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. Aerospace 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 worldclassresearch. To nurture creativity andinnovation.
- ✓ To instill highest ethical standards andvalues.
- ✓ To pursue activities for the development of theSociety.
- ✓ To develop national and international collaborations with institutes and industriesof 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 and Aerospace Engineering.

MISSION

M1: To provide conducive academic environment through well designed curriculum, teaching and learning process imparting high quality education for research and innovation.

M2: To provide hands on training on state-of-the-art technologies related to Aerospace engineering.

M3: To impart technical, leadership skills and life-long learning embedded with ethical values and social relevance.

B. Tech. Aerospace Engineering

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

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

PEO1: Graduates will be competent to use their technical knowledge in solving engineering problems in Aerodynamics, Propulsion, Structures and Space dynamics.

PEO2: Graduates will demonstrate their skills in multi-disciplinary projects utilizing modern tools as an individual and as a team with ethics.

PEO3: Graduates will engage in aspiring careers, entrepreneurship or pursue higher studies.

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 engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineeringsciences.

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

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 sustainabledevelopment.

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

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)

Program specific outcomes of B.Tech Aerospace Engineering are

PSO 1: Able to identify, formulate and solve engineering problems with the potential to design an Aerospace system, component or process to meet desired needs within socio economic and ethical values.

PSO 2 : Able to use the techniques, skills and modern engineering tools necessary for Aerospace engineering practices.

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 oflearning.

The system permits a student to

(i) Learn at their own pace through flexible registrationprocess

(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 MinorSpecialization

(v) Adopt an interdisciplinary approach inlearning

(vi) Avail transfer ofCredits

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

(viii) Make the best use of the expertise of availablefaculty.

(ix) Learn and earn credits through MOOC and Project BasedLearning

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

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 ANDNOMENCLATURE

In these Regulations, unless the context otherwise requires:

1. “Programme” means Degree Programme like B.Tech. DegreeProgramme.
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 asemester, (e.g. Mathematics, Physics, etc.).

4. “Vice – Chancellor of HITS” means the Head of theInstitution.
5. “Registrar” is the Head of all academic and General Administration of theInstitute.
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 anddegrees.
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 – teachermeet.
9. “HoD” means the Head of the Departmentconcerned.
10. “Institute” means Hindustan Institute of Technology and Science (HITS),Chennai.
11. “TCH” means Total Contact Hours – refers to the teaching – learningperiods.
12. “DEC” means Department ExamCommittee.
13. “BoS” means Board of Studies.
14. “BoM” means Board ofManagement.
15. “ACM”meansAcademicCouncilmeetingthehighestauthoritativebodyforapproval for all Academic Policies.
16. “ClassTeacher”isafacultyoftheclasswhotakescareoftheattendance,academic performance and the general conduct of the students of that class.
17. “CIA”isContinuousInternalAssessmentwhichisassessedforeverystudentforevery course during the semester.
18. “ESE” is End Semester Examination conducted by the Institute at the End ofthe Semester for all the courses of that semester.
19. “AICTE” means All India Council for TechnicalEducation.
20. “UGC” means University GrantsCommission.
21. “MHRD” means Ministry of Human Resource Development, Govt. ofIndia.

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

1.0 Vision, Mission andObjectives

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 instill highest ethical standards and values.
- TopursueactivitiesforthedevelopmentoftheSociety.
- Todevelopnationalandinternationalcollaborationswithinstitutesandindustriesof eminence.
- Toenablegraduatestobecomefutureleadersandinnovators.

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 LiberalArts.
- To develop graduates, with a global outlook, possessing Knowledge, Skills and Attitude and Capable of taking up challenging responsibilities in the respectivefields.
- 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 Allieddisciplines.

1.3 Aims and Objectives of the Institute are focusedon

- ProvidingstateofthearteducationinEngineering,Technology,AppliedSciencesand Managementstudies.
- 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 thenation.
- To inculcate a flair for Research, Development andEntrepreneurship.

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 theInstitute.

2.1. Eligibility for Admission

(i) RegularEntry

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

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

(ii) LateralEntry

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 Thecandidatehastofulfilalltheprescribedadmissionrequirements/normsof theInstitute.

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 befinal.

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 StudentDiscipline

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 Anyactofindisciplineofa studentreportedtotheDean(Studentaffairs)andHeadof 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 decisionwillbethefinal.

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 ofRegistration.

4.0 Structure of the B. Tech DegreeProgramme

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 periodperweek	--- 1 credit
Up to Three periods of Practicalperweek	--- 1 credit
4 periods of Practicalperweek	--- 2credits

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

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 comprisingof

- 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 thefollowing.**

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 – Engineeringdepartments.

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 underNE.

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 gradesheet.

4.4 Non – CGPAcourses

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 theDepartment.

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 shownin**Table2**andalsoaminimumtotalof**169credits-165credits(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 clause7.0.

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 clause8.0

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)	88	53
4	Department Elective (DE)	15	9
5	Non – Department Electives (NE)	10	6
6	Design Project (DP-PC)	3	2
7	Internship (I-PC)	1	0.5
8	Project (PROJECT-PC)	8	5
9	Comprehension (C-PC)	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 projectreports.

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 ClassCommittee

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

5.3 The constitution of the Class Committee will be asfollows:

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 commoncourses).
c. Class teacher of theclass.
d. All Faculty handling the courses for that class in thesemester.

e. Workshop Superintendent (for first two semesters); asapplicable.
f. Four students from the respective class nominated by Head of theDepartment
g. Faculty Advisors of the respectiveclass.

5.4 Coursecommittee

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 thesemester.

5.5 The basic responsibilities of the Class Committee and Course committeeare

a. To review periodically the progress of thestudents.
b. To discuss issues concerning curriculum and syllabi and the conduct of theclasses.
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 (StudentAffairs).
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, maintenanceetc.

6.0 Registration for courses in aSemester

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 andmaximum.

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 totime.

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 ofarrears.
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 asemester.
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 registrationprocess.
d. The student can also opt for post graduate levelcourses
e. The faculty advisor will suggest the additional courses to be taken by the students based on their choice and level of their academiccompetence.
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 additionalcourses.

8.0 B. Tech with Minorspecialization:

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 specialization groups offered by a departmentotherthantheirparentdepartment.Suchstudentsshallselectthestreamof

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 12credits.

b. The students are permitted to register for their minor specialization courses from the Vsemester onwardssubjecttoa maximumoftwoadditionalcoursespersemester.

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 registrationprocess.

d. The students have to pay the requisite fee for the additionalcourses.

9.0 Attendance

The faculty handling a course must finalize 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 AcademicLeave.

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

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 Repeatexamination.

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 thecourses.

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 attendanceandtheywillnotbepermittedtowritetheEndsemesterexamforthat

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 involvinghospitalization.

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 AssessmentProcedure

Every course shall have two components of assessment namely,

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

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 – DepartmentElective (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 TheoryCourse/DE/NEAssessmentweightages

The general guidelines for the assessment of Theory Courses, Department Electives "DE" andNon–DepartmentElectives"NE"shallbedoneonacontinuousbasisisgiveninTable 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 PracticalCourse: Forpracticalcourses,theassessmentwillbedonebythecourseteachers asbelow:

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 componenttheassessmentwillbecalculatedasfollowsasapprovedbythe"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 onemonth.

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 doneonacontinuousbasisasgiveninTable7

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 willbeawarded.

10.9 Flexibility inAssessment

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 subsequentsemester(s).

11.0 Procedures for Course Repetition / RepeatExaminations

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

a. Students under RC categoryi.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 thesummer.
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 (Clause11.3).
d. The revised CIA marks shall not exceed 60% of the total internal weightage for any repeatcourse.
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 thatcourse.

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 andvoid.

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 respectiveHoDs.

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 subsequentsemesters.

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 RepeatExaminations

a. Normally, the results of the End Semester Examinations for Regular Theory courses areannouncedwithinaperiodof10daysafterthelastregularexamination.

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 semestercourses.

c. The schedule for the Repeat Examinations will be notified through the AcademicCalendarwhichwillbepublishedatthebeginningofeveryacademicyear.
d. The students under "RC" category, who have secured the requisite attendance and internal assessment marks as applicable, by successfully completing the Summer / Wintercourse,areeligibletoregisterfortheRepeatExaminations.
e. ThestudentswhofailtosecureapassorbeingabsentforgenuinereasonsintheirEnd Semester Examination for the regular courses are permitted to appear for the Repeat Exams by paying the prescribedfee.
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 ofresults.

12.0 Progression to highersemester

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

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 and3rd Semesters
7	30 credits* in Theory courses up to5th 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. - LateralEntry

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 yearonly.

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 clause14.0.**

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 (StudentAffairs).

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 thatcourse.

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 suchattempts.

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 prescribedfee.

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 withPractical 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 thatcourse.

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 SemesterAbroadProgramme: Studentswhoareallowedtoundergointernshipor Training in Industries in India or abroad during their course work or attend any National/InternationalInstituteundersemesterabroadprogramme(SAP)uptoa 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 programmeetc., will be accounted for attendance.

16.0 Grading

16.1 AgradingsystemasshowninTable10willbefollowed.

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 specifiedin 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 andCGPA

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 TheGradecardwillnotincludethecomputationofGPAandCGPA forcourseswithletter grade**RA,RC**and**U**untilthosegradesareconvertedtotheregulargrades.

16.4 A course successfully completed cannot be repeated.

17.0 GradeSheet

17.1 Lettergrade

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/shesecuresalettergradeotherthan**U,RC,andRA**inthatcourse.

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

a. Programanddisciplineforwhichthestudenthasenrolled.
b. Semester ofregistration.
c. The coursecode,nameofthe course,categoryof courseandthecreditsforeachcourse registered in thatsemester
d. The letter grade obtained in each course
e. Semester Grade PointAverage(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. AdditionalcreditsearnedforB.Tech(Hons.)andB.TechwithMinorspecialization.

18.0 Class/Division

18.1 ClassificationisbasedonCGPAandisasfollows:

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 aboveclassification.

(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 CGPACredits)**

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 portionofcourseworkinanotherapprovedInstituteofreputeunderlateralentrybasedon therecommendationofthecredittransfercommitteeonacasetocasebasis.

19.3 Admission norms for working Professional:

Separate admission guidelines are available for working / experienced professionals forcandidates with theindustrial / 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 categoriesofcourses (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 ofDiscipline

21.1 IfthenumberofstudentsinanydisciplineofB.Tech.programmeasonthelastinstructional dayoftheFirstSemesterislessthanthesanctionedstrength,thenthevacanciesinthesaid 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-Chancellorshallbefinalwhileconsideringsuchrequests.

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 pernorms.

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 – AEROSPACE ENGINEERING									
(165 CREDIT STRUCTURE)									
SEMESTER – I									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	BS(HS)	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	MAA4117	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	ASB4117	Introduction to Aerospace Engineering	3	0	0	3	1	3
8	PC	ASB4131	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	0	2	4	0	5
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(HS)	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**	**0**	**11**	**20**	**4**	**27**
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	0	2	4	0	5
2	PC	AEB4216	Aircraft Structural Mechanics	3	1	0	4	1	4
3	PC	ASB4217	Aerospace Propulsion	3	1	0	4	1	4
4	PC	ASB4218	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**	**2**	**10**	**23**	**5**	**29**
***Lab IntegratedwithTheory**							**Non-CGPA course can bechosen**		

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	ASB4301	Aircraft Performance	3	0	0	3	1	3
3	PC	ASB4302	Aerospace Structures *	3	0	2	4	1	5
4	PC	ASB4303	Jet Propulsion	3	0	0	3	1	3
5	PC	ASB4304	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	ASB4331	Propulsion Lab - I	0	0	3	1	0	3
9	PC	ASB4332	Aerodynamics lab	0	0	3	1	0	3
10	PC(DP)	AEB4332	Computer Aided Modeling Project	0	0	2	1	1	2
11	PC(I)	AEB4333	Internship	0	0	0	1	0	0
Total				**20**	**2**	**10**	**27**	**5**	**32**
***Lab IntegratedwithTheory**							**Non-CGPA course can bechosen**		

SEMESTER – VI									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	BS(HS)	GEA4304	Business Economics	3	0	0	2	0	3
2	PC	ASB4317	Advanced Propulsion	3	0	0	3	1	3
3	PC	AEB4318	Control Theory	3	0	0	3	1	3
4	PC	ASB4319	Aircraft Stability& Control	3	0	0	3	1	3
5	DE	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(DP)	ASB4341	Design Project-I	0	0	3	1	0	3
9	PC	ASB4342	Propulsion Lab - II	0	0	3	1	0	3
10	PC	ASB4343	Computational Mechanics Lab.	0	0	3	1	0	3
11	PC(C)	ASB4344	Comprehension	0	0	2	1	1	2
Total				**20**	**0**	**11**	**23**	**4**	**31**
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	ASB4401	Space Mechanics	3	0	0	3	1	3
2	PC	ASB4402	Composite Materials and Structures	3	0	0	3	1	3
3	PC	ASB4403	Vibrations & Aero-elasticity	3	0	0	3	1	3
4	PC	ASB4404	FEM for Aerospace engineers	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-V	2	0	0	2	0	2
8	PC	ASB4431	Space propulsion Lab	0	0	3	1	0	3
9	PC	ASB4432	Composite Materials Laboratory	0	0	3	1	0	3
10	PC(DP)	ASB4433	Design Project-II	0	0	3	1	1	2
Total				**20**	**0**	**9**	**23**	**5**	**28**
***Lab IntegratedwithTheory**				**Non-CGPA course can bechosen**					

SEMESTER – VIII									
SL. NO	**COURSE CATEGORY**	**COURSE CODE**	**NAME OF THE COURSE**	**L**	**T**	**P**	**C**	**S**	**TCH**
1	PC(PR)	ASB4441	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	ASC4251	Aircraft Materials	3	0	0	3	0	3
5	DE	ASC4252	Experimental Stress Analysis	3	0	0	3	0	3
5	DE	AEC4252	Measurements and Instrumentation	3	0	0	3	0	3
5	DE	AEC4254	Mechanics of Machines	3	0	0	3	0	3
Department Elective- II									
6	DE	ASC4351	Mechanics of Structural Impact	3	0	0	3	0	3
6	DE	ASC4352	Fundamentals of Space Vehicle Design	3	0	0	3	0	3
6	DE	AEC4353	Wind Tunnel Techniques	3	0	0	3	0	3
Department Elective- III									
6	DE	ASC4356	Launch Vehicle Aerodynamics	3	0	0	3	0	3
6	DE	AEC4357	Heat Transfer	3	0	0	3	0	3
6	DE	ASC4358	Aircraft Navigation Systems	3	0	0	3	0	3
Department Elective- IV									
7	DE	ASC4366	Manned Space Missions	3	0	0	3	0	3
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	ASC4368	High Temperature Materials	3	0	0	3	0	3
			Department Elective- V						
7	DE	ASC4451	Satellites and Space System Design	3	0	0	3	0	3
7	DE	ASC4452	Theory of Combustion	3	0	0	3	0	3
7	DE	ASC4453	Cryogenic Propulsion	3	0	0	3	0	3
7	DE	ASC4454	Rockets & Missiles	3	0	0	3	0	3
7	DE	ASC4455	Hypersonic Aerodynamics	3	0	0	3	0	3

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	ASD4281	Introduction to NDT	2	0	0	2	0	2
4	NE	ASD4251	Innovative Practices in Aerospace Industry	2	0	0	2	0	2
4	NE	ASD4252	Aircraft Maintenance Practices	2	0	0	2	0	2
5	NE	ASD4381	Systems Engineering	2	0	0	2	0	2
5	NE	ASD4382	Aerospace Developments in India	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	ASD4391	Air Traffic Control and Planning	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	ASD4483	UAV System Design	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
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Practical Assessment	ESE
15%	15%	20%	50%

Course Description	This course broadly introduces the mechanical design using computer aided design tools and fundamentals of free hand sketching. It prepares the students to learn the basic concepts involved in technical drawing skills and computer graphics. It also emphasis on the principles and basic understanding of projections and visualizations aspects of component designing.
Course Objective	1. To understand the basics of Engineering graphics and plane curvatures using AutoCAD tool 2. To visualize the free hand sketch and orthographic projections and to solve simple problems 3. To comprehend the various geometrical models and its developments 4. To apply the transformation of 2D drafting to 3D models using CAD tools 5. To generate associated views of 3D models and related geometric dimensioning and tolerancing.
Course Outcome	Upon completion of this course, the students will be able to 1. Use the AutoCAD commands to generate simple drawings and understand drafting techniques. 2. Apply the acquired knowledge to solve simple problems involving straight planes and solids. 3. Visualize solid objects and apply AutoCAD commands to generate the models. 4. Recognize and use 3D model commands in AutoCAD tool to generate solid objects. 5. Generate the various views of the geometrical solid model manually and using AutoCAD as well.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO-3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	1	1	1	1	1	1	1	1	1	1	1	1	1
CO-2	3	1	2	1	3	1	1	1	1	1	1	1	1	1

CO-3	3	1	1	1	1	1	1	1	1	1	1	1	1	1
CO-4	3	1	1	1	3	1	1	1	1	1	1	1	1	1
CO-5	3	1	3	1	1	1	1	1	1	1	1	1	1	1

1: Weakly related, 2: Moderately related and 3: Strongly related

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. **Practical component:** AutoCAD – Solid modelling tool - Basics. **Suggested Readings:** Basics of drafting and dimensioning	**CO-1** **BTL-2**
MODULE 2: VISUALIZATION, ORTHOGRAPHIC PROJECTIONS AND FREE HAND SKETCHING(12)	
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. **Practical component:** 2D drafting, Orthographic projections **Suggested Readings:** AutoCAD tool – Commands for sketching , Projections	**CO-2** **BTL-2**
MODULE 3: GEOMETRICAL MODELLING, ISOMETRIC AND DEVELOPMENT OF SURFACES(12)	
Principles of isometric projection and solid modelling. Isometric drawing – IsoPlanes and 3D Modelling commands. Projections of Principal Views from 3-D Models. Solid Modeling – Types of modelling - Wire frame model, Surface Model and Solid Model – Introduction to graphic software for solid modelling. Development of Surfaces **Practical component:** 3D modelling and surface development **Suggested Readings:** Surface modelling and solid modeling	**CO-3** **BTL-3**
MODULE 4: COMPUTER AIDED DESIGN AND DRAFTING (12)	

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. **Practical component:** 2D to 3D transformation, plotting of drawings **Suggested Readings:** 3D modelling – view generations and commands	**CO-4** **BTL-2**
MODULE 5: SIMPLE DESIGN PROJECTS – COMPUTER AIDED DESIGN (12)	
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. **Practical component:** 3D solid meshed topology, geometrical dimensioning, simple components **Suggested Readings:** AutoCAD dimensioning, assembly of solid components	**CO-5** **BTL-3**

TEXT BOOKS	
1.	Jeyapoovan, T. (2016). Engineering Drawing and Graphics Using AutoCAD, 7th Edition, Vikas Publishing House Pvt Ltd., New Delhi, 2016.
REFERENCE BOOKS	
1.	Warren J. Luzadder and Jon. M. Duff. (2016). Fundamentals of Engineering Drawing, Prentice Hall of India Pvt. Ltd., Eleventh Edition.
2.	Jensen, J.D. Helsel, D.R. Short. (2012). Engineering Drawing and Design, McGraw-Hill, Sixth Edition.
E BOOKS	
1.	http://keralatechnologicaluniversity.blogspot.in/2015/06/engineering-graphics-j-benjamin-pentex-freeebook-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
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-5

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course has been designed to meet students' current and future language and communication needs. It attempts to develop their proficiency in the four language skills and knowledge of grammar and vocabulary. This course teaches students how to communicate accurately, appropriately and fluently in professional and social situations.
Course Objective	1. To acquire self-confidence by which the learner can improve upon their informative listening skills by an enhanced acquisition of the English language. 2. To provide an environment to Speak in English at the formal and informal levels and use it for daily conversation, presentation, group discussion and debate. 3. To equip the students to Read, comprehend and answer questions based on literary, scientific, and technological texts. 4. To enhance the writing skills of the students via training in instructions, recommendations, checklists, process-description, letter-writing, and report writing. 5. To equip the learners in analyzing and applying creative thinking skills and participate in brainstorming, mind-mapping, audiovisual activities and excel in employability skills.
Course Outcome	Upon completion of this course, the students will be able to 1. Apply the basics of English grammar and vocabulary, construct simple sentences and articulate ideas using simple sentences to form short paragraphs. 2. Respond to higher order English words, vocabulary, phrases, expressions, idioms, and proverbs and derive the contextual meaning through reading and listening from general and academic situations, identify specific details and general ideas. 3. Articulate ideas, concepts, and perceptions in a comprehensive manner in written business correspondence and speaking in formal and informal situations. 4. Analyze and transcode data, construct different types of written essays, read complex passages, and summarize ideas, create personal profiles in the form of a resume. 5. Induce critical and analytical thinking, participate in brainstorming on

	general topics, and transact information with an audience and prepare students for interview questions, presentation skills.

Prerequisites: Plus Two English-Intermediate Level

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO-10	PO -11	PO-12	PSO -1	PSO-2
CO-1	1	1	1	1	1	1	1	1	1	3	1	1	1	1
CO-2	1	1	1	1	1	1	1	2	2	3	1	1	1	1
CO-3	1	1	1	1	1	1	1	1	1	3	1	1	1	1
CO-4	1	1	1	1	1	1	2	1	1	3	2	1	1	1
CO-5	1	1	1	1	1	1	1	1	2	3	2	3	1	1

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: FUNCTIONAL GRAMMAR AND VOCABULARY (12)

Introduction to communication skills –Self Introduction - Basic grammar (tenses, subject verb agreement) - Basic vocabulary (prefixes , suffixes, roots, phrasal verbs and idioms)- Topic sentences , paragraph writing

Suggested Activities:

Short conversations-Situational Communication-Dialogue Writing - Writing short paragraph based on environment protection, societal issues, health, cultural contexts etc., identifying topic sentences, linking pairs of sentences**.**

CO-1
BTL-2

Suggested Reading:

1. An Introduction to Professional English and Soft Skills with audio CD by Dr. Bikram K. Das et al. Published by Cambridge University Press. 2009
2. Professional Speaking Skills by ArunaKoneru, Oxford Press, 2015
3. Embark, English for Under Graduates by Steve Hart, Arvind Nair, Veena Bhambhani, Cambridge University Press 2016**.**
4. English for Life and the Workplace Through LSRW&T skills, by Dolly John, Pearson Publications, 2014 edition

MODULE 2 – LISTENING AND SPEAKING SKILLS(12)

Academic listening (listening to lectures different topics, audio excerpts and answering question) - General listening (conversations, speeches: formal and informal) - Giving instructions and suggestions- Active and Passive Voice

Suggested activities:

Listen and repeat, Listening to audio excerpts-Listening to native speakers - TED Talks, short prepared speeches, Table topics – Speaking in different situations- MCQ's - Cloze exercises- Complete the Dialogue

CO-2
BTL-3

Suggested sources:

(Listening and Speaking Modules) – Language Lab

Professional Speaking Skills by ArunaKoneru, Oxford Press

English for Life and the Workplace Through LSRW&T skills, by Dolly John, Pearson Publications, 2014 edition

MODULE – 3 : FUNCTIONAL READING AND WRITING(12)

Reading comprehension (academic texts and general texts)-Reading and Interpreting visual data, charts, tables and graphs-- Report writing- accident, industrial, survey, general reports –Direct and Indirect speech **Suggested Activities:** Identify the errors in sentences, grammar exercise, reading passage for identifying the contextual meaning, interpreting charts, tables and graphs, choose the right meaning of the word given Assignment on suggested reading activity – Book review **Suggested sources:** Essential English Grammar by Raymond Murphy, Cambridge University Press, 2016 edition Embark, English for Under Graduates by Steve Hart, Arvind Nair, Veena Bhambhani, Cambridge University Press 2016.	**CO-4** **BTL-4**
MODULE – 4 : BUSINESS CORRESPONDENCE (12)	
Memo-Notice - Agenda – Minutes of the Meeting-Action Taken report- Report Writing-Connectives - Cause and effect **Suggested activities:** Drafting agenda, notice, memo, minutes of the meeting- ATR- Cause and effect exercises - Presentation in the language lab (Technical or Non-technical topic) **Suggested sources:** Cambridge Advanced English, Newspapers, library books, IELTS , IELTS Academic Writing 1, New Insights into IELTS, CUP	**CO-3** **BTL-5**
MODULE 5 – PRESENTATION SKILLS AND INTERVIEW SKILLS(12)	
Presentation Skills - Reading and Interpreting Advertisements—Job Application- Covering Letter -Curriculum Vitae –E-mail - Project proposal –Interview skills (HR questions) – Group Discussion **Suggested Activities:** Presentation in the language lab (Technical or Non-technical topic) Group Discussion (Tutorial Classes) **Suggested Sources:** English for Life and the Workplace Through LSRW&T skills, by Dolly John, Pearson Publications, 2014 edition Soft Skills and Employability Skills by Sabina Pillai and Agna Fernandez, Cambridge University Press, 2018. Education and personality development by K. Manoharan, APH Publishing Home, 2016	**CO-5** **BTL-5**

TEXT BOOKS	
1.	An Introduction to Professional English and Soft Skills with audio CD by Dr. Bikram K. Das et al. Published by Cambridge University Press. 2009
2	English for Life and the Workplace Through LSRW&T skills, by Dolly John, Pearson Publications, 2014 edition
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.	Professional Speaking Skills by ArunaKoneru, Oxford Publications, 2015
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.cambridgeenglish.org/learning-english/free-resources/write-and-improve/
5	Oneshopenglish.com
6	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			CREDITS	4
COURSE CODE	MAA 4101	COURSE CATEGORY	BS	L-T-P-S	3-0-2-1
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student understand the basic concepts of matrices and calculus using MATLAB
Course Objective	1. To Know how to perform some simple operations on matrices 2. To understand effectively the basic concepts of differentiation and partial differentiation and their applications. 3. To perform integration and other operations for certain types of functions and carry out the computation fluently. 4. To classify ordinary differential equations.
Course Outcome	Upon completion of this course, the students will be able to 1. Use the concept of matrices and Eigen Values. 2. Apply the concept of functions in Differential Calculus 3. Apply the concept of Integral Calculus 4. Apply the concepts of ordinary differential equation

Prerequisites: Knowledge in fundamentals of Mathematics at higher secondary level

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	1	1	1	1	1	1	1	1	1	1	1	1
CO-2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
CO-3	2	1	1	1	1	1	1	1	1	1	1	1	1	1
CO-4	2	1	1	1	1	1	1	1	1	1	1	1	1	1

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:MATRICES (13L+2P=15)	
Characteristic equation – Eigen values 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 **Lab1: Eigen values and Eigenvectors, Verification and inverse using Cayley**	**CO-1 BTL-1,2,3,4**

Hamilton theorem- Diagonalization	
MODULE 2: DIFFERENTIAL CALCULUS (13L+2P=15)	
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 **Lab2: Taylor's series – Maxima and minima of functions of two variables**	**CO-2** **BTL-1,2,3,4**
MODULE 3:INTEGRAL CALCULUS (13L+2P=15)	
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: Basicsof Integrations **Lab3: Applications of Integral Calculus: Area, Surface area and Volume.**	**CO-3** **BTL-1,2,3**
MODULE 4: ORDINARY DIFFERENTIAL EQUATIONS (13L+2P=15)	
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.	**CO-4** **BTL-1,2,3**

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 WithMatlab, Third Edition,2011 by CRC Press.
E BOOKS	
1.	http://nptel.ac.in/courses/111105035/ https://www.edx.org/.../introduction-engineering-mathematics-utarlingtonx-engr3
MOOC	
1.	https://www.mooc-list.com/tags/engineering-mathematics

COURSE TITLE	ENGINEERING PHYSICS	CREDITS	3

COURSE CODE	PHA4101	COURSE CATEGORY	BS	L-T-P-S	3-0-0-1
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course deals with fundamental principles of physics, using mathematical derivations, for first year B. Tech students; the principles and applications of elasticity, acoustics, ultrasonics, quantum physics, crystal physics, lasers and fiber optics are dealt in this course. Intended for Aeronautical, Automobile, Bio tech., Chemical, Civil and Mechanical branches.
Course Objective	1. To explain stress, strain and elastic moduli and apply the concepts to solve basic problems 2. To apply principles of acoustics to solve basic problems and use ultrasonics as an engineering tool 3. To explain particle nature of radiation, compute Schrodinger's wave equation and apply it to infinite potential well 4. To identify crystal structures and crystal planes, describe different magnetic materials and hysteresis based on concept of ferromagnetic domains. 5. To discuss the principles, working and applications of lasers and fiber optics
Course Outcome	Upon completion of this course, the students will be able to 1. Solve the basic problems in elasticity and explain the properties of matter 2. Apply the knowledge of acoustics in designing acoustical buildings and employing ultrasonic as an engineering tool. 3. Use mathematical derivations to solve quantum problems. 4. Identify the crystal lattice planes, distinguish different magnetic materials, and explain the ferromagnetic domain. 5. Familiarize with the principles, working and applications of lasers and fiber optics.

Prerequisites: Knowledge in fundamentals of Physics at higher secondary level

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO-3	PO -4	PO-5	PO-6	PO -7	PO-8	PO -9	PO-10	PO-11	PO -12	PSO -1	PSO-2
CO-1	3	2	1	1	1	1	1	1	1	1	1	1	1	1
CO-2	3	2	1	1	3	1	1	1	1	1	1	1	1	1
CO-3	3	2	1	1	3	1	1	1	1	1	1	1	1	1
CO-4	3	2	1	1	2	1	1	1	1	1	1	1	1	1

CO-5	3	2	1	1	3	1	1	1	1	1	1	1	1	1

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PROPERTIES OF MATTER AND HEAT (5L+4L=9L)	
Elasticity - Hooke's law- Elastic Moduli - Young's modulus of elasticity - Rigidity modulus - Bulk modulus - 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.	**CO-1** **BTL-3**
MODULE 2: ACOUSTICS AND ULTRASONIC (5L+4L=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	**CO-2** **BTL-3**
MODULE 3: QUANTUM PHYSICS(5L+4L=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)	**CO-3** **BTL-3**
MODULE 4: CRYSTAL PHYSICS AND MAGNETISM (5L+4L=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.	**CO-4** **BTL-3**
MODULE 5: PHOTONICS AND FIBER OPTICS (5L+4L=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.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	P.Mani, “Engineering Physics”, VolI& II, Dhanam Publications, Chennai. (2011)
REFERENCE BOOKS	
1.	Gaur R.K. and Gupta S.L., “Engineering Physics”, 8th edition, DhanpatRai publications (P) Ltd., New Delhi. (2010)
2.	P.Charles, Poople and Frank J. Owens, "Introduction to Nanotechnology", Wiley India. (2007)
3.	Arthur Beiser, "Concepts of Modern Physics", Tata McGraw – Hill Publications. (2007)
4.	Rajendran V. Marikani A., “Applied Physics for engineers”, 3rd edition, Tata McGraw –Hill publishing company Ltd., New Delhi. (2003)
E BOOKS	
1.	Dr. P. S. Aithal and Dr. H. J. Ravindra, “Textbook of Engineering Physics”, 1st edition, ACME Learning Pvt. Ltd., New Delhi (2011).
2.	John R. Gordon, Ralph V. McGrew and Raymond A. Serway, “Physics for Scientists and Engineers” 8th edition, Brooks/Cole Cengage learning, USA (2010).
MOOC	
1.	https://www.coursera.org/learn/how-things-work
2.	https://www.coursera.org/learn/quantum-physics
3.	https://onlinecourses.nptel.ac.in/noc21_ph21
4.	https://onlinecourses.swayam2.ac.in/aic20_sp64

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
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the students understand the basic concepts of Engineering Materials and their applications.
Course Objective	1. To make the students understand the basics of crystal structure and phase rule. 2. To provide an exposure on the fundamentals of powder metallurgy and applications of inorganic materials and composites. 3. To give a strong foundation on the basic concepts of nanomaterials, the general synthetic methods with emphasis on their applications. 4. To illustrate the applications of conducting polymers and liquid- crystals, with a good exposure on their basic terminologies. 5. To provide knowledge on the theoretical basis of the chemical composition, properties and applications of lubricants, adhesives and explosives.
Course Outcome	Upon completion of this course, the students will be able to 1. Propose and justify suitable metals/materials for alloying. 2. State and select a suitable high-temperature material for industrial applications. 3. Suggest an appropriate technique for nanomaterial synthesis and also select a property-guided molecular material for a given application. 4. Identify the materials which can be employed as organic conductors and liquid- crystals in electronic devices. 5. Distinguish and select a suitable organic / inorganic material as lubricant / adhesive / explosive based on its applications.

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

CO, PO AND PSO MAPPING

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	2	1	1	1	1	1	1	1	1	1	1	1	1
CO2	3	2	1	1	1	1	2	1	1	1	1	2	1	1
CO3	3	2	1	1	1	1	2	1	1	1	1	2	1	1
CO4	3	2	1	1	1	1	2	1	1	1	1	2	1	1
CO5	3	2	1	1	1	1	2	1	1	1	1	2	1	1

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: CRYSTAL STRUCTURE AND PHASE RULE (9)	
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.	**CO-1 BTL-1, 2,3**
MODULE 2: POWDER METALLURGY, INORGANIC MATERIALS AND COMPOSITES (9)	
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.	**CO-2 BTL-1,2**
MODULE 3: NANOMATERIALS AND MOLECULAR SIEVES (9)	
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.	**CO-3 BTL-2, 3**
MODULE 4: MATERIALS FOR ELECTRONIC APPLICATONS (9)	
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.	**CO-3 BTL-1,2**
MODULE 5: LUBRICANTS, ADHESIVES AND EXPLOSIVES(9)	
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.	**CO-4 BTL-1,2**

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.
REFERENCE BOOKS	
1.	Composite materials, K.K. Chawala, 3rd ed., (2012) Springer-Verlag, New York.
2.	Nanocomposite Science and Technology, P. M. Ajayan, L. S. Schadler, P. V. Braun, (2003), Wiley-VCH Verlag GmbH Co. KGaA, Weinheim.
3.	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

OURSE TITLE	**PROBLEM SOLVING USING C**			**CREDITS**	**3**
COURSE CODE	**CSA4101**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**2-0-2-1**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-4**

ASSESSMENT SCHEME

First Periodical Assessment	**Second Periodical Assessment**	**Practical Component**	**ESE**
15%	**15%**	**20%**	**50%**

Course Description	To introduce computers and programming in C and also explore the power of computational techniques that are currently used by engineers and scientists and to develop programming skills with reasonable complexity.
Course Objective	1. To acquire the basic knowledge in computer hardware, programming languages and Problem-solving techniques. 2. To learn the fundamentals of C programming. 3. To gain knowledge in Functions, arrays and strings in C programming. 4. To understand the pointers, Structures and Union in C programming 5. To gain Knowledge on Embedded Programming
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the basics of digital computer and programming languages. 2. Demonstrate problem solving techniques using flowchart, algorithm/pseudo code to solve the given problem. 3. Design and Implement C program using Control Statements and Functions. 4. Design and Implement C program using Pointers and File operations. 5. Identify the need for embedded C in real-time applications.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	**P**	**PO**	**PO-**	**PO-**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO**	**PO-**	**PSO**	**PSO-2**

	O - 1	-2	3	4	-5	-6	-7	-8	-9	-10	-11	12	-1	
CO-1	2	2	2	1	1	2	1	2	1	1	1	2	2	1
CO-2	3	3	3	2	2	1	1	2	2	1	1	1	2	3
CO-3	3	3	3	2	2	2	1	1	3	3	2	1	2	3
CO-4	3	3	3	2	1	1	1	1	1	1	1	1	1	2
CO-5	1	1	1	1	1	2	1	1	1	1	1	2	1	1

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO CYBER SECURITY (12)

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

CO-1

BTL-1

MODULE 2: SECURITY ATTACKS, PRINCIPLES AND MANAGEMENT (12)

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

CO-2

BTL-3

MODULE 3: SECURITY PLANS, POLICIES AND PROCEDURES (12)

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

CO-3

BTL-4

(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: OVERVIEW OF SECURITY COUNTERMEASURE TOOLS (12)	
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	**CO-4** **BTL-3**
MODULE 5: TESTING, DIGITAL FORENSICS AND NEXT GENERATION SECURITY (12)	
Structure of embedded C program - Data Types - Operators - Statements - Functions - Keil C Compiler. **Practical component:** Simple programs using embedded C	**CO-5** **BTL-2**

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.	YashavantKanetkar, “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			CREDITS	2
COURSE CODE	GEA4102	COURSE CATEGORY	PC	L-T-P-S	2-0-2-1
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	A study about Sustainability and green chemistry in day-to-day life
Course Objective	1.Understand the concept about fundamentals of sustainability and its frameworks 2. Gain knowledge about the various types of technologies , lifecycle assessment 3. Understand the Principles of Green Engineering and multifunctional materials 4. Learn implementation ofrecycling water management and E waste Management 5. Learn the water technology and sustainability behavior of humans
Course Outcome	Upon completion of this course, the students will be able to 1. Learn the principles of sustainability with case studies. 2. Understand assessing technologies and its impact on environment. 3. Learn the concept of Green Engineering and to apply in the projects at higher semesters. 4. Manage natural resources and waste management from various types of industries. 5. Learn water technology and behavioral aspects of humans toward sustainability.

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

CO, PO AND PSO MAPPING

CO	PO 1	PO 2	PO 3	PO 4	PO5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO12	PSO1	PSO2

CO-1	3	2	1	1	1	3	3	3	1	2	1	1	2	1
CO-2	3	3	2	1	1	2	1	3	1	3	1	3	1	3
CO-3	3	2	2	1	1	3	2	1	1	1	1	1	2	1
CO-4	3	1	3	1	1	2	1	3	1	2	1	2	1	1
CO-5	3	2	3	1	1	1	1	2	1	3	1	3	3	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PRINCIPLES OF SUSTAINABLE SYSTEMS (5)	
Sustainability Definitions - Principles of Sustainable Design, Sustainable Engineering - Frameworks for Applying Sustainability Principles - Summary & Activities	**CO-1 BTL-2**
MODULE 2: TECHNOLOGY DEVELOPMENT AND LIFECYCLE ASSESSMENT(5)	
Technology as a part of anthropogenic environment - Technology readiness levels (TRL) – technical metrics - Emerging, converging, disruptive technologies - Life Cycle Assessment (LCA) methodology - Summary & Activities	**CO-2 BTL-3**
MODULE 3: GREEN ENGINEERING(5)	
Principles of Green Engineering - Frameworks for assessment of alternatives - Green Engineering examples - Multifunctional Materials and Their Impact on Sustainability - Summary & Activities	**CO-3 BTL-3**
MODULE 4: RESOURCE MANAGEMENT TECHNOLOGIES (5)	
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.	**CO-4 BTL-2**
MODULE 5: SUSTAINABLE WATER AND WASTEWATER SYSTEMS (5)	
Water cycle - Water conservation and protection technologies - Water treatment systems Metrics for assessment of water management technologies-Summary & Activities	**CO-5 BTL-2**
MODULE 6: BEHAVIORAL ASPECTS AND FEEDBACKS (5)	
Collaborative Decision Making - Role of Community and Social Networking - Human Factor in Sustainability Paradigm - Summary & Activities.	**CO-5 BTL-2**
Prerequisites: NIL	

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	Introduction to Sustainability | Coursera
2	Best Graduate Diplomas in Sustainability Studies 2021 (academiccourses.com)
3	Ecosystem Services: a Method for Sustainable Development | Coursera

COURSE TITLE	**ENGINEERING AND DESIGN**			**CREDITS**	**3**
COURSE CODE	**AEB4101**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-1**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	This course is designed to study the fundamentals of the aircraft systems engineering and design
Course Objective	1. Gives knowledge about the design concepts used for design process. 2. Able to know the difference between the design makings in product. 3. Make the students to involve in the design process. 4. Calculate the bending stresses in unsymmetrical sections using different methods 5. Learn economic and environmental Issues, trade aspects and IPR

Course Outcome	Upon completion of this course, the students will be able to 1. Describe the different elements involved in good designs and to apply them in practice when called for. 2. Identify the product oriented and user-oriented aspects that make the design a success. 3. Express the innovative designs incorporating different segments of knowledge gained in the course. 4. Analyze the design perspective as a function, cost, environmental sensitivity, safety, and maintenance 5. Apply / Define the technical writing like IPR, Trademarks etc.,

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	2	1	1	2	1	2	1	1	2	2	3
CO-2	3	3	3	3	1	1	2	1	2	1	1	2	2	3
CO-3	3	3	3	3	1	1	2	1	2	1	1	2	2	3
CO-4	3	3	3	2	1	1	2	1	1	1	1	2	2	3
CO-5	3	2	2	3	1	1	2	1	2	1	1	2	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO AERONAUTICAL ENGINEERING DESIGN (7L+2P=9)	
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.	**CO-1** **BTL-2**
MODULE 2: PROCESSES IN DESIGN FOR AIRCRAFT SYSTEM(7L+2P=9)	
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	**CO-2** **BTL-2**
MODULE 3: PROTOTYPING OF AIRCRAFT COMPONENTS(4L+5P=9)	
Prototyping- rapid prototyping; testing and evaluation of design; Design modifications; Freezing the design; Cost analysis.	**CO-3** **BTL-3**

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=9)	
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.	**CO-4** **BTL-2**
MODULE 5: USER CENTRED DESIGNS IN ENGINEERING(4L+5P=9)	
Product centered and user centered design. Product centered attributes and user centered attributes. Bringing the two closer. i.e., 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 merit. **Project:** Examine the possibility of value addition for an existing product.	**CO-5** **BTL-2**
Prerequisites: NIL	

TEXT BOOKS	
1.	Balmer, R. T., Keat, W. D., Wise, G., and Kosky, P.(2015). Exploring Engineering, Third Edition: AnIntroduction to Engineering and Design, Academic press.
REFERENCE BOOKS	
1.	Pahl, G., Beitz, W., Feldhusen, J. and Grote, K. H. (2007). Engineering Design: A SystematicApproach, 3rd ed.
2.	Dym, C. L., Little, P. and Orwin, E. J. (2013). Engineering Design - A Project based introduction,4th ed, Wiley
E BOOKS	
1.	https://www.designbetter.co/design-engineering-handbook
MOOC	
1.	https://nptel.ac.in/courses/107/106/107106009/
2.	https://nptel.ac.in/courses/107/103/107103082/

COURSE TITLE	INTRODUCTION TO DIGITAL SYSTEMS			CREDITS	3
COURSE CODE	EEB4101	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3, 4

ASSESSMENT SCHEME					
First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	An introduction to digital system design, with an emphasis on practical design techniques and circuit implementation.
Course Objective	1. To Utilize binary and hexadecimal numbers. 2. Solve problems involving digital codes, operations, and number systems 3. To analyze and design combinational logic circuits
Course Outcome	Upon completion of this course, the students will be able to 1. Explain basic operation in digital systems and instruments. 2. Choose appropriate sensors and display units. 3. Apply the concepts of signal processing and converting elements. 4. Explain and apply concepts of microcontrollers, programmable logic controller and PID controller 5. Explain the concepts of consumer electronics and communication devices.

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	2	2	1	1	1	1	1	1	1	1	1

CO-2	3	3	2	2	3	1	1	1	1	1	1	1	1	1
CO-3	3	3	2	2	3	1	1	1	1	1	1	1	1	1
CO-4	3	3	2	2	3	1	1	1	1	1	1	1	1	1
CO-5	3	3	3	2	3	1	1	1	1	1	1	1	1	1

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1 – Introduction to Digital Systems	**(11)**
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). **Practical Component: (*To be done in Simulation environment*)** 1. Logic gates simulation 2. Boolean Identities and Property verification 3. Digital controller design **Suggested Reading:** Basics of number systems,All digital systems in consumer and industrial electronics.	**CO-1** **BTL-3**
MODULE 2 –Sensors and Displays	**(11)**
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. **Practical Component: - (To be done in Simulation environment)** **1.** Simulation of Sensor characteristics- potentiometer 2. Simulation of Sensor Characteristics-Strain Gauge 3. Simulation of Sensor characteristics-LVDT 4. Simulation of Sensor characteristics-RTD 5. Simulation of Sensor Characteristics-Thermocouple **Suggested Reading:**Primary sensing elements, introduction to displays.	**CO-2** **BTL-4**
MODULE – 3 :Signal Conditioning Circuits	**(9)**

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. **Practical Component: - (*To be done in Simulation environment*)** 1. Simulation of DC bridges 2. Operational amplifier applications 3. Active filter simulation 4. ADC- DAC simulation. **Suggested Reading:** Basic network theorems.	**CO-3** **BTL-4**
MODULE – 4 :Introduction to Micro controllers	**(9)**
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. **Practical Component: - (*To be done in Simulation environment*)** 1. PLC Ladder logic simulation. 2. Proportional controller simulation. 3. Proportional + Integral controller simulation. 4. Proportional + Derivative controller simulation. 5. Proportional +Integral + Derivative controller simulation. **Suggested Reading**: Hobby electronics with Microcontroller interface.	**CO-4** **BTL-3**
MODULE 5 – Consumer Electronics and Communication System	**(5)**
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.	**CO-5** BTL-3
TEXT BOOKS	
1.	Thomas l. Floyd (2018),*Digital Fundamentals*, , Pearson,11th edition .

2.	Ramakant A. Gayakwad (2017),*Op-amps and Linear Integrated Circuits*, Prentice Hall,4th edition.
3.	David A. Bell(2018) ,*Electronic Instrumentation and Measurements*, Oxford University Press.
4.	SepehrNaimi, SarmadNaimi, Muhammad Ali Mazidi (2017), *The 8051 Microcontroller and Embedded Systems Using Assembly And C*, Pearson,Second edition.
5.	Frank D. Petruzella (2016), *Programmable Logic Controllers*, , McGraw-Hill Education.
REFERENCE BOOKS	
1.	M. Morris Mano (2016), *Digital Logic and Computer Design*, Prentice-Hall.
2.	Roy Choudhury (2018), *Linear Integrated Circuits*, New Age International Publishers, 4th edition, 2018
3.	Thomas W. Schultz, Thomas W. (2018), *C and 8051*, Schultz Publishers, 4th edition.
4.	S.P Bali (2008), *Consumer Electronics*, Pearson Education Asia Pvt., Ltd.,
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			CREDITS	0.5
COURSE CODE	GEA4131	COURSE CATEGORY	BS	L-T-P-S	0-0-2-2
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

Experimentation	Calculation and Results	Viva	Record	ESE
30%	20%	20%	10%	20%

Course Description	This course provides information and hand on experience on different streams of Engineering and Technology. Thestudent should be able to identify and use different types of tools, types of joints used in welding, carpentry, and plumbing operations, IC engines and airfoils flow patterns. Moreover, the students will be exposed to nuances of electrical, electronics, mechatronics, and computer science engineering.
Course Objective	1. Identify and use different types of tools 2. Practice different types of joints in welding,carpentry and plumbing operations 3. Experience air flow patterns over airfoils and understand internal combustion engine principles 4. Hands on experience on electrical and electronics cum mechatronics lab practice 5. Learn the basics of computer hardware and softwareinstallaltions
Course Outcome	Upon completion of this course, the students will be able to 1. Apply different joint types of welding and carpentry for engineering applications 2. Apply the fundamentals of plumbing operations and use various joints for any applications 3. Understand the nuances of electrical, electronics and mechatronics concepts on wiring, circuits, and systems. 4. Demonstrate the software installations and operating systems 5. Explain internal combustion engine basics and flow patterns on air foils / objects

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	2	3	1	1	1	1	1	1	3	3	2
CO-2	3	3	3	2	3	1	1	1	1	1	1	3	3	2
CO-3	3	3	3	2	3	1	1	1	1	1	1	3	3	2
CO-4	3	3	3	2	3	1	1	1	1	1	1	3	3	2

CO-5	3	3	3	2	3	1	1	1	1	1	1	3	3	2
CO-6	3	3	3	2	3	1	1	1	1	1	1	3	3	2

1: Weakly related, 2: Moderately related and 3: Strongly related

LISTOFEXPERIMENTSTOTAL HOURS –15 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

LIST OF EQUIPMENTS

S.No.	Details of Equipment	Quantit	Experimen

		y	t Nos.
1.	PIC Kit	5	4
2.	Wind Tunnel test section size around300 x 300 mm with test section flow speed of 70 m/s.	1 No.	1, 2,3,
3.	Wings of various airfoil sections(Symmetrical & cambered airfoils)	2 Nos. each	3
4.	Angle of incidence changing mechanism	1 No.	1
5.	Multiple Manometer stands with20 – 30 manometer tubes	4 Nos.	2,3

REFERENCE BOOKS

1.	Mohamed Rafiquzzaman, "Microcontroller Theory and Applications with the PIC18F" Wiley, 2018
2.	Jeyapoovan T and Saravanapandian M., Engineering practices lab manual, 4th Edition, Vikas publishing House, New Delhi, 2015.
3.	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
4.	Ibrahim Zeid, CAD/CAM Theory and Practice, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2011
5.	Robert Quesada, Jeyapoovan T., Computer Numerical Control Machining and Turning Centers, Pearson Education, New Delhi, 2006

COURSE TITLE	ENGINEERING PHYSICS LAB (Common to ALL branches of Engineering)			CREDITS	1
COURSE CODE	PHA4131	COURSE CATEGORY	BS	L-T-P-S	0-0-2-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

Experimental	Calculation	Result	Viva	Record	ESE
30%	10%	10%	20%	10%	20%

Course Description	Learn experimental methods to determine engineering properties of materials and demonstrate the use of modern tools in engineering
Course Objective	1. To analyze elastic properties of materials 2. To determine thermal conductivity of a bad conductor. 3. To measure viscosity of liquids. 4. To study the V-I characteristics of diode. 5. To apply light phenomena to analyze materials.
Course Outcome	Upon completion of this course, the students will be able to 1. Determine elastic properties of materials 2. Estimate thermal conductivity of bad conductor 3. Analyze viscosity of liquids 4. Plot V-I characteristics of a diode. 5. Determine thickness of thin wire and refractive index of a material

Prerequisites: Physics practical at higher secondary level

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	1	1	1	1	1	1	3	1	1	3	2	3
CO-2	3	3	1	1	1	1	1	1	3	1	1	3	2	3
CO-3	3	3	1	1	1	1	1	1	3	1	1	3	2	3
CO-4	3	3	1	1	3	1	1	1	3	1	1	3	2	3
CO-5	3	3	1	1	1	1	1	1	3	1	1	3	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PROPERTIES OF MATTER- SOLID (9)

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.	**CO-1** **BTL-3**
MODULE 2: PROPERTIES OF MATTER- LIQUID (4)	
4. Viscosity – Determination of co-efficient of viscosity of a liquid by Poiseuille's flow.	**CO-2** **BTL-3**
MODULE 3: THERMAL CONDUCTIVITY (4)	
5. Lee's Disc – Determination of thermal conductivity of a bad conductor.Preparation of urea-formaldehyde resin.	**CO-3** **BTL-3**
MODULE 4: OPTICS (7)	
6. Air – Wedge – Determination of thickness of a thin wire 7. Spectrometer – refractive index of a prism	**CO-4** **BTL-3**
MODULE 5: ESTIMATION METAL ION CONTENTS IN THE SAMPLE (6)	
8.Semiconductor laser – Determination of wavelength of laser using grating 9.Semiconductor diode – VI characteristics	**CO-5** **BTL-3**

TEXT BOOKS	
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 BOOKS	
1.	http://www.aurora.ac.in/images/pdf/departments/humanities-and-sciences/engg-phy-lab-manual.pdf
MOOC	
1.	https://www.coursetalk.com/providers/coursera/courses/introduction-to-chemistry-1

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
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

Experimental	Calculation	Result	Viva	Record	ESE
30%	10%	10%	20%	10%	20%

Course Description	Learn and apply basic techniques used in materials chemistry laboratory for analysis of lubricants, refractories, & other engineering materials and spectrophotometric analysis of metal ions.
Course Objective	1. To learn about characterization of lubricants. 2. To construct and analyze phase diagram for partially miscible liquids. 3. To learn on the preparation of polymers for various engineering applications. 4. To imparthands on training and skillset of characterizing refractories. 5. To estimate metal ions using spectrophotometry.
Course Outcome	Upon completion of this course, the students will be able to 1. Grade the lubricants based on viscosity 2. Analyze the phase diagram and interpret the critical solution temperature. 3. Apply the practical knowledge gained on the preparation of polymers, for the preparation of other similar macromolecules. 4. Analyze the strength of refractories. 5. Apply the spectrophotometric method for the determination of metal ions in different environment.

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

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	1	1	1	1	2	1	1	1	1	2	1	1
CO-2	3	2	1	1	1	1	2	1	1	1	1	2	1	1
CO-3	3	2	1	1	1	1	2	1	1	1	1	2	1	1
CO-4	3	2	1	1	1	1	2	1	1	1	1	2	1	1
CO-5	3	2	1	1	1	1	2	1	1	1	1	2	1	1

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PROPERTIES OF LUBRICANTS (6)

1. Determination of viscosity of polymer using Ostwald Viscometer. 2. Determination of Viscosity Index of lubricants. 3. Determination of viscosity of oil using Red-Wood Viscometer.	**CO-1** **BTL-3**
MODULE 2: PHASE DIAGRAM IN LIQUID SYSTEM (6)	
4. Construction of phenol-water phase diagram. 5. Determination of adsorption isotherm for acetic acid on activated charcoal.	**CO-2** **BTL-3**
MODULE 3: PREPARATION POLYMER RESIN. (6)	
6. Preparation of urea-formaldehyde resin.	**CO-3** **BTL-3**
MODULE 4: BASIC PROPERTIES OF REFRACTORIES(6)	
7. Determination of porosity of a refractory. 8. Determination of apparent density of porous solids.	**CO-4** **BTL-3**
MODULE 5: ESTIMATION METAL ION CONTENTS IN THE SAMPLE (6)	
9. Estimation of dye content in the effluent by UV-Visible spectrophotometry. 10. Determination of copper / iron content in the alloy by colorimetry. 11. Estimation of sodium and potassium ions by flame photometry. 12. Verification of Beer-Lambert's law using gold nanoparticles.	**CO-5** **BTL-3**

TEXT BOOKS	
1.	P.S. Raghavan, Materials Chemicals Laboratory Manual, Dhanam Publications, 2018
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
E BOOKS	
1.	http://www.erforum.net/2016/01/engineering-chemistry-by-jain-and-jain-pdf-free-ebook.html
MOOC	
1.	https://www.coursetalk.com/providers/coursera/courses/introduction-to-chemistry-1

Semester - II

COURSE TITLE	ANALYTICAL MATHEMATICS			CREDITS	4
COURSE CODE	MAA4117	COURSE CATEGORY	BS	L-T-P-S	3-0-2-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student understand the basic analytical mathematical skills that is imperative for effective understanding of engineering subject using MATLAB.
Course Objective	1. To demonstrate the fundamental understanding and history of AI 2. To apply problem solving skills using the problem-solving methods of AI 3. Todemonstrate awareness and a fundamental understanding of various applications of AI techniques in intelligent agents, expert systems, artificial neural networks, and other machine learning models 4. To understand the applications of AI
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate effectively to evaluate surface and volume integrals. 2. Formulate and perform vector operations and interpret the results geometrically 3. Skilled to solve the system of ordinary differential equations using Laplace Transform 4. Calculate Proficiently any periodic function satisfying Dirichlet's conditions can be expressed as a Fourier series 5. Understandand use complex variable theory, applications of analytic function and harmonic conjugate.

Prerequisites: MAA4101MATRICES AND CALCULUS

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	2	1	1	1	1	2	1	1	1	1	1	2	3
CO-2	2	1	1	2	1	1	1	1	1	1	1	1	2	3
CO-3	2	1	1	2	1	1	1	1	1	1	1	1	2	3
CO-4	2	1	1	1	1	1	1	1	1	1	1	1	2	3

CO-5	2	1	1	1	1	1	2	1	1	1	1	1	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

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 using double and triple integration**.**	**CO-1** **BTL-1,2,3**
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**.**	**CO-2** **BTL-1,2,3**
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	**CO-3** **BTL-1,2,3**
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	**CO-3** **BTL-1,2,3**
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	**CO-4** **BTL-1,2,3**

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 https://www.khanacademy.org/.../double-integrals.../double-integral. nptel.ac.in/courses/115101005/downloads/lectures-doc/Lecture-1.pdf nptel.ac.in/syllabus/122104017/ nptel.ac.in/courses/111105035/22 nptel.ac.in/syllabus/111103070/
MOOC	
1.	https://www.edx.org/course/introduction-engineering-mathematics-utarlingtonx-engr3-0x

COURSE TITLE	ENGINEERING MECHANICS			CREDITS	3
COURSE CODE	AEB4116	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course is an introduction to learning and applying the principles required to solve engineering mechanics problems. Concepts will be applied in this course from previous courses you have taken in basic math and physics. The course addresses the modeling and analysis of static equilibrium problems with an emphasis on real world engineering applications and problem solving.
Course Objective	1. To solve basic problems of statics of particles. 2. To apply the fundamentals of mechanics, equation of static equilibrium & dynamic equilibrium of particles and rigid bodies. 3. To interpret the effect of friction on equilibrium. 4. To analyze kinematics, kinetics of particle and rigid body, related principles. 5. To implement the above know how to solve practical engineering problems.
Course Outcome	Upon completion of this course, the students will be able to 1. Effectively use the free body diagrams of basic structural elements to design structures to meet design requirements. 2. Demonstrate the ability to draw free body diagrams and calculate the forces in simple structures using hand calculation 3. Identify load paths in structures and demonstrate a knowledge of statics and dynamics of particles and rigid bodies 4. Calculate the area moment of inertia of structural members. 5. Apply the concepts of friction and basics of rigid body dynamics.

Prerequisites: Basic Physics

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	2	-	1	-	-	2	-	-	2	3	2
CO-2	3	3	2	2	-	1	-	-	2	-	-	2	3	2
CO-3	3	3	2	2	-	1	-	-	2	-	-	2	3	2

CO-4	3	3	2	2	-	1	-	-	2	-	-	2	3	2
CO-5	3	3	2	2	-	1	-	-	2	-	-	2	3	2

1: Weakly related, 2: Moderately related and 3: Strongly related

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.	**CO-1 BTL-2**
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.	**CO-2 BTL-2**
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	**CO-3 BTL-3**
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	**CO-4 BTL-2**
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.	**CO-5 BTL-2**

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	.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/
3.	https://www.edx.org/course/engineering-mechanics-2?index=product&queryID=bcb0d1e88c0dd3512f2fd07b11dc227f&position=1
4.	https://www.coursera.org/learn/engineering-mechanics-statics
5.	https://www.coursera.org/learn/engineering-mechanics-statics-2

COURSE TITLE	**INTRODUCTION TO AEROSPACE ENGINEERING**			**CREDITS**	**3**
COURSE CODE	**ASB4117**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-1**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-2**

ASSESSMENT SCHEME

First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	This course to provide a general overview of the field of Aerospace Engineering, and the current development in this field of engineering.
Course Objective	1. To understand the historical evaluation of aeroplanes 2. To study the different component systems and functions 3. To learn the basic principles behind propulsion of flight 4. To classify and categorizethe different structures & construction 5. To utilizethe various types of instruments and navigation systems

Course Outcome	Upon completion of this course, the students will be able to 1. Understand the history of aircraft & developments over the years 2. Identify the types & classifications of components and configurations. 3. Know the basic concepts of propulsion and power plants 4. Classify the types of fuselage, constructions and materials 5. Comprehend the different types of navigation and instruments for flight

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	1	-	-	3	2	2	2	-	1	2	2	3
CO-2	3	1	1	-	-	3	2	2	2	-	1	2	2	3
CO-3	3	1	1	-	-	3	2	2	2	-	1	2	2	3
CO-4	3	1	1	-	-	3	2	2	2	-	1	2	2	3
CO-5	3	1	1	-	-	3	2	2	2	-	1	2	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: HISTORICAL EVOLUTION 9	
History of aviation, early development of airplanes, biplanes and monoplanes, history of spaceflight, development of space vehicle, classification of duct jet propulsion, rocket propulsion, advance propulsion and applications	**CO-1 BTL-2**
MODULE 2: CONFIGURATIONS OF AIRCRAFT 9	
Anatomy of flight vehicles, components of an airplanes and their function, configuration of space vehicle, earth's atmosphere and gravitational field, bluff bodies v/s streamlined body, aero foil. Lift generation, significance of L/D ratio, aerodynamic forces,pressure, Actual and theoretical PV diagrams of four stroke and two stroke IC Engines.	**CO-2 BTL-2**
MODULE 3: PROPULSION 9	
Classification and essential features of propulsion, jet propulsion, general characteristics of rocket engines, theory of propulsion, elementary gas dynamics, spacecraft's and aircraft performance	**CO-3 BTL-2**
MODULE 4: AIRCRAFT STRUCTURES AND MATERIALS 9	
General types of construction and structural layout, flight envelope and V-n diagrams, monocoque, semimonocoque, corrugated, sandwich structure, reinforced and honeycomb structures, geodesic construction, aerospace materials, metallic and non-metallic materials, use of aluminum alloy, titanium, stainless steel, composite and ceramic materials.	**CO-4 BTL-2**
MODULE 5: INSTRUMENTS AND NAVIGATION 9	
Basic instrumentation electronics (dc electronics, ac electronics, semiconductors, electro-optics and digital electronics), sensing devices, bridge circuits, optical devices and introduction to computer based data acquisition, measurements in aerodynamics, flight structures, and flight control, principles of navigation, celestial, radio, and inertial navigation schemes, navigational and guidance requirements for orbital, planetary, and atmospheric entry missions.	**CO-5 BTL-2**

TEXT BOOKS

1.	Merrill, G., "Principle of Guided Missile Design", D. Van Nostrand Co., INC.,
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.	Anderson, J. D., "Introduction to Flight", McGraw-Hill, 2000.
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
4.	https://www.educba.com/course/elements-of-aeronautics/

COURSE TITLE	**AERO MODELLING LAB**			**CREDITS**	**1**
COURSE CODE	**ASB4131**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**0-0-2-1**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

Internal Assessment	**ESE**
80%	**20%**

Course Description	This is a creative course, which has as main objective of designing, building and flying of various models of airplanes or helicopters.
Course Objective	1. To introduce the use ofwood crafting planes 2. To know the different aircraft materials and its uses 3. To comprehend aerodynamics, designing, electronics and technology 4. To evaluate the different types of flying models

Course Outcome	Upon completion of this course, the students will be able to: 1. Get hands-on experience necessary for developing a practical aptitude. 2. Learn in detail about wood crafting and the technology of new materials 3. Able to understand aerodynamics, designing, electronics and technology and use it in design and fabricate different types of fly models.

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	3	1	2	1	1	1	1	1	1	2	1	2
CO-2	3	2	3	1	2	1	1	1	1	1	1	2	1	2
CO-3	3	2	3	1	2	2	1	1	1	1	1	2	1	2

1: Weakly related, 2: Moderately related and 3: Strongly related

LIST OF EXPERIMENTS(30)

1. Introduction to wing plan forms and Aerofoil 2. Introduction to Gliders 3. Design calculation of Gliders. 4. Fabrication of powered & Un-powered Gliders. 5. Simulation of RC plane Flight using simulators 6. Design calculation of RC plane	**CO 1-3** **BTL-3**

Semester - III

COURSE TITLE	PARTIAL DIFFERENTIAL EQUATIONS AND TRANSFORMS			CREDITS	4
COURSE CODE	MAA4201	COURSE CATEGORY	BS	L-T-P-S	3-0-2-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student understand the basic concepts of partial differential equations and transforms and its applications
Course Objective	1. To present the main results in the context of partial differential equations and to study numerical methods for the approximation of their solution 2. To introduce the wave equation including time and position dependence 3. to mathematically model the way thermal energy moves through the plate 4. To apply the concept of Fourier transform 5. To make use of Z-transform and its properties
Course Outcome	Upon completion of this course, the students will be able to 1. Formulate and solve some of the physical problems involving partial differential equations 2. Classify and solve the Wave and Heat equations 3. Classify and solve two-dimensional heat equations 4. Solveproblems proficientlyrelatedtoengineeringapplicationsbyusingFourier Transform techniques 5. Understand and analyze discrete transformappliedto engineeringproblems

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	1	1	1	1	2	1	1	2	1	2	2	3	2
CO-2	2	1	1	1	1	2	1	1	2	1	2	2	3	2
CO-3	2	1	1	1	1	2	1	1	2	1	2	2	3	2
CO-4	2	1	1	1	1	2	1	1	2	1	2	2	3	2
CO-5	2	1	1	1	1	2	1	1	2	1	2	2	3	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PARTIAL DIFFERENTIALEQUATIONS (9L+3T=12)

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	**CO-1** **BTL-1,2,3,4**
MODULE 2: ONE DIMENSIONAL WAVE AND HEAT FLOW EQUATION (9L+3T=12)	
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.	**CO-2** **BTL-2,3,4**
MODULE 3: TWO DIMENSIONAL HEAT FLOW EQUATION (9L+3T=12)	
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.	**CO-3** **BTL-1,2,3,4**
MODULE 4: FOURIERTRANSFORM (9L+3T=12)	
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.	**CO-3** **BTL-1,2,3**
MODULE 5: Z-TRANSFORM AND DIFFERENCE EQUATIONS (9L+3T=12)	
Z-Transform - Elementary Properties - Inverse Z-Transform - Convolution theorem - Formation of Difference equations - Solution of difference equations using Z-Transform Suggested Reading: Basic calculus	**CO-4** **BTL-1,2,3,4**

TEXT BOOKS

1.	P. Sivarama Krishna Das, C. Vijayakumar, "Transforms and partial differential equations", 1 Pearson Publication, 201
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

REFERENCE BOOKS

1.	BaILN.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:f/www.mooc-list.com/tags/laplace-transforms
2.	https://www.edx.org/course/introduction-differential-equations-bux-math226-1x-1

COURSE TITLE	SOLID MECHANICS			CREDITS	3
COURSE CODE	AEB4201	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The aim of this course is to introduce students to the fundamental concepts and principles applied by engineers in the design of structures of all sorts of sizes and purpose. This course aims also to engage students in the formulation and resolution of open-ended, design-type exercises, thereby bridging the divide between scientific theory and engineering practice.
Course Objective	1. Impart knowledge on the stresses and strain tensor and analysis of different bodies subjected to external loadings. Knowledge on calculating stresses and strain using energy methods will also be imparted. 2. Impart knowledge on Shear force and bending moment diagrams of beams along with estimation of direct and shear stresses in bending of beams. 3. Understand the different methods for calculating deflection in beams subjected to different loadings. 4. Comprehend on the concept of torsion and shear stresses in solid and hollow shafts along with deflection of springs. 5. Impart knowledge on the concept of multiaxial stresses, i.e., biaxial stresses along with theories of failure for brittle and ductile materials.
Course Outcome	Upon completion of this course, the students will be able to: 1. Understand the fundamental concepts of stress and strain in mechanics of solids and structures. 2. Analyze determinate beams and trusses to determine shear forces, bending moments and axial forces. 3. Analyze designing of shafts to transmit required power and springs for its maximum energy storage capacities. 4. Determine principal planes and stresses and apply the results to multiaxial loading case. 5. Analyze any structural members subjected to any forces.

Prerequisites: Engineering Mechanics

CO, PO AND PSO MAPPING

CO	PO - 1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO -10	PO-11	PO-12	PSO-1	PSO-2

CO-1	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-2	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-3	3	3	3	3	2	-	-	-	2	1	-	2	3	2
CO-4	3	3	3	2	2	-	-	-	2	1	-	2	3	2
CO-5	3	3	3	2	2	-	-	-	2	1	-	2	3	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BASICS AND AXIAL LOADING (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.	**CO-1 BTL-2, 3**
MODULE 2: STRESSES IN BEAMS(9)	
Shear force and bending moment diagrams for simply supported and cantilever beams, Bendingstressesinstraightbeams,ShearStressesinbendingofbeamswithvariouscrosssections,Beams ofuniformstrength, Composite beams	**CO-2 BTL-2, 3**
MODULE 3: DEFELECTION OF BEAMS(9)	
Deflection of beams using Double integration method, McCauley's method, Area moment method ,Conjugate beam method and Energy method. Principle of super position, Maxwell reciprocal theorem.	**CO-3 BTL-2, 3**
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.	**CO-4 BTL-2, 3**
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 and maximum 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.	**CO-5 BTL-3**

TEXT BOOKS

1	R.K.Bansal,"ATextBookofStrengthofMaterials",LakshmiPublicationsPvt.Limited,New Delhi,2010.
2	T.J.Prabhu,"Mechanicsofsolids",PrivatePublication,2002.
3	R.K.Rajput, "Strength of materials", Fourth Edition, S.Chand Limited,2007.

4	WilliamANash"TheoryandproblemsofStrengthofMaterials",Schaum'sOutlineSeries, McGraw Hill International Edition, 3rd Edition,2007
5	S.TimoshenkoandD.H.Young"ElementsofstrengthmaterialsVol.IandVol.II",T.VanNostrandCo-IncPrinceton-N.J. 1990.
REFERENCE BOOKS	
1	CliveL.DymandI.H.Shames,"SolidMechanics",1990.
2	L.S.Srinath," Advanced Mechanics of Solids", Tata McGraw Hill Publishing Company Ltd., NewDelhi,2009.
3	EgorP.Popov.,"Engineeringmechanicsofsolids",2ndedition,PrenticeHallof India Private Limited, New Delhi,2009.
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 KoyakushaLimited,2000.
E BOOKS	
1	http://www.springer.com/in/book/978146146767
2	http://royalmechanicalbuzz.blogspot.in/2015/04/strength-of-materials-book-by-r-k-bansal.html
3	http://www.engineering108.com/pages/Mechanical_Engineering/SM/Strength_of_Materials_ebooks_free_download.html
MOOC	
1.	https://ecourses.ou.edu/cgi-bin/ebook.cgi?topic=me
2.	http://esag.harvard.edu/rice/e0_Solid_Mechanics_94_10.pdf
3.	http://nptel.ac.in/courses/112107147/

COURSE TITLE	AERO THERMODYNAMICS (Common to Aeronautical, Aerospace and Avionics)			CREDITS	3
COURSE CODE	AEB4202	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	Thermodynamics deals on energy transfer and its effect on the physical properties of substances.These laws govern the principles of energy conversion. The applications of the thermodynamic laws andprinciples are found in all fields of energy technology, notably in gas turbines, gas dynamics, jet propulsion, compressors, steam and nuclear power plants, internalcombustion engines, refrigeration & air conditioning,and direct energy conversion devices.
Course Objective	1. To enable the students to have a basic idea about thermodynamic systems, and processes. 2. To understand the gas powercycles like (Otto, Diesel, and Dual combustion and Brayton combustion cycles) and PV diagrams of four stroke and two stroke IC Engines 3. To understand the properties of steam, vapor cycles and its derivatives. 4. To understand the fundamentals of combustion.
Course Outcome	Upon completion of this course, the students will be able to 1. Effectively use the basic concepts of thermodynamics and its Ist law of Thermodynamics. 2. Effectively use the laws of thermodynamics for basic calculations 3. Analyze various gas power cycles. 4. Analyze the power developed from steam as the working medium. 5. Understand the basics, and laws of combustion.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	-	-	-	-	2	2	-	2	2	3

CO-2	3	3	3	3	-	-	-	-	2	2	-	2	2	3
CO-3	3	3	3	3	-	-	-	-	2	2	-	2	2	3
CO-4	3	3	3	3	-	-	-	-	2	2	-	2	2	3
CO-5	3	3	3	3	-	-	-	-	2	2	-	2	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

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. **Suggested Readings:** Perpetual Motion Machine of the First Kind–PMM1, Variable Flow Processes	**CO-1** **BTL-2, 3**
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 **Suggested Readings:** Available Energy, Exergy, and Irreversibility	**CO-2** **BTL-2, 3**
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. **Suggested Readings:** Aircraft Propulsion, Brayton-Rankine Combined Cycle	**CO-3** **BTL-2, 3**
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. **Suggested Readings:** Exergy Analysis of Vapour Power Cycles	**CO-4** **BTL-2, 3**
MODULE 5: INTRODUCTION TO COMBUSTION(9)	
Mass fraction and mole fraction, p-v-t behavior and properties of ideal gas mixtures, Avogadro's law, Gibbs-Dalton law, enthalpy, and specific heat of a gas mixtures. Aerospace Chemical Propulsion: Fuels in combustion, Enthalpy of reaction, formation, and combustion. Stoichiometric Air-fuel ratio, equivalence ratio. Introduction to adiabatic flame temperature. **Suggested Readings:** Maxwell's Equations, Gibbs Phase Rule	**CO-5** **BTL-2, 3**
TEXT BOOKS	

1.	Nag, P. K, "Engineering Thermodynamics", 5th Edition, Tata McGraw Hill, New Delhi, 2013.
2.	Yunus A. Cengel and Michael A. Boles, "Thermodynamics an engineering approach", seventh edition, Mc Graw Hill Higher education, 2011.
REFERENCE BOOKS	
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	
1.	https://docs.google.com/file/d/0B7OQo6ncgyFjZTdUWEItdHRGbHc/edit
2.	https://books.google.co.in/books?id=GiLYEwSDLqsC&printsec=frontcover#v=onepage&q&f=false
MOOC	
1.	https://www.edx.org/course/thermodynamics-iitbombayx-me209-1x-1
2.	https://www.coursera.org/learn/thermodynamics-intro
3.	https://onlinecourses.nptel.ac.in/noc18_ch03/preview
4.	https://onlinecourses.nptel.ac.in/noc18_ch03/preview

COURSE TITLE	**Fluid Mechanics and Machinery**			**CREDITS**	**3**
COURSE CODE	**AEB4203**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-1**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course introduces students to the fundamentals of statics, dynamics, and hydraulic machines goal of this course is to teach students how to grasp fluid mechanics rules and how to analyze pres velocity, and acceleration fields for various fluid flows and hydraulic machinery perform characteristics.
Course Objective	1. To understand the principles of basic concepts and properties of fluid. 2. To appreciate and comprehend the fluid kinematics and its dynamics. 3. To know the basic concepts of incompressible flows 4. To study the basic concepts of fluid machines and hydraulic turbines. 5. To cognize the operation of hydraulic pumps & its applications

Course Outcome	Upon completion of this course, the students will be able to 1. Distinguish different types of fluids, its properties, and itsbehavior under various conditions. 2. Analyze the fluid flow field based on the concepts of fluid kinematics and fluid dynamics. 3. Formulate non-dimensional analysis of the fluid flow field and analyze the flow through pipes. 4. Gain knowledge on working principles of various hydraulic turbines and solve basic problems. 5. Acquire knowledge on working principles of centrifugal & reciprocating pumps and solve problems.

Prerequisites: Engineering Physics and Engineering Mathematics

CO, PO AND PSO MAPPING

CO	PO -1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO -10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	2	2	-	-	2	2	1	-	2	2	3
CO-2	3	2	2	2	2	-	-	2	2	1	-	2	2	3
CO-3	3	3	3	3	3	-	-	2	2	1	-	2	2	3
CO-4	3	3	2	2	2	-	-	1	1	1	-	2	2	3
CO-5	3	2	2	2	2	-	-	1	1	1	-	2	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

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.	**CO-1 BTL-3**

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.	**CO-2 BTL-3**

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.	**CO-3 BTL-3**

MODULE 4: HYDRAULIC TURBINES (9)

Fluid machines: Definition and classification - exchange of energy - Euler's equation for turbomachines - 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	**CO-4 BTL-3**

MODULE 5: HYDRAULIC PUMPS	**(9)**
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)	**CO-5 BTL-3**

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 mach Tata, McGraw Hill Edition, 2017
3.	A Textbook of Fluid Mechanics and Hydraulic Machines by R.K. Bansal , Lakshmi Publications Limited, New Delhi, 2010.
REFERENCE BOOKS	
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 of Mechanics"*, Seventh Edition, John Wiley & Sons, Inc. 2016
E BOOKS	
1.	http://www.engineering108.com/pages/Mechanical_Engineering/FM/Fluid_Mechanics_ebooks-fre wnload.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-ivfall-2 spring-2006/fluid-mechanics/

COURSE TITLE	**PROFESSIONAL ETHICS AND LIFE SKILLS**			**CREDITS**	**2**
COURSE CODE	**GEA4216**	**COURSE CATEGORY**	**BS**	**L-T-P-S**	**2-0-0-1**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	To study the concepts of business ethics, levels, myths,Employee & Corporate on responsibilities on aspects of contracts, equal opportunity , Affirmative action, sexual harassment etc.,
Course Objective	1. Know about fundamentals of professional ethics 2. Understand the ethical principles 3. Understand the principles of stake holder theory 4. Study the safety &reliability 5. Study the employee &corporate responsibilities
Course Outcome	Upon completion of this course, the students will be able to: 1. Develop an understanding of business ethics, levels, myths, use and train oneself to be ethical. 2. Acquire knowledge on ethical principles, reasoning, roles & responsibilities. 3. Develop an understanding of stake holder theory, individual and corporate responsibilities towards stake holders. 4. Understand corporate responsibilities towards product safety &reliability and environment friendly approach. 5. Understand the Employee & Corporate on responsibilities on aspects of contracts, equal opportunity , affirmative action, sexual harassment, etc.

Prerequisites: - Nil

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	1	1	1	1	1	1	1	1	1	3	3	2
CO-2	3	3	2	2	1	1	1	1	1	1	1	3	3	2
CO-3	3	3	2	2	1	1	1	1	1	1	1	3	3	2
CO-4	3	2	2	2	1	1	1	1	1	1	1	3	3	2
CO-5	3	3	2	2	1	1	1	1	1	1	1	3	3	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: HUMAN VALUES (6)

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

CO-1
BTL-2

MODULE 2: ENGINEERING ETHICS (6)

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

CO-2
BTL-2

MODULE 3: SAFETY, RESPONSIBILITIES AND RIGHTS(6)	
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	**CO-3** **BTL-2**
MODULE 4: LIFE SKILLS (6)	
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	**CO-4** **BTL-3**
MODULE 5: SOCIETIES IN PROGRESS (6)	
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	**CO-5** **BTL-3**

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. 2.	https://www.faa.gov/regulations_policies/handbooks_manuals/aircraft/amt_airframe_handbook/ media/ama_Ch11.pdf 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			CREDITS	1
COURSE CODE	AEB4231	COURSE CATEGORY	PC	L-T-P-S	0-0-3-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

Internal Assessment	ESE
80%	20%

Course Description	This course provides practical knowledge to the students in verification of principles of fluid flow. This course develops knowledge in measuring pressure, discharge and velocity of fluid flow using pump like centrifugal, reciprocating and gear pump and to find the rate of flow using rota meter.
Course Objective	1. To know the properties of the fluid and to learn about the pressure and velocity of the flowing fluid using venturimeter, orifice meter and pitot tube. 2. To understand the discharge of fluid by using pump like centrifugal, reciprocating and gear pump and also to find the rate of flow using rota meter. 3. To comprehend the efficiency of turbine like Kaplan and Francis. 4. To cognize the change in pressure (friction factor) of given set of pipes. 5. To study the efficiency of Pelton wheel.
Course Outcome	Upon completion of this course, the students will be able to 1. Determine the coefficient of discharge of orifice meter and venturimeter. 2. Determine the friction factor of given set of pipes when there is change in pressure& Calculate the rate of flow using Rotameter 3. Conduct experiments and draw the characteristics curves of Francis turbine and Kaplan turbine and also can find the efficiency of the turbine. 4. Conduct experiment and draw the characteristics curves of Pelton wheel. 5. Conduct experiments and draw the characteristic curves of centrifugal pump, submergible pump, reciprocating pump, and find the discharge of the pump.

Prerequisites: Fluid Mechanics and Machinery

CO, PO AND PSO MAPPING

CO	PO -1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO -10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	2	2	1	1	1	1	2	2	3	2	3
CO-2	3	3	3	2	2	1	1	1	1	2	2	3	2	3
CO-3	3	3	3	2	2	1	1	1	1	2	2	3	2	3
CO-4	3	3	3	2	2	1	1	1	1	2	2	3	2	3
CO-5	3	3	3	2	2	1	1	1	1	2	2	3	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

EXPERIMENT 1	
1. Calibration of venturimeter	**CO-1 BTL-3**
EXPERIMENT 2	
2. Pressure measurement with Pitot static tube	**CO-1 BTL-3**
EXPERIMENT 3	

3. Determination of pipe flow losses.	**CO-2 BTL-3**
EXPERIMENT 4	
4. Verification of Bernoulli's theorem	**CO-2 BTL-3**
EXPERIMENT 5	
5. Flow visualization by Heleshaw apparatus	**CO-2 BTL-3**
EXPERIMENT 6	
6. Performance test on Centrifugal pump	**CO-5 BTL-3**
EXPERIMENT 7	
7. Performance test on Reciprocating pump	**CO-4 BTL-3**
EXPERIMENT 8	
8. Performance test on Pelton wheel turbine	**CO-4 BTL-3**
EXPERIMENT 9	
9. Performance test on Francis turbine	**CO-3 BTL-3**
EXPERIMENT 10:	
10. Determination of Viscosity of a Fluid	**CO-5 BTL-3**

COURSE TITLE	**SOLID MECHANICS LABORATORY**			**CREDITS**	**1**
COURSE CODE	**AEB4232**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**0-0-3-0**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
Observation & Record		**Practical Demonstration, Lab Test Report& Viva**		**ESE**	
20%		**60%**		**20%**	
Course Description	This lab course is designed to provide hands on experience and practical learning in the material testing. Students will be able to test on their own to find the mechanical properties. The behavior of each type of material is also can be able to understand.				

Course Objective	1. To test a specimen using Brinell hardness testing machine. 2. To test a specimen using Rockwell hardness testing machine. 3. To perform tensiontest on mild steel a rod using universal testing machine 4. To perform torsion test on a mild steel rod using universal testing machine 5. To perform impact test using Izod and Charpy impact testing machine. 6. To perform fatigue test in rotating beam using fatigue tester 7. To perform tension and compression test on open and closed helical spring setup. 8. To perform tension and compression test on wood using UTM. 9. To perform the Maxwell reciprocal theorem and to verify
Course Outcome	Upon completion of this course, the students will be able to 1. Determine the hardness of the material 2. Determine the yield load, ultimate load and Young's modulus of the mild steel rod. 3. Determine the modulus of rigidity of the mild steel rod. 4. Determine the impact energy stored in the material. 5. Determine the deflection and stiffness of the spring. 6. Determine the failure strength under compression load. 7. Determine the young's modulus of aluminium using Mechanical and Electrical extensometers. 8. Verify the Maxwell reciprocal theorem and Principle of Superposition.

Prerequisites: Engineering immersion Lab, Solid Mechanics

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	-	-	1	-	3	2	-	-	3	2	3
CO-2	3	3	3	-	-	1	-	3	2	-	-	3	2	3
CO-3	3	3	3	-	-	1	-	3	2	-	-	3	2	3
CO-4	3	3	3	-	-	1	-	3	2	-	-	3	2	3
CO-5	3	3	3	-	-	1	-	3	2	-	-	3	2	3
CO-6	3	3	3	-	-	1	-	3	2	-	-	3	2	3
CO-7	3	3	3	-	-	1	-	3	2	-	-	3	2	3
CO-8	3	3	3	-	-	1	-	3	2	-	-	3	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

SOLID MECHANICS LAB (30 HOURS)

1. 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 Deflection of beams	**CO-1,2,3,4,5** **BTL-3**

LIST OF EQUIPMENTS

S.No	Items	Quantity	Experiment No
1	Brinell hardness Testing Machine	1	1
2	Rockwell Hardness Testing Machine	1	1
3	Universal Testing Machine	1	2,3,6
4	Izod Impact Testing Machine	1	4
5	Charpy Impact Testing Machine	1	4
6	Cantilever beam setup with strain gauge and mechanical extensometer	2	7,8
7	Simply supported beam setup	1	9
8	Compression testing machine	1	5

COURSE TITLE	THEROMODYNAMICS LAB (Common to Aeronautical, Aerospace)			CREDITS	1
COURSE CODE	AEB4233	COURSE CATEGORY	PC	L-T-P-S	0-0-3-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3
ASSESSMENT SCHEME					
Internal Assessment Examination					ESE
80%					20%

Course Description	To provide hands on experience in operating various types of internal combustion engines and understand their functioning and working of Refrigeration cycles, Heat transfer, gas turbine characteristics.
Course Objective	1. To carry out performance test on a four-strokeengine 2. To carry out valve timing of a four-stroke engine and port timing of a two-stroke engine 3. To carry out test on effectiveness of a parallel flow heat exchanger 4. To carry out test on effectiveness of a counter flow heat exchanger 5. To carry out test for determination of viscosity of a given liquid 6. To carry COP test on a vapour compression refrigeration test rig. 7. To study about the characteristics of a Gas turbine Engine 8. To carry out experiment on evaluation of conductive heat transfer coefficient 9. To carry out experiment on evaluation of thermal resistance of composite wall
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the 4-stroke engine cycle and its performance 2. Understand the port timing mechanism and valve timing mechanism 3. Learn about effectiveness of a parallel flow heat exchanger 4. Learn about effectiveness of a counter flow heat exchanger 5. Understand the viscosity effects in a given fluid flow 6. Estimate COP by conducting a test on a vapour compression refrigeration test rig 7. Estimate the heat transfer coefficient by conductive mode of heat transfer 8. Understand the performance of a Gas Turbine Engine

Prerequisites: Aero Thermodynamics

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO-9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	3	2	3	2	2	2	1	2	1	2	2	2	3
CO-2	3	3	2	3	2	2	2	1	2	1	2	2	2	3
CO-3	3	3	2	3	2	2	2	1	2	1	2	2	2	3
CO-4	3	3	2	3	2	2	2	1	2	1	2	2	2	3
CO-5	3	3	2	3	2	2	2	1	2	1	2	2	2	3
CO-6	3	3	2	3	2	2	2	1	2	1	2	2	2	3
CO-7	3	3	2	3	2	2	2	1	2	1	2	2	2	3
CO-8	3	3	2	3	2	2	2	1	2	1	2	2	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

LIST OF EXPERIMENTS (30 hrs)

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

No Details of Equipment Qty.	**No Details of Equipment Qty**	**No Details of Equipment Qty.**	**No Details of Equipment Qty.**
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			CREDITS	4
COURSE CODE	MAA4217	COURSE CATEGORY	BS	L-T-P-S	3-0-2-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student understand the basic concepts and techniques of numerical solution of algebraic equation, numerical solution of differentiation, integration and their application to engineering and science.
Course Objective	1. To solve system of linear equations by substitution and elimination 2. To define interpolation and prove the order of the polynomial is unique. 3. To develop own numerical differentiation and experience computational limitation 4. To identify the suitable methods to solve ordinary differential equations 5. To identify suitable method to solve partial differential equations
Course Outcome	Upon completion of this course, the students will be able to 1. Apply the techniques for solving the algebraic and transcendental equations, system of equations and Eigenvalue problems. 2. Construct an approximate polynomial to represent the given data and know to find the intermediate values. 3. Obtain the differentiation and integration when the functions are inanalytical form. 4. Solve ordinary differential equation using an appropriate numerical method. 5. Solve partial differential equation using an appropriate numerical method.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	1	1	1	2	1	1	1	1	1	1	2	2	3
CO-2	2	1	1	1	1	1	1	1	1	1	1	2	2	3

CO-3	2	1	1	1	2	1	1	1	1	1	1	2	2	3
CO-4	2	1	1	1	2	1	1	1	1	1	1	2	2	3
CO-5	1	1	1	1	2	1	1	1	1	1	1	2	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS(9L+3T=12)	
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	**CO-1** **BTL-1,2,3,4**
MODULE 2:INTERPOLATION AND APPROXIMATION (9L+3T=12)	
Lagrangian Polynomials – Divided difference – Newton forward and backward difference method – Cubic Spline interpolation. Suggested Reading: Relations and functions	**CO-2** **BTL-1,2,3,4**
MODULE 3:NUMERICAL DIFFERENTIATION AND INTEGRATION (9L+3T=12)	
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	**CO-3** **BTL-1,2,3,4**
MODULE 4: NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATIONS (9L+3T=12)	
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	**CO-4** **BTL-1,2,3,4**
MODULE 5:BOUNDARY VALUE PROBLEMS (9L+3T=12)	
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	**CO-5** **BTL-1, 2, 3, 4**

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.
4.	Raj Kumar Bansal,Ashok Kumar Goel, Manoj Kumar Sharma, "MATLAB and its Applications in Engineering", Pearson Publication, Second Edition, 2016.

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
	Dean G. Duffy., "Advanced Engineering Mathematics with MATLAB", CRC Press, Third Edition 2013.
E BOOKS	
1.	http://nptel.ac.in/courses/112106061/Module_2/Lecture_2.2.pdf
2.	http://www.nptel.ac.in/courses/122104018/node109.html
3.	http://nptel.ac.in/courses/122107036/35
MOOC	
1.	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**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course is an introduction for the analysis of aircraft structures. It bridges together the basic solid mechanics with applications to aerospace/aircraft structures. The course starts with the introduction to the analysis of basic structures used in aircraft construction followed by the study of Theoretical foundations and limitations involved in the analysis and design of modern Aircraft/Aerospace structures. The main aim of this course is to furnish students with the knowledge of aircraft structural analysis, increase their awareness of recent developments in aircraft/aerospace structural materials and prepare them for a possible career as a structural specialist or a researcher. This will be accomplished through clear statements, examples delivered in lectures, supported by assignments and seminars.				
Course Objective	1. Tofind forces acting in the individual truss members and deflection of the truss using different methods 2. Tocalculate the reaction forces and draw shear force and bending moment diagrams for indeterminate beams using different methods 3. To calculate the bending stresses in unsymmetrical sections using different methods 4. To calculate crippling load of columns and beam columns with various end				

	conditions using Euler's method and Rankine's formula 5. To find the buckling and crippling load carrying capacity of rectangular shear panels
Course Outcome	Upon completion of this course, the students will be able to 1. Analyze the truss structure and calculate the forces acting on the individual member. 2. Analyze and draw shear force and bending moment diagrams of indeterminate beams. 3. Estimate the bending stress and draw the stress distribution of unsymmetrical sections. 4. Compute crippling load of columns and beam columns with various end conditions using Euler's method and Rankine's formula. 5. Differentiate between column and plate buckling and find the crippling load carrying capacity of rectangular shear panels

Prerequisites: SOLID MECHANICS

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-2	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-3	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-4	3	3	3	2	-	-	-	-	2	1	-	2	3	2
CO-5	3	3	3	3	-	-	-	-	2	1	-	2	3	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: STATICALLY DETERMINATE STRUCTURES (12)	
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.	**CO-1 BTL-3**
MODULE 2: STATICALLY DETERMINATE STRUCTURES (12)	
She.ar 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	**CO-2 BTL-3**
MODULE 3: UNSYMMETRICAL BENDING (12)	
Bending stresses in beams of unsymmetrical sections, Bending of symmetric sections with Skew loads, Principal axis method, Neutral axis method, Generalized K method.	**CO-3 BTL-3**
MODULE 4: BUCKLING OF COLUMNS (12)	
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.	**CO-4 BTL-3**
MODULE 5: BUCKLING AND CRIPPLING OF PANELS (12)	

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	**CO-5 BTL-3**

TEXT BOOKS	
1.	T.M.G. Megson, 'Aircraft Structures for Engineering Students(Sixth edition)', Butterworth-Heinemann, 2017.
REFERENCE BOOKS	
1.	E.H. Bruhn. 'Analysis and Design of Flight Vehicles Structures', Tri-state off- set company, USA, 1985.
2.	B.K. Donaldson, "Analysis of Aircraft Structures - An Introduction", Second edition, Cambridge University Press, 2012.
E BOOKS	
1.	http://www.jdrr.yolasite.com/resources/Aeronautical_Engineering/BOOKS/Aircraft%20Structures%20by%20Megson%20-%20Book.pdf
MOOC	
1.	https://www.edx.org/course/introduction-to-aerospace-structures-and-materials
2.	https://onlinecourses.nptel.ac.in/noc20_ae08/preview

COURSE TITLE	**AEROSPACE PROPULSION**			**CREDITS**	**4**
COURSE CODE	**ASB4217**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-1-0-1**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	To study in detail about fundamentals of aircraft propulsion, advanced propulsion systems in gas turbine engine. To understand the principles of operation and design of aircraft power plants.
Course Objective	1. Know the fundamentals of gas turbines and its components 2. Know the steady one dimensional flow of perfect gas. 3. Know the different types of gas turbine engines and engine performances. 4. Study the fundamentals of rocket propulsion. 5. Study the performance of aerospace vehicles

Course Outcome	Upon completion of this course, the students will be able to 1. Understand the propulsion systems (turbojets, turbofans, turboprops, ramjets, scramjets) and its application to aerospace vehicles 2. Apply basic principles of flows based on steady one-dimensional flow. 3. Understand the fundamentals ofgas turbine engine systems. 4. Understand rocket propulsion systems and itsfundamental application to aerospace vehicles. 5. Able to relate forces and performance characteristics of aerospace vehicles

Prerequisites: Aero Thermodynamics

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	3	2	**3**	2	2	3	1	2	3	2	2
CO-2	3	2	2	3	2	**3**	2	2	3	1	2	3	2	2
CO-3	3	2	2	3	2	**3**	2	2	3	1	2	3	2	2
CO-4	3	2	2	3	2	**3**	2	2	3	1	2	3	2	2
CO-5	3	2	2	3	2	**3**	2	2	3	1	2	3	2	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO AIRCRAFT PROPULSION	**(9L+3T=12)**
Introduction to propulsion, Basic thermodynamics, Fundamental equations, Types of aircraft engines Performance parameters, thrust equation, factors affecting thrust and efficiencies. **Practical component:** Assembly and dismantling of aircraft piston engine and jet engine **Suggested Readings:** Evolution of Gas turbine engine	**CO-1** **BTL-1**
MODULE 2: STEADY ONE DIMENSIONAL FLOW(9L+3T=12)	
One dimensional flow of a perfect gas, isentropic flow, non-isentropic flow, frictionless constant area flow, constant area flow with friction, without friction, normal shock and oblique shocks **Practical component:** Jet characteristics study using free jet and wall jet **Suggested Readings:** Fano flow and Rayleigh flow	**CO-2** **BTL-2**
MODULE 3: FUNDAMENTALS OF GAS TURBINE ENGINES	**(9L + 3T=12)**
Working principle of gas turbine engine, gas turbine cycle, and turboprop, turbofan and turbojet engines -Thrust and efficiency - Methods of thrust augmentation -- Engine Performance characteristics **Practical component:** Starting of piston engine and jet engine procedures	**CO-3** **BTL-3**

Suggested Readings: Gas turbine engine	
MODULE 4: FUNDAMENTALS OF ROCKET PROPULSION	**(9L+3T=12)**
History of rocket propulsion, types of rocket, Basic configurations and application - Types of missiles and their structure, Heat transfer and cooling system in rocket, classification of Chemical rocket propulsion system. **Practical component:** Testing of hybrid rocket **Suggested Readings:** Rocket propulsion elements	**CO-4** **BTL-2**
MODULE 5: PERFORMANCE OF AEROSPACE VEHICLES (9L+3T=12)	
Static performance, vehicle acceleration, performance characteristics, nozzle, solid, liquid and hybrid rocket and their propellants. **Practical component:** Fabrication of solid propellant **Suggested Readings:** Rocket propulsion elements	**CO-5** **BTL-2**

TEXT BOOKS	
1.	Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Addison - Wesley Longman INC, 1999.
2.	G.P Sutton & O. Biblarz, "Rocket Propulsion Elements", John Wiley & Son Inc., 2001.
REFERENCE BOOKS	
1.	Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H. "Gas Turbine Theory", Longman, 1989.
2.	Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAA Education Series, New York, 1985.
E BOOKS	
1.	https://www.google.co.in/books/edition/Rocket_Propulsion_Elements
MOOC	
1.	https://nptel.ac.in/courses/101/106/101106033/
2.	http://nptel.ac.in/courses/101101002/

COURSE TITLE	LOW SPEED AERODYNAMICS (Integrated with Lab) (Common to Aeronautical and Avionics)			CREDITS	4
COURSE CODE	ASB4218	COURSE CATEGORY	PC	L-T-P-S	3-0-2-1
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	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.
Course Objective	1. To know about the continuity, momentum, and energy equations 2. To study about the basic flows, and theorems. 3. To apply the conformal transformation to symmetrical and unsymmetrical airfoil 4. To understand the concept of lifting line theory and thin aero foil theory 5. To derive the Navier stokes and boundary layer equations.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the importance of three fundamentalgoverning equations in aerodynamics. 2. Apply two-dimensional flows in aerodynamics (elementary flows) and its combinations. 3. To understand Joukowski transformation and its application to fluid flow problems, Kutta condition, Blasius theorem (Conformal transformation). 4. Apply airfoil and wing theory (Infinite vs Finite wing theory) to practical problems. 5. Understand the real time viscous flow and boundary layer behavior

Prerequisites: Fluid Mechanics and Machinery

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-2	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-3	3	3	3	2	-	-	-	-	2	1	-	2	3	2
CO-4	3	3	3	3	-	-	-	-	2	2	-	2	3	2
CO-5	3	3	3	3	-	-	-	-	2	1	-	2	3	2

1: Weakly related, 2: Moderately related and 3: Strongly related	
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.	**CO-1** **BTL-2**
MODULE 2: TWO DIMENSIONAL FLOWS12 (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 symmetrical airfoil.	**CO-2** **BTL-3**
MODULE 3: CONFORMAL TRANSFORMATION 12 (9L + 3T)	
Joukowski transformation and its application to fluid flow problems.	**CO-3** **BTL-3**
MODULE 4:AIRFOIL AND WING THEORY12 (9L + 3T)	
Airfoils Nomenclature and NACA series, Airfoil Characteristics, Vortex sheet, Kelvin Circulation theorem Thinaerofoil 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. Supersonic wind tunnel calibration and flow visualization with Schlieren system.	**CO-4** **BTL-3**
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	**CO-5** **BTL-3**

TEXT BOOKS	
1.	L J Clancy,"*Aerodynamics"* Paperback 2006
2	Frank M White,"*Fluid Mechanics in S.I Units"* Paperback 2017
3	Aerodynamics by J.D.Anderson-2012
REFERENCE BOOKS	
1.	http://soaneemrana.org/onewebmedia/Aerodynamics---Houghton&Carpenter.pdf
2.	http://www.engbrasil.eng.br/artigos/art19.pdf
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/

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	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.	Woodenmodelsofcone,wedgeandbluntbodyconfigurations 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 AND INSTRUMENTATION			CREDITS	3
COURSE CODE	AEB4219	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The course enables the students to understand various types of airplanes systems and understand the working principle of aircraft instruments and engine instruments.
Course Objective	1. To understand the concepts of mechanical and electrical controlsystems of aircraft. 2. To learn the working principle of hydraulic system of modern aircrafts andexplain its functions 3. To understand the working aspects of piston & gas turbine engines 4. To explain the working principles of air-conditioning system &fire protectionsystem. 5. To categorize aircraft instruments and engineinstruments.
Course Outcome	Upon completion of this course, the students will be able to 1. Describe the various aircraft mechanical and electrical control systems. 2. Apply the working principle of hydraulic system for a modern aircraft and explain its function in detail 3. Interpret the working aspects of piston & gas turbine engines and the purpose of each system 4. Analyze the working principles of air-conditioning system &fire protection system 5. Remember the working principle of aircraft instruments and engine instruments in detail

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	2	2	1	-	1	1	1	-	2	2	2
CO-2	3	3	3	2	2	1	-	1	1	1	-	2	2	2
CO-3	3	3	3	2	2	1	-	1	1	1	-	2	2	2
CO-4	3	3	3	2	2	1	-	1	1	1	-	2	2	2

CO-5	3	3	3	2	2	1	-	1	1	1	-	2	2	2

1: Weakly related, 2: Moderately related and 3: Strongly related

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 **Suggested Readings:** AMT Airframe Handbook	**CO-1** **BTL-2**
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 pressuresystem – Brake system - Typical Pneumatic power system - Components, Landing Gear systems -Classification – Shock absorbers - Retractive mechanism. **Suggested Readings:** AMT Airframe Handbook	**CO-2** **BTL-2**
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 **Suggested Readings:** AMT Airframe Handbook	**CO-3** **BTL-3**
MODULE 4: AUXILLIARY SYSTEM**(6L)**	
Air conditioning-Pressurization systems- Oxygen systems - Fire protection systems, De-icing and anti-icing systems. **Suggested Readings:** AMT Airframe Handbook	**CO-4** **BTL-2**
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. **Suggested Readings:** S. Nagabhushana ,"*Aircraft Instrumentation and Systems"* I K International Publishing House Pvt .Ltd 2010	**CO-5** **BTL-2**
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
REFERENCE BOOKS	
1.	Ian Moir, Allan Seabridge "Aircraft Systems: Mechanical, Electrical, and Avionics SubsystemsIntegration"third edition,2008 John Wiley And SonsLtd.
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/

COURSE TITLE	**AIRCRAFT SYSTEMS LABORATORY (Common to Aeronautical and Avionics**			**CREDITS**	**1**
COURSE CODE	**AEB4241**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**0-0-3-0**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
Internal Assessment Examination					**ESE**
80%					**20%**
Course Description	This course provides information about maintenance of aircraft systems.				
Course Objective	1.Learn how to do Jacking up and levelling of an aircraft 2. Understand and experience how to do rigging and symmetry check of the aircraft 3. Hands on experience about flow test and pressure test and maintenance, rectification of snags of hydraulic systems. 4. Conducting functional test to adjust operating pressure of oleo struts. 5. Perform bleeding and assembly / disassembly disc wheel brake units.				

Course Outcome	Upon completion of this course, the students will be able to 1. Have hands on experience of the aircraft jacking up without any damage to men and equipment. 2.Carry out aircraft levelling as per procedure using levelling boards. 3.Have hands on experience on the various checks to be carried out to ensure the alignment of control surfaces 4.Perform aircraft symmetry checks as per procedure 5.Have hands on experience of the flow test and pressure test on hydraulic hoses 6.Have hands on experience of the functional test to adjust operating pressures of oleo struts 7.Have hands on experience of bleeding and assembly / disassembly of disc wheel brake units 8.Understand themaintenance and rectification of snags in hydraulic systems

Prerequisites:

CO, PO AND PSO MAPPING

CO	PO -1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	-	-	-	-	2	-	-	3	2	3
CO-2	3	3	3	3	-	-	-	-	2	-	-	3	2	3
CO-3	3	3	3	3	-	-	-	-	2	-	-	3	2	3
CO-4	3	3	3	3	-	-	-	-	2	-	-	3	2	3
CO-5	3	3	3	3	-	-	-	-	2	-	-	3	2	3
CO-6	3	3	3	3	-	-	-	-	2	-	-	3	2	3
CO-7	3	3	3	3	-	-	-	-	2	-	-	3	2	3
CO-8	3	3	3	3	-	-	-	-	2	-	-	3	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

LISTOFEXPERIMENTSTOTAL HOURS -45

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

LIST OF EQUIPMENTS

S.No.	Details of Equipment	Quantity	Experiment Nos.
1.	Hydraulic jack	4	**1,2,3,4,7,8,9**

2	Spirit level	2	**2**
3	Leveling board	2	**2**
4	hydraulic systems	1	**6,7,10**
5	filter element	1	**5**
6	multi disc wheel brake units	1	**8,9**
7	Plumb bob	1	**4**
8	Measuring tape 100M	1	**4**
9	Cable Tensiometer	1	**3**

REFERENCE BOOKS	
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)**			**CREDITS**	**1**
COURSE CODE	**AEB4242**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**0-0-3-1**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

Observation & Record	**Practical Demonstration, Lab Test Report& Viva**	**ESE**
20%	**60%**	**20%**

Course Description	The course should enable the students to design and computer model various aircraft structural components
Course Objective	1. To understand the basic tools and commands of Solid works software 2. To model aircraft structural members such as rips, spars, and stringers 3. To model typical wing surface using aero foil co-ordinates 4. To model a typical aircraft wing 5. To model a typical fuselage structure 6. To Model a typical landing gear 7. To design and model an aircraft engine

Course Outcome	Upon completion of this course, the students will be able to 1. Apply software tool to design aircraft structural members 2. Apply software tool to model wing surface using aerofoil coordinates. 3. Apply software tool to model aircraft wing with structural members. 4. Apply software tool to model aircraft centre fuselage with structural members. 5. Apply the software tool to model turbojet engine (Two Stage Axial Flow Compressor, Annular Combustion Chamber and Single Stage Turbine). 6. Apply the software tool to model aircraft landing gear.

Prerequisites: Engineering immersion lab and Engineering Graphics and Computer Aided Design

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	3	2	3	3	2	3	1	2	3	2	2
CO-2	3	2	2	3	2	3	3	2	3	1	2	3	2	2
CO-3	3	2	2	3	2	3	3	2	3	1	2	3	2	2
CO-4	3	2	2	3	2	3	3	2	3	1	2	3	2	2
CO-5	3	2	2	3	2	3	3	2	3	1	2	3	2	2
CO-6	3	2	2	3	2	3	3	2	3	1	2	3	2	2

1: Weakly related, 2: Moderately related and 3: Strongly related

COMPUTER AIDED MODELLING LAB	**(45 HOURS)**
1. Introduction to Solidworks. 2. Modelling of Aircraft Structural Members. 3. Modelling of Wing Surface using Aerofoil coordinates. 4. Modelling of Aircraft Wing with Structural Members. 5. Modelling of Aircraft Centre Fuselage with Structural Members. 6. Modelling of Turbojet Engine (Two Stage Axial Flow Compressor, Annular Combustion Chamber and Single Stage Turbine). 7. Modelling of Aircraft Landing Gear. 8. Drafting of Aircraft Landing Gear.	**CO-1,2,3,4,5** **BTL-3**

LIST OF EQUIPMENTS

S. No	Items	Quantity	Ex
1	Computer and modelling software	i5 IVth gen (8 GB RAM) PC's, - 40 Nos.	1 - 8
		License of Software(Auto CAD, SOLID WORKS) – 40 Nos	

Semester - V

COURSE TITLE	OPTIMIZATION TECHNIQUES			CREDITS	4
COURSE CODE	MAA4301	COURSE CATEGORY	BS	L-T-P-S	3-1-0-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To make the student develop a knowledge in the field of optimization techniques their basic concepts, principles of linear and integer programming, assignment and transportation problems
Course Objective	1. To understand the concept of optimization 2. To formulate linear programming model 3. To understand the concept of integer programming 4. To understand the assignment and transportation problem 5. To understand the concept of network analysis
Course Outcome	Upon completion of this course, the students will be able to 1. Formulate mathematical model 2. Cast engineering maxima/minima problems into optimization framework. 3. Solve the integer programming problems 4. Solve the assignment and transportation problems 5. Analyze the designs of networks

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
CO-2	2	1	1	1	1	1	1	1	1	1	1	1	1	1
CO-3	2	1	1	1	1	1	1	1	1	1	1	1	1	1
CO-4	2	1	1	1	1	1	1	1	1	1	1	1	1	1
CO-5	2	1	3	1	1	1	1	1	1	1	1	1	1	1

1: Weakly related, 2: Moderately related and 3: Strongly related	
MODULE 1:INTRODUCTION TO OPTIMIZATION (9L+3T=12)	
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	**CO-1** **BTL-1,2**
MODULE 2:LINEAR PROGRAMMMING PROBLEM (9L+3T=12)	
Solving LPP using simple method – Big-M method – Two phase method – conversion of primal to dual. Suggested Reading: System of equations	**CO-2** **BTL-1,2,3**
MODULE 3:INTEGER PROGRAMMING (9L+3T=12)	
Integer programming – Cutting plane method – Gomory's Mixed integer method – Branch and Bound method Suggested Reading: System of equations	**CO-3** **BTL-1,2,3,4**
MODULE 4:ASSIGNMENT AND TRANSPORTATION PROBLEM (9L+3T=12)	
Hungarian Method – Maximization and unbalanced assignment problem – Basic feasible solution of transportation problem – Modi method – Degeneracy – Unbalanced Transportation problem. Suggested Reading: Arithmetic Calculation	**CO-3** **BTL-1,2,3,4**
MODULE 5:PERT AND CPM (9L+3T=12)	
Network diagram – Representation – Labeling – CPM – PERT probabilities of CPM – PERT probabilities of project duration. Suggested Reading: Basics of graphs	**CO-4** **BTL-1,2,3,4**

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	AIRCRAFT PERFORMANCE			CREDITS	3
COURSE CODE	ASB4301	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course focuses on the major principles in understanding the basics of the various forces and moments acting on aircraft. It provides a platform to evaluate and understand the various drag characteristics which lay a paradigm for evaluating the aircraft performance.This course is engaging the basic principles with respect to aircraft take-off and landing performance. The key aspect of the course is that it highlights the helicopter rotor mechanics and performance.
Course Objective	1. Understanding about various characteristics of aircraft 2. Apply concepts with the basic understanding on various drag characteristics. 3. Focus on in depth analysis on aircraft take-off and landing performance 4. Knowledge in basic understanding of helicopter rotor mechanics.
Course Outcome	Upon completion of this course, the students will be able to 1. Effectively use performance calculations for aircraft design project. 2. Demonstrate the ability to draw flight envelope diagrams and calculate the limit load factor and ultimate load factor. 3. Understand flight maneuvering characteristics. 4. Calculate the landing and take-off distances. 5. Apply propeller blade element theory.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO-3	PO-4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	3	-	-	-	-	2	1	-	2	2	2
CO-2	3	3	3	2	-	-	-	-	2	1	-	2	2	2
CO-3	3	3	3	2	-	-	-	-	2	1	-	2	2	2
CO-4	3	3	3	3	-	-	-	-	2	1	-	2	2	2
CO-5	3	3	3	2	-	-	-	-	2	1	-	2	2	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: FORCES AND MOMENTS	**(9)**
Forces and moments acting on a vehicle in flight. Equations of motion of a rigid flight vehicle, Different types of drag and the factor affecting them, Drag estimation using proper area method. Drag polar of vehicles from low speeds to hypersonic speeds, drag bucket and its limitations.	**CO-1 BTL-3**
MODULE 2: AIR BREATHING ENGINES AND ROCKETS(9)	
International Standard Atmosphere-Variation of thrust, power and SFC with velocity and altitudes for air breathing engines and rockets - Power available and power required curves	**CO-2 BTL-3**
MODULE 3: UNACCELERATED FLIGHT	**(9)**
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.	**CO-3 BTL-3**
MODULE 4: ACCELERATED FLIGHT	**(9)**
Accelerated flight, turn, maneuvers, Takeoff and Landing Performance. Flight envelope, load factor and its influence on flight envelope – ultimate load factors – limit load factor – factor of safety	**CO-4 BTL-3**
MODULE 5: PROPELLER THEORIES	**(9)**
The early development of the screw propeller-Assumptions for conceptual modelling of a propeller-Momentum Theory and Blade Element Theory.	**CO-5 BTL-3**

TEXT BOOKS	
1.	John. D. Anderson., "Airplane Performance and design," Tata McGraw-Hill Edition 2010.
REFERENCE BOOKS	
1.	Mc Cormik, B. W., "Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, 1995.
2.	Nelson, R.C., "Flight Stability and Automatic Control", McGraw Hill, 1989
3.	Etkin, B., "Dynamics of Flight Stability and Control", Edn. 2, John Wiley, New York, 1912.
4.	Babister, A.W., "Aircraft Dynamic Stability and Response", Pergamon Press, Oxford, 1910
5.	Dommasch, D.O., Shelby, S.S., and Connolly, T.F., "Aeroplane Aero dynamics", Third Edition,
6.	Issac Pitman, London, 1911.4. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 1991
E BOOKS	
1.	https://www.faa.gov/regulations_policies/handbooks.../aviation/.../13_phak_ch11.pdf https://books.google.co.in/books?isbn=0070702454
MOOC	

1.	https://onlinecourses.nptel.ac.in/noc15_ae02

COURSE TITLE	AEROSPACE STRUCTURES (Integrated with lab) (Common to Aeronautical and Avionics)			CREDITS	4
COURSE CODE	ASB4302	COURSE CATEGORY	PC	L-T-P-S	3-0-2-1
Version	1.0	Approval Details	23rd ACM, 06.02.2021	Learning Level	BTL -4

Assessment Scheme

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignment/ Project	Surprise Test / Quiz		Attendance	ESE
15%	15%	10%	5%	5%		50%

Course Description	The Aircraft Structure course is providingin-depth knowledge of aircraft structural analysis and to provide exploring ability of criticality in the primary, secondary and tertiary structural components.
Course Objective	**The course should enable the students to** 1. Acquire the knowledge of computing the shear flow and shear center in thin wall aircraft structures 2. Improve the ability to analyseflexural and torsional shear flow in closed sections 3. Explore the knowledge of structural behavior in fuselage and wing structures 4. Expand the analyses skill to find stresses in the aircraft structural components. 5. Know process of analysis in the aircraft secondary and tertiary structures.
Course Outcome	**Upon completion of this course, the students will be able to** 1. Analyze the thin-walled open sections and able to calculate shear flow and shear centre. 2. Compute the flexural and torsional shear flow in closed sections. 3. Analyze load paths and demonstrate the knowledge of structural behavior in fuselage and wing structures. 4. Calculate the stresses in wing, fuselage, wing spar, attachments. 5. Differentiate and analyze the types of aircraft fittings, bolt fittings, riveted connections, and their failures.

Prerequisites:ENGINEERING MECHANICS, SOLID MECHANICS, AIRCRAFT STRUCTURAL MECHANICS.

CO, PO & PSO MAPPING

CO / PO & PSO	PO1	PO2	PO3	PO4	PO5	PO6	PO 7	PO 8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO-1	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-2	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-3	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-4	3	3	3	3	-	-	-	-	2	1	-	2	3	2

CO-5	3	2	2	2	-	-	-	-	2	1	-	2	3	2

1- Weakly Related, 2 – Moderately Related, 3 – Strongly Related

MODULE 1: SHEAR FLOW IN OPEN SECTIONS 9L + 3P = 12	CO-1 BTL 3, 4
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 **Practical Component:** Locating the Shear Centre for open section. **Suggested Readings:** Analysis and Design of Flight Vehicles Structures	
MODULE 2: SHEAR FLOW IN CLOSED SECTIONS 9L + 3P = 12	CO-2 BTL 3, 4
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 **Practical Component:** Locate Shear Centre for closed section and Determination of Principal axis of Unsymmetrical beams. **Suggested Readings:** Shear flow in Thin wall closed section.	
MODULE 3: ANALYSIS OF WINGS AND FUSELAGE - 9L + 3P = 12	CO-3 BTL 3, 4
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. **Practical Component:** Column testing and Vibrations of beams. **Suggested Readings:** Stress analysis of aircraft Wings and Fuselage	
MODULE 4: ANALYSIS OF WING SPAR - 9L + 3P = 12	CO-4 BTL 3, 4
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 **Practical Component:** Wagner beam – Tension field beam, Constant Strength Beam and Beam Subjected to complex loading. **Suggested Readings:** Analysis of wing structural elements	
MODULE 5: AIRCRAFT FITTINGS AND CONNECTIONS - 9L + 3P = 12	CO-5 BTL 3, 4
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. **Practical Component:** Stresses in circular discs and beams using photo-elastic techniques and Stress concentration factor of tensile strip with central circular hole **Suggested Readings:** Ananlysis of Aircraft tertiary structural elements.	

COURSE TITLE	**JET PROPULSION**			**CREDITS**	**3**
COURSE CODE	**ASB4303**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-1**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The course deals with the flow and thermodynamic processes of the gas turbine engine components. The course explains the working principles and the preliminary equations pertaining to the performance calculations.
Course Objective	1. To equip the students with the concepts in working concepts of the gas turbine engine components 2. To provide an overview of the velocity diagrams and the design calculations of the compressors 3. To prepare the students in internal and flow based numerical problems pertaining to the inlets and the nozzles
Course Outcome	Upon completion of this course, the students will be able to 1. Contrast the internal flow and external flow characteristics of the subsonic and supersonic inlets. 2. Explain the types and working principles of axial compressors, and infer velocity diagrams, blade design and performance characteristics of compressors. 3. Explain the working principles of centrifugal compressors and infer velocity diagrams. 4. Classify types and working methods in combustion chambers and explain the flame stabilization and flame techniques. 5. Solve the nozzle flows, and explain the choking, losses in nozzle, variable area nozzle and thrust vectoring.

Prerequisites: ASB4217- Aerospace Propulsion

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	2	2	3	2	3	2	2	3	1	2	3	2	2
CO-2	3	2	2	3	2	3	2	2	3	1	2	3	2	2
CO-3	3	2	2	3	2	3	2	2	3	1	2	3	2	2
CO-4	3	2	2	3	2	3	2	2	3	1	2	3	2	2
CO-5	3	2	2	3	2	3	2	2	3	1	2	3	2	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: DIFFUSERS (9)

Subsonic inlet and Internal flow - Major features of external flow - Relation between minimum area ratio and external deceleration ratio - Supersonic inlets - Starting problem on supersonic inlets - Shock swallowing by area variation - External deceleration - Modes of inlet operation. **Practical component:** Marking the velocity profiles using free jet and wall jet apparatus **Suggested Readings:** Theory of supersonic intakes	**CO-1** **BTL-3**
MODULE 2: AXIAL COMPRESSORS (9)	
Working principle of axial compressor, Elementary theory - Velocity triangles, Degree of reaction - Three-dimensional flow - Compressor blade design & stage performance calculation - Factors affecting stage pressure ratio, off-design performance- Axial compressor performance characteristics **Practical component:** Pressure distribution over the axial compressor blades in a cascade wind tunnel **Suggested Readings:** Theory of compressor blade design	**CO-2** **BTL-3**
MODULE 3: CENTRIFUGAL COMPRESSORS (9)	
Working principle of a centrifugal compressor - Work done and pressure rise - Inducer and impellor - Velocity diagrams - Compressor stage design - Concept of pre-whirl - Rotation stall –Centrifugal compressor performance characteristics. **Practical component:** Determination of pre-whirl angles for varying inlet Mach numbers using MATLAB	**CO-3** **BTL-2**
MODULE 4: COMBUSTION CHAMBERS (9)	
Classification of combustion chambers - Important factors affecting combustion chamber design - Combustion process - Combustion chamber performance - Effect of operating variables on performance - Flame tube cooling - Flame stabilization - Use of flame holders **Practical component:** 1. Combustion chamber performance analyzer 2. Effect of swirler in flame stabilization 3. Exhaust gas analyzer for various fuel -air ratios **Suggested Readings:** Analytic Combustion: With Thermodynamics, Chemical Kinetics and Mass Transfer	**CO-4** **BTL-2**
MODULE 5: NOZZLES (9)	
Theory of flow in isentropic nozzles - Convergent nozzles and nozzle choking - Nozzle throat conditions - Nozzle efficiency - Losses in nozzles - Over expanded, under - expanded nozzles, Ejector and variable area nozzles. **Practical component:** Nozzle design using MoC in MATLAB **Suggested Readings:** Applied Gas dynamics	**CO-5** **BTL-3**

COURSE TITLE	COMPRESSIBLE AERODYNAMICS (Aerospace)			CREDITS	4
COURSE	ASB4304	COURSE CATEGORY	PC	L-T-P-S	3-1-0-1

TEXT BOOKS	
1.	Zucrow, M. J. and Hoffman, J. D. (1977) *Gas Dynamics, Multi-Dimensional Flow*. Wiley (Gas Dynamics).
2	Hill, P. and Peterson, C. (2014) Mechanics and thermodynamics of propulsion. New Delhi: Pearson Education India.
REFERENCE BOOKS	
1.	Saravanamuttoo, H., Rogers, G. and Cohen, H. (2009) Gas turbine theory (6a. ed.). Harlow: Pearson Educatión.
2.	El-Sayed, A. (2017) Aircraft Propulsion and Gas Turbine Engines, Second Edition. Milton: Chapman and Hall/CRC.
3	Oates, G. (2007) Aerothermodynamics of gas turbine and rocket propulsion. Norwich, NY: Knovel.
4	Mattingly, J. and Boyer, K. (2016) Elements of Propulsion: Gas Turbines and Rockets, Second Edition. Washington, DC: American Institute of Aeronautics and Astronautics.
E BOOKS	
1.	Propulsion/ACEE - NASA Technical Reports Server (NTRS)
MOOC	
1.	NPTEL- AIRCRAFT PROPULSION

CODE					
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	To understand about performance of the airfoil in the high-speed flows.
Course Objective	1. To know about the compressible flow equations. 2. To understand about the types of shocks and its effects. 3. To understand about the differential flow equations. 4. To know about the performance of the airfoils under high speed flows. 5. To understand the working principles of high speed wind tunnels.
Course Outcome	1. Asses and derive the one dimensional compressible flow equations. 2. Know about the normal, oblique shocks, expansion waves and calculate the various flow properties across these waves. 3. Comprehend the linearized differential equations of motion for steady compressible flows and different compressibility corrections. 4. Know about the different air foil/wings design in high speed flows. 5. Classify different types of high speed wind tunnels and their operations and also different optical technique for supersonic flow visualization

Prerequisites: Fluid Mechanics

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-2	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-3	3	3	3	2	-	-	-	-	2	1	-	2	3	2
CO-4	3	3	3	2	-	-	-	-	2	1	-	2	3	2
CO-5	3	2	2	2	-	-	-	-	2	1	-	2	3	2

1: Weakly related, 2: Moderately related and 3: Strongly related

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	**CO-1 BTL-2**
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.	**CO-2 BTL-2**
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.	**CO-3 BTL-3**
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.	**CO-4 BTL-2**
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.	**CO-5 BTL-2**

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., NewYork.
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

OURSE TITLE	Propulsion Lab – I			CREDITS	1
COURSE CODE	ASB4331	COURSE CATEGORY	PC	L-T-P-S	0-0-3-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

Internal Assessment Examination	ESE
80%	20%

Course Description	To understand the concepts of aircraft propulsion covered in theory course in a laboratory by conducting experiments
Course Objective	1. Study aircraft piston engine, and the assembly of sub systems 2. Understand aircraft piston engine's components, functions, operating principles 3. Study aircraft jet engine, and the assembly of sub systems 4. Understand aircraft jet engine's components, functions, operating principles 5. Study about forced convective heat transfer 6. Study about free convective heat transfer
Course Outcome	The students should be able to: 1. Learn various systems of aircraft piston engine and show the systems on the engines available in the lab 2. Proficient on the working cycle of the aircraft piston engine and description of various components and its functions. 3. Gain knowledge about systems that form a jet engine by showing the systems on the engines available in the Aero Hangar 4. Learn about the working cycle of the aircraft jet engine and description of various components and its functions by visually them on the engines available in the Aero Hangar. 5. Understand the concept of forced convective heat transfer and perform experiment on the heat transfer apparatus 6. Understand the concept of free convection heat transfer and perform experiment on the heat transfer apparatus

LIST OF EXPERIMENTSTOTAL HOURS – 45

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

LIST OF EQUIPMENTS

Sl. No	Equipment	Qty	Experiments No.
1	Piston engines	2	1,2
2	Jet Engine /Engine model	1	3,4
3	Forced Convective apparatus	3	5
4	Free Convective apparatus	3	6

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	3	3	2	2	2	2	2	2	1	2	2	2	3
CO-2	3	3	3	2	2	2	2	2	2	1	2	2	2	3
CO-3	3	3	3	2	2	2	2	2	2	1	2	2	2	3
CO-4	3	3	3	2	2	2	2	2	2	1	2	2	2	3
CO-5	3	3	3	2	2	2	2	2	2	1	2	2	2	3
CO-6	3	3	3	2	2	2	2	2	2	1	2	2	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

COURSE TITLE	AERODYNAMICS LAB			CREDITS	1
COURSE CODE	ASB4332	COURSE CATEGORY	PC	L-T-P-S	0-0-3-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

Internal Assessment Examination	ESE
80%	20%

Course Description	This lab is designed to understand the aerodynamic characteristics of various models.
Course Objective	1. To understand different angle of incidence. 2. To learn about the flow over a cylinder 3. To learn about the flow pattern over an airfoil at different angle of incidence 4. To understand the working principle of Schlieren technique. 5. To calculate the boundary layer thickness for the flow
Course Outcome	Upon completion of this course, the students will be able to 1. Analyze the flow pattern over a flat plate at different angle of incidence 2. Analyze the low-speed flow over a cylinder. 3. Analyze the flow pattern over an airfoil at different angle of incidence 4. Measure the Mach no at the test section of wind tunnel for various operating Pressure 5. Understand the working principle of Schlieren technique for supersonic flow visualization 6. Calculate the boundary layer thickness for the flow over an object.

Prerequisites: Introduction to Aerospace Engineering

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2	PSO-3
CO-1	3	3	3	3	3	2	2	1	2	2	2	1	3	2	3
CO-2	3	3	3	3	3	2	2	1	2	2	2	1	3	2	3
CO-3	3	3	3	3	3	2	2	1	2	2	2	1	3	2	3
CO-4	3	3	3	3	3	2	2	1	2	2	2	1	3	2	3
CO-5	3	3	3	3	3	2	2	1	2	2	2	1	3	2	3
CO-6	3	3	3	3	3	2	2	1	2	2	2	1	3	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

LIST OF EXPERIMENTS	45 hours
1. Flow over a flat plate at different angles of incidence. 2. Flow visualization studies in low speed flows over cylinder. 3. Flow visualization studies in low speed flows over airfoil with different angle of attack. 4. Calibration of supersonic wind tunnel. 5. Supersonic flow visualization with Schlieren system. 6. Flow visualization over missile body 7. Boundary Layer Calculation	
LIST OF EQUIPMENT/ SOFTWARE	
1. WindTunneltestsectionsizearound300x300mmwithtestsection flow speed of 70 m/s. 2. Wings of various airfoil sections (Symmetrical & cambered airfoils) 2 Nos. each 3. Angle of incidence changing mechanism 1 No. 4. Wings with winglets 5. U-Tube Manometer 6. Static Pressure Probes 4 Nos. 7. Total Pressure Probes 4 Nos. 8. Pitot-Static Tubes 4 Nos. 9. Wooden models of 3Dbodies 10 Water flow channel 11 Smoke technique	

COURSE TITLE	COMPUTER AIDED MODELLING PROJECT		CREDITS		1
COURSE CODE	AEB4332	COURSE CATEGORY	PC	L-T-P-S	0-0-2-1
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

CIA	ESE
80%	20%

Course Description	The course enables the students to model different components of aircraft and assemble them
Course Objective	1. To know about the various tools needed to model aircraft wing 2. To learn about various tools needed to model aircraft fuselage. 3. To Understand tools required to model aircraft empennage 4. To have knowledge of modeling the engine 5. To have knowledge of modeling aircraft landing gear 6. To have knowledge of assembly of different components and parts
Course Outcome	Upon completion of this course, the students will be able to 1. Understand and able to model aircraft wing 2. Model aircraft fuselage. 3. Understand and able to model aircraft empennage 4. Apply and model engine 5. Model aircraft landing gear 6. Assembly of all the above modules.

Prerequisites :Computer Aided Modelling lab

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	-	-	-	-	2	-	-	3	2	3
CO-2	3	3	3	3	-	-	-	-	2	-	-	3	2	3
CO-3	3	3	3	3	-	-	-	-	2	-	-	3	2	3
CO-4	3	3	3	3	-	-	-	-	2	-	-	3	2	3
CO-5	3	3	3	3	-	-	-	-	2	-	-	3	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

LIST OF EXPERIMENTS **(30 hrs)**

1. Modelling of typical Aircraft Wing with Structural Members.	**CO1, BTL3**
2. Modelling of typical Aircraft Fuselage with Structural Members.	**CO2, BTL3**
3. Modelling of typical Aircraft Empennage.	**CO3, BTL3**
4. Modelling of typical Turbojet Engine.	**CO4, BTL3**
5. Modelling and Assembly of typical Aircraft Landing Gear.	**CO5, BTL3**

6. Assembly of all the above modules	**CO6, BTL3**

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	**1-6**

SEMESTER – VI

COURSE TITLE	BUSINESS ECONOMICS			CREDITS	2
COURSE CODE	GEA4304	COURSE CATEGORY	BS	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-2

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To impart the knowledge of economics as a subject and its importance in business.
Course Objective	1. To integrate the basic concepts of economics 2. To know about the tools of mathematics and statistics in business. 3. To analyze and make optimal business decisions. 4. To estimate the concept of price and output decisions of firms under various market structure 5. To understand the aspects about finance and financial environment
Course Outcome	Upon completion of this course, the students will be able to 1. Demonstrate an understanding the introduction of economics 2. Demonstrating to know knowledge about cost analysis 3. Able to build knowledge about consumer's and producer's behavior 4. Enabling to know about budget 5. Educate about financial services

Prerequisites: :Nil

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	1	1	1	1	1	1	1	3	1	1	3	2	1	1
CO-2	1	1	1	1	1	1	1	3	1	1	3	2	1	1
CO-3	1	1	1	1	1	1	1	3	1	1	2	2	1	1
CO-4	1	1	1	1	1	1	1	3	1	1	3	2	1	1
CO-5	1	1	1	1	1	1	1	3	1	1	3	2	1	1

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO ECONOMICS (6L)	
Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics **Suggested Readings:** Indian Economics	**CO-1** **BTL-2**
MODULE 2: COST ANALYSIS(6L)	
Types of Cost, Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis, Economies of Scale Cost Classification **Suggested Readings:** Study costs involved in any 1 FMCG product from raw material to market.	**CO-2** **BTL-2**
MODULE 3: CONSUMER'S AND PRODUCER'S BEHAVIOUR(6L)	
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 **Suggested Readings:** Study on reviews of customers from any ecommerce site to understand customer behaviour.	**CO-3** **BTL-2**
MODULE 4: BUDGET(6L)	
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. **Suggested Readings:** Study on 3 previous year budgets proposed by finance ministry in Government of Indian	**CO-4** **BTL-2**
MODULE 5:FINANCE (6L)	
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. **Suggested Readings:** Study on finance planning of few businesses/companies that are active in market.	**CO-5** **BTL-2**

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.
E BOOKS	

1	https://sites.google.com/site/readbookpdf7734/pdf-download-business-economics-by---marktaylor-read-online
2	https://bookboon.com/en/economics-ebooks
MOOC	
1	https://www.onlinestudies.com/Courses/Business-Economics/

COURSE TITLE	**ADVANCED PROPULSION**			**CREDITS**	**3**
COURSE CODE	**ASB4317**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-1**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This is an introductory course on rocket propulsion. The objective of this course is to impart knowledge about rocket propulsion to UG students. In this course, fundamentals aspects of rocket propulsion namely solid, liquid and hydride rocket engines are to be covered extensively.				
Course Objective	1. To study the basics of ramjet with their performance characteristics 2. To study the solid rocket propellant and their working principles 3. To study about liquid rocket propellants and their components 4. To study the advances in rocket propulsion and space propulsion 5. To study the basics of scramjet with their performance characteristics				
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the operating principle of ramjet, combustion, and its performance, basics of scramjet engine and integral ram engine. 2. Understand in detail about solid propellant rockets and the various types of propellants used with their grain structure and their burning rates. 3. Understand in detail about liquid propellant rockets and the various types of propellants used and their combustion process. 4. Understand advanced propulsion techniques like electric, ion and nuclear rockets and basics of solar sails and its operating principle. 5. Understand the operating principle, performance parameter of scramjet engine.				
Prerequisites: AEB4217 – Aircraft Propulsion					

CO, PO AND PSO MAPPING

CO	PO -1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO -10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	3	2	3	2	2	3	1	2	3	2	2
CO-2	3	2	2	3	2	3	2	2	3	1	2	3	2	2
CO-3	3	2	2	3	2	3	2	2	3	1	2	3	2	2
CO-4	3	2	2	3	2	3	2	2	3	1	2	3	2	2
CO-5	3	2	2	3	2	3	2	2	3	1	2	3	2	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:	**RAMJET PROPULSION**	**(9)**
Operating principle - Sub critical, critical and supercritical operation - Combustion in ramjet engine - Ramjet performance - Sample ramjet design calculations - Introduction to scramjet – supersonic combustion - Numerical problems.		**CO-1 BTL-3**
MODULE 2:	**SOLID PROPELLANT ROCKETS**	**(9)**
Solid propellant rockets - Selection criteria of solid propellants, hazards - Important hardware components of solid rockets - Propellant grain design considerations, combustion of solid propellants, Numerical problems.		**CO-2 BTL-3**
MODULE 3:	**LIQUID PROPELLANT ROCKETS**	**(9)**
Liquid propellant rockets - Selection of liquid propellants - Thrust control in liquid rockets - Cooling in liquid rockets - Limitations of hybrid rockets - Relative advantages of liquid rockets over solid rockets-Numerical Problems.		**CO-3 BTL-3**
MODULE 4:	**ADVANCED PROPULSION TECHNIQUES**	**(9)**
Electric rocket propulsion–Electrostatic, Electro thermal, Electromagnetic thrusters – Ion propulsion - nuclear propulsion techniques- Solar sail		**CO-4 BTL-2**
MODULE 5:	**SCRAMJET PROPULSION**	**(9)**
Fundamentals of hypersonic air birthing vehicles, Preliminary concepts in engine airframe integration, Various types of supersonic combustors, Requirements for supersonic combustors, Performance estimation of supersonic combustors.		**CO-5** BTL-3

TEXT BOOKS

1.	Sutton, G. P. and Biblarz, O., Rocket Propulsion Elements, 7th ed., John Wiley (2000).
2.	Hill, P. G. and Peterson, C. R., Mechanics and Thermodynamics of Propulsion, 2nd ed.,Addison-Wesley (1992).

REFERENCE BOOKS

1.	Cohen,H.,Rogers,G.F.C.andSaravanamuttoo,H.I.H.,"GasTurbineTheory",LongmanCo., ELBS Ed.,2008.
2.	Gorden,C.V.,"Aero thermodynamics of 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.

E BOOKS

1.	https://books.google.co.in/books/about/Rocket_Propulsion_Elements.html?id=LQbDOxg3XZcC
MOOC	
1.	http://nptel.ac.in/courses/101106033/
2.	http://nptel.ac.in/courses/101101001/

COURSE TITLE	**CONTROL THEORY**			**CREDITS**	**3**
COURSE CODE	**AEB4318**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-1**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**
ASSESSMENT SCHEME					
First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**
Course Description	This course is designed to study the fundamentals of the control theory systems and design				
Course Objective	1. To apply various real-world problems in order to obtain models. 2. To understand the mathematical modeling and its effect on design 3. To discuss about the response analyses of systems 4. To understand the various design controllers using classical methods. 5. To apply control systems analysis and design.				
Course Outcome	Upon completion of this course, the students will be able to 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 2. Predict system behavior based on the mathematical model of that system where the model may be expressed in time or frequency domain 3. Analyze the behavior of closed loop systems using tools such as root locus, Routh Hurwitz, Bode, Nyquist, and Matlab. 4. Design controllers using classical PID methods, root locus methods, and frequency domain methods. 5. Devise a safe and effective method of investigating a system identification problem in the lab				
Prerequisites: - Engineering mathematics					
CO, PO AND PSO MAPPING					

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	3	3	2	2	1	-	1	1	1	-	2	2	2
CO-2	3	3	3	2	2	1	-	1	1	2	-	2	2	2
CO-3	3	3	3	2	2	1	-	1	1	1	-	2	2	2
CO-4	3	3	3	2	2	1	-	1	-	1	-	2	2	2
CO-5	3	3	3	2	2	1	-	1	-	1	-	2	2	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: Mathematical modelling of control systems	**(9)**
Introduction • History of Automatic Control • Control Engineering Practice • The Future Evolution of Control Systems • Engineering Design • Mechatronic Systems • Control System Design • Transfer function • Mathematical modeling of mechanical systems • Mathematical modeling of Electrical systems. • Transformation of mathematical models with MATLAB	**CO-1** **BTL-2**
MODULE 2: Mathematical modeling of Hydraulic, Pneumatic and thermal systems	**(9)**
• 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	**CO-2** **BTL-2**
MODULE 3: Transient and steady-state response analyses	**(9)**
• 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	**CO-3** **BTL-2**
MODULE 4: Control systems Analysis and design by the Root-Locus method	**(9)**
• Introduction • Root-locus plot • Lead compensation • Lag Compensation	**CO-4** **BTL-2**

• Plotting Root loci with MATLAB	
MODULE 5: Control systems analysis and design by the frequency- Response method (9)	
• Introduction • Bode plot: Concepts and construction • Lead and lag compensation technique based on the frequency-response approach. • Experimental problem using MATLAB	**CO-5** **BTL-2,3**

TEXT BOOKS	
1.	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 &
3	Sons(2014).
4	Control Systems Engineering by Nagrath and Gopal New Age Publication (2001)
E BOOKS	
1. 2	Glad, T., Ljung, L. (2000). Control Theory. London: CRC Press. 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	**AIRCRAFT STABILITY AND CONTROL**			**CREDITS**	**3**
COURSE CODE	**ASB4319**	**COURSE CATEGORY**	**PC**	**L-T-P-S**	**3-0-0-1**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	This course is designed to understand stability and control aspects of an airplane. This course will also help in creating a background to design an airplane from stability and control aspects.

Course Objective	1. To understand stability of aircraft 2. To learn about the various components to stability. 3. To learn about the flight maneuvering characteristics 4. To understand about the lateral and directional stabilities. 5. To apply the dynamic stabilities
Course Outcome	Upon completion of this course, the students will be able to 1. Effectively understand the use of stability for Aircraft. 2. Understand the contributions of various components towards stability. 3. Understand the flight maneuvering characteristics 4. Know the lateral and directional stabilities. 5. Remember the methodology and apply the dynamic stabilities

Prerequisites:**Introduction to Aerospace Engineering**

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-2	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-3	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-4	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-5	3	3	3	2	-	-	-	-	2	1	-	2	3	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION (2L+7L=9)

Degree of freedom of rigid bodies in space - Static and dynamic stability - Purpose of controls in airplanes -Inherently stable and marginal stable airplanes. Equations of equilibrium and stability- contribution of various components.

Practical component:

- Purpose of controls in airplanes.

Suggested Readings:

Equations of equilibrium

CO-1
BTL-2

MODULE 2: LONGITUDINAL STATIC STABILITY (2L+7L=9)

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

Practical component:

Influence of CG location

Suggested Readings:

CO-2
BTL-2

Effects of fuselage and nacelle	
MODULE 3: LONGITUDINAL CONTROL	**(2L+7L=9)**
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. **Practical component:** Aerodynamic balancing **Suggested Readings:** Determination of neutral points and manoeuvre points from flight test	**CO-3** **BTL-3**
MODULE 4: LATERAL AND DIRECTIONAL STABILITY	**(2L+7L=9)**
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. **Practical component:** Coupling between rolling and yawing moments. **Suggested Readings:** Static directional stability	**CO-4** **BTL-2**
MODULE 5: DYNAMIC STABILITY	**(2L+7L=9)**
Brief description of lateral and directional dynamic stability- spiral, divergence and dutch roll. Response, automatic control, autorotation and spin. **Practical component:** spiral, divergence and Dutch roll. **Suggested Readings:** Autorotation and spin	**CO-5** **BTL-2**

TEXT BOOKS	
1.	Perkins, C. D., and Hage, R, E., "Airplane Performance, Stability and Control," Wiley India, 2011, ISBN-10: 8126530154, ISBN-13: 978-8126530151.
REFERENCE BOOKS	
1.	McCormick, B. W., "Aerodynamics, Aeronautics and Flight Mechanics", 2nd Ed. Wiley India, 2009, ISBN-10: 8126523786, ISBN-13: 978-8126523788.
2.	Nelson, R.C., "Flight Stability and Automatic Control", 2nd Ed., McGraw Hill, 2017, ISBN-10: 0070661103, ISBN-13: 978-0070661103.
E BOOKS	
1.	https://ocw.mit.edu/courses/aeronautics...aircraft-stability-and-control.../lecture-notes/
MOOC	
1.	https://nptel.ac.in/courses/101106043/
2.	https://nptel.ac.in/courses/101106041/

COURSE TITLE	Design Project - I			CREDITS	1
COURSE CODE	ASB4341	COURSE CATEGORY	PC	L-T-P-S	0-0-3-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-2

ASSESSMENT SCHEME

CIA	ESE
80 %	20%

Course Description	This course will expose the students to the different steps and factors need to be considered for aircraft design. It will enhance the student to upgrade their skill towards advanced developments.
Course Objective	The course will enable the student to 1. Understand the existing airplanes and their design features 2. Learn how to carry out the preliminary calculations 3. Estimate the performance of the aircraft and draw the design
Course Outcome	Upon Completion the student will be able to 1. Distinguish, understand, and compare different types of airplanes and theirSpecifications 2. Perform preliminary calculations and sizing of an aircraft 3. Carryout performance calculations and design three views of the aircraft

Prerequisites: Principles of Flight

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	2	3	2	2	2	3	2	3	2	3	2
CO-2	3	3	3	2	3	2	2	2	3	2	3	2	3	2
CO-3	3	3	3	2	3	2	2	2	3	2	3	2	3	2
CO-4	3	3	3	2	3	2	2	2	3	2	3	2	3	2
CO-5	3	3	3	2	3	2	2	2	3	2	3	2	3	2

1: Weakly related, 2: Moderately related and 3: Strongly related

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.	CO-1 BTL-2
2) Preliminary weight estimation, Selection of design parameters, power plant selection, aerofoilselection, fixing the geometry of Wing, tail, control surfaces Landing gear selection.	CO-1,2 BTL-2
3) Preparation of layout drawing, construction of balance and three view diagrams of the airplaneunder consideration.	CO-3 BTL-3
4) Drag estimation, Performance calculations, Stability analysis and V- n diagram	CO-3 BTL-2

TEXT BOOKS	
1.	Daniel P. Raymer, "Aircraft Design: A Conceptual Approach (AIAA Education Series) 5th Edition", 2018
2.	E.F. Bruhn, "Analysis and Design of Flight Vehicle Structures", Tristate Offset Co., U.S.A., 1980.
REFERENCE BOOKS	
1.	Jan Roskam, "Airplane Design", Part 1-8, Darcorporation, 2nd edition, 2003

COURSE TITLE	PROPULSION LAB - II			CREDITS	1
COURSE CODE	ASB4342	COURSE CATEGORY	PC	L-T-P-S	0-0-3-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME	
Internal Assessment Examination	ESE
80%	20%

Course Description	To understand the basic concepts and carryout experiments in aerospace propulsion.
Course Objective	1. Performa cascade testing of a model of axial compressor blade row. 2. Conduct combustion performance studies in a jet engine combustion chamber 3. Determination of heat of combustion of aviation fuel using bomb calorimeter. 4. Carry out combustion performance studies in a jet engine combustion chamber. 5. Study on the free jet and wall jet.
Course Outcome	Upon completion of this course, the students will be able to 1. Conduct tests the cascade blade row and analyze its performance. 2. Demonstrate the variation of thrust by using adjustable pitch propeller. 3. Experimentationon given fuel sample and find the heat of combustion value. 4. Examine the combustion performance of jet engine. 5. Estimate the jet characteristics for free jet. 6. Estimate the jet characteristics for wall jet.

Prerequisites: AEB4303 – Advanced Propulsion

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	2	2	2	2	2	1	2	2	2	3
CO-2	3	3	3	3	2	2	2	2	2	1	2	2	2	3
CO-3	3	3	3	3	2	2	2	2	2	1	2	2	2	3
CO-4	3	3	3	3	2	2	2	2	2	1	2	2	2	3
CO-5	3	3	3	3	2	2	2	2	2	1	2	2	2	3
CO-6	3	3	3	3	2	2	2	2	2	1	2	2	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

LIST OF EXPERIMENTS 30 hrs

1. Cascade testing of a model of axial compressor blade row.	**CO1,BT3**
2. Study of performance of a propeller.	**CO2,BT3**
3. Determining the heat of combustion of aviation fuel.	**CO3,BT3**
4. Combustion performance studies in a jet engine combustion chamber.	**CO4,BT2**
5. Characteristic plots of a free jet through a non-circular / circular orifice.	**CO5,BT3**
6. Characteristic plots of a wall jet through a circular orifice.	**CO6,BT3**

COURSE TITLE	COMPUTATIONAL MECHANICS LAB (Integrated with Lab) (Common to Aeronautical and Avionics)			CREDITS	1
COURSE CODE	ASB4343	COURSE CATEGORY	PC	L-T-P-S	0-0-3-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

Internal Assessment Examination	ESE
80%	20%

Course Description	This course provides a fundamental knowledge and understanding of fluid dynamics and structural analysis software tools to understand andinvestigate the behavior of various model under different operating conditions and also their application.
Course Objective	1. To understand fluid dynamics software tools. 2. To understand the structural analysis software tools 3. To know about these tools in aeronautical and aerospace applications. 4. To study about wind tunnel measurement instruments and aerodynamics forces. 5. To understand the interpolate the simulation and experimental results.
Course Outcome	Upon completion of this course, the students will be able to 1. Familiarize with computational fluid dynamics software tools 2. Familiarize with structural analysis software tools 3. Employ these tools in Aerospace applications 4. Expose themselves to different simulation techniques of wings & Structures. 5. interpolate the simulation results with experimental results

Prerequisites: AEB4218 LOW SPEED AERODYNAMICS

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	3	2	2	2	1	2	1	2	2	2	3
CO-2	3	3	2	3	2	2	2	1	2	1	2	2	2	3
CO-3	3	3	2	3	2	2	2	1	2	1	2	2	2	3
CO-4	3	3	2	3	2	2	2	1	2	1	2	2	2	3
CO-5	3	3	2	3	2	2	2	1	2	1	2	2	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

1. Simulation of flow over a circular cylinder (in- viscous and Viscous Flows)	CO-1 BTL-2

2. Simulation of flow over an airfoil for various angle of attack.	CO-2 BTL-2
3. Simulation of supersonic flow over a wing of biconvex cross section	CO-3 BTL-3
4. Hot flow simulation through an axial flow turbine blade passage	CO-4 BTL-2
5. Simulation of flow through subsonic and supersonic diffusers	CO-5 BTL-2
6. Structural analysis of a tapered wing	CO-6 BTL-2
7. Structural analysis of a fuselage structure	CO-7 BTL-3
8. Structural analysis of a landing gear	CO-8 BTL-2
9. Structural analysis of cut outs	CO-9 BTL-2
10. Analysis of composite laminate structure	CO-9 BTL-2

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.	J. D. Anderson, "Computational Fluid Dynamics: The Basics with Applications", McGraw Hill Education, Indian Edition 2017
2.	Tavoularis Stavros, "Measurement in Fluid Mechanics", Cambridge University Press, ISBN-10: 0521138396, ISBN-13: 978-0521138390, 370 pages, 2005.
3.	John F. Wendt (Editor), "Computational Fluid Dynamics: An Introduction", A Von Karman Institute Book, 3rd Edition. 2009
REFERENCE	
1.	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
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	COMPREHENSION			CREDITS	1
COURSE CODE	AEB4344	COURSE CATEGORY	PC	L-T-P-S	0-0-2-1
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

Internal Assessment Examinations	ESE
100%	Nil

Course Description	To encourage the students to comprehend the knowledge acquired from the first semester to Sixth semester of B. Tech Degree Course through periodic exercise based on MCQ patterns and Power presentations.
Course Objective	1. Recall the basics and concept of Fundamental subjects 2. Recall the basic knowledge in Aerodynamics related courses. 3. Recall the basic knowledge in Propulsion related courses. 4. Recall the basic knowledge in Aircraft Structures 5. Recall the basic knowledge in Aircraft Maintenance and Avionics
Course Outcome	Upon completion of this course, the students will be able to 1. Comprehend subject knowledge on Aerodynamics and Aircraft structures. 2. Comprehend subject knowledge on Propulsion 3. Comprehend subject knowledge on Aircraft maintenance and Avionics. 4. Comprehend the design of Aerospace structures and Rockets. 5. Comprehend appear for the competitive exam

Prerequisites: All courses

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	1	3	1	1	1	1	1	1	1	3	1	2
CO-2	3	1	2	2	1	1	1	1	1	1	1	3	3	2
CO-3	3	1	2	2	1	1	1	1	1	1	1	1	1	3
CO-4	3	2	3	1	1	1	1	1	1	1	1	3	2	2
CO-5	3	1	2	2	1	1	1	1	1	1	1	3	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

Semester VII

COURSE TITLE	SPACE MECHANICS			CREDITS	3
COURSE CODE	ASB4401	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course focuses on an elaborate understanding of n-body problem which also aids to analyze and determine the various satellite orbit perturbation.The module on missile trajectories and the concepts involved in inter planetary trajectories makes this course more challenging and industry ready.
Course Objective	1. This course is designed to provide students with an introduction to basic concepts in astronomy which will enable them to provide unique career opportunities in the field of astrodynamics. 2. It also gives an updated understanding with respect to satellite perturbation and ballistic missile trajectories. 3. This gives the necessary skills and knowledge to succeed in the field of astrodynamics.
Course Outcome	Upon completion of this course, the students will be able to 1. Understand solar time solar system and associated basic terms. 2. Gain knowledge of satellite orbits relation between position and time. 3. Understand satellite orbit transfer, special perturbations. 4. Know about the various phases in missile launching. 5. Learn about the spacecraft trajectories between planets.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	3	3	3	2	1	1	1	2	2	2	3	3	2
CO-2	3	3	3	3	2	1	1	1	2	2	2	3	3	2
CO-3	3	3	3	3	2	1	1	1	2	2	2	3	3	2
CO-4	3	3	3	3	2	1	1	1	2	2	2	3	3	2

CO-5	3	3	3	3	2	1	1	1	2	2	2	3	3	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BASIC CONCEPTS	**(8)**
The solar system, Reference frame and coordinate, the celestial sphere, the ecliptic , sidereal time, solar time, standard time, the earth atmosphere	**CO-1 BTL-3**
MODULE 2: N- BODY PROBLEM	**(12)**
The many body problem, circular restricted three body problem, liberation points, two body problem, satellite orbits, relation between position and time, orbital element	**CO-2 BTL-3**
MODULE 3: SATELLITE INJECTION AND SATELLITE ORBIT PERTURBATIONS	**(10)**
Introduction to satellite injection , satellite orbit transfer, orbit deviation due to injection errors, special and general perturbations, methods of vibration of orbital elements	**CO-3 BTL-3**
MODULE 4: BALLISTIC MISSILE TRAJECTORY	**(5)**
The boost phase, the ballistic phase, trajectory geometry, optimal flights, time of flight, re-entry phase, the position of the impact point , influence coefficients.	**CO-4 BTL-3**
MODULE 5: INTERPLANETARY TRAJECTORIES	**(10)**
Two dimensional interplanetary trajectories, Fast interplanetary trajectories, three dimensional interplanetary trajectories, Launch of Interplanetary spacecraft, Trajectory about the target planet.	**CO-5 BTL-3**

TEXT BOOKS	
1.	Cornelisse, J.W., " Rocket propulsion and space dynamics ", W.H. Freeman & co.
REFERENCE BOOKS	
1.	Sutton, G. P., "Rocket Propulsion Elements", John Wiley, 1993
2.	Van de Kamp, P., "Elements of Astromechanics", Pitman,
3.	Parker, E. R., "Materials for Missile and Spacecraft", McGraw-Hill Book Co.
E BOOKS	
1.	http://textofvideo.nptel.iitm.ac.in/115106068/lec1.pdf http://www.nptel.ac.in/courses/101106046/ http://ocw.mit.edu/courses/aeronautics-and-astronautics/16-346-astrodynamics-fall-2008
MOOC	
1.	https://nptel.ac.in/courses/101105030/
2.	https://nptel.ac.in/courses/101106046/12

COURSE TITLE	COMPOSITE MATERIALS AND STRUCTURES			CREDITS	3
COURSE CODE	ASB4402	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course will provide fundamental information on the various types of fibres and resin that constitutes composites, their performance under various mechanical loads, fabrication of composite and sandwich structures as well as their applications. The course is also designed to compute lamina and laminate characteristics as well as predict the failure behavior in the composites and sandwich structure.
Course Objective	1. To derive Hooke's law for composite materials and solve problems related to it 2. To compute young's modulus, transverse modulus, shear strain and shear modulus using the micromechanics approach for the lamina 3. To understand the failure criteria of the composites and sandwich structures 4. To fabricate composite and sandwich structures using different fabrication methods 5. To determine mechanical properties of the composite materials with various stacking sequence
Course Outcome	Upon completion of this course, the students will be able to 1. Explain the various types of composites & their applications; derive the Hooke's law for the composites and solve problems based on it. 2. Familiarize with the micromechanics approach for a composite lamina and macromechanics approach for the composite laminate 3. Derive the classical laminate theory for composite laminate, explain and differentiate between failure modes that can occur in a composite. 4. Design and fabricate sandwich structures, identify failure under mechanical loads and explain their applications. 5. Distinguish between the open mould and closed mould fabrication process for the composites and perform netting analysis.

Prerequisites: AIRCRAFT MATERIALS

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO -12	PSO-1	PSO-2
CO-1	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-2	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-3	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-4	3	3	3	3	-	-	-	-	2	1	-	2	3	2
CO-5	3	3	3	2	-	-	-	-	2	1	-	2	3	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: STRESS AND STRAIN RELATION (9L)	
Introduction, Classification and Application to composite materials Generalized Hooke's Law - Elastic constants for anisotropic, orthotropic and isotropic materials **Practical component:** Selection of fibres and resins based on their properties, response to mechanical loads, etc. **Suggested Readings:** Evolution of Aircraft materials	**CO-1** **BTL-2,3**
MODULE 2: METHOD OF ANALYSIS(9L)	
Micro mechanics - Mechanics of materials approach, elasticity approach to determine material properties - Macro Mechanics - Stress-strain relations with respect to natural axis, arbitrary axis. **Practical component:** Determine young's modulus, transverse modulus and poisson's ratio **Suggested Readings:** Micromechanical behavior of a lamina and macromechanical behavior of a laminate	**CO-2** **BTL-3**
MODULE 3: LAMINATE PLATES (9L)	
Governing differential equation for a general laminate, Stacking sequences in laminate - Failure criteria for composites. **Practical component:** Failure criteria and composite laminate with distinct fibres in its stacking sequence. **Suggested Readings:** Design and Failure Analysis of Laminates	**CO-3** **BTL-2,3**
MODULE 4: SANDWICH STRUCTURES (9L)	
Basic design concepts of sandwich construction - Failure modes of sandwich panels – Application and testing of sandwich structures. **Practical component:** Design and construction of sandwich materials, flexural and compression test. **Suggested Readings:** Fundamentals of sandwich structures and their constituent properties	**CO-4** **BTL-2,3**

MODULE 5: FABRICATION PROCESS (9L)	
Various Open and closed mould processes. Manufacturing of fibres - Types of resins and properties and applications - Netting analysis. **Practical component:** Fabrication of composites. **Suggested Readings:** Manufacturing methods for composite materials	**CO-5** **BTL-2**

TEXT BOOKS	
1.	Calcote, L R. "The Analysis of laminated Composite Structures", Von-NostrandReinhold 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
4.	Dan Zenkert, “An Introduction to Sandwich Structures”, Student Edition, 1995.
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, 19914.Lalit Gupta., “ Advanced Composite materials”, Himalayan books, Revised Edition, 2005
E BOOKS	
1.	https://www.diva-portal.org/smash/get/diva2:1366182/FULLTEXT01.pdf
MOOC	
1.	https://www.coursera.org/lecture/material-behavior/1-6-composites-R1boo
2.	https://onlinecourses.nptel.ac.in/noc20_me95/preview

COURSE TITLE	VIBRATION AND AERO-ELASTICITY			CREDITS	3
COURSE CODE	ASB4403	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course covers the fundamental principles of vibration with single and multi-degree freedom systems. Natural frequencies and modes of vibrations, resonance, beat phenomenon, effect of damping, applications to practical problems, aero elastic effects and these methods to avoid excessive vibrations. This will provide the adequate understanding about the general vibrating system. This will help to apply and frame the simple mechanical problems or system.
Course Objective	1. To study the fundamentals of vibration and various types. 2. To obtain the differential equation for free and forced vibration and to get the amplitude. 3. To find the multi-degree freedom system characteristics includes the mode shape and behavior 4. To study the various method to solve the vibrating system in terms of frequency 5. To knowledge to acquire in aero elastic and fluttering
Course Outcome	Upon completion of this course, the students will be able to 1. Define the basic fundamentals of vibrations and simple harmonic motion. 2. Differentiate types of vibrations according to damping system and to determine the differential equation. 3. Define the multi degree freedom system and to find the mode shapes of the double and multi degree freedom system 4. Solve Rayleigh and Holzer method to find natural frequency of an object. 5. Relate the aero elastic behavior in aircraft wing and control surfaces.

Prerequisites: Engineering mechanics

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	2	3	2	-	-	-	2	1	-	2	2	2

CO-2	3	3	2	3	2	-	-	-	2	1	-	2	2	2
CO-3	3	3	2	3	2	-	-	-	2	1	-	2	2	2
CO-4	3	3	2	3	2	-	-	-	2	1	-	2	2	2
CO-5	3	3	2	3	2	-	-	-	2	1	-	2	2	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BASIC NOTIONS (8)	
Simple harmonic motion - Terminologies - Newton's Law - D' Alembert's principle - Energy Methods **Suggested Readings: Tuning fork ,Musical instruments**	**CO-1** **BTL-3**
MODULE 2: SINGLE DEGREE OF FREEDOM SYSTEMS (12)	
Free vibrations - Damped vibrations - Forced Vibrations, with and without damping - support excitation - Vibration measuring instruments. **Practical component:** Vibrometer (Aircraft structures lab) **Suggested Readings: Tuning fork ,Musical instruments**	**CO-2** **BTL-3**
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. **Practical component:** MATLAB application	**CO-3** **BTL-3**
MODULE 4: APPROXIMATE METHODS (5)	
Rayleigh's and Holzer Methods to find natural frequencies	**CO-4** **BTL-3**
MODULE 5: TESTING, DIGITAL FORENSICS AND NEXT GENERATION SECURITY (10)	
Concepts - Coupling - Aero elastic instabilities and their prevention - Basic ideas on wing divergence, loss and reversal of aileron control - Flutter and its prevention. **Suggested Readings:** FLIGHT STABILITY AND AUTOMATIC CONTROL by Robert C nelson	**CO-5** **BTL-3**

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" - Addision Wesley Publication, New York.
2.	TSE. F.S., MORSE, I.F., HUNKLE, R.T., "Mechanical Vibrations", - Prentice Hall, New York,
3.	SCANLAN R.H. & ROSENBAUM R., "Introduction to the study of Aircraft Vibration &Flutter", John Wiley and Sons. New York.
4.	BENSON H.TONGUE, "Principles of Vibration", Oxford University Press, 2000.

E BOOKS

1.	http://160592857366.free.fr/joe/ebooks/Mechanical%20Engineering%20Books%20Collection/VIBRATIONS/mechVib%20theory%20and%20applications.pdf

MOOC	
1.	https://nptel.ac.in/courses/101104005/
2.	https://nptel.ac.in/courses/112106072/

COURSE TITLE	FEM FOR AEROSPACE ENGINEERS			CREDITS	3
COURSE CODE	ASB4404	COURSE CATEGORY	PC	L-T-P-S	3-0-0-1
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The objective of the course is to apprise the students about the basics of the Finite Element Technique, a numerical tool for the solution of different classes of problems in solid mechanics. Different application areas will be dealt with after introducing the basic aspects of the method.
Course Objective	1. To learn basic principles of finite element analysis procedure. 2. To learn the theory and characteristics of finite elements that represent engineering structures. 3. To learn and apply finite element solutions to structural, thermal, dynamic problem 4. To develop the knowledge and skills needed to effectively evaluate finite element analyses.
Course Outcome	Upon completion of this course, the students will be able to 1. Effectively use basic structural elements to design structures to meet design requirements 2. Demonstrate the ability to analyze simple structures using finite element method 3. Understand and demonstrate the knowledge of structural behavior using FEM 4. Formulation the stiffness, mass matrix for various finite elements 5. Gain Knowledge about the iso-parametric problems

Prerequisites: Engineering Mechanics, Solid Mechanics

CO, PO AND PSO MAPPING

CO	PO -1	PO-2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO - 10	PO-11	PO-12	PSO -1	PSO -2
CO-1	3	3	2	3	2	-	-	-	2	1	-	2	2	2
CO-2	3	3	2	3	2	-	-	-	2	1	-	2	2	2
CO-3	3	3	2	3	2	-	-	-	2	1	-	2	2	2
CO-4	3	3	2	3	2	-	-	-	2	1	-	2	2	2

CO-5	3	3	2	3	2	-	-	-	2	1	-	2	2	2

1: Weakly related, 2: Moderately related and 3: Strongly related

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	**CO-1 BTL-2**
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	**CO-2 BTL-2**
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	**CO-3 BTL-3**
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.	**CO-4 BTL-3**
MODULE 5: PLATE AND SHELL ELEMENT	**(9)**
Stiffness matrix derivation for plate bending element and general shell element using classical and iso-parametric approach. Numerical integration in two dimensions	**CO-5 BTL-3**

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.	Holman, J.P., Experimental methods for engineers, McGraw-Hill, 2013
5.	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.	https://onlinelibrary.wiley.com/doi/book/10.1002/9781119107323

MOOC

1.	https://www.coursera.org/courses?query=finite%20element
2.	https://www.edx.org/course/a-hands-on-introduction-to-engineering-simulations

COURSE TITLE	SPACE PROPULSION LABORATORY			CREDITS	1
COURSE CODE	ASB4431	COURSE CATEGORY	PC	L-T-P-S	0-0-3-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

Internal Assessment Examination	ESE
80%	20%

Course Description	The student will be able to learn about the basics, theory and physical concepts of combustion.
Course Objective	1. Method of preparing the propellants. 2. Scheme of identifying the burning rate of the propellant. 3. Technique to find the calorific value of the propellant. 4. Method of finding the ignition delay in rocket. 5. Understand the principle of water jet and measuring the velocity. 6. Testing the hybrid motor
Course Outcome	Upon completion of this course, the students will be able to 1. Apply the method of preparing the propellants. 2. Identify the scheme of burning rate of the propellant. 3. Estimate the calorific value of the propellant. 4. Identify using method for the ignition delay in rocket. 5. Understand the principle of water jet and measure the velocity. 6. Perform testing of the hybrid motor

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	2	2	3	2	2	3	1	2	3	2	2
CO-2	3	2	2	2	2	3	2	2	3	1	2	3	2	2
CO-3	3	2	2	2	2	3	2	2	3	1	2	3	2	2
CO-4	3	2	2	2	2	3	2	2	3	1	2	3	2	2
CO-5	3	2	2	2	2	3	2	2	3	1	2	3	2	2
CO-6	3	2	2	2	2	3	2	2	3	1	2	3	2	2

1: Weakly related, 2: Moderately related and 3: Strongly related

LIST OF EXPERIMENTS	TOTAL HOURS 45

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

LIST OF EQUIPMENT

1. Propellant Preparation Set-up
2. Window Bomb Set-Up
3. Bomb Calorimeter
4. Hybrid Motor Setup

COURSE TITLE	COMPOSITE MATERIALS LABORATORY			CREDITS	1
COURSE CODE	ASB4432	COURSE CATEGORY	PC	L-T-P-S	0-0-3-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

Observation & Record	Practical Demonstration, Lab Test Report& Viva	ESE
20%	60%	20%

Course Description	This lab course is designed to provide hands on experience and practical learning in the composite fabrication and testing. Students will be able to fabricate composites and estimate the density as well as fibre volume fraction of the fabricated composite. Performance of the fabricated composites can be evaluated under the static loads and low velocity impact.
Course Objective	1. To derive Hooke's law for composite materials and solve problems related to it 2. To compute young's modulus, transverse modulus, shear strain and shear modulus using the micromechanics approach for the lamina 3. To understand the failure criteria of the composites and sandwich structures 4. To fabricate composite and sandwich structures using different fabrication methods 5. To determine mechanical properties of the composite materials with various stacking sequence

Course Outcome	Upon completion of this course, the students will be able to 1. Fabricate the laminate plate using various manufacturing techniques. 2. Calculate the density and constitute fraction of the fabricated composite panel. 3. Evaluate the mechanical properties of the composite specimen under uniaxial tensile load, bending, shear load and joint strength characteristics as per the respective ASTM standards. 4. Evaluate the low velocity impact response of the composite panel 5. Determine the buckling characteristics of composite column.

Prerequisites: COMPOSITE MATERIALS AND STRUCTURES, SOLID MECHANICS LAB

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO -3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO-11	PO-12	PSO-1	PSO-2
CO-1	2	2	2	2	-	1	1	-	2	2	-	2	2	3
CO-2	2	2	2	2	-	1	1	-	2	2	-	2	2	3
CO-3	2	2	2	2	-	1	1	-	2	2	-	2	2	3
CO-4	2	2	2	2	-	1	1	-	2	2	-	2	2	3
CO-5	2	2	2	2	-	1	1	-	2	2	-	2	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

COMPOSITE MATERIALS LABORATORY LAB	**(45 HOURS)**
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 Molding 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.	**CO-1,2,3,4,5** **BTL-3**

COURSE TITLE	Design Project - II			CREDITS	1
COURSE CODE	ASB4433	COURSE CATEGORY	PC	L-T-P-S	0-0-3-1
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-4

ASSESSMENT SCHEME

CIA	ESE
80 %	20%

Course Description	This course will expose the students to the different steps and factors need to be considered for aircraft and aerospace design. It will enhance the student to upgrade their skill towards advanced developments.
Course Objective	The course will enable the student to 1. Understand the detailed design of the aircraft and aerospace structures 2. Learn how to design the control surfaces in the aircraft and aerospace structures 3. Factors need to be considered in designing the wing root attachment and propulsion aspects for aerospace applications
Course Outcome	Upon Completion the student will be able to 1. Perform preliminary design of an aircraft wing 2. Carryout detailed design of an aircraft fuselage – design of bulkheads and longeronsbending stress and shear flow calculations – buckling analysis of fuselagePanels 3. Perform design of the control surfaces - balancing and maneuvering loads on the tailplane and aileron, rudder loads 4. Perform design the wing- root attachment 5. Conduct detailed design of landing gear

Prerequisites: - Principles of Flight

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	2	3	2	2	2	3	2	3	2	3	2
CO-2	3	3	3	2	3	2	2	2	3	2	3	2	3	2
CO-3	3	3	3	2	3	2	2	2	3	2	3	2	3	2
CO-4	3	3	3	2	3	2	2	2	3	2	3	2	3	2
CO-5	3	3	3	2	3	2	2	2	3	2	3	2	3	2

1: Weakly related, 2: Moderately related and 3: Strongly related List of Experiments	
1. Preliminary design of an aircraft wing – Shrenck's curve, structural load distribution, shear force,bending moment and torque diagrams	CO-1 BTL-2
2. Detailed design of an aircraft wing – Design of spars and stringers, bending stress and shear flowcalculations – buckling analysis of wing panels	CO-1,2 BTL-2
3. Preliminary design of an aircraft fuselage – load distribution on an aircraft fuselage	CO-2 BTL-3
4. Detailed design of an aircraft fuselage – design of bulkheads and longerons – bending stress and shearflow calculations – buckling analysis of fuselage panels	CO-2 BTL-2
5. Design of control surfaces - balancing and maneuvering loads on the tail plane and aileron, rudderloads	CO-3 BTL-4
6. Design of wing- root attachment	CO-3 BTL-4
7. Design of Landing gear	CO-3 BTL-4
8. Preparation of a detailed design report with CAD drawings	CO-3 BTL-3

TEXT BOOKS	
1.	Daniel P. Raymer, "Aircraft Design: A Conceptual Approach (Aiaa Education Series) 5th Edition", 2018
2.	E.F. Bruhn, "Analysis and Design of Flight Vehicle Structures", Tristate Offset Co., U.S.A., 1980.
REFERENCE BOOKS	
1.	Jan Roskam, "Airplane Design", Part 1-8, Darcorporation, 2nd edition, 2003

Semester VIII

COURSE TITLE	Project & Viva–voce			CREDITS	8
COURSE CODE	ASB4441	COURSE CATEGORY	PC	L-T-P-S	0-0-24-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3, 4

ASSESSMENT SCHEME

First Review	Second Review	Third Review	ESE
10%	20%	20%	50%

Course Description	The course should enable the students to do capstone project by applying knowledge the students gained in the programme.
Course Objective	1. Make comprehensive use of the technical knowledge gained from previous courses. 2. Understand technologies concerned with the project 3. Apply project management skills (scheduling work, procuring parts and documenting expenditures and working within the confines of a deadline). 4. Analyze, develop, and demonstrate the proposed work 5. Communicate technical information by means of ethical writing and presentation
Course Outcome	Upon completion of this course, the students will be able to 1. Apply the basic concepts and technical knowledge gained in previous courses in the capstone project work. 2. Carry out literature review and understand the current scenarios and technological level with respect to the project 3. Apply project management skills 4. Analyze, develop, and demonstrate the proposed project work 5. Communicate technical information by means of ethical writing of project report and technical presentations.

Prerequisites: All courses in this B. Tech Programme

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	3	2	3	3	3	3	3	3	3	3
CO-2	3	3	3	3	3	2	3	3	3	3	3	3	3	3
CO-3	3	3	3	3	3	2	2	2	3	3	3	3	3	3
CO-4	3	3	3	3	3	2	2	2	3	3	3	3	3	3

CO-5	3	3	3	3	3	2	2	2	3	3	3	3	3	3

LIST OF DEPARTMENTAL ELECTIVES – I (SEMESTER V)

COURSE TITLE	**AIRCRAFT MATERIALS**			**CREDITS**	**3**
COURSE CODE	**ASC4251**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	The course enables the students to learn about the various material aspects like properties, defects, strengthening mechanisms and about various materials, its heat treatment process and application. Students will also learn about various characterization techniques.
Course Objective	1. To know about the material properties, defects, and various destructive and NDT tests. 2. To learn the various mechanisms by which materials can be strengthened. 3. To know about the various materials used in aircraft construction 4. To have knowledge of composites, sandwich structures and adhesives 5. To have knowledge of nanomaterials and various characterization technique
Course Outcome	Upon completion of this course, the students will be able to 1. Explain about the material properties, defects and various destructive and NDT tests that can be conducted in different materials 2. Familiarize with the strengthening mechanisms that can be used for strengthening of materials 3. Use different materials for making different parts of aircraft 4. Familiarize with composite, honeycomb structures and the method by which they are constructed as well as their application 5. Apply different techniques for determining different properties.

Prerequisites : NIL

CO, PO AND PSO MAPPING

CO	**PO-1**	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**	**PO-7**	**PO-8**	**PO-9**	**PO-10**	**PO-11**	**PO-12**	**PSO-1**	**PSO-2**
CO-1	3	1	1	-	1	2	2	1	1	-	-	2	2	2
CO-2	3	1	1	-	1	2	2	1	1	-	-	2	2	2
CO-3	3	1	1	-	1	2	2	1	1	-	-	2	2	2

CO-4	3	1	1	-	1	2	2	1	1	-	-	2	2	2
CO-5	3	1	1	-	1	2	2	1	1	-	-	2	2	2

1: Weakly related, 2: Moderately related and 3: Strongly related

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.	**CO-1 BTL-2**
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 - Annealing, Tempering, Carburizing.	**CO-2 BTL-3**
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	**CO-3 BTL-3**
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.	**CO-4 BTL-3**
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)	**CO-5 BTL-3**

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-processingcharacterization-mechanical-behavior-and-applications
MOOC	
1.	https://onlinecourses.nptel.ac.in/noc18_me03/preview

COURSE TITLE	**MEASUREMENTS AND INSTRUMENTATION**			**CREDITS**	**3**
COURSE CODE	**AEC4252**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	This course is designed to study the fundamentals of the Measurements and Instrumentation.
Course Objective	1. To study about the analyze the instruments errors and calibration 2. To Understand and determine problems in electrical and electronic instruments 3. To Apply various measurement and safety techniques for instruments 4. To understand the various flight data storage devices and display systems. 5. To understandapplication of sensors and transducers for data acquisition in aircraft.
Course Outcome	Upon completion of this course, the students will be able to 1. Estimate the error and interpret the instrument datasheet 2. Select the appropriate instrument for measuring A.C & D.C currents and voltages 3. Derive the balance equations to analyze the unknown electrical quantities 4. Select the appropriate recorders and display devices to show the physical parameters. 5. Choose the sensors and transducers for data acquisition in aircraft
Prerequisites:	

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	2	2	1	-	1	1	1	-	2	2	2
CO-2	3	3	3	2	2	1	-	1	1	1	-	2	2	2
CO-3	3	3	3	2	2	1	-	1	1	1	-	2	2	2
CO-4	3	3	3	2	2	1	-	1	1	1	-	2	2	2
CO-5	3	3	3	2	2	1	-	1	1	1	-	2	2	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION	**(9)**
Functional elements of an instrument – Static and dynamic characteristics – Errors in measurement – Statistical evaluation of measurement data – Standards and calibration	**CO-1** **BTL-2**
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.	**CO-2** **BTL-2**
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.	**CO-3** **BTL-2**
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	**CO-4** **BTL-2**
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.	**CO-5** **BTL-2,3**

TEXT BOOKS

1.	A.K. Sawhney, 'A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Raiand Co, 2015
2	J. B. Gupta, 'A Course in Electronics & Electrical Measurements And Instrumentation', S. K. Kataria&Sons, Delhi, 2008.

REFERENCE BOOKS

1.	Alan S. Morris and Reza Langari, 'Measurement and Instrumentation: Theory and Application',Second Edition, Academic Press, 2015.
2.	John G. Webster, HalitEren 'Measurement, Instrumentation, and Sensors Handbook: Two-Volume Set', edition 2 revised, CRC Press, 2018.

E BOOKS	
1.	https://nptel.ac.in/courses/112106139/pdf/1_1.pdf
MOOC	
1.	https://swayam.gov.in/course/3764-industrial-instrumentation
2.	https://nptel.ac.in/syllabus/108106070/

COURSE TITLE	EXPERIMENTAL STRESS ANALYSIS			CREDITS	3
COURSE CODE	ASC4252	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The student will be able to learn about the various instrument measurement techniques, analyses and interpret the results.
Course Objective	1. To analyze instruments for measurements 2. To understand the principle working of various extensometer 3. To analyze the electrical strain gauge effectively 4. To analyze and interpret the photo elastic fringe pattern 5. To analyze different NDT techniques
Course Outcome	Upon completion of this course, the students will be able to 1. Explain the fundamental principle of instruments for measurements 2. Familiarize with principle working of various extensometer. 3. Formulate and design the electrical strain gauge effectively 4. Interpret the photo elastic fringe pattern. 5. Familiarize with the features of different NDT techniques

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	2	2	-	-	-	1	-	-	2	2	3
CO-2	3	2	2	2	2	-	-	-	1	-	-	2	2	3

CO-3	3	2	2	2	2	-	-	-	1	-	-	2	2	3
CO-4	3	2	2	2	2	-	-	-	1	-	-	2	2	3
CO-5	3	2	2	2	2	-	-	-	1	-	-	2	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: MEASUREMENTS (9)	
Principles of measurements, Accuracy, Sensitivity and range of measurements **Practical component:** Calibration of the instrument **Suggested Readings:** Types of measurement	**CO-1** **BTL-2**
MODULE 2: EXTENSOMETERS (9)	
Mechanical, Optical, Acoustical and Electrical extensometers and their uses. Advantages and Disadvantages. **Practical component:** Determination of young modulus using extensometers **Suggested Readings:** Applications of extensometer	**CO-2** **BTL-2**
MODULE 3: ELECTRICAL RESISTANCE STRAIN GAUGES(9)	
Principle of operation and requirements of electrical strain gauges. Types and their uses, Materials for strain gauge. Calibration and temperature compensation, cross sensitivity, Rosette analysis. Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain Indicators. **Practical component:** Determination of strain measurement using electrical strain gauges **Suggested Readings:** Types and their uses, Materials for strain gauge	**CO-3** **BTL-3**
MODULE 4: PHOTOELASTICITY (9)	
Two dimensional photo elasticity, Concept of light - photo elastic effects, stress optic law, Interpretation of fringe pattern, Compensation and separation techniques, Photo elastic materials. Introduction to three-dimensional photo elasticity. **Practical component:** Calibration of photoelastic materials **Suggested Readings:** stress optic law	**CO-4** **BTL-2**
MODULE 5: NON -DESTRUCTIVETESTING (9)	
Fundamentals of NDT. Radiography, ultrasonic, magnetic particle inspection, Fluorescent penetrant technique, Eddy current testing, Acoustic Emission Technique, Fundamentals of brittle coating methods, Introduction to Moiré techniques, Holography, ultrasonic C-Scan, Thermograph, Fiber - optic Sensors.	**CO-5** **BTL-2**

Practical component: Testing of materials using NDT methods **Suggested Readings:** Fundamentals of NDT	
TEXT BOOKS	
1.	UC Jindal "Experimental Stress Analysis",Pearson Education India; First edition (1 January 2012)
REFERENCE BOOKS	
1.	Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., "Experimental Stress Analysis", Tata McGraw-Hill, New Delhi,2010.
2.	Dally, J.W., and Riley, W.F., "Experimental Stress Analysis", McGraw-Hill Inc., New York,2001.
3.	Hetyenyi, M., "Hand book of Experimental Stress Analysis", John Wiley and Sons Inc., New York,1972
E BOOKS	
1.	Alessandro Freddi ,Giorgio Olmi, Luca Cristofolini "Experimental Stress Analysis for Materials and Structures",ISBN: 978-3-319-06086-6.
MOOC	
1.	https://nptel.ac.in/courses/112/106/112106068/

COURSE TITLE	MECHANICS OF MACHINES			CREDITS	3
COURSE CODE	AEC4254	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	According to kinematics of mechanisms, it is the study of machine parts in motion withoutconsidering the forces andkinetics of mechanisms is by considering the forces which causes that motion. Mechanics of Machines, involves thestudyofposition,displacement,rotation, speed,velocity and acceleration. Also, Static and dynamic analysis of machines, inertia forces, gyroscopic forces, Static and dynamic balancing of machines. This course provides a detailed study on different types of mechanical vibrations.
Course Objective	1. To understand the concept of kinematic analysis of simple mechanisms and its velocity and accelerations. 2. To understand the concept of various drives such as belt and rope drives and to understand friction in screw and nut and its application. 3. To understand the Gear and Gear profile and Gear trains and its application and to understand the graphical treatment of CAM profile. 4. To understand the concepts of static and dynamic balancing of the various masses in different planes. 5. To understand the concept of vibrations of single degree of freedom systems, free vibration, forced vibration, damped systems and vibration isolation.
Course Outcome	Upon completion of this course, the students will be able to 1. Analyze the various mechanisms, its degree of freedom and to analyze velocity and acceleration of given mechanism. 2. Apply the effect of centrifugal and initial tension in belt and rope drives for maximum power transmission condition. 3. Determine the speed and torque of the various types of gear trains and to identify the follower motions of cam profile for suitable applications. 4. Apply the concept of balancing in rotating mass and balancing of radial V-engine (reciprocating mass). 5. Apply the concepts of Free, forced, and damped vibrations to the given system.

Prerequisites: AEB4116-ENGINEERING MECHANICS

CO, PO AND PSO MAPPING

CO	PO -1	PO -2	PO-3	PO -4	PO -5	PO -6	PO -7	PO -8	PO -9	PO -10	PO -11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	2	-	-	2	-	1	-	1	2	2	3
CO-2	3	2	2	2	-	-	2	-	1	-	1	2	2	3
CO-3	3	2	2	2	-	-	2	-	1	-	1	2	2	3
CO-4	3	2	2	2	-	-	2	-	1	-	1	2	2	3
CO-5	3	2	2	2	-	-	2	-	1	-	1	2	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: MECHANISMS (9)

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.

CO-1
BTL-2

Suggested Readings:

Computer applications in the kinematic analysis of simple mechanisms.

MODULE 2: FRICTION (9)

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.

CO-2
BTL-3

Suggested Readings:

Friction aspects in Brakes, Friction in vehicle propulsion and braking.

MODULE 3: GEARING AND CAMS (9)

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

CO-3
BTL-3

Suggested Readings:

Helical, Bevel, Worm, Rack and Pinion gears (Basics only) and Differentials.

MODULE 4: BALANCING (9)

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.

CO-4
BTL-3

Suggested Readings:

Balancing machines-Field balancing of discs and rotors.

MODULE 5: VIBRATION (9)

Free, forced and damped vibrations of single degree of freedom systems – Force

CO-5

transmitted to supports – Vibration isolation – Vibration absorption – Torsional vibration of shaft – Single and multi-rotor systems – Geared shafts – Critical speed of shaft. **Suggested Readings:** *Vibration measurement and FFT Analysis using MATLAB©*	**BTL-3**

TEXT BOOKS	
1.	Rattan.S.S, "Theory of Machines", Tata McGraw–Hill Publishing Co, New Delhi, 4th Edition, 2014.
2.	llaney.P.L, "Theory of Machines", Khanna Publishers, New Delhi, 2002.
3.	Khurmi, R.S.,"Theory of Machines", 14th Edition, S Chand Publications, 2015.
4.	Shigley, J.E. and Uicker, J.J., "Theory of Machines and Mechanisms", McGraw-Hill, 4th Edition, 2014.
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", Satya Prakasam, Tech. India Publications, 1989.
3.	Gosh, A. and Mallick, A.K., "Theory of Machines and Mechanisms", Affiliated East West Press, Edition: 3rd, 2006.
4.	lliam L. Cleghorn,and Nikolai Dechev "Mechanisms of Machines", 2nd Edition, Oxford University Press,2014
5.	rton Paul, "Kinematics and Dynamic of Planer Machinery", Prentice Hall.
6.	bert L. Norton, "Kinematics and Dynamics of Machinery", 2nd Edition, McGraw-Hill Education - Europe, 2012.
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

LIST OF DEPARTMENT ELECTIVES – II (SEMESTER – VI)

COURSE TITLE	MECHANICS OF STRUCTURAL IMPACT			CREDITS	3
COURSE CODE	ASC4351	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course provides the students to get the knowledge on impact load behavior on the structures. On performing the various methods to predict the failure of the materials students can ale to implement this technique in their projects and useful forthe lifelong learning.
Course Objective	The students will be able to 1. Understand about the impact resistance on the structures 2. Understand about the various Impact mechanics 3. Analyze the failure loads on the metallic and composites structures 4. Predict different failure on materials experimentally and perform simulations using computational methods
Course Outcome	Upon completion of this course, the students will be able to 1. Define the structural impact of rigid bodies 2. Apply the concepts of impact mechanics 3. Predict the various failure modes of metallic and composite structures 4. Identify the failures of different materials experimentally 5. Perform the computational methods for predicting impact failures

Prerequisites: Solid Mechanics

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	-	-	-	-	2	-	-	3	3	2
CO-2	3	3	3	3	-	-	-	-	2	-	-	3	3	2
CO-3	3	3	3	3	-	-	-	-	2	-	-	3	3	2

CO-4	3	3	3	3	-	-	-	-	2	-	-	3	3	2
CO-5	3	3	3	3	-	-	-	-	2	-	-	3	3	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION TO STRUCTURAL IMPACT (9)	
Introduction to Structural Impact, Rigid Body Impact Mechanics, Coefficient of Restitution, Oblique Impact, One Dimensional Impact Mechanics of Deformable Bodies,1-D Wave Propagation in Solids Induced by Impact.	**CO-1 BTL-2**
MODULE 2: MULTI DIMENTIONAL STRUCTURAL IMPACT MECHANICS (9)	
Analysis of Stress, Mohr's Circles, Octahedral Stress, Decomposition Into Hydrostatic and Pure States, Equation of motion of body in Cartesian, Cylindrical, Spherical coordinates, Analysis of Strain, Linearized Stress Strain Relations, Wave propagation in infinite and semi-infinite media.	**CO-2 BTL-2**
MODULE 3: MODELLING OF DEFORMATION/FAILURE (9)	
Constitutive models for material deformation and plasticity, Isotropic and Kinematic Hardening,Thermo Elastic Plastic, Power law, Johnson-Cook, Zerilli – Amstrong, Steinberg-Guinan, Constitutive models for composites, Failure and damage models	**CO-3 BTL-3**
MODULE 4: EXPERIMENTAL IMPACT MECHANICS (9)	
Quasi-static material test, Pendulum Impact Test, Split-Hopkinson's Bar Test, Taylor Cylinder Test, Drop Impact Test, Drop Weight Impact Test	**CO-4 BTL-2**
MODULE 5: COMPUTATIONAL IMPACT MECHANICS (9)	
Principles of numerical formulations, Classical continuum methods, Particle based Methods, Meshless Methods, Numerical Integration Methods, and Contact Impact Considerations.	**CO-5 BTL-2**

TEXT BOOKS	
1.	C. Lakshmana Rao, V.Narayanamurthy, K. R. Y. Simha, Applied Impact Mechanics,2016, Print ISBN:9781119241805
2.	J.Stronge, Impact Mechanics, Cambridge University Press January 2010, doi.org/10.1017/CBO9780511626432
3.	W3. Norman Jones Structural Impact,February 2012,isbn: 9781139200493.
REFERENCE BOOKS	
1.	Stefan Hiermaier, Structures Under Crash and Impact: Continuum Mechanics,2010.
2.	Tod A. Laursen, Computational Contact and Impact Mechanics: Springer Publications 2014
3.	C. A. Brebbia,Advances in Dynamics and Impact Mechanics,2003.
E BOOKS	
1	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://onlinecourses.nptel.ac.in/noc17_ce25 https://www.xn--mooclist 3m3d.com/course/engineering%E2%80%90mechanics%E2%80%90coursera

COURSE TITLE	FUNDAMENTALS OF SPACE VEHICLE DESIGN			CREDITS	3
COURSE CODE	ASC4352	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To provide student with a fundamental knowledge and understanding of space mission design and its applications
Course Objective	1. To know need and requirement of space mission. 2. To know the requirements, process, analysis and verification with future space structure 3. To know the thermal design in of orbiter and satellite 4. To know the basics of telecommunication and navigation. 5. To know the quality control cost estimation in the design.
Course Outcome	1. Understand the importance of mission objectives, needs, requirements and constraints, logistics 2. Understand the design requirements, process, analysis, and verification with future space structure 3. Understand the thermal design, balance, and analysis of satellite 4. Understand the basic launch vehicle consideration, selection process, spacecraft design envelope, Attitude requirements, Space control system, Navigation & Telecommunication, Onboard systems, Science instrument 5. Understand the vehicle design and mission concept, System engineering, Product assurance, Spacecraft integration and test, reliability and quality assurance, Small satellite engineering and application and its costing system

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	-	-	-	-	2	1	-	2	2	3
CO-2	3	3	3	3	-	-	-	-	2	1	-	2	2	3
CO-3	3	3	3	3	-	-	-	-	2	1	-	2	2	3
CO-4	3	3	3	3	-	-	-	-	2	1	-	2	2	3

CO-5	3	3	3	3	-	-	-	-	2	1	-	2	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: SPACE MISSION ANALYSIS AND DESIGN PROCESS(9)	
Space mission life cycle, Mission objectives, Mission needs, Mission requirements and constraints, Space environment and survivability, Space logistics and reliability, Orbital debris	**CO-1 BTL-2**
MODULE 2: SPACECRAFT CONFIGURATION AND STRUCTURAL DESIGN(9)	
Design requirements, Design process, Material solution, Analysis, Design verification, Impact protection, Configuration, The future of space structure	**CO-2 BTL-2**
MODULE 3: THERMAL CONTROL OF SPACECRAFT(9)	
Thermal environment, Thermal balance, Thermal analysis, Thermal design, Thermal technology, Thermal design verification, Satellite thermal design	**CO-3 BTL-3**
MODULE 4: SPACECRAFT ATTITUDE, CONTROL AND INSTRUMENTATION(9)	
Basic launch vehicle consideration, Launch system selection process, Determining the spacecraft design envelope, Attitude requirements, kinematics, measurements, estimation and dynamics, Space control system, Telecommunication, Onboard systems, Science instruments, Navigation	**CO-4 BTL-2**
MODULE 5: SPACECRAFT DESIGN MANAGEMENT (9)	
Vehicle design and mission concept, System engineering, Product assurance, Spacecraft integration and test, Spacecraft reliability and quality assurance, Small satellite engineering and application, Cost	**CO-5 BTL-2**

TEXT BOOKS	
1.	V.L. Pisacane and R.C. Moore, "Fundamentals of Space Systems", AIAA Series, 2003
REFERENCE BOOKS	
1.	P. Fortescue, J. stark, and G. Swinerd, " Spacecraft Systems Engineering" AIAA Series, 2005
2.	W.J. Larson and J. R. Wertz., "Space Mission Analysis and design", AIAA Series, 1998 M.J.L. Turner, "Rocket and Spacecraft Propulsion" (Principles, Practice and New Developments)
E BOOKS	
1.	https://arc.aiaa.org/doi/book/10.2514/4.862403
2.	https://www.springer.com/gp/book/9780792309710
MOOC	
1.	https://nptel.ac.in/courses/101106046/21%202.%20
2.	https://nptel.ac.in/courses/101105030/

COURSE TITLE	WIND TUNNEL TECHIQUES	COURSE TITLE	WIND TUNNEL TECHIQUES

OURSE TITLE	WIND TUNNEL TECHIQUES			CREDITS	3
COURSE CODE	AEC4353	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To provide student with a fundamental knowledge and understanding of wind tunnels and their functions, model tesing, wind tunnel measurement and flow visualization of different model for subsonic,supersonic and hypersonic flow.
Course Objective	1. To understand about model Test section and scale effects 2. To study about different of types of wind tunnels and water tunnels and their working and 3. To know about calibration of wind tunnel, buoyancy, flow angularities and turbulence in the flow. 4. To study about wind tunnel measurement instruments and aerodynamics forces. 5. To study the flow visualization of model for incompressible and compressible flow.
Course Outcome	1. Understand the Buckingham theorem and types of similarity for model 2. Understand the working principle of different types of subsonic, supersonic and hypersonic wind tunnels and water tunnels and their specifications. 3. Understand the Flow angularities, turbulentmeasurement and Calibration of wind tunnel 4. Know the wind tunnel aerodynamic measurements and three and six component external and internal balances for steady and unsteady force measurements. 5. Understand the Flow visualization of different model for subsonic and supersonic flow.

Prerequisites: LOW SPEED AERODYNAMICS

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	2	2	1	1	1	1	2	2	3	2	3
CO-2	3	3	3	2	2	1	1	1	1	2	2	3	2	3
CO-3	3	3	3	2	2	1	1	1	1	2	2	3	2	3
CO-4	3	3	3	2	2	1	1	1	1	2	2	3	2	3
CO-5	3	3	3	2	2	1	1	1	1	2	2	3	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: PRINCIPLES OF MODEL TESTING (6)

Buckingham Theorem - Non-dimensional numbers - Scale effects, Types of similarities. **Lab:** 1.Determine the velocity of Model using Reynolds Model Law. 2.Determine the scale effect of model by force measurements	**CO-1** **BTL-2**
MODULE 2:WIND TUNNELS	**(12)**
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. **Lab:** 1. Draw the pressure distribution of missile model using subsonic wind tunnel 2. Determine the force over the airctaft model using 3-component balance.	**CO-2** **BTL-2**
MODULE 3: CALIBRATION OF WIND TUNNELS**(9)**	
Test section speed - Horizontal buoyancy - Flow angularities - Turbulence measurements - Associated instrumentation - Calibration of low and high speed wind tunnels and water tunnels. Lab: 1. Calibration of low speed subsonic wind tunnel for different propeller rotations 2. Calibration of Supersonic Wind tunnel	**CO-3** **BTL-3**
MODULE 4: WIND TUNNEL MEASUREMENTS**(11)**	
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. **Lab :** 1. Determine the co-efficient of Pressure over the symmetric airfoil 2. Determine the Presure co-efficent of cambered airfoil	**CO-4** **BTL-2**
MODULE 5: FLOW VISUALIZATION	**(7)**
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. **Lab:** 1. Flow visualization of Model using Water tunnel 2. Flow Visualization of Models uisng Smoke Generator	**CO-5** **BTL-2**

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.	Russo Giuseppe P., “Aerodynamic measurements: From physical principles to turnkey instrumentation”, Woodhead Publishing, ISBN-10: 1845699920, ISBN-13: 978-1845699925, 281 pages, 2011.
2.	Tavoularis Stavros, “Measurement in Fluid Mechanics”, Cambridge University Press, ISBN-10: 0521138396, ISBN-13: 978-0521138390, 370 pages, 2005.
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)

LIST OF DEPARTMENT ELECTIVES – III (SEMESTER – VI)

COURSE TITLE	**LAUNCH VEHICLE AERODYNAMICS**			**CREDITS**	**3**
COURSE CODE	**ASC4356**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course deals toenhance your knowledge of the fundamentals of launch vehicle aerodynamics and heat transfer effects at hypersonic speed
Course Objective	1. To study the basic concept of high-speed aerodynamics 2. To understand the boundary layer theory 3. To calculate drag for launch vehicles 4. To initiate different shaped bodies aerodynamics 5. To introduce launch vehicle aspects
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the basic concept of high-speed aerodynamics 2. Apply the concept of boundary layer theory 3. Remember and apply the drag calculations/estimation 4. Understand the aerodynamics of different shaped bodies 5. Apply and understand launch vehicle aspects

Prerequisites: Compressible Aerodynamics

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	3	-	-	-	-	2	1	-	2	2
CO-2	3	3	3	3	3	-	-	-	-	2	1	-	2	2
CO-3	3	3	3	3	3	-	-	-	-	2	1	-	2	2
CO-4	3	3	3	3	3	-	-	-	-	2	1	-	2	2

CO-5	3	3	3	3	3	-	-	-	-	2	1	-	2	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: BASICS OF HIGH SPEED AERODYNAMICS(9)	
Compressible flows-Isentropic relations-mathematical relations of flow properties across shock and expansion waves-fundamentals of Hypersonic Aerodynamics	**CO-1 BTL-2**
MODULE 2:: BOUNDARY LAYER THEORY (9)	
Basics of boundary layer theory-compressible boundary layer-shock shear layer interaction-Aerodynamic heating-heat transfer effects	**CO-2 BTL-2**
MODULE 3: :LAUNCH VEHICLE CONFIGURATIONS AND DRAG ESTIMATION(9)	
Types of Rockets and missiles-various configurations-components-forces on the vehicle during atmospheric flight-nose cone design and drag estimation	**CO-3 BTL-3**
MODULE 4: AERODYNAMICS OF SLENDER AND BLUNT BODIES (9)	
Aerodynamics of slender and blunt bodies, wing-body interference effects-Asymmetric flow separation and vortex shedding-unsteady flow characteristics of launch vehicles- determination of aero elastic effects.	**CO-4 BTL-2**
MODULE 5: AERODYNAMIC ASPECTS OF LAUNCHING PHASE (9)	
Booster separation-cross wind effects-specific considerations in missile launching-missile integration and separation-methods of evaluation and determination- Stability and Control Characteristics of aunch Vehicle Configuration- Wind tunnel tests – Comparison with CFD Analysis.	**CO-5 BTL-2**

TEXT BOOKS

1.	Anderson, J.D., “Fundamentals of Aerodynamics”, McGraw-Hill Book Co., New York
2.	Chin SS, Missile Configuration Design, Mc Graw Hill, New York
3.	Anderson, J.D., “Hypersonic and High Temperature Gas Dynamics”, AIAA Education Series.

REFERENCE BOOKS

1.	Nielson, Jack N, Stever, Gutford, “Missile Aerodynamics”, Mc Graw Hill, New York
2.	Anderson Jr., D., – “Modern compressible flows”, McGraw-Hill Book Co., New York 1999.
3.	Charles D.Brown, “Spacecraft Mission Design”, AIAA Education Series, Published by AIAA, 1998
4.	Elements of Space Technology for Aerospace Engineers”, Meyer Rudolph X, Academic Press,1999.

COURSE TITLE	HEAT TRANSFER			CREDITS	3
COURSE CODE	AEC4357	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	According to thermodynamic systems, heat transfer is defined as the movement of heat across the border of the system due to a difference in temperature between the system and its surroundings. Heat can travel from one place to another in several ways. This course provides a detailed study on different modes of heat transfer that includes, Conduction, Convection and Radiation.
Course Objective	1. To understand the difference between various modes of heat transfer and to apply electrical analogy concepts in heat conduction. 2. To understand the concept of heat generation and to analyze the heat transfer from extended surfaces. To understand the transient heat conduction and its application. 3. To understand the free convection concepts and to apply various correlation used in free convective heat transfer and to understand the concepts of boundary layer. 4. To understand the forced convection concepts and to apply various correlation used in forced convective heat transfer and to understand the concepts of boundary layer and to design/size a heat exchanger. 5. To understand the concepts of Black Body, Grey Body, View factor and Radiation shields and types of laws associated with it.
Course Outcome	Upon completion of this course, the students will be able to 1. Apply steady stateconcepts involving conductive mode of heat transfer 2. Apply transient concepts based on heat transfer by conduction 3. Apply concepts of convective mode of heat transfer 4. Apply radiative mode of heat transfer to engineering applications. 5. Understand the mode of heat transfer in heat exchangers.

Prerequisites: Aero Thermodynamics

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	2	2	2	2	2	1	2	2	2	3
CO-2	3	3	3	3	2	2	2	2	2	1	2	2	2	3

CO-3	3	3	3	3	2	2	2	2	2	1	2	2	2	3
CO-4	3	3	3	3	2	2	2	2	2	1	2	2	2	3
CO-5	3	3	3	3	2	2	2	2	2	1	2	2	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

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. **Practical component:** Steady state conduction through composite wall. **Suggested Readings:** *Numerical methods in conduction, two dimensional conduction problems using MATLAB©,*	**CO-1** **BTL-3**
MODULE 2: 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. **Practical component:** Pin fin heat transfer and heat generation. **Suggested Readings:** *Numerical methods in Transient conduction in semi infinite solids, Transient conduction problems using MATLAB©.*	**CO-2** **BTL-3**
MODULE 3: 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 **Practical component:** Free convection through vertical pipe and horizontal pipe. **Suggested Readings:** *Transition and turbulence in Free convection, Combined Free and Forced Convection.*	**CO-3** **BTL-3**
MODULE 4: 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 **Practical component:** Forced convection heat exchange and double pipe heat exchanger. **Suggested Readings:** *Pressure drop and pumping power in the design of heat exchanger, Compact heat exchangers*	**CO-4** **BTL-3**
MODULE 5: RADIATIVE HEAT TRANSFER	**(9)**
Nature of thermal radiation-definitions and concepts- monochromatic and total emissive powerIntensity 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). **Practical component:** Emissivity measurement and Radiation heat exchange. **Suggested Readings:** *Coefficient of Radiant heat transfer and Radiation combined with convection, Radiation from vapours and flames.*	**CO-5** **BTL-3**

TEXT BOOKS	
1.	YunusA.Cengel, "Heat and Mass Transfer – Fundamentals & Applications", Fifth edition, 2017.
2.	C.Sachdeva, "Fundamentals of Heat and Mass Transfer", New age International Publishers, Fifth edition, 2017.
3.	R.K.Rajput, "Heat and Mass Transfer", S.Chand Publishers, Fifth Edition, 2012.
4.	P.K.Nag, "Heat and Mass Transfer", Mcgraw Hill Edition, 3 edition, 2011.
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.	J.P.Holman, "Heat Transfer", McGraw Hill Publishers, 10th edition, 2017.
DATA BOOK	
1.	C. P.Kothandaraman, Heat and Mass Transfer Data Book, New Age International Publishers, Eighth Edition, 2014
E BOOKS	
1.	http://web.mit.edu/lienhard/www/ahtt.html

2.	https://books.google.co.in/books?isbn=0070664609-Ozisik, M.N.
MOOC	
1.	https://www.class-central.com/course/nptel-heat-transfer-10061
2.	https://www.mooc-list.com/course/heat-transfer-saylororg
COURSEWARE LINK	
1.	https://sites.google.com/a/hindustanuniv.ac.in/stanleyaeroedu/subjects/heat-transfer

COURSE TITLE	**Aircraft Navigation Systems**			**CREDITS**	**3**
COURSE CODE	**ASC4358**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course provides information about various navigation schemes that are available to provide assistance in obtaining position fixing and guidance in the field of aviation.
Course Objective	1. To study about the different sensors and navigation systems. 2. To explain about the various component of inertial navigation system. 3. To summarize and apply the different radio navigation techniques. 4. To illustrate the need for different navigation techniques for missile and UAV. 5. To demonstrate the need for satellite and hybrid navigation in aviation industry.
Course Outcome	Upon completion of this course, the students will be able to 1. Identify the primary components of the navigation system and classify the different navigation system. 2. Interpret the information obtained from the inertial navigation system and model the system for the different types of error. 3. Outline about the different radio navigation aids and the emergency system. 4. Apply different navigation methods to guide a missile and UAV. 5. Make use of satellite navigation and the application of Kalman filtering in estimation of position.

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	2	2	1	-	1	1	1	-	2	2	2

CO-2	3	3	3	2	2	1	-	1	1	1	-	2	2	2
CO-3	3	3	3	2	2	1	-	1	1	1	-	2	2	2
CO-4	3	3	3	2	2	1	-	1	1	1	-	2	2	2
CO-5	3	3	3	2	2	1	-	1	1	1	-	2	2	2

1: Weakly related, 2: Moderately related and 3: Strongly related

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.	**CO-1 BTL-2**
MODULE 2: INERTIAL NAVIGATIONSYSTEMS (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.	**CO-2 BTL-2**
MODULE 3: NAVIGATION, TRACKING ANDSAFETYSYSTEMS (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.	**CO-3 BTL-2**
MODULE 4: MISSILE ANDUAV 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, Collision Avoidance and Mid-air Collision (MAC) Avoidance.	**CO-4 BTL-3**
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.	**CO-5 BTL-3**

TEXT BOOKS

1.	Mike Tooley, David Wyatt“Aircraft Communications and Navigation Systems”, 2nd edition, Routledge, 2018
2.	Global Navigation Satellite Systems, Inertial Navigation, and Integration, Mohinder S. Grewal, Angus P. Andrews, Chris G. Bartone, Wiley, 2020
3.	Myron Kyton, Walfred Fried, ‘Avionics Navigation Systems’, John Wiley & Sons,2nd edition, 1997
4.	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.	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	
1.	https://www.faa.gov/regulations_policies/handbooks_manuals/aircraft/amt_airframe_handbook/media/ama_Ch11.pdf
MOOC	
1.	http://nptel.ac.in/courses/101108056/

LIST OF DEPARTMENT ELECTIVES – IV (SEMESTER – VII)

COURSE TITLE	MANNED SPACE MISSIONS			CREDITS	3
COURSE CODE	ASC4366	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The course is designed to impart the fundamental knowledge on spacecraft requirements and showcase the ongoing research necessary for the safety of future manned space missions
Course Objective	1. To understand the fundamentals of space and space vehicle design. 2. To be able to differentiate the conditions in space with that on the earth 3. To learn the design of ECLSS and be capable of designing the missions 4. To understand the importance of logistical solutions to space applications 5. To learn the different subsystems in a space vehicle
Course Outcome	Upon completion of this course, the students will be able to 1. Know the advanced concepts of manned space missions to the engineers 2. Understand the space environment and its conditions 3. Apply the concept of life supporting devices 4. Understand the mission logistics and planning 5. Study the various subsystems involved in manned space missions

Prerequisites: Nil

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	-	-	-	-	2	1	-	2	2	3
CO-2	3	3	3	3	-	-	-	-	2	1	-	2	2	3
CO-3	3	3	3	3	-	-	-	-	2	1	-	2	2	3
CO-4	3	3	3	3	-	-	-	-	2	1	-	2	2	3

CO-5	3	3	3	3	-	-	-	-	2	1	-	2	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: INTRODUCTION (9)	
The physics of space - Current missions: space station, Moon mission,and Mars missions- Engineering challenges on Manned vs. unmanned missions - Scientific and technological gains from space programs - Salient features of Apollo and Space station missions – space shuttle mission.	**CO-1 BTL-2**
MODULE 2: SPACE VS EARTH ENVIRONMENT (9)	
Atmosphere: Structure and Composition - -Atmosphere: Air Pressure, Temperature, and Density - Atmosphere: Meteoroid, Orbital Debris & Radiation Protection - Human Factors of CrewedSpaceflight, Safety of Crewed Spaceflight - Magnetosphere - Radiation Environment: GalacticCosmic Radiation (GCR) , Solar Particle Events (SPE) - Radiation and the Human Body – Impact ofmicrogravity and g forces on humans – space adaptation syndrome.	**CO-2 BTL-2**
MODULE 3: LIFE SUPPORT SYSTEMS AND COUNTERMEASURES(9)	
Life Support Systems and Space Survival Overview - Environment Controlled Life Support Systems (ECLSS) - Human / Machine Interaction - Human Factors in Control Design – CrewAccommodations	**CO-3 BTL-2**
MODULE 4: MISSION LOGISTICS AND PLANNING (9)	
Group Dynamics: Ground Communication and Support - Space Resources and Mission Planning -Space Mission Design: Rockets and Launch Vehicles - Orbital Selection and Astrodynamics,Entry, Descent, Landing, and Ascent, Designing and Sizing Space elements, Transfer, Entry, Landing, and Ascent Vehicles, Designing, Sizing, and Integrating a Surface Base, Planetary Surface Vehicles.	**CO-4 BTL-2, 3**
MODULE 5: SUBSYSTEMS (9)	
Spacecraft Subsystems: Space Operations - Space Architecture, Attitude Determination and Control -Designing Power Systems - Extravehicular Activity (EVA) Systems - Space Robotics –Mission Operations for Crewed Spaceflight - Command, Control, and Communications Architecture	**CO-5 BTL-2**

TEXT BOOKS

1.	Larson, W. J. and Pranke, L. K., Human Spaceflight: Mission Analysis and Design, McGraw-HillHigher Education, Washington, DC , 1999
2.	McNamara, Bernard. 2000. Into the Final Frontier: The Human Exploration of Space. (BrooksCole Publishing.)

REFERENCE BOOKS

1.	Connors, M.M., Harrison, A.A., and Akins, F.R. 2005. Living Aloft: Human Requirements forExtended Spaceflight, University Press of the Pacific,Honolulu, Hawaii: ISBN: 1-4102-1983-6
2.	Eckart, P. 1996. Spaceflight Life Support and Biospherics.

MOOC

1.	https://nptel.ac.in/syllabus/101106046/
2.	https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-885j-aircraft-systems-engineering-fall-2005/video-lectures/lecture-1/
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, Narosa Publishing House, 2009
5.	Klaus A. Hoffmann and Steve T. Chiang, "Computational Fluid Dynamics for Engineers", Vols. I,II and III, 4thEdition, Engineering Education System, Wichita, KS, 67208-1078 USA, 2000
6.	SedatBiringen and Chuen-Yen Chow, "An Introduction to Computational Fluid Mechanics by Example", 2nd Ed., John Wiley and Sons, New York, 2011
7.	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

COURSE TITLE	**COMPUTATIONAL FLUID DYNAMICS (COMMON TO AERONAUTICAL AND AEROSPACE)**			**CREDITS**	**3**
COURSE CODE	**AEC4366**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	This course deals with aspects of computationally solving various flow problems applying different methods suitable for a given situation and also to familiarize the students to the commercial flow solvers.
Course Objective	To provide the students with a comprehensive overview of computational fluid dynamics to enable the students to apply appropriate techniques in solving flow problems along with the commercial flow solvers.
Course Outcome	Upon completion of the course the students will be able to 1.Distinguish the elliptic, parabolic and hyperbolic equations of fluid dynamics; Gain knowledge on the basics of gird generation; Apply source and vortex panel methods. 2. Discretize flow governing equations in explicit and implicit formulations with knowledge on stability and numerical dissipation. Apply upwind discretization to hyperbolic systems. 3. Apply strong and weak formulations including weighted residual, Galerkin and variational formulations for the implementation of finite element method to flow

	problems. 4. Apply finite volume method with cell centered and cell vertex formulations for single and multi-stage time stepping; Apply finite volume formulation with central and upwind type discretization. 5. Apply SIMPLE algorithm and its variants; Gain knowledge on various turbulence models and their implementation.

Prerequisites: Fluid Mechanics, Heat Transfer and Numerical Methods

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	2	3	1	-	1	2	2	1	2	3	3
CO-2	3	3	3	2	3	1	-	1	2	2	1	2	3	3
CO-3	3	3	3	2	3	1	-	1	2	2	1	2	3	3
CO-4	3	3	3	2	3	1	-	1	2	2	1	2	3	3
CO-5	3	3	3	2	3	1	-	1	2	2	1	2	3	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE:1 FUNDAMENTAL CONCEPTS (8)	
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; Explicitfinite difference methods of subsonic, supersonic and viscous flows- Implicit and explicit schemes; Source panel method - Vortex panel method.	**CO-1 BTL-1,2,3**
MODULE 2: DISCRETIZATION (10)	
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.	**CO-2 BTL-1,2,3**
MODULE 3:FINITE ELEMENT TECHNIQUES (10)	
Finite Element Techniques in Computational Fluid Dynamics; Introduction - Strong and weak formulations of a boundary value problem - Strong formulation - Weighted residual formulation - Galerkin formulation; Weak formulation - Variational formulation - Piecewise defined shape functions; Implementation of the FEM - The solution procedure	**CO-3 BTL-1,2,3**
MODULE 4: FINITE VOLUME TECHNIQUES (8)	
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.	**CO-4 BTL-1,2,3**
MODULE 5: FLOW FIELD ANALYSIS AND TURBULENCE MODELS (9)	
Pressure and Velocity corrections - Pressure correction equation; SIMPLE algorithm and its variants; PISO algorithms; Turbulence models – algebraic	**CO-5**

mixing length model, one and two equation models - High and low Reynolds number models.	**BTL-1,2,3**
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: TheFinite Volume Method", 2nd Edition, Pearson Education, 2010.
REFERENCE BOOKS	
1.	J. D. Anderson, "Computational Fluid Dynamics: The Basics with Applications", McGraw HillEducation, 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, Narosa Publishing House, 2009
5.	Klaus A. Hoffmann and Steve T. Chiang, "Computational Fluid Dynamics for Engineers", Vols. I,II and III, 4thEdition, Engineering Education System, Wichita, KS, 67208-1078 USA, 2000
6.	SedatBiringen and Chuen-Yen Chow, "An Introduction to Computational Fluid Mechanics by Example", 2nd Ed., John Wiley and Sons, New York, 2011
7.	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

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
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course deals with various aspects of the high temperature flows to enable the students to understand and apply appropriate relations suitable for different applications.
Course Objective	To provide the students with a comprehensive knowledge of high temperature gas dynamics.
Course Outcome	Upon completion of the course the students will be able to 1. Acquire knowledge on high temperature flows and the associated gas equations and functions. 2. Apply the basics of statistical thermodynamics to calculate the thermodynamic properties of gas species. 3. Understand the governing equations of inviscid high temperatureequilibrium and non-equilibrium flows. 4. Distinguish the mechanism of thermal conduction and diffusion and calculate transport properties. 5. Acquire knowledge of the governing equations of viscous chemically reacting flows and apply parabolized Navier-Stokes equations for chemically reacting flows.

Prerequisites: Thermodynamics

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	2	3	2	2	2	2	2	3	2	3
CO-2	3	3	3	3	2	3	2	2	2	2	2	3	2	3
CO-3	3	3	3	3	2	3	2	2	2	2	2	3	2	3
CO-4	3	3	3	3	2	3	2	2	2	2	2	3	2	3

CO-5	3	3	3	3	2	3	2	2	2	2	2	3	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

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.	**CO-1 BTL-2**
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.	**CO-2 BTL-2,3**
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.	**CO-3 BTL-2**
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.	**CO-4 BTL-2,3**
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.	**CO-5 BTL-2,3**

TEXT BOOK

1.	John D. Anderson Jr., "Hypersonic and High-Temperature Gas Dynamics", 2nd Edition, AIAA Education Series, 2006.

REFERENCE BOOKS

1.	John D. Anderson, "Modern Compressible Flow: with Historical Perspective", McGraw Hill Education, Indian Edition, 2017
2.	Tarit K. Bose, "High Temperature Gas Dynamics – An Introduction for Physicists and Engineers", 2nd Edition, Springer, 2014.

3.	H.W. Liepmann and A Roshko, "Elements of Gas Dynamics", Dover Publications, 2001
E BOOKS	
1.	https://www.kobo.com/in/en/ebook/high-temperature-gas-dynamics
MOOC	
1.	https://nptel.ac.in/courses/101103003/44

COURSE TITLE	**HIGH TEMPERATURE MATERIALS**			**CREDITS**	**3**
COURSE CODE	**ASC4368**	**COURSE CATEGORY**	**DE**	**L-T-P-S**	**3-0-0-0**
Version	**1.0**	**Approval Details**	**23rd ACM, 06.02.2021**	**LEARNING LEVEL**	**BTL-3**

ASSESSMENT SCHEME

First Periodical Assessment	**Second Periodical Assessment**	**Seminar/ Assignments/ Project**	**Surprise Test / Quiz**	**Attendance**	**ESE**
15%	**15%**	**10%**	**5%**	**5%**	**50%**

Course Description	The course enables the students to learn about the various material aspects and its behavior when subjected to high temperature regimes.
Course Objective	1. To know about the creep behavior, mechanisms, and effect of different parameters like stress, temporary, strain rate on creep 2. To understand the various laws that would be beneficial in determining the rupture life of a component 3. To understand how various types of fracture will occur and its influence on materials at high temperature. 4. To have knowledge of Oxidation and Corrosion, its interaction, transition and methods to combat hot corrosion. 5. To have knowledge of super alloys and other materials that can be used at high temperature
Course Outcome	Upon completion of this course, the students will be able to 1. Explain behavior of materials undergoing creep and the mechanisms dominating it. 2. Familiarize with various laws that would be beneficial in determining the rupture life of a component 3. Determine how a material can fracture when operating at high temperature 4. Apply different techniques to stop the influence of oxidation and corrosion 5. Recognize the various materials that can be effectively used at high

	temperature regimes.

Prerequisites :AIRCRAFT MATERIALS

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	1	1	-	1	2	2	1	1	-	-	2	2	2
CO-2	3	1	1	-	1	2	2	1	1	-	-	2	2	2
CO-3	3	1	1	-	1	2	2	1	1	-	-	2	2	2
CO-4	3	1	1	-	1	2	2	1	1	-	-	2	2	2
CO-5	3	1	1	-	1	2	2	1	1	-	-	2	2	2

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: CREEP (9)	
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	**CO-1 BTL-2**
MODULE 2: LAWS TO DETERMINE CREEP (9)	
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	**CO-2 BTL-3**
MODULE 3: HIGH TEMPERATURE FRACTURE (9)	
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.	**CO-3 BTL-3**
MODULE 4: OXIDATION & CORROSION (11)	
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	**CO-4 BTL-3**
MODULE 5: HIGH TEMPERATURE RESISTANT MATERIALS (7)	
Super Alloys – Cobalt Base, Nickel base, Iron Base. Ultra High Temperature Ceramics, Intermetallics, Thermal Barrier Coatings, Hydrogen Embrittlement, Refractory Metals, Structural Heat Resistant Composites	**CO-5 BTL-2**
TEXT BOOKS	

1.	Norman E Dowling, “Mechanical Behaviour of Materials” Pearson Publisher, Fourth Edition, 2012.
2	Jun-Shan Zhang, “High Temperature Deformation and Fracture of Materials”, First Edition, Woodhead Publishing, 2010.
REFERENCE BOOKS	
1.	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/BarCohen/p/book/9781138071544
MOOC	
1.	https://www.coursera.org/learn/materials-science/lecture/Fpo4U/mechanisms-for-creepdeformation

LIST OF DEPARTMENT ELECTIVE – V (SMESTER – VII)

COURSE TITLE	SATELLITES AND SPACE SYSTEM DESIGN			CREDITS	3
COURSE CODE	ASC4451	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course is designed to study the fundamentals of the spacecraft and satellite systems design
Course Objective	1. To study about the Space system design 2. To understand the Spacecraft environment and its effect on design 3. To discuss about the Spacecraft systems 4. To explain the Product assurance of satellite systems and components 5. To relate the Satellite engineering and applications
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the Payloads and missions, system view of spacecraft propulsion system, launch vehicles, and spacecraft mechanisms 2. Understand preoperational spacecraft environment, operational spacecraft environments, Environmental effects on design, the sun, the earth, and spacecraft effects, spacecraft structure and thermal control. 3. Discuss the various Attitude control, Electrical power systems, Telecommunications, telemetry command, data handling and process. 4. Explain the various Failures, Reliability, material and process, safety, configuration control, build and verification, system engineering, case studies 5. Relate Satellite design philosophy, satellite system design, COTS components in the space environment. Micro satellites, mini satellites and nano satellites, in orbit operation, satellite application for meteorology, navigation, communication, geo observation, and space environment study
Prerequisites: Nil	
CO, PO AND PSO MAPPING	

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	-	-	-	-	2	1	-	2	2	3
CO-2	3	3	3	3	-	-	-	-	2	1	-	2	2	3
CO-3	3	3	3	3	-	-	-	-	2	1	-	2	2	3
CO-4	3	3	3	3	-	-	-	-	2	1	-	2	2	3
CO-5	3	3	3	3	-	-	-	-	2	1	-	2	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: SPACE SYSTEM DESIGN (9)	
Payloads and missions, system view of spacecraft propulsion system, launch vehicles, spacecraft mechanisms.	**CO-1 BTL-2**
MODULE 2: SPCAECRAFT ENVIRONMENT AND ITS EFFECTS ON DESIGN (9)	
Preoperational spacecraft environment, operational spacecraft environments, Environmental effects on design, the sun, the earth, and spacecraft effects, spacecraft structure, thermal control.	**CO-2 BTL-2**
MODULE 3: SPACECRAFT SYSTEMS(9)	
Attitude control, Electrical power systems, Telecommunications, telemetry command, data handling and process.	**CO-3 BTL-2**
MODULE 4: PRODUCT ASSURANCE (9)	
Failures, Reliability, material and process, safety, configuration control, build and verification, system engineering, case studies	**CO-4 BTL-2**
MODULE 5: SATELLITE ENGINEERING AND APPLICATIONS (9)	
Satellite design philoshopy, satellite system design, COTS components in the space environment. Micro satellites, mini satellites and nano satellites, in orbit operation, satellite application for meteorology, navigation, communication, geo observation, and space environment study.	**CO-5 BTL-2,3**

TEXT BOOKS	
1.	P.Fortescue J. Stark, and G.Swinerd, "Spacecraft systems engineering", John Wiley and sons, 2002.
REFERENCE BOOKS	
1.	W.J. Larson and J. R. Wertz., "Space Mission Analysis and design", AIAA Series, 1998
2.	M.J.L. Turner, "Rocket and Spacecraft Propulsion" (Principles, Practice and New Developments).
E BOOKS	
1.	https://docplayer.net/10176025-Spacecraft-systems-engineering.html
MOOC	
1.	https://nptel.ac.in/noc/courses/noc17/SEM2/noc17-ec14/
2.	https://nptel.ac.in/noc/courses/noc21/SEM1/noc21-ae06/

COURSE TITLE	THEORY OF COMBUSTION			CREDITS	3
COURSE CODE	ASC4452	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The student will be able to learn about the basics, theory and physical concepts of combustion.
Course Objective	1. To understand physical concepts of combustion 2. To Understand and analyze the combustion process in the rocket combustion engines 3. To analyze the different configurations of flames 4. To understand combustion stoichiometry and chemical equilibrium 5. To analyze different combustion diagnosis techniques
Course Outcome	Upon completion of this course, the students will be able to 1. Acquire knowledge on basics, theory and physical concepts of combustion. 2. Understand and analyze the combustion process, in the rocket combustion engines 3. Apply the basics of different configurations of flames Hydrogen-Oxygen, hydrocarbon flame 4. Understand Combustion stoichiometry and chemical equilibrium and combustion chemistry. 5. Acquire knowledge of Non resonant techniques, Algebraic turbulence in combustion diagnosis.

Prerequisites: NIL

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	-	-	-	-	2	1	-	2	2	3
CO-2	3	3	3	3	-	-	-	-	2	1	-	2	2	3
CO-3	3	3	3	2	-	-	-	-	2	1	-	2	2	3

CO-4	3	3	3	2	-	-	-	-	2	1	-	2	2	3
CO-5	3	2	2	2	-	-	-	-	2	1	-	2	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1:INTRODUCTION (4)	
Combustion chemistry, Droplet combustion, reduced kinetic schemes, Combustion instability, Combustion enhancement, Modeling and simulation, Combustion diagnostics. **Practical component:** Modeling and simulation of Combustion **Suggested Readings:** Combustion enhancement techniques	**CO-1** **BTL-2**
MODULE 2: CHEMISTRY AND DYNAMICS (6)	
Experimental and theoretical methods, Matrix isolation, Computational chemistry methods, Determination of strain energies and heat of formation of model compound, Determination of the chemical mechanism of strain energy. **Practical component:** Determination of strain energies and heat of formation of model compound **Suggested Readings:** Combustion Chemistry	**CO-2** **BTL-2**
MODULE 3: REDUCED KINETIC SCHEMES IN COMBUSTION(11)	
Different approach, Hydrogen-Oxygen and hydrocarbon flame, Propellant deflagration **Practical component:** Hydrogen-Oxygen combustion **Suggested Readings: flame** velocity measurement	**CO-3** **BTL-3**
MODULE 4: COMBUSTION INSTABILITY (12)	
Types of instability, Theoretical analysis, Numerical simulation, Experimental studies. **Practical component:** Experimental measurement of combustion instability **Suggested Readings:** Types of instability in liquid rocket	**CO-4** **BTL-2**
MODULE 5: COMBUSTION DIAGNOSTICS (12)	
Nonresonant techniques, Absorption, Fluorescence, Algebraic turbulence, Closures for two-phase flows, Stochastic modeling. **Practical component:** Fluorescencecombustion technique **Suggested Readings:** Stochastic modeling	**CO-5** **BTL-2**

TEXT BOOKS	
1.	G.D.Roy,"Propulsion Combustion", Taylor & Francis, 1997
REFERENCE BOOKS	
1.	N.Kuboto, "Propellants and Explosives", Wiley-VCH VerkegGmbh& co KGOA, 2007
E BOOKS	
1.	N.Kuboto, "Propellants and Explosives", Wiley-VCH VerkegGmbh& co KGOA, 2007
MOOC	
1.	https://nptel.ac.in/courses/101104014/

2.	https://nptel.ac.in/courses/101106037/2.

COURSE TITLE	CRYOGENIC PROPULSION			CREDITS	3
COURSE CODE	ASC4453	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	The course explains the thermodynamic process involved in the cryogenic engineering. the liquefaction process and the instrumentations involved in the cryogenic engineering.
Course Objective	1. To provide an overview on the different cryogenic fluids and their liquefaction process 2. To give an insight into the instrumentation and the equipment involved in the cryogenic fluid handling
Course Outcome	Upon completion of this course, the students will be able to 1. Differentiate the properties of cryogenic fluids 2. Identify the cycles and different systems for the liquefaction of gases 3. Explain the different insulation systems for the cryogenic systems 4. Outline the design aspects of the cryo vessels and cryo valves 5. Describe the various cryogenic equipment and the performance

Prerequisites: Aero Engineering Thermodynamics

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	2	3	2	2	2	2	2	3	2	3
CO-2	3	3	3	3	2	3	2	2	2	2	2	3	2	3
CO-3	3	3	3	3	2	3	2	2	2	2	2	3	2	3
CO-4	3	3	3	3	2	3	2	2	2	2	2	3	2	3
CO-5	3	3	3	3	2	3	2	2	2	2	2	3	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

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, Refrigeration and liquefaction principals; Joule Thomson effect and inversion curve; Adiabatic and isenthalpic expansion with their comparison.	**CO-1 BTL-2**
MODULE 2: CRYOGENIC FLUIDS 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 gases	**CO-2 BTL-3**
MODULE 3: CRYOGENIC INSULATION (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.	**CO-3 BTL-3**
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.	**CO-4 BTL-2**
MODULE5: CRYOGENIC EQUIPEMENT (9)	
Cryogenic heat exchangers - recuperative and regenerative; Variables affecting heat exchanger andsystem 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.	**CO-5 BTL-2**

TEXT BOOKS

1.	Timmerhaus, K. and Flynn, T. (2013) *Advances in Cryogenic Engineering*. New York, NY: Springer
2.	Jha, A. (2006) *Cryogenic technology and applications*. Amsterdam: Elsevier AcademicPress.

REFERENCE BOOKS

1.	Kelley, J. (1991) *Applications of cryogenic technology*. 1st edn. New York: Springer Science + Business Media, LLC.
2.	Zohuri, B. (2018) *Physics of cryogenics*. Elsevier.
3	Mukhopadhyay, M. (2010) *Fundamentals of cryogenic engineering*. Delhi: PHI Learning Private Limited.
4	Zohuri, B. (2018) *Physics of cryogenics*. Elsevier.

MOOC	
1.	NPTEL :: Mechanical Engineering - Cryogenic Engineering

COURSE TITLE	ROCKETS & MISSILES			CREDITS	3
COURSE CODE	ASC4454	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	To introduce basic concepts of design, study the performance of rockets and missiles under various operating conditions and also to estimate burn out velocity of rockets.
Course Objective	1. To know the various system of rocket, its functions and operations. 2. To understand the Aerodynamics of Rockets, Missiles and Airframe Components. 3. To study the Rocket Motion in Free Space and Gravitational Field. 4. To know the Staging and Control of Rockets and Missiles. 5. To know the types & material Selection for Rockets and Missiles.
Course Outcome	Upon completion of this course, the students will be able to 1. Design Consideration of liquid Rocket Combustion Chamber and Design Considerations of Igniter and types of igniters. 2. Describing Aerodynamic Forces and Moments. Lateral Damping Moment and Longitudinal Moment of a Rocket. 3. Explain the One Dimensional and Two Dimensional rocket Motions in Free Space and Homogeneous Gravitational Fields. 4. Gain knowledge in various methods of thrust determinations and thrust vector control. It will also describe the rockets Separation Techniques. 5. Know the selection criteria of materials and Special Requirements of Materials to Perform under Adverse Conditions.

Prerequisites: Advanced Propulsion

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	3	3	3	2	2	2	2	2	2	2	3	2	3
CO-2	3	3	3	3	2	2	2	2	2	2	2	3	2	3
CO-3	3	3	3	3	2	2	2	2	2	2	2	3	2	3

CO-4	3	3	3	3	2	2	2	2	2	2	2	3	2	3
CO-5	3	3	3	3	2	2	2	2	2	2	2	3	2	3

1: Weakly related, 2: Moderately related and 3: Strongly related

MODULE 1: ROCKET SYSTEMS (10)	
Ignition System in rockets - types of Igniters - Igniter Design Considerations - Design Consideration of liquid Rocket Combustion Chamber, Injector Propellant Feed Lines, Valves, Propellant Tanks Outlet and Helium Pressurized and Turbine feed Systems - Propellant Slosh and Propellant Hammer - Elimination of Geysering Effect in Missiles - Combustion System of Solid Rockets. **Practical component:** Working of Igniters **Suggested Readings:** Working of all cycles including various cooling method used in rocket engines	**CO-1** **BTL-2**
MODULE 2: AERODYNAMICS OF ROCKETS AND MISSILES (8)	
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. **Practical component:** Rocket drag & forces estimation **Suggested Readings:** Detailed classification of missiles	**CO-2** **BTL-3**
MODULE 3: ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD (9)	
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. **Practical component:** Burn out time **Suggested Readings:** Equations of motions & approximations	**CO-3** **BTL-3**
MODULE 4: STAGING AND CONTROL OF ROCKETS AND MISSILES (9)	
Rocket Vector Control - Methods - Thrust determination - SITVC - Multistaging of rockets -Vehicle Optimization - Stage Separation Dynamics - Separation Techniques **Practical component:** Thrust vector control **Suggested Readings:** Stage separation & its functions	**CO-4** **BTL-2**
MODULE 5: MATERIALS FOR ROCKETS AND MISSILES (9)	
Selection of Materials - Special Requirements of Materials to Perform under Adverse Conditions. **Practical component:**	**CO-5** **BTL-2**

Comparison of materials properties **Suggested Readings:** Selection criteria of advanced materials	
TEXT BOOKS	
1.	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.
1.	https://www.nasa.gov/pdf/635963main_RocketsPeopleVolume2-ebook.pdf
MOOC	
1.	https://nptel.ac.in/courses/112/106/112106073/

COURSE TITLE	HYPERSONIC AERODYNAMICS			CREDITS	3
COURSE CODE	ASC4455	COURSE CATEGORY	DE	L-T-P-S	3-0-0-0
Version	1.0	Approval Details	23rd ACM, 06.02.2021	LEARNING LEVEL	BTL-3

ASSESSMENT SCHEME

First Periodical Assessment	Second Periodical Assessment	Seminar/ Assignments/ Project	Surprise Test / Quiz	Attendance	ESE
15%	15%	10%	5%	5%	50%

Course Description	This course deals with gas-dynamical phenomena encountered as the Mach number of the flow becomes high (> 5 or more)
Course Objective	1. To introduce fundamental concepts of hypersonic flows 2. To know the shock wave nature in hypersonic flow regime 3. To solve inviscid and viscous flows in the hypersonic regime 4. To evaluate the Boundary layer interaction in hypersonic flow 5. To study futuristic design of the vehicles at hypersonic speeds
Course Outcome	Upon completion of this course, the students will be able to 1. Understand the fundamentals of hypersonic flows 2. Understanding the shock wave nature in hypersonic flow regime and quantitatively analyze the property variation. 3. Solve the inviscid and viscous flows in the hypersonic regime using specific methods 4. Evaluate the Boundary layer interaction in hypersonic flow. Understand and analyze the heat-transfer related issues in the hypersonic regime. 5. Prepare for futuristic design of the vehicles including high speed heat transfer problems in aerospace

Prerequisites: Compressible Aerodynamics

CO, PO AND PSO MAPPING

CO	PO-1	PO-2	PO-3	PO-4	PO-5	PO-6	PO-7	PO-8	PO-9	PO-10	PO-11	PO-12	PSO-1	PSO-2
CO-1	3	2	2	2	-	-	-	-	2	1	-	2	3	2
CO-2	3	2	2	2	-	-	-	-	2	1	-	2	3	2
CO-3	3	2	2	2	-	-	-	-	2	1	-	2	3	2
CO-4	3	2	2	2	-	-	-	-	2	1	-	2	3	2
CO-5	3	2	2	2	-	-	-	-	2	1	-	2	3	2

1: Weakly related, 2: Moderately related and 3: Strongly related

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	**CO-1 BTL-2**
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	**CO-2 BTL-2, 3**
MODULE 3: VISCOUS HYPERSONIC FLOW THEORY(9)	
Boundary layer equation for hypersonic flow – hypersonic boundary layers – self similar and nonself-similar layers – solution methods for non-self-similar boundary layers Aerodynamic heating	**CO-3 BTL-2**
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	**CO-4 BTL-2**
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	**CO-5 BTL-2**
TEXT BOOKS	
1.	John D. Anderson Jr., "Hypersonic and High Temperature Gas Dynamics," McGraw Hill Series, New York,
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=booknzSPVBZ_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.	Ht https://onlinecourses.nptel.ac.in/noc18_oe05/preview