/creep/index.php
COURSEWARE LINK
https://sites.google.com/a/hindustanuniv.ac.in/amit/letter/high-temperature-materials

LIST OF DEPARTMENT ELECTIVE – V (SMESTER – VII)

COURSE TITLE	HELICOPTER MAINTENANCE			CREDITS	3
COURSE CODE	AEC4451	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES At the end of this course, students should be capable of understand	PO
1	Helicopter basics and various maintenance procedures.	1,5,6
2	Clear idea about Head maintenance with flight and mast control systems.	3, 5, 6
3	The transmission process in helicopter rotor and torque meter working.	2, 3,6
4	The working of Power plant rotors and tail rotor.	2, 3,6
5	The fuselage maintenance procedures with special hardware requirements.	1,4,5, 6

Prerequisites : Nil

MODULE 1: HELICOPTER FUNDAMENTALS **5**

Basic directions - Ground handling, bearing - Gears.

MODULE 2: MAIN ROTOR SYSTEM **9**

Head maintenance - blade alignment - Static main rotor balance - Vibration - Tracking - Span wise dynamic balance - Blade sweeping -Electronic balancing - Dampener maintenance - Counter weight adjustment - Auto rotation adjustments - Mast & Flight Control Rotor - Mast - Stabilizer, dampeners- Swash plate flight control systems collective - Cyclic - Push pull tubes - Torque tubes - Bell cranks - Mixer box - Gradient unit control boosts - Maintenance & Inspection control rigging.

MODULE 3: MAIN ROTOR TRANSMISSIONS **12**

Engine transmission coupling - Drive shaft - Maintenance clutch - Freewheeling units - Spray clutch - Roller unit - Torque meter - Rotor brake - Maintenance of these components - vibrations - Mounting systems - Transmissions.

MODULE 4: POWER PLANTS & TAIL ROTORS **12**

Fixed wing power plant modifications - Installation - Different type of power plant maintenance. Tail rotor system - Servicing tail rotor track - System rigging.

MODULE 5: AIRFRAMES AND RELATED SYSTEMS **7**

Fuselage maintenance - Airframe Systems - Special purpose equipment

TEXT BOOKS

1. JEPPESEN, "Helicopter Maintenance", Jeppesons and Sons Inc., 2000.
2. Lalit Gupta and M.R.Sivaraman", Helicopter Engineering, Himalaya Publishing House,2015.

REFERENCE BOOKS

1. Joe Schafer, " Helicopter Maintenance", Aviation Maintenance Pub,2007.
2. "Civil Aircraft Inspection Procedures", Part I and II, CAA, English Book House, New Delhi, 1916.
3. LARRY REITHMIER, "Aircraft Repair Manual", Palamar Books Marquette, 1992.

E BOOKS

1. http://www.flightschoollist.com/free-aviation-books.php
2. http://libguides.hcc.hawaii.edu/aero

MOOC

1. http://nptel.ac.in/courses/101104017/
2. https://www.canvas.net/browse/erau/courses/aviation-maintenance

COURSE TITLE	FATIGUE AND FRACTURE MECHANICS			CREDITS	3
COURSE CODE	AEC4452	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES At the end of this course, students	PO
1	should be able to understand the various empirical relation to calculate endurance limit	1,5,6
2	should be able to know about the fatigue behaviour in strain based approach	3, 5, 6
3	should be able to understand the phases in fatigue fracture surfaces.	2, 3,6
4	should be able to analyze the strength of cracked bodies by various approach	2, 3,6
5	should be able to know about the damage tolerant structures	1,4,5, 6

Prerequisites : Nil

MODULE 1: FATIGUE OF STRUCTURES **9**

S.N. curves - Endurance limit - Effect of mean stress - Goodman, Gerber and Soderberg relations and diagrams - Notches and stress concentrations - Neuber's stress concentration factors - plastic stress concentration factors - S-N curves for typical notched geometries.

MODULE 2: STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR **9**

Low cycle and high cycle fatigue - Coffin-Manson's relation - Transition life - Cyclic Strain hardening and softening - Analysis of load histories - Cycle counting techniques - Cumulative damage - Miner's theory - other theories.

MODULE 3: PHYSICAL ASPECTS OF FATIGUE **9**

Phase in fatigue life - Crack initiation - Crack growth - Final fracture - Dislocations - Fatigue fracture surfaces.

MODULE 4: FRACTURE MECHANICS **9**

Strength of cracked bodies - potential energy and surface energy - Griffith's theory - Irwin - Orwin extension of Griffith's theory to ductile materials - Stress analysis of cracked bodies - Effect of thickness on fracture toughness - Stress intensity factors for typical geometries.

MODULE 5: FATIGUE DESIGN AND TESTING **9**

Safe life and fail-safe design philosophies - Importance of Fracture Mechanics in aerospace structure - Application to composite materials and structures.

TEXT BOOKS

1. Prashant Kumar, *Elements of Fracture Mechanics,* McGraw Hill Education; July 2017, ISBN-10: 0070656967.
2. **F. C. Campbell,** Fatigue and Fracture: Understanding the Basics,ASM International, 2012, ISBN-10: 1615039767.
3. D.Brock, “Elementary Engineering Fracture Mechanics”, Noordhoff International Publishing Co., London, 1994.

REFERENCE BOOKS
1. Nestor Perez, *Fracture Mechanics*, Springer International Publishing AG; 2nd ed. 2017 edition, ISBN-10: 9783319249971 2. **J. Y. Mann, I. S. Milligan, *Aircraft Fatigue: Design, Operational and Economic Aspects*,**Pergamon, 2015, ISBN-10: 1483114031 3. W.Barrois and L.Ripley, "Fatigue of Aircraft Structures", Pergamon Press, Oxford, 1983.
E BOOKS
https://www.elsevier.com/books/basic-fracture-mechanics/smith/978-0-7506-1489-4
MOOC
1. https://ecourses.ou.edu/cgi-bin/ebook.cgi?topic=me 2. http://www.nptel.ac.in/courses/112106065/

COURSE TITLE	HELICOPTER AERODYNAMICS			CREDITS	3
COURSE CODE	AEC4453	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES	PO
1	Understand the various configuration propulsive devices and its performances at different flight conditions	1,5,6
2	Have a fundamental knowledge types of helicopter and its control system.	3, 5, 6
3	Understand the momentum theory, power estimation and constant chord and ideal twist rotors	2, 3,6
4	Understand power requirements, performance Curves, variation altitude in forward flight and helicopter stability	2, 3,6
5	Understand Hovercraft types, lift augmentation and power calculations of plenum chambers, applications	1,4,5, 6

Prerequisites : AERODYNAMICS

MODULE 1: LIFT, PROPULSION AND CONTROL OF V/STOL AIRCRAFT	12 (9L + 3T)
Various configurations - propeller, rotor, ducted fan and jet lift-Tilt wing and vectored thrust - performance of VTOL and STOL aircraft in hover, transition and forward motion.	
MODULE 2: ELEMENTS OF HELICOPTER AERODYNAMICS	**12 (9L + 3T)**
Configurations based on torque reaction - Jet rotors and compound helicopters - Methods of control - collective and cyclic pitches changes - Lead - lag and flapping hinges.	
MODULE 3: IDEAL ROTOR THEORY	**12 (9L + 3T)**
Hovering performance - Momentum and simple blade element theories - Figure of merit - Profile and induced power estimation - Constant chord and ideal twist rotors.	
MODULE 4: POWER ESTIMATES	**12 (9L + 3T)**
Induced, profile and parasite power requirements in forward flight - performance curves with effects of altitude - Preliminary ideas on helicopter stability.	

MODULE 5: GROUND EFFECT MACHINES	12 (9L + 3T)
Types - Hover height, lift augmentation and power calculations for plenum chamber and peripheral jet machines - Drag of hovercraft on land and water. Applications of hovercraft.	
TEXT BOOKS	
B.W. Mc Cormic, "Aerodynamics of V/STOL Flight", Academic Press, New York, 1978.	
REFERENCE BOOKS	
1. Gessow and G.C.Meyers, "Aerodynamics of the Helicopter", Macmillan and Co., New York, 1982. 2. G.H. Elsley and A.J. Devereux, "Hovercraft Design and Construction, David Charies, London, 1982. 3. Anderson J.D. "Aerodynamics", John Wiley, 1995.	
E BOOKS	
https://www.abebooks.com/9780521660600/Principles-Helicopter-Aerodynamics-Cambridge-Aerospace-0521660602/plp	
MOOC	
http://nptel.ac.in/Clarify_doubts.php?subjectId=101104017	
COURSEWARE LINK	
https://sites.google.com/a/hindustanuniv.ac.in/	
TUTORIAL LINK	
https://sites.google.com/a/hindustanuniv.ac.	

COURSE TITLE	ROCKET AND MISSILES			CREDITS	3
COURSE CODE	AEC4454	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES The students should be able to :	PO
1	Design Consideration of liquid Rocket Combustion Chamber and Design Considerations of Igniter and types of igniters.	1,5,6
2	Describing Aerodynamic Forces and Moments. Lateral Damping Moment and Longitudinal Moment of a Rocket	2, 3,6
3	Explain the One Dimensional and Two Dimensional rocket Motions in Free Space and Homogeneous Gravitational Fields.	1,4,5, 6
4	Understand various methods of thrust determinations and thrust vector control. It will also describe the rockets Separation Techniques.	1,5,6
5	Understanding of selection criteria for materials and Special Requirements of Materials to Perform under Adverse Conditions.	3, 5, 6

Prerequisites : PROPULSION	
MODULE 1: ROCKET SYSTEMS	**10 (8L + 2T)**
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.	

MODULE 2: AERODYNAMICS OF ROCKETS AND MISSILES 8 (6L + 2T)
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
MODULE 3: ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD 9 (7L + 2T)
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.
MODULE 4: STAGING AND CONTROL OF ROCKETS AND MISSILES 9 (7L + 2T)
Rocket Vector Control - Methods - Thrust determination - SITVC - Multistaging of rockets -Vehicle Optimization - Stage Separation Dynamics - Separation Techniques.
MODULE 5 : MATERIALS FOR ROCKETS AND MISSILES 9 (7L + 2T)
Selection of Materials - Special Requirements of Materials to Perform under Adverse Conditions.
TEXT BOOKS
Sutton, G.P., et al., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 1993.
REFERENCE BOOKS
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.
E BOOKS
https://www.nasa.gov/pdf/635963main_RocketsPeopleVolume2-ebook.pdf
MOOC
http://nptel.ac.in/courses/112106073/
COURSEWARE LINK
TUTORIAL LINK

COURSE TITLE	HYPERSONIC AERODYNAMICS			CREDITS	3
COURSE CODE	AEC4455	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL- 3				

CO	COURSE OUTCOMES	PO
1	Understand the fundamentals of hypersonic flows and also	1,5,6
2	understanding the shock wave nature in hypersonic flow regime and quantitatively analyse the property variation.	3, 5, 6
3	Solve the inviscid and viscous flows in the hypersonic regime using specific methods.	2, 3,6
4	Evaluate the Boundary layer interaction in hypersonic flow. Understand and analyse the heat-transfer related issues in the hypersonic regime..	2, 3,6
5	Prepare themselves for the futuristic design of the vehicles including high speed heat transfer problems in aerospace	1,4,5, 6

Prerequisites : Nil

MODULE 1: FUNDAMENTALS OF HYPERSONIC AERODYNAMICS **9**

Introduction to hypersonic aerodynamics – differences between hypersonic aerodynamics and supersonic aerodynamics – concept of thin shock layer and entropy layers – hypersonic flight paths – hypersonic similarity parameters

Shock wave and expansion wave relations of inviscid hypersonic flows

MODULE 2: SIMPLE SOLUTION METHODS FOR HYPERSONIC INVISCID FLOWS **9**

Local surface inclination method – Newtonian theory – modified Newtonian law

Tangent wedge and tangent cone and shock expansion methods

Approximate methods – hypersonic small disturbance theory – thin shock layer theory

MODULE 3: VISCOUS HYPERSONIC FLOW THEORY **9**

Boundary layer equation for hypersonic flow – hypersonic boundary layers – self similar and non-self-similar layers – solution methods for non-self-similar boundary layers

Aerodynamic heating

MODULE 4: VISCOUS INTERACTION IN HYPERSONIC FLOWS **9**

Introduction to the concept of viscous interaction in hypersonic flows – Strong and weak interactions – hypersonic viscous interaction similar parameter

Introduction to shock wave layer interactions

MODULE 5: HEAT TRANSFER PROBLEMS IN AEROSPACE ENGINEERING **9**

Nature of the high temperature flows – chemical effects in air – real and perfect gases – Gibb's free energy and entropy

Chemically reacting mixtures – recombination and dissociations

TEXT BOOKS

John D. Anderson Jr., *"Hypersonic and High Temperature Gas Dynamics,"* McGraw Hill Series, New York, 1996

REFERENCE BOOKS

1. William, H. D., "*Viscous Hypersonic Flow – Theory of Reacting and Hypersonic Boundary Layers*,"

Dover Publications Inc. Mineola, New York, 2017.
2. Murthy, T. K. S., "Computational Methods in Hypersonic Aerodynamics," Springer, New Delhi, 1992 edition.
3. Dr. Mukarram Hussain, "*Hypersonic Aerodynamic Performances of Asymmetric Re-Entry Vehicles*," LAP Lambert Academic Publishing, Saarbrücken, Germany, 2011.
4. John D. Anderson Jr., *"Modern Compressible Flow with Historical Perspective"*. McGraw Hill Publishing Company, New York, 1996.
5. John T. Bertin, *"Hypersonic Aerothermodynamics"*, published by AIAA Inc.,

E-BOOKS

1. https://play.google.com/store/books/details?id=nzSPVBZ_Yg0C&rdid=book-nzSPVBZ_Yg0C&rdot=1&source=gbs_vpt_read&pcampaignid=books_booksearch_viewport
2. https://play.google.com/store/books/details/Victor_Giurgiutiu_Structural_Health_Monitoring_wit?id=AG5h8Hu-MdUC

MOOC

Ht https://onlinecourses.nptel.ac.in/noc18_oe05/preview

COURSE TITLE	AEROSPACE STRUCTURAL HEALTH MONITORING SYSTEM (Smart Sensor Technologies and Signal Processing)			CREDITS	3
COURSE CODE	AEC4456	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES After learning the course the students should be able to:	PO
1	Develop the new type of smart sensor for health monitoring system	1,5,6
2	Design the damage detection using different technique.	3, 5, 6
3	Understand the development of sensor using smart materials for aerospace application	2, 3,6
4	Analysis, assessment of manufactured sensor	2, 3,6
5	Understand the difference between theoretical developments and engineering applications	1,4,5, 6

Prerequisites : Nil

Module 1: AIRCRAFT STRUCTURAL HEALTH AND USAGE MONITORING 10 (8L + 2T)

Introduction - aircraft structural damage - ageing aircraft problem - lifecycle cost of aerospace structures - aircraft structural design - damage monitoring systems in aircraft - non-destructive testing - structural health monitoring - emerging monitoring techniques and sensor technologies

MODULE 2: OPERATIONAL LOAD MONITORING USING OPTICAL FIBRE SENSORS 8 (6L + 2T)

Introduction - Fibre Optics - Sensor Target Specifications - Reliability of Fibre Bragg Grating Sensors - Fibre Coating Technology - Example of Surface Mounted Operational Load Monitoring Sensor System - Optical Fibre Strain Rosette - Example of Embedded Optical Impact Detection System

MODULE 3: DAMAGE DETECTION USING STRESS AND ULTRASONIC WAVES	9 (7L + 2T)
Acoustic Emission – Ultrasonics - Acousto-ultrasonics - Guided Wave Ultrasonics - Piezoelectric Transducers - Passive Damage Detection Examples - Active Damage Detection Examples	
MODULE 4: SIGNAL PROCESSING FOR DAMAGE DETECTION	**9 (7L + 2T)**
Introduction - Data Pre-processing - Signal Features for Damage Identification - Time–Domain Analysis - Spectral Analysis - Instantaneous Phase and Frequency - Time–Frequency Analysis - Wavelet Analysis - Dimensionality Reduction Using Linear and Nonlinear Transformation - Data Compression Using Wavelets Wavelet-based Denoising - Pattern Recognition for Damage Identification - Artificial Neural Networks	
MODULE 5: STRUCTURAL HEALTH MONITORING EVALUATION TESTS	**9 (7L + 2T)**
Introduction - Large-scale Metallic Evaluator - Large-scale Composite Evaluator- Flight Tests - Summary	
TEXT BOOKS	
Staszewski, W., Boller, C., & Tomlinson, G. R. (Eds.). (2004). Health monitoring of aerospace structures: smart sensor technologies and signal processing. John Wiley & Sons.	
REFERENCE BOOKS	
Title : Structural Health Monitoring for Space Systems (Aerospace Series) Editors : Andrei Zagrai (Editor), Brandon Arritt (Editor), Derek Doyle (Editor) Publisher : Wiley-Blackwell **ISBN-10:** 1118729641	
E- BOOKS	
1. https://play.google.com/store/books/details?id=nzSPVBZ_Yg0C&rdid=book-nzSPVBZ_Yg0C&rdot=1&source=gbs_vpt_read&pcampaignid=books_booksearch_viewport 2. https://play.google.com/store/books/details/Victor_Giurgiutiu_Structural_Health_Monitoring_wit?id=AG5h8Hu-MdUC	
MOOC	
1. https://onlinecourses.nptel.ac.in/noc18_oe05/preview 2. http://www.cism.it/courses/A1102/ 3. http://courses.ce.metu.edu.tr/ce5802/2015/02/11/hello-world/	

COURSE TITLE	INTRODUCTION TO NANOCOMPOSITES			CREDITS	3
COURSE CODE	AEC4457	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL-3				

CO	COURSE OUTCOMES The students should be able to	PO
1	To know about the various types of nanomaterials and its dispersibility.	1,5,6
2	To have the knowledge about the synthesis methods for the manufacturing of nanocomposite.	3, 5, 6
3	To understand the various characterizing techniques.	2, 3,6
4	To know about the theory and modeling of nanocomposite materials.	2, 3,6
5	To know about the application of nanocomposite materials in different fields	1,4,5, 6

Prerequisites : Basic Composite Materials and Structures

MODULE 1: INTRODUCTION TO NANOCOMPOSITE MATERIALS (8)

Nanomaterials- classification of nanomaterials, carbon and – non carbon based nanomaterials- properties of materials, different polymers such as thermoplastic, thermoset and elastomer - characterization of nanocomposite materials and their dispersibility.

MODULE 2: SYNTHESIS OF NANOCOMPOSITES (10)

Top Down Approach Grinding, Planetary milling and Comparison of particles, Bottom Up Approach, Wet Chemical Synthesis Methods, Preparation technologies - mechanical alloying, Colloidal Nanoparticles production, Sol Gel Methods, Gas phase Production Methods : physical/Chemical Vapour Depositions.

MODULE 3: CHARACTERIZATION OF NANOCOMPOSITES (9)

Morphological Studies – Scanning Electron Microscopy (SEM) / Transmission Electron Microscopy (TEM) / Atomic Force Microscopy (AFM) –– Structural and Thermal studies – Melt Flow Index (MFI) – Fourier transform Infra-red (FTIR) – X Ray Diffraction (XRD).

MODULE 4: MULTI SCALE MODELING IN NANOCOMPOSITES (6)

Nanocomposite materials modelling: current issues. Multiscale modelling. Multi-physics modelling, Basics of MD simulations, Modelling of nanocomposites and its constituents.

MODULE 5: APPLICATIONS TO NANOCOMPOSITES (12)

Nanocomposites for fiber reinforced polymer matrix composites, Thermoplastic elastomer nanocomposites for propulsion systems, Thermoset nanocomposites for rocket ablative materials, nano modified carbon-carbon composites, Sensors for aerospace and defense applications.

TEXT BOOKS

1. Ajayan P.M., Schadler L.S., Braun P.V. "Nanocomposites Science and Technology", Wiley-VCH, 2003.

REFERENCE BOOKS

1. Riichiro Saito, Gene Dresslhaus, and Dresselhaus M.S., "Physical Properties of Carbon Nanotubes", Imperial College Press, 1999.
2. Joseph H. Koo, “Polymer Nanocomposites”: Processing, Characterization and applications, McGraw-Hill Nanoscience and Technology series(McGraw-Hill professional, 2006.

3. B. D.Cullity, —Elements of X - ray Diffraction, 4th Edition, Addison Wiley, 1978.
4. A.D. Pomogailo and V.N. Kestelman, Metallopolymer Nanocomposites, Springer-Verlag Berlin Heidelberg 2005, ISSN 0933-033x.
5. K K Chattopadhyay And A N Banerjee, Introduction To Nanoscience And Nanotechnology, PHI Learning, ISBN-978-81-203-3608-7, 2009.
6. Introduction to Nanocomposite Materials: Properties, Processing, Characterization by Thomas E. Twardowski, DEStech Publications, Inc (21 June 2007), ISBN-10: 1932078541
7. Shaker A. Meguid, Advances in Nanocomposites: Modeling, Characterization and Applications, Springer International Publishing, ISBN:978-3-319-31660-4, 2016.

E-BOOK

https://www.nanowerk.com/nanotechnology/periodicals/ebook_a.php

MOOC

http://nptel.ac.in/courses/118102003/27

COURSE TITLE	AIRBORNE RADAR SYSTEM (Common to Aeronautical and Avionics)			CREDITS	3
COURSE CODE	AEC4458	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
CIA	50%			ESE	50%
LEARNING LEVEL	BTL- 3				

CO	COURSE OUTCOMES At the end of this course, students should be able to	PO
1	Know the concepts of Phased array antennas and detection of moving targets	1,5,6
2	Classify the Antennas and propagation as related to various types of radar systems	3, 5, 6
3	Explain the Radars requirements and waveforms	2, 3,6
4	Device the Advantages and constraints of tracking radars	2, 3,6
5	Apply the concepts of radar systems for aircraft in landing and other aids.	1,4,5, 6

Prerequisites : Nil

MODULE 1: INTRODUCTION TO RADAR **9**

Basic Radar –The simple form of the Radar Equation- Radar Block Diagram- Radar Frequencies – Applications of Radar- Receiver noise and signal to noise ratio- Radar cross section (RCS) – Radar system –system losses- Radar Antennas types.

MODULE 2:TYPES OF RADARS **9**

CW and FMCW radars-Tracking radars-MTI radar -Principles of coherent MTI radars - Digital MTI, Synthetic Aperture radar, Principles of Pulsed Doppler Radar, Low-, High-, and medium-PRF Mode.

MODULE 3: RADAR SIGNAL PROCESSING **9**

Radar requirements –Matched filters- Radar ambiguity function – Optimum waveforms for detection in clutter – Classes of waveforms – Digital representation of signals -Pulse compression.

MODULE 4: TRACKING RADAR **9**

Tracking with radar – Monopulse Tracking – conical scan and sequential lobing – limitations to tracking Accuracy- Kalman Tracker -Fundamentals of Airborne radar.

MODULE 5:FLIGHT RADAR SYSTEM	9
History of flight radar-Role of radar in military and civil aircraft-Airborne Radars-Aircraft Doppler Stabilization and Navigation- Applications of Doppler Weather Radar-Air Traffic Control radar beacon system- Applications of microwave radar.	
TEXT BOOKS	
1. Merrill I. Skolnik ," Introduction to Radar Systems", 3rd Edition Tata Mc Graw-Hill 2003. 2. N.S.Nagaraja, "Elements of Electronic Navigation Systems", 2nd Edition, TMH, 2000.	
REFERENCE BOOKS	
1. Peyton Z. Peebles:, "Radar Principles", John Wiley, 2004 2. J.C Toomay, " Principles of Radar", 2nd Edition –PHI, 2004	