RAMAIAH
Institute of Technology

CURRICULUM
for the Academic year 2026 – 2027

DEPARTMENT OF AEROSPACE ENGINEERING

RAMAIAH INSTITUTE OF TECHNOLOGY
(Autonomous Institute, Affiliated to VTU)
BANGALORE – 54

V & VI Semester
B. E. Aerospace Engineering
Batch-2024

About the Institute:

Dr. M. S. Ramaiah a philanthropist, founded 'Gokula Education Foundation' in 1962 with an objective of serving the society. M S Ramaiah Institute of Technology (MSRIT) was established under the aegis of this foundation in the same year, creating a landmark in technical education in India. MSRIT offers 18 UG programs and 15 PG programs. All these programs are approved by AICTE. All eligible UG and PG programs are accredited by National Board of Accreditation (NBA). The institute is accredited with **'A^{+}' grade by NAAC in March 2021** for 5 years. University Grants Commission (UGC) & Visvesvaraya Technological University (VTU) have conferred Autonomous Status to MSRIT for both UG and PG Programs since 2007. The institute has also been conferred autonomous status for Ph.D. program since 2021. The institute is a participant to the Technical Education Quality Improvement Program (TEQIP), an initiative of the Government of India. The institute has 380 competent faculty out of which 70% are doctorates. Some of the distinguished features of MSRIT are: State of the art laboratories, individual computing facility for all faculty members, all research departments active with sponsored funded projects and more than 300 scholars pursuing Ph.D. To promote research culture, the institute has established Centre of Excellence for Imaging Technologies, Centre for Advanced Materials Technology, Centre for Antennas and Radio Frequency systems (CARFS), Center for Cyber Physical Systems, Schneider Centre of Excellence & Centre for Bio and Energy Materials Innovation.

The Entrepreneurship Development Cell (EDC) and "Ramaiah Evolute" have been set up on campus to incubate startups. MSRIT has a strong Placement and Training department with a committed team, a good Mentoring/Proctorial system, a fully equipped Sports department, large air-conditioned library with good collection of book volumes and subscription to International and National Journals. The Digital Library subscribes to online e-journals from Elsevier Science Direct, IEEE, Taylor & Francis, Springer Link, etc. The Institute is a member of DELNET, CMTI and VTU E-Library Consortium. The Institute has a modern auditorium, recording studio, and several hi-tech conference halls with video conferencing facilities. The institute has excellent hostel facilities for boys and girls. MSRIT Alumni have distinguished themselves by occupying high positions in India and abroad and are in touch with the institute through an active Alumni Association.

As per the National Institutional Ranking Framework (NIRF), MoE, Government of India, M S Ramaiah Institute of Technology has achieved 75th rank among 1463 top Engineering Institutions & 21st Rank among 115 Schools of Architecture in India for the year 2025.

About the Department

The Department of Aerospace Engineering was established in 2024 and offers a four-year B.E. Aerospace Engineering Program with an intake of 60 students and a two-year M.Tech. Aerospace Engineering Program with an intake of 18 students. The emphasis of the department is on imparting quality education in Aerospace Engineering, enabling the creation of expertise in this specialized area to cater to the requirements of the fast-growing aerospace sector in the country. In addition, the Department actively promotes research initiatives in the various sub-domains of the discipline.

At present, the department has seven full-time faculty members with all of them possessing Ph.D. degrees with specializations across various streams within aerospace engineering. All faculty members have extensive teaching and research experience and have consistently published and presented their work in reputed peer-reviewed international journals and conferences. In addition, they possess proven expertise in executing externally funded research projects. The faculties have been recognized as Research Supervisors by Visvesvaraya Technological University to supervise Scholars pursuing Ph.D./M.S.(Research)/ Integrated Ph.D. programs.

The department has established well-equipped academic laboratories in areas of aerodynamics, structures, propulsion and flight simulation. Key facilities include a well-instrumented computerized subsonic wind tunnel, a micro gas turbine engine test rig, and a high-fidelity flight simulator with advanced features. The department also supports design and analysis activities via CAD modelling and simulation facilities. These resources significantly support both faculty and students in conducting in-house research and development activities. The department has been promoting extracurricular activities, allowing students to establish clubs like the Aeromodelling Club, CubeSat Club, alongside many other initiatives which are currently in the pipeline. In addition to academics, the students are encouraged to participate in various competitions allowing them to gain recognition and receive prizes.

VISION OF THE INSTITUTE

To be an Institution of International Eminence, renowned for imparting quality technical education, cutting edge research and innovation to meet global socio-economic needs

MISSION OF THE INSTITUTE

RIT shall meet the global socio-economic needs through

1. Imparting quality technical education by nurturing a conducive learning environment through continuous improvement and customization
2. Establishing research clusters in emerging areas in collaboration with globally reputed organizations
3. Establishing innovative skills development, techno-entrepreneurial activities and consultancy for socio-economic needs

QUALITY POLICY

We at M S Ramaiah Institute of Technology strive to deliver comprehensive, continually enhanced, global quality technical and management education through an established Quality Management System complemented by the synergistic interaction of the stakeholders concerned

VISION OF THE DEPARTMENT

To be a centre of repute in Aerospace Engineering in imparting quality technical education with emphasis on industrial connect and research.

MISSION OF THE DEPARTMENT

1. To create conducive learning environment with state-of-the-art facilities to impart quality education in aerospace engineering
2. To promote industry collaborated activities to develop aerospace domain clusters for skill development suitable for aerospace research and employment
3. To develop and promote student centric centers of aerospace engineering for providing national/ international exposure through projects and related activities

Program Educational Objectives (PEOs):

To produce engineers

PEO 1 – with the ability to apply their knowledge in basic sciences, engineering sciences and aerospace engineering domain to excel in their professional career

PEO 2 – with the ability to apply learnt skills to solve real-time problems in areas of aeronautics and space applications

PEO 3 – with capabilities to work in teams and communicate effectively to take up diverse roles in the field of aerospace engineering

PEO 4 – with environmental awareness, commitment towards professional ethics, social responsibilities and focus on lifelong learning.

Knowledge and Attitude Profile (WK)

WK1: A systematic, theory-based understanding of the natural sciences applicable to the discipline and awareness of relevant social sciences.

WK2: Conceptually-based mathematics, numerical analysis, data analysis, statistics and formal aspects of computer and information science to support detailed analysis and modelling applicable to the discipline.

WK3: A systematic, theory-based formulation of engineering fundamentals required in the engineering discipline.

WK4: Engineering specialist knowledge that provides theoretical frameworks and bodies of knowledge for the accepted practice areas in the engineering discipline; much is at the forefront of the discipline.

WK5: Knowledge, including efficient resource use, environmental impacts, whole-life cost, re-use of resources, net zero carbon, and similar concepts, that supports engineering design and operations in a practice area.

WK6: Knowledge of engineering practice (technology) in the practice areas in the engineering discipline.

WK7: Knowledge of the role of engineering in society and identified issues in engineering practice in the discipline, such as the professional responsibility of an engineer to public safety and sustainable development.

WK8: Engagement with selected knowledge in the current research literature of the discipline, awareness of the power of critical thinking and creative approaches to evaluate emerging issues.

WK9: Ethics, inclusive behavior and conduct. Knowledge of professional ethics, responsibilities, and norms of engineering practice. Awareness of the need for diversity by reason of ethnicity, gender, age, physical ability etc. with mutual understanding and respect, and of inclusive attitudes.

Program Outcomes (POs): As per NBA guidelines

PO1: Engineering Knowledge: Apply knowledge of mathematics, natural science, computing, engineering fundamentals and an engineering specialization as specified in WK1 to WK4 respectively to develop to the solution of complex engineering problems.

PO2: Problem Analysis: Identify, formulate, review research literature and analyze complex engineering problems reaching substantiated conclusions with consideration for sustainable development. (WK1 to WK4)

PO3: Design/Development of Solutions: Design creative solutions for complex engineering problems and design/develop systems/components/processes to meet identified needs with consideration for the public health and safety, whole-life cost, net zero carbon, culture, society and environment as required. (WK5)

PO4: Conduct Investigations of Complex Problems: Conduct investigations of complex engineering problems using research-based knowledge including design of experiments, modelling, analysis & interpretation of data to provide valid conclusions. (WK8).

PO5: Engineering Tool Usage: Create, select and apply appropriate techniques, resources and modern engineering & IT tools, including prediction and modelling recognizing their limitations to solve complex engineering problems. (WK2 and WK6)

PO6: The Engineer and The World: Analyze and evaluate societal and environmental aspects while solving complex engineering problems for its impact on sustainability with reference to economy, health, safety, legal framework, culture and environment. (WK1, WK5, and WK7).

PO7: Ethics: Apply ethical principles and commit to professional ethics, human values, diversity and inclusion; adhere to national & international laws. (WK9)

PO8: Individual and Collaborative Team work: Function effectively as an individual, and as a member or leader in diverse/multi-disciplinary teams.

PO9: Communication: Communicate effectively and inclusively within the engineering community and society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations considering cultural, language, and learning differences

PO10: Project Management and Finance: Apply knowledge and understanding of engineering management principles and economic decision-making and apply these to one's own work, as a member and leader in a team, and to manage projects and in multidisciplinary environments.

PO11: Life-Long Learning: Recognize the need for, and have the preparation and ability for i) independent and life-long learning ii) adaptability to new and emerging technologies and iii) critical thinking in the broadest context of technological change. (WK8)

PSOs of the Program Offered:

Aerospace Engineering Graduates will be able to:

PSO1: apply their knowledge in aerospace sub-domains of aerodynamics, propulsion, structures, control, guidance and navigation to solve real-time problems

PSO2: apply the knowledge gained / skills acquired to work and excel in professional roles in the aerospace engineering domain

PSO3: inculcate ethical practices, support social and environmental concerns and evolve as responsible professionals

Breakup of Credits for BE Degree Curriculum. (I to VIII Semester) BATCH 2024-2028

Semester / Course Category	First	Second	Third	Fourth	Fifth	Sixth	Seventh	Eighth	Total Credits
Basic Sciences (BSC)	08	08	03	03	--	--	--	--	22
Engineering Sciences (ESC)	08	09	--	--	--	--	--	--	17
Humanities, Social Sciences and Management (HSMC)	02	02	--	--	03	03	--	--	10
Ability Enhancement Course (AEC)	02	01	01	01	01	--	03	--	09
Universal Human Values (UHV)	--	--	02	--	--	--	--	--	02
Professional Core Courses (PCC)	--	--	11	12	12	06	04	--	45
Integrated Professional Core Course (IPCC)	--	--	04	04	03		04	--	15
Professional Elective Courses (PEC)	--	--	--	--	03	06	03	--	12
Institutional Open Elective Courses (IOE)	--	--	--	--	--	03	03	--	06
Internship (INT)	--	--	--	✔	--	--	--	05	05
Mini Project / Project Work (PW)	--	--	--	--	--	04	--	13	17
Non Credit Mandatory Courses (NCMC)	--	--	--	--	✔	✔	--	--	--
Total Credits	20	20	21	20	22	22	17	18	160

B.E. in Aerospace Engineering
Scheme of Teaching
Batch 2024

V SEMESTER												
Sl. No.	**Course Code**	**Course**	**Teaching Department**	**Category**	**Credits**				**Total contact hours/week**			
					L	**T**	**P**	**Total**	**L**	**T**	**P**	**S**
1	AS51	Flight Dynamics	AS	PCC	3	1	0	4	3	2	0	3
2	AS52	Computational Fluid Dynamics	AS	IPCC	2	0	1	3	2	0	2	2
3	AS53	Aerospace Structures	AS	PCC	2	1	0	3	2	2	0	2
4	AS54	Flight Vehicle Design	AS	PCC	3	0	0	3	3	0	0	3
5	ASE55x	Program Elective Course – 1	AS	PEC	3	0	0	3	3	0	0	3
6	ASL56	Aerospace Structures Lab	AS	PCC	0	0	1	1	0	0	2	0
7	ASL57	Flight Simulation lab	AS	PCC	0	0	1	1	0	0	2	0
8	**AL58**	**Research Methodology & Intellectual property rights**	**AS**	**HSMC**	3	0	0	3	3	0	0	3
9	ASAEC59	Flow Measurement Techniques	AS	AEC	1	0	0	1	1	0	0	1
				Total	**17**	**2**	**3**	**22**	**17**	**4**	**6**	**17**
10	HS510	Environmental Studies *****		NCMC	0	0	0	0	-			

LIST OF COURSES OFFERED UNDER PROGRAM ELECTIVE COURSE -1

Sl. No.	Subject Code	Subject
1	ASE551	High Speed Aerodynamics
2	ASE552	Aircraft Maintenance, Repair and Overhaul
3	ASE553	Aerospace Systems and Instrumentation
4	ASE554	Numerical Methods
5	ASE555	Fundamentals of Jet Combustion

Nomenclature: IC: Integrated Course (Practical Integrated with Theory Course), **PCC:** Professional Core Course, **PEC:** Professional Elective Course, **AEC:** Ability Enhancement Course**, HSMC:** Humanity, Social Sciences & Management Course, **NCMC:** Non-credit Mandatory Course

Credit Definition:

- **1 credit = 1 hour/week of lecture (L)**
- **1 credit = 2 hours/week of tutorial (T)**
- **1 credit = 2 hours/week of practical(P)**
- **Self-Learning Hours (S)**

PCC(IC) is an Integrated course, combining theory with practical components.

- Theory sessions shall be conducted for 3 hours per week, while the practical sessions shall be conducted for 2 hours per week.
- Theory components shall be evaluated through both Continuous Internal Evaluation (CIE) and Semester End Examination (SEE).
- The practical component shall be assessed only through CIE (No SEE).
- The CIE shall consist of two internal test of 30 marks each. Each test will have three questions and student shall answer any two full questions. Each question shall have all CO's addressed for that test. An average of two test shall be taken to award 30 marks.
- The CIE shall have other component for 20 marks assessed through assignments, quiz, surprise test, etc. as decided by the instructor of the course.
- The SEE examination shall consist of 10 questions with internal choice and student shall answer any five full questions.

- However, questions from the practical component of the Integrated course (IC) can be included in the SEE question paper.

PCC & PEC & HSMC courses are theory courses with or without tutorial sessions.

- Each theory credit corresponds to one contact hour per week, while each tutorial credit corresponds to two contact hours per week.
- The course shall be evaluated through Continuous Internal Evaluation (CIE) and Semester End Examination (SEE), each having a weightage of 50%.
- The CIE is evaluated for 50 marks through internal tests (30 marks) and other components (20 marks). Each internal test will have three questions and students shall answer any two full questions. Each question shall address all the Course Outcomes (COs) prescribed for that test. The average of the two tests shall be considered for awarding 30 marks. The remaining 20 marks shall be assessed through assignments, tutorial tests, quizzes, surprise tests, mini-projects, or other components as decided by the course instructor.
- The SEE examination shall consist of ten questions with internal choice (two questions per unit). Students shall answer any five full questions, selecting at least one question from each unit.

AEC is a 1-credit course involving 1 contact hour per week. The course shall be evaluated through Continuous Internal Evaluation (CIE) and Semester End Examination (SEE), each having a weightage of 50%.

- The CIE will comprise of two tests of 30 marks each having Part-A with MCQs for 6 marks and Part-B with Descriptive questions. The remaining 20 marks shall be assessed through assignments, surprise tests, quizzes, or other components as decided by the course instructor.
- The SEE will comprise of Part-A with MCQs (10 marks) and Part-B (5x8=40 marks) with descriptive questions.

PCC Laboratory is a 1-credit lab course involving 2 hours of lab sessions per week and uses both Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) for assessment.

- CIE totals 50 marks, with 30 marks for lab sessions (Each laboratory experiment shall be evaluated for 10 marks based on the experiment record, conduction of the experiment, and observations, and the cumulative marks shall be scaled down to 30 marks.). Another 15 marks from a lab test and 05 marks for viva.
- SEE totals 50 marks, comprising 40 marks for procedure write up, experiment conduction & results and 10 marks for viva voce.

NCMC is a 0-credit course involving 1 contact hour per week. The course shall be evaluated through Continuous Internal Evaluation (CIE) only.

- The students shall attend classes for the course during the semester and complete all formalities of attendance and CIE. In case, any student fails to secure the minimum 40% of the prescribed CIE marks, he/she shall be deemed to have secured 'F' grade. In such a case, the student has to fulfil the requirements during subsequent semester/s to appear for CIE. In case the student fails to register for the said course/ falls short of attendance, he/she will repeat the course whenever it is offered next.
- The CIE will comprise of two tests of 30 marks each having Part-A with MCQs for 6 marks and Part-B with Descriptive questions. The remaining 20 marks shall be assessed through assignments, surprise tests, quizzes, or other components as decided by the course instructor.
- Environmental Studies* shall have CIE component only and **no SEE component**.

AICTE Activity Points Requirement for BE Programs: As per AICTE guidelines (refer Chapter 6 – *AICTE Activity Point Program, Model Internship Guidelines*), in addition to academic requirements, students must earn a specified number of **Activity Points** to be eligible for the award of the degree. The points to be earned is:

1. **Regular students** admitted to a 4-year degree program must earn **100 Activity Points**.
2. **Lateral entry students** (joining from the second year) must earn **75 Activity Points**.
3. **Students transferred** from other universities directly into the V semester must earn **50 Activity Points** from the date of entry into VTU.

These Activity Points are non-credit and will not be considered for the SGPA/CGPA or be used for vertical progression. However, earning Activity Points is mandatory for the award of the degree, and the points earned will be reflected on the eighth semester Grade Card. If a student completes all the semesters (eight or six) at the end of the program but fails to earn the required Activity Points, the VIII semester Grade Card will be withheld until the requirement is fulfilled. Also, the degree will be awarded only after the Grade Card has been released. The hours spent earning the activity points will not be counted for regular attendance requirements. Students can accumulate these points at any time during their program period, including weekends, holidays, and vacations, starting from the year of admission, provided they meet the minimum hours of engagement prescribed for each activity by AICTE.

B.E. in Aerospace Engineering
Scheme of Teaching
Batch 2024

VI SEMESTER												
Sl. No.	**Course Code**	**Course**	**Teaching Department**	**Category**	**Credits**				**Total contact hours/week**			
					L	**T**	**P**	**Total**	**L**	**T**	**P**	**S**
1	**AL61**	**Management & Entrepreneurship**	**AS**	**HSMC**	**3**	**0**	**0**	**3**	**3**	**0**	**0**	**3**
2	AS62	Materials & Manufacturing	AS	PCC	3	1	0	4	4	0	0	4
3	ASE63x	Program Elective Course – 2	AS	PEC	3	0	0	3	3	0	0	3
4	ASE64x	Program Elective Course – 3	AS	PEC	3	0	0	3	3	0	0	3
5	ASL65	Aircraft Design Lab	AS	PCC	0	0	1	1	0	0	2	0
6	ASL66	Aerospace Manufacturing Lab	AS	PCC	0	0	1	1	0	0	2	0
7	ASOE0x*	Institutional Open Elective - 1		IOE	3	0	0	3	3	0	0	3
8	**ASP67**	**Mini Project**	**AS**	**PW**	0	0	4	4	0	0	8	0
				Total	15	1	6	22	16	0	12	16

LIST OF COURSES OFFERED UNDER PROGRAM ELECTIVE COURSE -2

Sl. No.	Subject Code	Subject
1	ASE631	Structural Dynamics
2	ASE632	Dynamic stability and augmentation
3	ASE633	Rocket Propulsion
4	ASE634	Industrial Aerodynamics
5	ASE635	Fatigue and Fracture Mechanics

LIST OF COURSES OFFERED UNDER PROGRAM ELECTIVE COURSE -3

Sl. No.	Subject Code	Subject
1	ASE641	Satellite Attitude Dynamics
2	ASE642	Aeroelasticity
3	ASE643	Cryogenic Technology
4	ASE644	Helicopter Aerodynamics
5	ASE645	Boundary Layer Theory

LIST OF COURSES OFFERED UNDER INSTITUTIONAL OPEN ELECTIVE COURSE -1

Sl.No.	Subject Code	Subject
1	ASOE01	Fundamentals of Flight

Nomenclature: PCC: Professional Core Course, **PEC:** Professional Elective Course, **SDC:** Skill Development Course**, OEC:** Open Elective Course**, PW:** Project Work, **NCMC:** Non-credit Mandatory Course.

Credit Definition:

- **1 credit = 1 hour/week of lecture (L)**
- **1 credit = 2 hours/week of tutorial (T)**
- **1 credit = 2 hours/week of practical(P)**
- **Self-Learning Hours (S)**

PCC & PEC & OEC courses are theory courses with or without tutorial sessions.

- Each theory credit corresponds to one contact hour per week, while each tutorial credit corresponds to two contact hours per week.
- The course shall be evaluated through Continuous Internal Evaluation (CIE) and Semester End Examination (SEE), each having a weightage of 50%.
- The CIE is evaluated for 50 marks through internal tests (30 marks) and other components (20 marks). Each internal test will have three questions and students shall answer any two full questions. Each question shall address all the Course Outcomes (COs) prescribed for that test. The average of the two tests shall be considered for awarding 30 marks. The remaining 20 marks shall be assessed through assignments, tutorial tests, quizzes, surprise tests, mini-projects, or other components as decided by the course instructor.
- The SEE examination shall consist of ten questions with internal choice (two questions per unit). Students shall answer any five full questions, selecting at least one question from each unit.

SDC Courses:

- The Technical Skill Enhancement course is designed on the Finishing School model, providing students with an industry-oriented overview and integration of the technical concepts studied from the I to VI semesters.
- Industry experts are invited to deliver the course during the semester, with two-hour sessions held every Saturday, focusing on the application-oriented coverage of core technical concepts from the I to VI semesters.
- Assessment shall be based on CIE for 100 marks. Marks shall be awarded for each session by the internal faculty coordinator for attendance and performance in quiz/assignment/ session-specific activity designed. Ten session specific activities to be designed for 10 marks each.
- The Technical Skill Enhancement course shall have CIE component only and no SEE component.

Mini-project work Assessment (PW):

- Mini Project is a laboratory-oriented course which will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications.
- Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to a group having not more than 4 students.
- A guide/s shall be allocated to the group in the beginning of the semester.
- The CIE totals 50 marks shall be awarded by a committee constituted by of the Head of the concerned department. The CIE marks shall be awarded with 20 marks for the first presentation and 30 marks for the second presentation as per the rubrics defined by the department.
- SEE shall be conducted for 50 marks by two examiners appointed from within the Institute/ Department. SEE marks awarded for the mini project shall be based on the evaluation of brief outline of the work, presentation & report for 40 marks and 10 marks question & answer session.

PCC Laboratory is a 1-credit lab course involving 2 hours of lab sessions per week and uses both Continuous Internal Evaluation (CIE) and Semester End Examination (SEE) for assessment.

- CIE totals 50 marks, with 30 marks for lab sessions (Each laboratory experiment shall be evaluated for 10 marks based on the experiment record, conduction of the experiment, and observations, and the cumulative marks shall be scaled down to 30 marks.). Another 15 marks from a lab test and 05 marks for viva.

- SEE totals 50 marks, comprising 40 marks for procedure write up, experiment conduction & results and 10 marks for viva voce.

AICTE Activity Points Requirement for BE Programs: As per AICTE guidelines (refer Chapter 6 – *AICTE Activity Point Program, Model Internship Guidelines*), in addition to academic requirements, students must earn a specified number of **Activity Points** to be eligible for the award of the degree. The points to be earned is:

1. **Regular students** admitted to a 4-year degree program must earn **100 Activity Points**.
2. **Lateral entry students** (joining from the second year) must earn **75 Activity Points**.
3. **Students transferred** from other universities directly into the V semester must earn **50 Activity Points** from the date of entry into VTU.

These Activity Points are non-credit and will not be considered for the SGPA/CGPA or be used for vertical progression. However, earning Activity Points is mandatory for the award of the degree, and the points earned will be reflected on the eighth semester Grade Card. If a student completes all the semesters (eight or six) at the end of the program but fails to earn the required Activity Points, the VIII semester Grade Card will be withheld until the requirement is fulfilled. Also, the degree will be awarded only after the Grade Card has been released. The hours spent earning the activity points will not be counted for regular attendance requirements. Students can accumulate these points at any time during their program period, including weekends, holidays, and vacations, starting from the year of admission, provided they meet the minimum hours of engagement prescribed for each activity by AICTE.

The Non Credit Mandatory Course, Physical Education (Sport and Athletics)/Yoga/National Service Scheme (NSS):

- Student shall select any one of the NCMC's namely, Physical Education (Sport and Athletics)/Yoga/ NSS prescribed for four semesters and shall attend the course from the III semester to VI semester to complete all the formalities of the course and earn requisite CIE score. The Pass/Fail shall be reflected in the VI semester grade card.
- The above mentioned NCMC's shall not be considered for vertical progression as well as for the calculation of SGPA/CGPA but completion of the courses shall be mandatory for the award of degree.
- CIE marks will be allotted by the concerned course teacher based on attendance and performance in the practice sessions/field work every semester (III to VI) for 100 marks and the total 400 marks scored by the student are scaled down to 100 in the VI semester.
- In case, any student fails to secure the minimum 40% of the prescribed marks, he/she shall be deemed to have secured 'F' grade.

V SEMESTER

FLIGHT DYNAMICS	
Course Code: AS51	**Credits: 3:1:0**
Prerequisite:	**Contact Hours: 45L + 15T + 45S**
Course Coordinator: Dr. Vigneswaran C M	

Course Content

Unit I

Steady, Level and Climbing Flight: Introduction, four forces of flight, General equation of motion for steady level and climb flight, thrust required curves and Power required curves, Altitude effects, Rate of climb, climb performance graph (hodograph diagram); Absolute ceiling, Service ceiling, Time to climb, climb, gliding flight, sink rate.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation

Unit II

Flight Performance Metrics: Range for piston and jet engine aircraft, Endurance for piston and jet engine aircraft, Take off performance and landing performance, v-n diagram.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation

Unit III

Longitudinal Static Stability: Introduction to stability, Types of stability, Longitudinal static stability, stability criteria, Contribution of airframe components: Wing contribution, Tail contribution, Fuselage contribution, Power effects- Propeller airplane and Jet airplane.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation

Unit IV

Longitudinal Control-Stick fixed: Introduction, Trim condition. Static margin. stick fixed neutral points. Longitudinal control, Elevator power, Elevator angle versus equilibrium lift coefficient, Elevator required for landing, Restriction on forward C.G. range

Longitudinal Control-Stick free: Introduction, Hinge moment parameters, Control surface floating characteristics and aerodynamic balance, Estimation of hinge moment parameters, Stick-free Neutral point.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation

Unit V

Directional static stability and control: Introduction, stability criteria, Contribution of airframe components: Tail contribution, swept back wing contribution, Engine contribution, one engine inoperative condition, Weather cocking effect, Directional control, Rudder lock,

Lateral static stability and control: Introduction, Stability criteria, Effect of wing sweep, flaps, and power., Dihedral Effect, Lateral control, coupling between rolling and yawing moments. Adverse yaw effects. Aileron reversal.

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation

Text books:

1. Airplane Performance stability and Control, Perkins, C.D., and Hage, R.E, John Wiley , New York, 1998.
2. Flight Stability and Automatic Control, Nelson, R.C, McGraw-Hill Book Co, 2007.
3. Airplane performance & design, John D. Anderson, Jr, McGraw-Hill, Aerospace Science Technology Editions, 2000.

Reference books:

1. Introduction to flight, John D. Anderson, Jr, McGraw-Hill, Aerospace Science Technology Editions, 2000.
2. The Principles of the Control and Stability of Aircraft, W.J. Duncan, Cambridge University Press, 2016.

Course Outcomes (COs):

After completing this course, students will be able to

1. Analyze aircraft performance characteristics for steady flight(PO-3, PO-4, PO-5)
2. Understand and analyze aircraft performance parameters for maneuvering flight (PO-3, PO-4, PO-5)
3. Articulate aircraft stability criteria and assess contribution of aircraft components towards attaining stability (PO-3, PO-4, PO-5)
4. Employ stick-fixed and stick-free methods to estimate the longitudinal control of an aircraft (PO-3, PO-4, PO-5)
5. Illustrate the concepts and control mechanisms for lateral-directional static stability. (PO-3, PO-4, PO-5)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1, CO-2
Internal test-II	30	CO-3, CO-4, CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Presentations	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Assignment writing	10	CO-1, CO-2, CO-3, CO-4 & CO-5
Semester End Examination (SEE) - 100		
Semester End Examination	100	CO-1, CO-2, CO-3, CO-4 & CO-5

COMPUTATIONAL FLUID DYNAMICS	
Course Code: AS52	**Credits: 2:0:1**
Prerequisite:	**Contact Hours: 45L + 30P + 45S**
Course Coordinator: Dr. Anand M. Raikar	

Course Content

Unit I

Introduction: CFD Applications. Need for Parallel Computers in CFD algorithms. Models of flows. Substantial derivative, Divergence of velocity, Continuity, Momentum, and Energy Equations-Derivation in various form, Integral versus Differential form of equations, Comments on governing equations, Physical boundary conditions, Forms of equations especially suitable for CFD work, Shock capturing, and shock fitting.

- https://nptel.ac.in/courses/103106119
- https://doc.cfd.direct/notes/cfd-general-principles/
- Pedagogy/Course delivery tools:- Chalk and talk, animated videos
- Lab Component/Practical Topics: Modeling of Symmetrical/Cambered Aerofoil Geometry, and Generation of Body Fitting Adaptive Mesh.
- Lab Component/Practical Topics: Modeling of 2-D Incompressible and Inviscid Flow over Symmetrical/Cambered Aerofoil, and Plotting of Pressure distribution and Velocity vectors for Subsonic/Supersonic Mach numbers.

Unit II

Mathematical Behavior of Partial Differential Equations: Classification of partial differential equations, Cramer Rule and Eigen value methods for classification, Hyperbolic, parabolic and elliptic forms of equations, Impact of classification on physical and computational fluid dynamics, Case studies: steady inviscid supersonic flow, unsteady inviscid flow, steady boundary layer flow, and unsteady thermal conduction, steady subsonic inviscid flow.

- http://www.ae.iitm.ac.in/~krishna/ecfd4tab.pdf
- https://onlinecourses.nptel.ac.in/noc21_me126/preview
- Pedagogy/Course delivery tools:- Chalk and talk, animated videos
- Lab Component/Practical Topics: Modeling of 2-D Compressible and Viscid Flow over Symmetrical/Cambered Aerofoil, and Plotting of Pressure distribution and Velocity vectors for Subsonic Mach numbers.
- Lab Component/Practical Topics: Isentropic Flow Analysis in a 2-D Subsonic Diffuser and a Subsonic Nozzle.
- Lab Component/Practical Topics: Isentropic Flow Analysis in a 2-D Supersonic Diffuser and a Supersonic Nozzle.

Unit III

Grid Generation and Adaptive Grids: Need for grid generation and Body-fitted coordinate system, Structured Grids-essential features, Structured Grid generation techniques- algebraic and numerical methods, Unstructured Grids-essential features, Unstructured Grid generation techniques- Delaunay-Voronoi diagram, advancing front Method, Surface grid generation, multi-block grid generation, and meshless methods. Grid quality and adaptive grids, Structured grids adaptive methods and unstructured grids adaptive methods, modern developments in grid generation, Computer Graphic Techniques used in CFD.

- Pedagogy/Course delivery tools:-Chalk and talk, Power point presentation, animated videos
- Lab Component/Practical Topics: Geometric Modeling and Mesh Generation of a 2-D Convergent-Divergent Nozzle and Analysis of flow for Adiabatic Conditions (Fanno Flow).
- Lab Component/Practical Topics: Geometric Modeling and Mesh Generation of a 2-D Pipe and Modeling of Steady/Unsteady Heat Convection and Conduction (Rayleigh Flow).

Unit IV

Discretisation: Finite differences methods, and difference equations. Explicit and Implicit approaches, Unsteady Problem -Explicit versus Implicit Scheme, Errors and stability analysis, Time marching and space marching, Reflection boundary condition, Relaxation techniques, Alternating direction implicit method, Successive over relaxation/under relaxation, Second order Lax-Wendroff method, mid-point Leap frog method, upwind scheme, numerical viscosity, and artificial viscosity.

- Pedagogy/Course delivery tools:-Chalk and talk, Power point presentation, animated videos
- Lab Component/Practical Topics: Structural Modeling of Sandwich Beam of Rectangular Cross-section and Analyses for Stress for Unsymmetrical bending case.
- Lab Component/Practical Topics: Structural Modeling and Stress Analysis of a Torsion Box of a Wing, Fuselage Frame & Tapered I-Section Spar.
- Lab Component/Practical Topics: Determine the Natural frequency and Mode shapes of a Cantilever beam under UDL.

Unit V

Finite Volume Technique: Spatial discretisation- cell centered and cell vertex techniques (overlapping control volume, dual control volume), Temporal discretisation- Explicit time stepping, and implicit time stepping, Time step calculation, Upwind scheme and high resolution scheme, Flux vector splitting, approximate factorization, Artificial dissipation and flux limiters, Upwind biasing.

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos
- Lab Component/Practical Topics: A Plate fixed at one end has a hole in centre and has varying thickness, Determine stresses developed due to applied static loads in vertical direction.
- Lab Component/Practical Topics: A Tapered Plate fixed at one end has a hole in centre and has varying thickness, determine stresses developed due to applied static loads in vertical direction.

Text Books:

1. John D. Anderson, "Computational Fluid Dynamics" McGraw Hill, 2013, ISBN-13: 978-0070016859.
2. Fletcher C.A.J., "Computational Techniques for Fluid Dynamics", 2nd edition, Springer, Berlin, 2002,ISBN-13: 978-3540543046

Reference Books:

1. John F. Wendt, "Computational Fluid Dynamics - An Introduction", 3rd edition, Springer, 2013
2. Charles Hirsch, "Numerical Computation of Internal and External Flows" 1st edition, Elsevier, 2007, ISBN-13: 978-9381269428.

3. Klaus A Hoffmann and Steve T. Chiang., "Computational Fluid Dynamics for Engineers", Vols. I & II Engineering Education System 67208 - 1078 USA, 1993.

Course Outcomes (COs):

1. Explain the basic governing equations of fluid flow (continuity, momentum, and energy) and their physical meaning for CFD problems.
2. Identify different types of fluid-flow governing equations and relate them to real flow situations.
3. Create structured and unstructured computational grids and assess their quality for CFD analysis.
4. Examine finite difference methods for steady and unsteady flows and their numerical behavior.
5. Use finite volume methods to solve simple practical CFD problems involving fluid flow.

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE):50Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal Test-I	30	CO1 & CO2
Internal Test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Lab components - 20 Marks		
Experiment Conduction and record writing	10	CO1 to CO5
Lab CIE	10	CO1 to CO5
Semester End Examination (SEE):100Marks		
Semester End Examination (SEE):	100	CO1 to CO5

AEROSPACE STRUCTURES	
Course Code: AS53	**Credits: 2:1:0**
Prerequisite:	**Contact Hours: 45L + 15T+ 45S**
Course Coordinator: Dr. Radhakrishnan P M	

Course Contents

Unit I

Introduction to Aircraft Structures: Basic elasticity – Equations of Equilibrium, Stress-strain relationship, Compatibility Equations, Plane Stress, Plane Strain, Determination of stresses and strains on inclined planes, Principal stresses and strains, Mohr's circle of stress and strain. Structural components of aircraft – Loads and functions; Airworthiness – Flight envelope; Airframe Loads–Inertia Loads, Symmetric Maneuver Loads, Numerical problems

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, Animated videos

Unit II

Bending of Open, Closed and Thin-Walled Beams: Symmetrical bending - Assumptions, direct Stress distribution, anticlastic bending. Unsymmetrical bending – Sign conventions, direct stress distribution, position of neutral axis, deflections due to bending, approximations for thin-walled sections, Numerical problems.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, Animated video

Unit III

Shear of Beams: General Stress, Strain, and Displacement Relationships for Open and Single Cell Closed Section Thin-Walled Beams. Open section beams: shear flow distribution, shear centre. Closed section beams: Shear flow distribution, shear centre, Numerical Problems

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos

Unit IV

Torsion of Beams: Torsion of closed section beams- Bredt-Batho theory, Displacements associated with the Bredt-Batho shear flow, condition for zero warping. Torsion of open section beams, warping of cross section, Numerical Problems.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, Animated videos

Unit V

Stress Analysis of Aircraft Components: Structural Idealization – Principle, Idealization of A Panel, Effect of idealization on Analysis of Open and Closed Section beams. Wing Spars and Box Beams – Tapered Wing Spar, Open and Closed Section Beams. Fuselages: Bending, Shear and Torsion, Numerical Problems.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, Animated videos

Text Books:

1. T. H. G. Megson, Aircraft structures for Engineering Students, 6th Edition, Butterworth-Heinemann, 2016.
2. T. H. G. Megson, An Introduction to Aircraft Structural Analysis, 2nd Edition, Elsevier Science, 2014.

Reference Books:

1. T.H.G. Megson, Structural and Stress Analysis, 4th Edition, Butterworth-Heinemann, 2019.
2. E. F. Bruhn, Analysis & Design of Flight Vehicle Structures, TriState Offset, 3rd Edition, 1965.
3. David Peery, J. J. Azar, Aircraft Structures, McGraw-Hill Education, 2nd Edition, 1982.

Course Outcomes (COs):

At the end of the course, students will be able to

1. Apply foundational concepts of aerospace structures to solve related structural problems effectively (PO-3, PO-4, PO-5)
2. Evaluate stresses in beams and thin-walled sections subjected to symmetric / unsymmetric bending (PO-3, PO-4, PO-5)
3. Analyze shear flow distribution in thin-walled beams (PO-1, PO-3, PO-4, PO-5)
4. Analyze open and closed section structural members subjected to torsional loads (PO-1, PO-3, PO-4, PO-5)
5. Estimate stresses in aerospace components through structural idealization techniques (PO-1, PO-3, PO-4, PO-5)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1 &CO-2
Internal test-II	30	CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Quiz/Case Study/Mini Project/Surprise Test/ Presentation	10	CO-1, CO-2, CO-3, CO-4, CO-5
Assignment	10	CO-1, CO-2, CO-3, CO-4, CO-5
Semester End Examination (SEE) - 100		
Semester End Examination	100	CO-1, CO-2, CO-3, CO-4 & CO-5

FLIGHT VEHICLE DESIGN	
Course Code: AS54	**Credits: 3:0:0**
Prerequisite:	**Contact Hours: 45L + 0P + 45S**
Course Coordinator: Dr. Vigneswaran C M	

Course Content

Unit I

Introduction: Overview of Design Process: Introduction, Requirements, Phases of design, Conceptual Design Process, Initial Sizing, Take-off weight build up, Empty weight estimation, Fuel fraction estimation, Take- off weight calculation.

Thrust to Weight Ratio & Wing Loading: Thrust to Weight Definitions, Statistical Estimate of T/W. Thrust matching, Spread sheet in design, Wing Loading and its effect on Stall speed, Take-off Distance, Catapult takeoff, and Landing Distance. Wing Loading for Cruise, Loiter, Endurance, Instantaneous Turn rate, Sustained Turn rate, Climb, & Glide, Maximum ceiling.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos

Unit II

Wing and Fuselage Design: Configuration Layout & loft: Conic Lofting, Conic Fuselage Development, Conic Shape Parameter, Wing-Tail Layout & Loft. Aerofoil Linear Interpolation. Aerofoil Flat-wrap Interpolation. Wing aerofoil layout-flap wrap. Wetted area determination. Special considerations in Configuration Layout: Aerodynamic, Structural, Detectability. Crew station, Passenger, and Payload arrangements.

Design of Structural Components: Fuselage, Wing, Horizontal & Vertical Tail. Spreadsheet for fuselage design. Tail arrangements, Horizontal & Vertical Tail Sizing. Tail Placement. Loads on Structure. V-n Diagram, Gust Envelope. Loads distribution, Shear and Bending Moment analysis

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos

Unit III

Engine Selection & Flight Vehicle Performance: Turbojet Engine Sizing, Installed Thrust Correction, Spread Sheet for Turbojet Engine Sizing. Propeller Propulsive System. Propeller design for cruise. Take-off, Landing & Enhanced Lift Devices: Ground Roll, Rotation, Transition, Climb, Balanced Field Length, Landing Approach, Braking, Spread Sheet for Take-off and Landing. Enhanced lift design -Passive & Active. Spread Sheet.

Unit IV

Static Stability & Control: Longitudinal Static Stability, Pitch Trim Equation. Effect of Airframe components on Static Stability. Lateral stability. Contribution of Airframe components. Directional Static stability. Contribution of Airframe components. Aileron Sizing, Rudder Sizing. Spread Sheets. Flying qualities. Cooper Harper Scale. Environmental constraints, Aerodynamic requirements.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos

Unit V

Design Aspects of Subsystems: Flight Control system, Landing Gear and subsystem, Propulsion and Fuel System Integration, Air Pressurization and Air Conditioning System, Electrical & Avionic Systems, Structural loads, Safety constraints, Material selection criteria.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos

Text books:

1. Aircraft Design - A Conceptual Approach, Daniel P. Raymer, AIAA Education Series, IV Edition, 2006.
2. Design of Aircraft, Thomas C Corke, Pearson Edition. Inc. 2003.

Reference books:

1. Introduction to Aircraft Design, John Fielding, Cambridge University Press, 2009.
2. Aeroplane Design, J Roskam.
3. Standard Handbook for Aeronautical & Astronautical Engineers, Editor Mark Davies, Tata McGraw Hill, 2010.

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Illustrate various design phases and perform aircraft weight estimation (PO-3, PO-4, PO-5)
2. Evolve suitable wing and fuselage configurations for various design considerations (PO-3, PO-4, PO-5)
3. Comprehend propulsion system requirements for various design configurations (PO-3, PO-4, PO-5)
4. Estimate stability and performance parameters for different aircraft configurations (PO-3, PO-4, PO-5)
5. Articulate mechanical and electrical systems for various aircraft specifications (PO-3, PO-4, PO-5)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1, CO-2
Internal test-II	30	CO-3, CO-4 &CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Quiz	10	CO-1, CO-2, CO-3, CO-4 &CO-5
Assignments	10	CO-1, CO-2, CO-3, CO-4 &CO-5
Semester End Examination (SEE) - 100		
Semester End Examination	100	CO-1, CO-2, CO-3, CO-4 &CO-5

AEROSPACE STRUCTURES LAB	
Course Code: ASL56	**Credits: 0:0:1**
Prerequisite:	**Contact Hours: 15P**
Course Coordinator: Dr. Radhakrishnan P M	

List of Experiments

1. Deflection of a cantilever beam.
2. Deflection of a simply supported beam.
3. Beam under combined loading using the superposition theorem.
4. Verification of Maxwell's reciprocal theorem.
5. Determination of Young's Modulus using strain gages.
6. Determination of Poisson's Ratio using strain gages.
7. Determination of buckling load for slender column.
8. Deflection of a tension field beam.
9. Determine the shear center location of open section.
10. Determine the shear center location of closed section.
11. Free vibration of cantilever beam.
12. Forced vibration of cantilever beam.

Course Outcomes (COs):

Students will be able to:

1. Determine deflection, stress, strain, elastic constants, and buckling behavior of structural members under static loading (PO-1, PO-2, PO-3, PO-4, PO-5, PO-9, PO-10).
2. Evaluate structural behavior of thin-walled members, including tension field action and shear center location (PO-1, PO-2, PO-3, PO-4, PO-5, PO-9, PO-10).
3. Identify dynamic characteristics of beams subjected to free and forced vibrations (PO-1, PO-2, PO-3, PO-4, PO-5, PO-9, PO-10).

Course Assessment and Evaluation

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	**Marks**	**Course Outcomes addressed**
Weekly evaluation of laboratory journals/ reports after the conduction of every Experiment	30	CO1, CO2 & CO3
Practical Test	20	CO1, CO2 & CO3
Semester End Examination (SEE)	50	CO1, CO2 & CO3

FLIGHT SIMULATION LAB	
Course Code: ASL57	**Credits: 0:0:1**
Prerequisite:	**Contact Hours: 15P**
Course Coordinator: Dr. Vigneswaran C M	

Course Content

1. Experimental evaluation of autopilot-controlled climb performance and generation of required flight data using a flight simulator
2. Experimental investigation of autopilot-controlled banking dynamics at a specified constant altitude
3. Experimental study on instrument landing system (ILS) frequency tuning and precision approach guidance
4. Experimental analysis of aircraft navigation accuracy using VOR frequency tuning and radial tracking technique
5. Experimental demonstration of GPS-based navigation for identification and tracking of the nearest airport from a given location
6. Experimental investigation of power required curves at a specified altitude using flight simulator measurements
7. Experimental analysis of aircraft performance under weather-induced variations using flight simulator data
8. Experimental study on the effect of atmospheric turbulence on aircraft stability and flight parameters
9. Experimental investigation of crosswind effects on aircraft takeoff performance
10. Experimental investigation of crosswind effects on aircraft landing performance.

Text books:

1. Airplane Performance stability and Control, Perkins, C.D., and Hage, R.E, John Wiley , New York, 1998.
2. Flight Stability and Automatic Control, Nelson, R.C, McGraw-Hill Book Co, 2007.

Course Outcomes (COs):

At the end of the course the students will be able to:

1. Apply flight simulator tools to generate, record, and interpret aircraft performance and navigation data under various flight conditions. (PO-1, PO-2, PO-3, PO-4, PO-5)
2. Analyze aircraft flight performance, stability, and control characteristics using simulator-based experimental data for different operational scenarios. (PO-1, PO-2, PO-3, PO-4, PO-5)
3. Demonstrate the ability to evaluate aircraft navigation, guidance, and autopilot systems using ILS, VOR, GPS, and environmental effect simulations. (PO-1, PO-2, PO-3, PO-4, PO-5)

Course Assessment and Evaluation

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	**Marks**	**Course Outcomes addressed**
Weekly evaluation of laboratory journals/ reports after the conduction of every Experiment	30	CO1, CO2 & CO3
Practical Test	20	CO1, CO2 & CO3
Semester End Examination (SEE)	50	CO1, CO2 & CO3

RESEARCH METHODOLOGY & INTELLECTUAL PROPERTY RIGHTS	
Course Code: AL58	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 45L + 45S**
Course Coordinator:	

Course Content

Unit I

Research Methodology

Introduction: Meaning of Research, Objectives of Research, Types of Research, Ethics in Research, Types of Research Misconduct. Literature Review and Technical Reading, New and Existing Knowledge, Analysis and Synthesis of Prior Art, Bibliographic Databases, Conceptualizing Research, Critical and Creative Reading.

Citations: Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge flow through Citations, Acknowledgments, and Attributions.

- Pedagogy / Course delivery tools: Chalk and talk, PowerPoint presentation.
- Links: https://onlinecourses.nptel.ac.in/noc22_ge08/preview

Unit II

Research Design: Need for Research Design, Important Concepts Related to Research Design: Dependent and Independent Variables, Extraneous Variable, Variable, Common Control, Confounded Relationship, Research Hypothesis, Experimental and Control Groups, Treatments.

Experimental Designs: Introduction to Randomised Block Design, Complete Randomised Design, Latin Square Design, and Factorial Design.

- Pedagogy / Course delivery tools: Chalk and talk, PowerPoint presentation.
- Links: https://onlinecourses.nptel.ac.in/noc22_ge08/preview

Unit III

Method of Data Collection: Primary and Secondary Data Collection.

Sampling Design: Sampling fundamentals, Measurement, and Scaling Techniques, Criteria of Selecting a Sampling Procedure, Characteristics of a Good Sample Design, and Types of Sample Design.

Data Analysis: Testing of Hypotheses: Null Hypothesis, Alternative Hypothesis, Type I and Type II Errors, Level of Significance. Procedure for Hypothesis Testing: Mean, Variance, Proportions. Chi-square Test, Analysis of Variance (One Way ANOVA), and Covariance (ANOCOVA)

- Pedagogy / Course delivery tools: Chalk and talk, PowerPoint presentation.
- Links: https://onlinecourses.nptel.ac.in/noc22_ge08/preview

Unit IV

Introduction to IPR: Different forms of IPR, Role of IPR in Research and Development. TRIPS Agreement, Patent Cooperation Treaty (PCT).

Patents: Brief history of Patents-Indian and Global Scenario, Principles Underlying Patent Law, Types of Patent Applications in India, Procedure for Obtaining a Patent. Non Patentable Inventions. Rights Conferred to a Patentee, Basmati Rice Patent Case.

- Pedagogy / Course delivery tools: Chalk and talk, PowerPoint presentation.

- Links: https://onlinecourses.nptel.ac.in/noc22_ge08/preview

Unit V

Design: What is a Design? Essential Requirements for a Registrable Design, Procedure of Registration of a Design,

Trademarks: Essentials of a Trademark, Registration, and Protection of Trademarks, Rights Conferred by Registration of Trademarks, Infringements, Types of Reliefs, Case Studies.

Copyrights: Characteristics of Copyrights, Rights Conferred by Registration of Copyrights, Registration of Copyrights, Infringements, Remedies against Infringement of Copyrights, Case studies.

- Pedagogy / Course delivery tools: Chalk and talk, PowerPoint presentation.
- Links: https://onlinecourses.nptel.ac.in/noc22_ge08/preview

Text books:

1. C. R Kothari, Gourav Garg, Research Methodology − Methods and Techniques. New Age International Publishers.
2. Dr. B L Wadehra − Law relating to Intellectual property. Universal Law Publishing Co.
3. Dipankar Deb, Rajeeb Dey, Valentina E. Balas "Engineering Research Methodology", ISSN 1868-4394 ISSN 1868-4408 (electronic), Intelligent Systems Reference Library, ISBN 978-981-13-2946-3 ISBN 978-981-13-2947-0 (eBook) https://doi.org/10.1007/978-981-13-2947-0.

Reference books:

1. David V. Thiel "Research Methods for Engineers" Cambridge University Press, 978-1-107-03488-4

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Possess the knowledge of research and conduct a literature review**.** (PO8,10, 11)
2. Apply the knowledge of research design and design of experiments. (PO4, 8, 10,11)
3. Analyse data collection methods, analysis, and sampling design. (PO4,8,10,11)
4. Understand the global and Indian scenarios of patents and patent applications. (PO8,10, 11)
5. Acquire the requirements of registration and infringements related to trademarks, copyrights, and designs. (PO8, 10, 11)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1, CO-2
Internal test-II	30	CO-3, CO-4 &CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Quiz	10	CO-1, CO-2, CO-3, CO-4 &CO-5
Assignments	10	CO-1, CO-2, CO-3, CO-4 &CO-5
Semester End Examination (SEE) - 100		
Semester End Examination	100	CO-1, CO-2, CO-3, CO-4 &CO-5

FLOW MEASUREMENT TECHNIQUES	
Course Code: ASAEC59	**Credits: 1:0:0**
Prerequisite:	**Contact Hours: 15L**
Course Coordinator: Dr. Inamul Hasan	

Course Content

Unit I

Fundamentals of Measurements in Fluid Mechanics: Role of experimentation in fluid mechanics - Measurement systems: sensors, transducers, and signal conditioning - Static and dynamic characteristics of instruments - Errors, uncertainty analysis, and calibration procedures

- Pedagogy/Course delivery tools:-Chalk and talk, animated videos

Unit II

Pressure and Velocity Measurement Techniques: Pressure measurement: manometers, pressure transducers, and gauges - Velocity measurement methods: Pitot-static tube, Flow rate measurement: orifice meter, venturimeter, rotameter - Limitations and practical considerations

- Pedagogy/Course delivery tools:-Chalk and talk, animated videos

Unit III

Velocity Measurement Techniques: Particle Image Velocimetry (PIV): principles, setup, and data interpretation - Laser Induced Fluorescence (LIF) for velocity and scalar measurements - Applications in internal and external flows

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Unit IV

Flow Visualization and Optical Techniques: Qualitative and quantitative flow visualization methods - Smoke, dye, and particle-based visualization - Schlieren and shadowgraph techniques - Hot-Wire Anemometry (HWA): working principle and limitations - Introduction to laser-based diagnostics.

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Unit V

Force, Temperature, and Turbulence Measurements: Three component and six component balance - Force and torque measurements in fluid flows -Temperature measurement techniques in fluids - Turbulence measurements and statistical analysis - Frequency response of measuring instruments

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Text Books:

1. Radhakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids", CRC Press, Taylor & Francis, 2007.
2. Holman, J.P., "Experimental Methods for Engineers", McGraw-Hill Education, 8th

Edition, 2012.
3. Goldstein, R.J. (Ed.), "Fluid Mechanics Measurements", Taylor & Francis, 2nd Edition, 1996.

Reference Books:

1. Radhakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids", CRC Press – Taylor & Francis, 2007.
2. Raffel, M., Willert, C.E., Wereley, S.T., and Kompenhans, J., "Particle Image Velocimetry: A Practical Guide", Springer, 2nd Edition, 2007.

Course Outcomes (COs):

1. Understand basic measurement systems, instrument characteristics, and uncertainty in fluid mechanics.
2. Use pressure, velocity, and flow measurement techniques for fluid flow applications
3. Understand the basic principles of PIV and LIF for velocity measurements
4. Explain flow visualization methods and the working of hot-wire anemometry.
5. Understand force, temperature, and turbulence measurement techniques in fluid flows.

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal Test-I	30	CO1 &CO2
Internal Test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1 to CO5
Quiz	10	CO1 to CO5
Semester End Examination (SEE): 50 Marks		
Semester End Examination (SEE):	50	CO1 to CO5

ENVIRONMENTAL STUDIES	
Course Code: HS510	**Credits: 0:0:0 (NCMC)**
Prerequisite:	**Contact Hours: 15L**
Course Coordinator:	

Course Contents

Unit I

Environment, Ecology and Biodiversity

Definition, scope, and importance. Multidisciplinary nature of Environmental studies. Food chain and food web. Energy flow and material cycling in the ecosystem. Biodiversity and threats to biodiversity. Concept of sustainable development: Definition, objectives, and applications.

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint presentations, Videos, Models
- Link: https://youtu.be/I_bnGkviWOU
  https://youtu.be/Ar04qG1P8Es

Unit II

Natural resources

Forest resources: Ecological importance of forests. Water resources: Global water resources distribution. Mineral resources: Environmental effects of extracting and processing Mineral resources. Food resources: Effects of modern agriculture. Land resources: Soil erosion and Desertification.

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint presentations, Videos
- Link: https://youtu.be/vsXv3anIBSU
  https://youtu.be/1rOVPqaUyv8

Unit III

Energy sources

Growing energy needs. Conventional and non-conventional / Renewable and Non-renewable energy sources. Bio Energy-Ethanol and Bio mass energy. Energy of the future – Hydrogen fuel cells and Nuclear energy. Environmental Impact Assessment (EIA): Definition, Objectives and benefits. Step by step procedure of conducting EIA.

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint presentations, Animations, Models
- Link: https://youtu.be/mh51mAUexK4
  https://youtu.be/XS-eXqppf_w

Unit IV

Environmental pollution

Definition, Causes, Effects and control measures of Water pollution, Air pollution and Soil/ land pollution. Management of Municipal Solid Waste and treatment methods of municipal solid waste.

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint presentations, Videos
- Link: https://youtu.be/NroFvz8Ugeo
  https://youtu.be/DAQapF-F4Vw

Unit V

Environmental protection

Global warming and Climate change, Acid rain, Ozone layer depletion. Salient features of Environmental Protection Act, Air & Water Acts. Functions of Central and State Pollution Control Boards.

- Pedagogy/Course delivery tools: Chalk and Talk, PowerPoint presentations, Videos, Open source softwares
- Link: https://youtu.be/iV-BvYwl4Y8
  https://youtu.be/BYqLRGawoH0

Text Books:

1. S M Prakash – Environmental Studies, Elite Publishers, 2007

Reference Books:

1. P. Venugopala Rao – Principles of Environmental Science & Engineering Prentice Hall of India, 1st edition, 2006.

Web links and video Lectures (e- Resources):

1. 1. https://youtu.be/I_bnGkviWOU
2. 2. https://youtu.be/vsXv3anIBSU
3. 3. https://youtu.be/mh51mAUexK4
4. 4. https://youtu.be/NroFvz8Ugeo
5. 5. https://youtu.be/iV-BvYwl4Y8

Course Outcomes (COs):

At the end of the course, students will be able to

1. Describe the importance of environmental studies, sustainable development and biodiversity (PO-1, 7)
2. Explain the importance and conservation of impacts of natural resources (PO-1, 7)
3. Distinguish the energy sources and identify the alternative energy sources for sustainable development (PO-1, 7)
4. Identify the causes, effects and control measures of pollution in developmental activities (PO-1, 7)
5. Outline the current environmental issues and the role of the agencies for environmental protection (PO-1, 7)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1 & CO-2
Internal test-II	30	CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment – MCQ, Objectives	10	CO-1, CO-2, CO-3, CO-4, CO-5
Assignment – Quiz, Group presentation	10	CO-1, CO-2, CO-3, CO-4, CO-5
Semester End Examination (SEE) - 50 Marks		
Semester End Examination	50	CO-1, CO-2, CO-3, CO-4 & CO-5

HIGH SPEED AERODYNAMICS	
Course Code: ASE551	**Credits: 3:0:0**
Prerequisite: Fluid Mechanics	**Contact Hours: 45L + 45S**
Course Coordinator: Dr. Inamul Hasan	

Course Content

Unit I

Isentropic Relations: Introduction to compressible flow - Thermodynamic concepts and equations - Momentum and Energy equations for compressible fluid flow - Speed of sound derivation - Change in entropy relation - Isentropic relations - Quasi-1D Flow - Mach number, and flow regimes -Characteristic Mach number

- Pedagogy/Course delivery tools:-Chalk and talk, animated videos

Unit II

Shock waves: Normal Shock – Moving shock wave and its reflection – Shock tube and its applications – Oblique Shock waves and its relations -

- Pedagogy/Course delivery tools:-Chalk and talk, animated videos

Unit III

Expansion Waves and Nozzle Flows: Governing equation of Prandtl- Meyer expansion waves - Shock Expansion theory: flat plate and Diamond airfoil - Shock Expansion theory using computational tools - Nozzle flow relations: Area-velocity, Area-Mach number, Maximum mass flow rate - Supersonic nozzle and diffuser - Variation of Pressure and Mach number along the C-D nozzle - Under expansion and over expansion nozzle

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Unit IV

Rayleigh Flow and Fanno Flow: Rayleigh flow equations - Variation of flow properties for subsonic flow and supersonic flow - Critical reference states - Normal shock in Rayleigh flows - Rayleigh curve - Fanno flow equations - Variation of flow properties with duct length for subsonic flow and supersonic flow - Critical reference states - Normal shock in Fanno flows - Fanno curve.

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Unit V

Linearized theory and Method of Characteristics: Velocity potential equation for compressible flow - small perturbation theory - Linearized pressure coefficient – Prandtl-Glauert compressibility correction - Supersonic linearized theory - Application of Supersonic linearized theory - Method of characteristics and its Application.

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Text Books:

1. Anderson J. D., Jr., "Modern Compressible Flow with Historical Perspective," McGrawHill Publishing Co., 3rd edition, 2020
2. Rathakrishnan, E., "Gas Dynamics", Prentice Hall India Learning Private Limited, Seventh edition, Delhi, India, 2020.
3. Shapiro, A.H., "The Dynamics and Thermodynamics of Compressible Fluid Flow (Vol I and Vol II)", Ronald Press, 1962.

Reference Books:

1. Yahya, S. M., "Fundamentals of Compressible Flow with Aircraft and Rocket Propulsion", New Age International Publishers; Sixth edition, 2018.
2. Zucker, R. D., Biblarz, O., "Fundamentals of Gas Dynamics", Wiley-Blackwell; Third edition, 2019.
3. S.M. Yahya, Gas Tables - For Compressible Flow Calculations, New Academic Science Limited, 2012.

Course Outcomes (COs):

1. Calculate the thermodynamic properties of isentropic flow
2. Calculate the normal and oblique shock wave flow properties
3. Determine the expansion fan and nozzles flow characteristics
4. Calculate the change in flow properties across duct due to heat transfer and frictional effect
5. Determine the compressibility effects and contour design of the supersonic nozzle

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal Test-I	30	CO1 &CO2
Internal Test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1 to CO5
Quiz	10	CO1 to CO5
Semester End Examination (SEE): 100		
Semester End Examination (SEE):	100	CO1 to CO5

AIRCRAFT MAINTENANCE, REPAIR AND OVERHAUL	
Course Code: ASE552	**Credits: 3:0:0**
Prerequisite:	**Contact Hours: 45L + 45S**
Course Coordinator: Dr. Inamul Hasan	

Course Content

Unit I

Fundamentals of Maintenance & Certification: Types of maintenance, Redesign, Failure rate pattern, Other maintenance considerations. Aviation industry certification requirements, Type certificate (FAA form 8110.9), Airworthiness certificate (FAA form 8100-2), Aviation maintenance certifications, General, Airframe, Power plants and Avionics certifications.

- Pedagogy/Course delivery tools:-Chalk and talk, animated videos

Unit II

Documentation for Maintenance: Manufacturers documentation, Airplane maintenance manual, Fault insulation manual, Illustrated parts catalogue, structural repair manual, wiring diagram manual, Master minimum equipment, Federal Aviation regulation (FAR), Advisory circulars, Airworthiness direction ATA document standards, Technical policies and procedure manuals (TPPM).

- Pedagogy/Course delivery tools:-Chalk and talk, animated videos

Unit III

Aircraft Management Maintenance: Structure, Role of aviation management, Line supervisory management, Management areas of concern in airlines, Manager of overhaul shops, Line maintenance control centre flight line (prefight & post flight), Aircraft Logbook, Maintenance crew skill requirements

- Pedagogy/ Course delivery tools: Chalk and talk, Power point presentation, animated videos

Unit IV

Hangar Maintenance (on Aircraft) & Material Support: Introduction, organization of hangar maintenance, Non- routine item, parts availability, cannibalization, Types of shops- sheet metal shop, Aircraft interior shop, Engine shop, Avionics shop, ground support equipment, outsourcing of shop maintenance work, operation of overhaul shops, Material support, Material management inventory control, Support functions of material, Parts ordering, Storage, Issue, control and handling, Parts receiving quality control, calibration program, stock level adjustments, shelf life, exchanges, warranty & modifications of parts.

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Unit V

Maintenance Safety & Trouble shooting: Safety regulations, occupational safety and health standards maintenance safety program, Airlines safety management, General safety rules, Accident & injury reporting, Hazardous materials storage and handling aircraft furnishing practices trouble shooting, Knowledge of malfunctions

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Text Books:

1. Aviation Maintenance Management, Harry A Kinnison, Tariq Siddiqui, Mc Graw Hill education, 2012, ISBN: 9780071805032
2. Aircraft maintenance and repair, Kroes, Watkins, Delp, Mc Graw Hill, 2013 McGraw-Hill Education, 7th edition, 2013, ISBN: 978-0071801508

Reference Books:

1. Aircraft Repair Manual, Larry Reithmaier, Palmar Books, Marquette, 1992, ISBN: 978-0932882028.
2. Aircraft Maintenance, Brimm. DJ, Bogges, HE, Pitman publishing corp, London, 1952, ASIN:B000NQ539E

Course Outcomes (COs):

1. Understand core principles and regulations for aircraft maintenance and certification
2. Comprehend skills for effective documentation in compliance with industry standards
3. Demonstrate knowledge of aircraft maintenance management, line and overhaul operations, aircraft logbook usage, and maintenance crew skill requirements.
4. Apply knowledge to ensure safety, troubleshoot, and maintain airworthiness
5. Acquire expertise in hangar maintenance procedures, including facility upkeep, equipment management, and safety protocols to support efficient aircraft maintenance operations

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal Test-I	30	CO1 &CO2
Internal Test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1 to CO5
Quiz	10	CO1 to CO5
Semester End Examination (SEE): 100		
Semester End Examination (SEE):	100	CO1 to CO5

AEROSPACE SYSTEMS & INSTRUMENTATION	
Course Code: ASE553	**Credits: 3:0:0**
Prerequisite:	**Contact Hours: 45L + 45S**
Course Coordinator: Dr. Senthamilselvi A	

Course Content

Unit I

Aircraft Systems: Hydraulic Systems, components, controllers modes. Pneumatic Systems and Landing Gear, including shock absorbers and retraction mechanisms.

- Pedagogy/Course delivery tools: - Chalk and talk, Power point presentation, animated videos.

Unit II

Airplane Control Systems: Conventional Systems, fully powered flight controls, Power actuated systems, Modern control systems, Digital fly by wire systems, Auto pilot system active control Technology.

- Pedagogy/Course delivery tools: - Chalk and talk, Power point presentation, animated videos.

Unit III

Engine Systems: 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.

- Pedagogy/ Course delivery tools: - Chalk and talk, Power point presentation, animated videos.

Unit IV

Auxiliary System: Basic Air cycle systems, Vapour Cycle systems, Evaporative vapour cycle systems

- Pedagogy/ Course delivery tools: - Chalk and talk, Power point presentation, animated videos.

Unit V

Aircraft Instruments: 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.

- Pedagogy/ Course delivery tools: -Chalk and talk, Power point presentation, animated videos

Text Books:

1. Ian Moirand Allan Seabridge, Aircraft Systems: Mechanical, Electrical and Avionics-Subsystem Integration, Wiley India Pvt Ltd, 3rd edition, 2012.
2. Lalit Gupta and OP. Sharma, Aircraft Systems (Fundamentals of Flight Vol. IV),

Himalayan Books, 2006.
3. Craig Lawson & David Judt, Aircraft Systems: A Design and Development Guide, Wiley, 2025.

Reference Books:

1. William A Neese, Aircraft Hydraulic Systems, Himalayan Books, 2007
2. SR. Mujumdar, Pneumatic Systems, Tata McGraw Hill Publishing Co, 1st Edition, 2001
3. Allan Seabridge, Aircraft Systems Classifications: A Handbook of Characteristics and Design Guidelines, Wiley, 2021.

Course Outcomes (COs):

1. Distinguish the conventional and modern control systems.
2. Analyse the aircraft systems.
3. Analyse the working of Aircraft engine systems.
4. Describe aircraft Auxiliary systems.
5. Apply different aircraft instruments.

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal Test-I	30	CO1 &CO2
Internal Test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1 to CO5
Quiz	10	CO1 to CO5
Semester End Examination (SEE): 100		
Semester End Examination (SEE):	100	CO1 to CO5

NUMERICAL METHODS	
Course Code: ASE554	**Credits: 3:0:0**
Prerequisite:	**Contact Hours: 45L + 45S**
Course Coordinator: Dr. B Azghar Pasha & Dr. G Kalpana	

Course Content

Unit I (9 hours)

Numerical Solution of Algebraic & Transcendental equations: Review of Bisection, Regula Falsi and Newton-Raphson methods. Fixed point iteration method. Aitken's $\Delta 2$ method, Horner's method, Graeffe's root squaring method. Birge-Vietta method. Newton-Raphson method for system of non-linear equations.
Problem solving/demonstration of methods using PYTHON.

- Pedagogy/Course delivery tools: ➢ Chalk and talk, Power Point Presentation
- Links: ➢ https://nptel.ac.in/courses/111105134
- Impartus recording: ➢ https://a.impartus.com/ilc/#/course/2583981/1205
  ➢ https://a.impartus.com/ilc/#/course/619570/1030

Unit II (9 hours)

Interpolation: Piecewise linear, quadratic and cubic interpolation, Cubic spline interpolation. Hermite interpolation.
Curve Fitting: Curve fitting by the method of least squares, fitting linear, quadratic and geometric curves.
Problem solving/demonstration of methods using PYTHON.

- Pedagogy/Course delivery tools: ➢ Chalk and talk, Power Point Presentation, Videos
- Links: ➢ https://nptel.ac.in/courses/111106101
- Impartus recording: ➢ https://a.impartus.com/ilc/#/course/3111313/1447
  ➢ https://a.impartus.com/ilc/#/course/119635/593

Unit III (9 hours)

Bivariate Interpolation: Lagrange's bivariate interpolation. Newton's bivariate interpolation.
Numerical Differentiation: Derivatives using finite differences of higher order.
Numerical Integration: Review of Newton-Cotes quadrature technique. Gauss Legendre one point, two point and three point techniques. Romberg integration.
Problem solving/demonstration of methods using PYTHON.

- Pedagogy/Course delivery tools: ➢ Chalk and talk, Power Point Presentation
- Links: ➢ https://nptel.ac.in/courses/111105134
- Impartus recording: ➢ https://a.impartus.com/ilc/#/course/3111313/1447

Unit IV(9 hours)

Numerical solutions of higher order ODE's: Picard's method & Taylor's series method for second order ODE & simultaneous first order ODE's. Runge-Kutta method for second order ODE and simultaneous first order ODE's. Finite difference method. Linear shooting method.
Problem solving/demonstration of methods using PYTHON.

- Pedagogy/Course delivery tools: ➢ Chalk and talk, Power Point Presentation, Videos
- Links: ➢ https://nptel.ac.in/courses/111106101
- Impartus recording: ➢ https://a.impartus.com/ilc/#/course/2583981/1205

Unit V (9 hours)

Numerical solution of PDE's: Finite difference approximation of partial derivatives. Solution of one dimensional heat equation by explicit (Schmidt method) and implicit (Crank-Nicolson) techniques. Numerical Solution of one dimensional wave equation. Numerical solution of two dimensional Laplace equation and Poisson equation.

Problem solving/demonstration of methods using PYTHON.

- Pedagogy/Course delivery tools: ➢ Chalk and talk, Power Point Presentation, Videos
- Links: ➢ https://nptel.ac.in/courses/111106101
- Impartus recording: ➢ https://a.impartus.com/ilc/#/course/2583981/1205

Text Books:

1. Richard. L. Burden, J. Douglas Faires, Annette M. Burden - Numerical Analysis, Brooks Cole - 10th edition, 2015.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain – Numerical methods for scientific and Engineering computation – New Age International Publisher – 6th edition, 2012.

Reference Books:

1. Anthony Ralston, Philip Rabinowitz – A first course in Numerical Analysis – McGraw Hill Publication – 2nd edition, 2001.
2. B.S Grewal – Numerical Methods in Engineering and Science with programs in C, C++ & MATLAB – Khanna Publishers - 11th edition, 2013.
3. Steven C. Chapra – Applied Numerical Methods with MATLAB for Engineers and Scientists – McGraw Hill Publications - 3rd edition, 2011.

Course Outcomes (COs):

1. Find the roots of algebraic and transcendental equations. (PO-1, 2 & PSO-1 ,2)
2. Fit a curve to a given data using interpolation & Least squares techniques. (PO-1, 2 & PSO-1 ,2)
3. Evaluate derivatives and integrals of data using numerical techniques. (PO-1, 2 & PSO-1 ,2)
4. Analyse and solve first-order systems & second order ODE's numerically. (PO-1, 2 & PSO-1, 2)
5. Compute numerical solution of 1D heat and wave equations and 2D Laplace and Poisson equations. (PO-1, 2 & PSO-1 ,2)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE):50Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal Test-I	30	CO1 & CO2
Internal Test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components - 20 Marks		
Assignment	10	CO1 to CO5
Quiz	10	CO1 to CO5
Semester End Examination (SEE):100Marks		
Semester End Examination (SEE):	100	CO1 to CO5

FUNDAMENTALS OF JET COMBUSTION	
Course Code: ASE555	**Credits: 3:0:0**
Prerequisite:	**Contact Hours: 45L + 45S**
Course Coordinator: Dr. Anand M Raikar	

Course Content

Unit I

Introduction: Introduction to combustion, Applications of combustion, Types of fuel and oxidizers, Characterization of fuel, Various combustion mode, Scope of combustion.

- Pedagogy/Course delivery tools:- Chalk and talk, animated videos

Unit II

Thermodynamics of Combustion: Thermodynamics properties, Laws of thermodynamics, Stoichiometry, Thermo chemistry, adiabatic temperature, chemical equilibrium.

Chemistry of Combustion: Basic Reaction Kinetics, Elementary reactions, Chain reactions, Multistep reactions, simplification of reaction mechanism, Global kinetics.

- Pedagogy/Course delivery tools:- Chalk and talk, animated videos

Unit III

Physics of Combustion: Fundamental laws of transport phenomena, Conservations Equations, Transport in Turbulent Flow.

Premixed Flame: One dimensional combustion wave, Laminar premixed flame, Burning velocity measurement methods, Effects of chemical and physical variables on Burning velocity, Flame extinction, Ignition, Flame stabilizations, Turbulent Premixed flame.

- Pedagogy/Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Unit IV

Diffusion Flame: Gaseous Jet diffusion flame, Liquid fuel combustion, Atomization, Spray Combustion, Solid fuel combustion.

- Pedagogy/Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Unit V

Combustion and Environment: Atmosphere, Chemical Emission from combustion, Quantification of emission, Emission control methods.

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Text Books:

1. D.P. Mishra, Fundamentals of Combustion,Prentice Hall of India, New Delhi, 2008.
2. Kuo K.K."Principles of Combustion" John Wiley and Sons, 2005.

Reference Books:

1. Strehlow R A., “Fundamentals of combustion” McGraw Hill Book Company, 1984.

Course Outcomes (COs):

1. Recognize fuels, oxidizers, and combustion modes used in engineering applications.
2. Use thermodynamic and chemical relations to analyze combustion processes.
3. Examine premixed flame behavior and transport effects in combustion.
4. Compare diffusion flames and combustion of gaseous, liquid, and solid fuels.
5. Evaluate combustion emissions and basic control methods.

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE):50Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal Test-I	30	CO1 & CO2
Internal Test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components - 20 Marks		
Assignment	10	CO1 to CO5
Quiz	10	CO1 to CO5
Semester End Examination (SEE): 100Marks		
Semester End Examination (SEE):	100	CO1 to CO5

VI SEMESTER

MANAGEMENT & ENTREPRENEURSHIP	
Course Code: AL61	**Credits: 3:0:0**
Prerequisite:	**Contact Hours: 45L + 45S**
Course Coordinator:	

Course Content

Unit I

Introduction to Management: Definition of Management, Its nature and purpose, Contributions of F.W. Taylor and Henry Fayol to management theory, Functions of managers.

Planning: Types of plans, Steps in planning, the planning process, Management by Objectives (MBO).

Organizing: The nature and purpose of organizing, Formal and informal organization. Organization levels and Span of management, Principle of span of management, the structure and process of organizing.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://onlinecourses.nptel.ac.in/noc23_mg33/preview
- https://www.digimat.in/nptel/courses/video/110107150/L01.html

Unit II

Staffing: Situational factors affecting staffing.
Leading: Human factors in managing, definition of leadership, Ingredients of leadership
Controlling: Basic control process, Critical control points and standards, Control as a feedback system, Feed forward control, Requirements for effective controls.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links: https://nptel.ac.in/courses/110107150

Unit III

Introduction to Entrepreneurship: The Foundations of Entrepreneurship: What is an Entrepreneurship? The benefits of Entrepreneurship, The potential drawbacks of Entrepreneurship; Inside the Entrepreneurial Mind: From Ideas to Reality: Creativity, Innovation and Entrepreneurship, Creative Thinking, Barriers to Creativity Problems

- Pedagogy: Chalk and Talk, PowerPoint Presentation
- Links: https://www.youtube.com/watch?v=Hgj_kRrvbhQ&list=PL7oBzLzHZ1wXW3mtolxV5nIGn48NLKwrb

Unit IV

The Entrepreneurial Journey: Crafting a Business Plan: The benefits of creating a business plan, the elements of a business plan; Forms of Business Ownership and Buying an Existing Business: Sole proprietorships and partnership.

Launching the Business: Franchising and the Entrepreneur: Types of Franchising, the benefits of buying a Franchise Problems

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links:https://www.youtube.com/watch?v=Tzzfd6168jk&list=PLyqSpQzTE6M8EGZbmNUuUM7Vh2GkdbB1R https://www.youtube.com/watch?v=5RMqxtMwejM&list=PLyqSpQzTE6M9zMKj_PSm81k9U8NjaVJkR

Unit V

Small Scale Industry: Definition, Characteristics, types, role of SSI in Economic Development, steps to start SSI- Govt. Policy towards SSI, Institutional support- TECKSOK, KIADB, KSSIDC, KSIMC, DIC, NSIC, SIDBI, KSFC.

- Pedagogy: Chalk and Talk, PowerPoint Presentations
- Links:https://www.nptel.ac.in/courses/110/105/110105067/

Text Books:

1. Harold Koontz, H. Weihrich, and A.R. Aryasri, Principles of Management, Tata McGraw-Hill, New Delhi, 2004.
2. Essentials of Entrepreneurship and Small Business Management − Norman Scarborough & Jeffrey Cornwall (Pearson, 2016)
3. Management and Entrepreneurship by K. R. Phaneesh, Sudha Publications, Bangalore

Reference books:

1. Innovation & Entrepreneurship – Peter Drucker (Harper, 2006)
2. Entrepreneurship: The Art, Science, and Process for Success – Charles Bamford & Garry Bruton (McGraw-Hill, 2015)
3. Management and Entrepreneurship-NVR Naidu, T Krishna Rao, I.K. International Publishing House Pvt. Ltd.@ 2008
4. Entrepreneurship Development and Small Business Enterprises - Poornima M Charantimath, Pearson Education, 2006.

Course Outcomes (COs):

At the end of the course the student will be able to

1. Apprehend the planning and organizing functions of management (PO-6,9,11)
2. Identify the enabling factors for staffing, leading and controlling functions in an organization. (PO-6,8,9,10)
3. Analyze the advantages and potential drawbacks of Entrepreneurship. (PO-6,7,8)
4. Develop a basic business plan and analyze the benefits of buying Franchise. (PO-3,5,7,8,11)
5. Identify the various institutions that provide financial support to small scale industries. (PO-6,11)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	Marks	Course outcomes addressed
Internal Test-I	30	CO1, CO2
Internal Test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Quiz	10	CO1, CO2, CO3
Assignment	10	CO3, CO4, CO5
Semester End Examination (SEE): 100		
Course end examination (Answer any one question from each unit – Internal choice)	100	CO1 to CO5

MATERIALS & MANUFACTURING	
Course Code: AS62	**Credits: 3:1:0**
Prerequisite:	**Contact Hours: 45L + 15T + 45S**
Course Coordinator: Dr. Om Prakash	

Course Content

Unit I

Manufacturing overview and the nature of materials: Introduction, Production Systems, Manufacturing economics, Nature of materials, Mechanical properties of materials, Physical properties of materials, Materials selection in design.

- Pedagogy/ Course delivery tools: -Chalk and talk, Power point presentation, animated videos.

Unit II

Engineering materials and product attributes: Metals and their alloys (ferrous), Metals and their alloys (non-ferrous), Polymers, Ceramics, glass, composites.

- Pedagogy/ Course delivery tools: -Chalk and talk, Power point presentation, animated videos.

Unit III

Manufacturing Processes-I: Solidification processes fundamentals, Metal casting processes, Shaping processes for plastics, Processing of polymer matrix composites, Fundamentals of metal forming, Bulk deformation processing in metalworking, sheet metal processes.

- Pedagogy/ Course delivery tools: -Chalk and talk, Power point presentation, animated videos.

Unit IV

Manufacturing Processes-II: Material removal processes, economic and product design considerations in machining, Non-traditional machining processes, Powder processing of metals and ceramics, Surface processing, heat treatment, Plating, Coating, CVD, PVD, Welding, Brazing, Soldering, Adhesive bonding, Rapid prototyping and additive manufacturing.

- Pedagogy/ Course delivery tools: -Chalk and talk, Power point presentation, animated videos,

Unit V

Manufacturing Systems and Support Systems: Automation technologies for manufacturing systems, Integrated manufacturing systems, Quality control and inspection.

- Pedagogy/ Course delivery tools: -Chalk and talk, Power point presentation, animated videos.

Text Books:

1. Mikell R Groover, Fundamentals of Modern Manufacturing: Materials, processes, and systems, SI Edition, Wiley (2018).
2. Serope Kalpakjian and Steven R. Schmid, Manufacturing Engineering and Technology, Pearson Publishing (2015).

Reference Books:

1. M.F. Ashby and D.R.H. Jones, Engineering materials I, Pergamon (2014).

2. M.F. Ashby and D.R.H. Jones, Engineering materials II, Pergamon (2014).
3. G. K. Lal, S. K. Choudhury, Fundamentals of Manufacturing Process, Narosa (2009).

Course Outcomes (COs):

1. Understand fundamentals, classification, manufacturing, and applications of engineering materials.
2. Understand materials selection approaches for engineering applications and apply to example case studies.
3. Gain knowledge of various manufacturing processes and their applicability to various applications with special emphasis on aerospace.
4. Demonstrate awareness of emerging materials and manufacturing processes that are enabling modern, high performance applications.
5. Appreciate manufacturing systems that entail consideration such as quality control, automation technologies in today's production systems.

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal Test-I	30	CO1 &CO2
Internal Test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1 to CO5
Quiz	10	CO1 to CO5
Semester End Examination (SEE): 100		
Semester End Examination (SEE):	100	CO1 to CO5

AIRCRAFT DESIGN LAB	
Course Code: ASL65	**Credits: 0:0:1**
Prerequisite:	**Contact Hours: 15P**
Course Coordinator: Dr Senthamilselvi A	

List of Experiments

1. Estimation of wing loading and thrust-to-weight ratio based on mission requirements.
2. Design of wing planform (aspect ratio, taper ratio, sweep, dihedral) and computation of aerodynamic characteristics.
3. Design of fuselage layout considering passenger/cargo configuration and aerodynamic efficiency.
4. Design of tail surfaces (horizontal and vertical stabilizers) for stability and control requirements.
5. Design of landing gear configuration (tricycle, tail-dragger) and determination of loads during landing/take-off.
6. Weight estimation and center of gravity calculation for the designed aircraft.
7. Preparation of constraint diagram (matching thrust-to-weight and wing loading for performance requirements).
8. Estimation of aircraft performance, including take-off distance, rate of climb, maximum speed, stall speed, and range/endurance.
9. Preparation of detailed three-view drawing of the designed aircraft.
10. Case study of an existing aircraft (comparison of design parameters with the student's design).

Course Outcomes (COs):

At the end of the course, the student will be able to

CO1: Apply fundamental principles of flight mechanics and aerodynamics to estimate wing loading, thrust-to-weight ratio, and design major aircraft components (wing, fuselage, tail, landing gear) considering mission requirements, stability, and control.

CO2: Perform weight estimation, center of gravity analysis, and prepare constraint diagrams to evaluate aircraft performance, ensuring balance, efficiency, and compliance with design criteria.

CO3: Demonstrate competence in preparing detailed aircraft design documentation including three-view drawings and comparative case studies, and critically analyze existing aircraft to validate and refine design decisions.

Text Books:

1. D.P. Raymer, Aircraft Design: A Conceptual Approach, AIAA Education Series, 5th Edition, 2012.
2. Lloyd R. Jenkinson, Paul Simpkin & Darren Rhodes, Civil Jet Aircraft Design, Butterworth-Heinemann, 1999.
3. A.C. Kermode, Flight Without Formulae, Pearson, 5th Edition, 2006.

Reference Books:

1. John D. Anderson, Aircraft Performance and Design, McGraw Hill, 1999.
2. E.L. Houghton & P.W. Carpenter, Aerodynamics for Engineering Students, Butterworth-Heinemann, 7th Edition, 2017.
3. Martin Hollmann, Aircraft Design Guide, Hollmann Aviation, 2000

Course Assessment and Evaluation

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	**Marks**	**Course Outcomes addressed**
Weekly evaluation of laboratory journals/ reports after the conduction of every experiment	30	CO1, CO2 & CO3
Practical Test	20	CO1, CO2 & CO3
Semester End Examination (SEE)	50	CO1, CO2 & CO3

AEROSPACE MANUFACTURING LAB	
Course Code: ASL66	**Credits: 0:0:1**
Prerequisite:	**Contact Hours: 15P**
Course Coordinator: Dr. Om Prakash	

List of Experiments

1. Understand and experience the turning operation on a lathe machine.
2. Drilling of holes in bulk metal, sheet metal and composite coupons.
3. Operation of milling machine and unique requirements of machining of titanium.
4. Sheet Metal Processes such as bending and forming.
5. Introduction to Common NDT Techniques
6. Composite Manufacturing – Fabrication using Vacuum Bagging.
7. Composite Manufacturing – Resin Transfer Moulding
8. Additive Manufacturing – FDM
9. Additive Manufacturing – Resin Processes
10. Determination of volume fraction and density of FRP composite
11. Determination of tensile properties of FRP composite.
12. Determination of compression properties of FRP composite.
13. Determination of flexural properties of FRP composite.
14. Determination of inter-laminar shear strength of FRP composite

Course Outcomes (COs):

Students will be able to:

1. Understand and experience conventional machining processes.
2. Gain experience in emerging processes such as Additive manufacturing and quality control approaches in manufacturing.
3. Gain experience in the fabrication and properties of composite materials.

Course Assessment and Evaluation

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment Tool	**Marks**	**Course Outcomes addressed**
Weekly evaluation of laboratory journals/ reports after the conduction of every experiment	30	CO1, CO2 & CO3
Practical Test	20	CO1, CO2 & CO3
Semester End Examination (SEE)	50	CO1, CO2 & CO3

STRUCTURAL DYNAMICS	
Course Code: ASE631	**Credits: 3:0:0**
Prerequisite:	**Contact Hours: 45L + 45S**
Course Coordinator: Dr. Senthamilselvi A	

Course Content

Unit I

Fundamentals of Aerospace Vibrations: Single Degree of Freedom (SDOF) systems in aerospace structures - Free vibration of aircraft wings and fuselage panels - Damping mechanisms in aerospace materials - Forced vibration under aerodynamic loads, resonance in flight structures.

- Pedagogy/Course delivery tools:-Chalk and talk, animated videos, MATLAB/ANSYS demos

Unit II

Multi-Degree of Freedom Systems in Aircraft: Two-degree and multi-degree freedom models for landing gear and rotor blades - Equations of motion for aerospace structures - Mode shapes, orthogonality, and modal analysis of aircraft frames - Case studies: vibration of helicopter rotor systems, aircraft landing gear dynamics.

- Pedagogy/Course delivery tools:-Chalk and talk, animated videos, simulation software

Unit III

Continuous Systems in Aerospace: Dynamics of beams, wings, fuselage panels - Longitudinal, torsional, and flexural vibrations in aircraft structures - Wave propagation in aerospace materials (composite wings, fuselage skins) -Approximate methods: Rayleigh's method, Dunkerley's method applied to aerospace structures.

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos, case studies

Unit IV

Aeroelasticity & Flight Applications: Coupled vibration and flutter phenomena in wings and control surfaces - Divergence and control reversal in aircraft structures - Seismic and gust load response for aerospace structures - Dynamic stability and aeroelastic design considerations.

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos, aeroelastic case studies

Unit V

Advanced Computational Methods: Numerical methods in aerospace structural dynamics (FEM basics) - Time history analysis for aircraft under gust loads - Newmark-beta and Wilson-θ methods for aerospace applications - Nonlinear dynamics in aerospace structures (composite wings, high-speed aircraft)

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos, software demonstrations (ANSYS, NASTRAN, MATLAB)

Text Books:

1. Anil K. Chopra, Dynamics of Structures: Theory and Applications to Earthquake Engineering, Pearson, 5th Edition, 2020.
2. Mario Paz & Young Hoon Kim, Structural Dynamics: Theory and Computation, Springer, 6th Edition, 2019.
3. R.L. Bisplinghoff, H. Ashley & R.L. Halfman, Aeroelasticity, Dover Publications, 1996. (Classic aerospace-specific text)

Reference Books:

1. R.W. Clough & J. Penzien, Dynamics of Structures, McGraw Hill, 2nd Edition, 2003.
2. Y.K. Lin, Probabilistic Theory of Structural Dynamics, McGraw Hill, 1967.
3. Mechanics of materials, James. M Gere. Thomson, 5th edition, 2004 D.J. Inman, Engineering Vibration, Pearson, 4th Edition, 2014. (Widely used in aerospace vibration analysis)

Course Outcomes (COs):

1. Distinguish vibration characteristics of aerospace structures (wings, fuselage, rotor blades).
2. Analyze multi-degree freedom systems in aircraft and spacecraft structures.
3. Apply continuous system dynamics to aerospace beams, panels, and composite structures.
4. Evaluate aeroelastic phenomena such as flutter, divergence, and control reversal
5. Use computational methods and software tools for aerospace structural dynamics.

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal Test-I	30	CO1 &CO2
Internal Test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1 to CO5
Quiz	10	CO1 to CO5
Semester End Examination (SEE): 100		
Semester End Examination (SEE):	100	CO1 to CO5

DYNAMIC STABILITY AND AUGMENTATION	
Course Code: ASE632	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 45L + 45S**
Course Coordinator: Dr. Vigneswaran C M	

Course Content

Unit I

Introduction To Dynamic Stability: Introduction to dynamic stability, Spring mass damper system, Aircraft Rigid Body Equation of Motion, longitudinal dynamic stability, Small Perturbation Theory

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation

Unit II

Longitudinal Dynamic Stability Derivatives: Derivatives due to change in forward speed, Derivatives due to the pitching velocity, Derivatives due to the time rate of change of angle of attack, Derivatives due to rolling rate, Derivatives due to yawing rate.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation

Unit III

Modes of Longitudinal Dynamics: Longitudinal Characteristic Equation, Routh's Criteria and Longitudinal Dynamic Stability, Longitudinal Modes: Short Period and Phugoid, Short period Mode Approximation, Long Period Mode (Phugoid) Approximation

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation

Unit IV

Lateral Directional Stability: Introduction to Lateral Directional Stability, Perturbed Equation of Motion for Lateral Directional Dynamics, Lateral Directional Stability Derivatives, Spiral and Dutch Roll modes approximation.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation

Unit V

Stability Augmentation: Introduction to Stability Augmentation, SAS for Longitudinal Dynamics, SAS for Lateral directional Dynamics, Flight Handling Qualities.

- Pedagogy/Course delivery tools: Chalk and talk, PowerPoint presentation

Text books:

1. Airplane Performance stability and Control, Perkins, C.D., and Hage, R.E, John Wiley, New York, 1998.
2. Flight Stability and Automatic Control, Nelson, R.C, McGraw-Hill Book Co, 2007.

Reference books:

1. Introduction to flight, John D. Anderson, Jr, McGraw-Hill, Aerospace Science Technology Editions, 2000.

2. The Principles of the Control and Stability of Aircraft, W.J. Duncan, Cambridge University Press, 2016.

Course Learning Outcomes (COs):

At the end of the course, students will be able to

1. Formulate aircraft rigid body equation of motion (PO-3, PO-4, PO-5)
2. Analyze aircraft longitudinal dynamic stability by evaluating the aerodynamic derivatives (PO-3, PO-4, PO-5)
3. Illustrate the concepts of longitudinal dynamic modes during flight (PO-3, PO-4, PO-5)
4. Assess aircraft lateral directional dynamic stability by evaluating the aerodynamic derivatives (PO-3, PO-4, PO-5)
5. Discuss systems and techniques to augment aircraft stability (PO-3, PO-4, PO-5)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1 &CO-2
Internal test-II	30	CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO-1,CO-2, CO-3
Quiz	10	CO-4 & CO-5
Semester End Examination (SEE) - 100		
Semester End Examination	100	CO-1,CO-2, CO-3, CO-4 & CO-5

ROCKET PROPULSION	
Course Code: ASE633	**Credits: 3:0:0**
Prerequisite:	**Contact Hours: 45L + 45S**
Course Coordinator: Dr. Anand M Raikar	

Course Content

Unit I

Motion in space: Rotational frame of reference, orbital and escape velocities, Velocity requirements for space missions.

Theory of Rockets: Basic principles of rocket propulsion, rocket equation, staging of rockets.

- Pedagogy/Course delivery tools:- Chalk and talk, animated videos

Unit II

Nozzles: Review of Rocket Principles: Propulsion Efficiency, Examples Illustrating Theory of Rocket Propulsion and Introduction to Nozzles, Theory of Nozzles

Propellants: Divergence Loss in Conical Nozzles and the Bell Nozzles, Unconventional Nozzles and Problems in Nozzles, Criterion for Choice of Chemical Propellants, Performance Prediction Analysis, Factors Influencing Choice of Chemical Propellants.

- Pedagogy/Course delivery tools:- Chalk and talk, animated videos

Unit III

Solid Propellant Rockets: Low energy liquid propellants and Hybrid propellants, Introduction to Solid Propellant Rockets, Burn Rate of Solid Propellants and Equilibrium Pressure in Solid Propellant Rockets.

Design Aspects of Solid Propellant Rockets: Burning Surface Area of Solid Propellant Grains, Ignition of Solid Propellant Rockets. Feed Systems for Liquid Propellant Rockets. Feed System Cycles for Pump Fed Liquid Propellant Rockets.

- Pedagogy/Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Unit IV

Analysis of Gas Generator and Staged combustion cycles and introduction to injectors, Injectors, Cooling of Chambers and Mixture Ratio Distribution, Efficiencies due to mixture ratio distribution and incomplete vaporization.

- Pedagogy/Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Unit V

Pumps and Turbines: Propellant Feed System at Zero "g" Conditions. Review of Liquid Bi-propellant Rockets and Introduction to Mono-propellant Rockets. Introduction to Hybrid Rockets and a Simple Illustration of Combustion instability in Liquid Propellant Rockets.

Principles of Electrostatic and Electromagnetic Rockets: Electrical Thrusters. Electrical and Nuclear Rockets; Advanced Propulsion.

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Text Books:

1. Prof. K Ramamurthi, Prof. S Varun Kumar, "Rocket Propulsion" NPTEL Book, https://drive.usercontent.google.com/download?id=1bF9OrBr9gs-0PHxQR-YdjIN4jnmQDhxv&export=download&authuser=0
2. George P. Sutton & Oscar Biblarz. "Rocket Propulsion Elements", John Wiley & Sons, New York, 2010.
3. G. S. Gopi Chand. "Elements of Space Technology", Prentice Hall of India, New Delhi, 2010.

Reference Books:

1. R. W. Humble, G. N. Henry & W. J. Larson. "Space Propulsion Analysis and Design", McGraw-Hill, New York, 1995.
2. D. K. Huzel & D. H. Huang. "Modern Engineering for Design of Liquid Propellant Rocket Engines", AIAA Education Series, Washington D.C., 1992.
3. V. Yang & W. E. Anderson. "Liquid Rocket Engine Combustion Instability", AIAA, Washington D.C., 1995.
4. George Sterling. "Rocket Engines", Elsevier, Oxford, 2016.

Course Outcomes (COs):

1. Analyze motion in space using rotational frames of reference and estimate orbital, escape, and mission velocity requirements
2. Apply rocket propulsion principles and the rocket equation to evaluate staging effects and propulsion performance.
3. Evaluate nozzle flow behavior and assess chemical propellant selection based on performance and design constraints.
4. Analyze solid, liquid, and hybrid rocket systems with respect to combustion, grain design, feed systems, and operating parameters.
5. Compare advanced propulsion systems-including staged combustion, electric, nuclear, and hybrid rockets-based on efficiency, stability, and application.

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE):50Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal Test-I	30	CO1 & CO2
Internal Test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components - 20 Marks		
Assignment	10	CO1 to CO5
Quiz	10	CO1 to CO5
Semester End Examination (SEE):100Marks		
Semester End Examination (SEE):	100	CO1 to CO5

INDUSTRIAL AERODYNAMICS	
Course Code: ASE634	**Credits: 3:0:0**
Prerequisite:	**Contact Hours: 45L + 45S**
Course Coordinator: Dr. Inamul Hasan	

Course Content

Unit I

Atmosphere Aerodynamics: Aviation Aerodynamics vs Non-Aviation Aerodynamics, Industrial Aerodynamics and its need, Branches of Industrial Aerodynamics, Atmospheric layers, Atmospheric circulations, Local winds, Terrain types, Atmospheric Boundary Layer (ABL), Aerodynamic Roughness length, Mean velocity profiles, Power-law and Logarithmic law, Variation of wind velocity with height in ABL for different terrain types, Turbulence Intensity and its variation in ABL, Need for ABL simulation, Boundary layer tunnels, Simulation of ABL in a wind tunnel, Methods to produce ABL

- Pedagogy/Course delivery tools:-Chalk and talk, animated videos

Unit II

Automotive Aerodynamics: Rolling resistance Vs Air resistance, Need for automotive aerodynamics, History of Automotive Aerodynamics, Evolution of Automobile styling, Classification of cars, Pressure distribution over cars, Aerodynamic forces on Automobiles, Lift, Drag and Moments, Sources of vortices in automobiles, Flow separation and wake dynamics, Aerodynamic Improvements, Aerodynamics Vs Styling - Limitations, Aerodynamics of motor bikes, Aerodynamics of roofless vehicles, Aerodynamics of Trucks and Buses, Aerodynamics of Trains, Ahmed body – Generic automobile shape, Wind tunnel experiments and numerical simulations

- Pedagogy/Course delivery tools:-Chalk and talk, animated videos

Unit III

Sports Aerodynamics and Fluid-Structure Interactions: Aerodynamics of race cars, Ground effects, Down force generation, Frontal and rear wings, Aerodynamic braking - Spoilers, Aerodynamics of wheels, Introduction to sports aerodynamics, Aerodynamics of Cricket ball, Swing and Spin, Effect of dimples on golf ball, Vortex shedding, Strouhal number, Flow induced vibrations, Fluid-structure interactions, Effect of Reynolds number on wake, Aerodynamic flutter, Wake galloping, Vortex shedding control methods

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Unit IV

Building Aerodynamics: Need for Building aerodynamics, Environmental winds in city blocks, Low-rise buildings (LRB), Roof suction effects, High-rise buildings (HRB), Dynamic loads, Aerodynamic load mitigation techniques for LRB, Aerodynamic load mitigation techniques for HRB, Flow over a simplified building, Pressure distribution, Wind loads – TVL Formula, Funneling effect, Ventilation, HVAC, Architectural Aerodynamics, Wind catchers, Building codes, loads on launch vehicles subjected to winds

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Unit V

Wind Turbine Aerodynamics: Need for renewable energy sources, Wind energy and its importance, Wind turbine and its parts, Classification of wind turbines, Horizontal axis wind turbine (HAWT), Advantages and disadvantages of HAWT, Vertical axis wind turbine (VAWT), Advantages and disadvantages of VAWT, Wind power, Power coefficient, Tip speed ratio, Solidity ratio, 1-D Momentum theory, Betz limit, Power losses, Methods for power control, Blade sections - Airfoils, Wind turbine siting

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Text Books:

1. Tom Lawson, Building aerodynamics. Imperial College Press, 2001.
2. Joseph Katz, Automotive Aerodynamics, John Wiley & Sons, 2016.
3. Erich Hau, Wind turbines: fundamentals, technologies, application, economics. Springer Science & Business Media, 2013

Reference Books:

1. Martin OL Hansen, Aerodynamics of wind turbines. Routledge, 2015.
2. Robert D Blevins, Flow-induced vibration. Van Nostrand Reinhold Co., 1977.
3. Helge Nørstrud, Sport aerodynamics. Springer Science & Business Media, 2009.

Course Outcomes (COs):

1. Explain atmospheric aerodynamics concepts including ABL, terrain effects, wind profiles, and wind tunnel simulation methods.
2. Describe aerodynamic forces, flow features, and drag-reduction concepts in automobiles and ground transport vehicles.
3. Interpret sports aerodynamics phenomena and fluid–structure interaction effects such as vortex shedding and flutter.
4. Assess wind effects on low-rise and high-rise buildings and aerodynamic load mitigation techniques.
5. Describe wind turbine aerodynamics, power extraction principles, and factors affecting wind energy performance.

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal Test-I	30	CO1 &CO2
Internal Test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1 to CO5
Quiz	10	CO1 to CO5
Semester End Examination (SEE): 100		
Semester End Examination (SEE):	100	CO1 to CO5

FATIGUE AND FRACTURE MECHANICS	
Course Code: ASE635	**Credits: 3:0:0**
Prerequisite: Mechanics of Materials	**Contact Hours: 45L + 45S**
Course Coordinator: Dr. Radhakrishnan P M	

Course Contents

Unit I

Introduction to Fatigue: Basic understanding of fatigue, Phases in fatigue life, Factors affecting fatigue life, Micro-mechanisms of fatigue crack initiation in ductile and brittle solids, types of fatigue failure, Case Studies, Cyclic strain hardening – softening features, Bauschinger effect, Fatigue testing, S-N curves, high and low cycle fatigue, Endurance limit, Fatigue strength, Corrosion Fatigue and Creep Fatigue.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, Animated videos

Unit II

Fatigue Characteristics: Basquin's Equation, Coffin-Manson's relation, Transition life, Analysis of load histories, Cycle counting techniques, Miner's theory, Cumulative damage. Fatigue design criteria, Fatigue life methods, Effect of mean stress: Goodman, Gerber and Soderberg relations and diagrams.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, Animated video

Unit III

Introduction to Fracture: Historical perspective, Fracture mechanics approach to design, Energy criterion, stress-intensity approach, Time dependent crack growth, effect of material properties on fracture, dimensional analysis in fracture mechanics.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, Animated video

Unit IV

Linear Elastic Fracture Mechanics: An Atomic View of Fracture, Stress concentration effect of flaws, Griffith energy balance, Modified Griffith, Energy release rate, Instability & R curve, Stress analysis of cracks, Crack tip plasticity

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, Animated videos

Unit V

Elastic Plastic Fracture Mechanics: Crack tip opening displacement, J-integral: Non-linear energy release rate, path dependent line integral, stress intensity parameter, large strain zone and laboratory measurement, Relationship between J and CTOD.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, Animated videos

Text Books:

1. T.L. Anderson, "Fracture Mechanics - Fundamentals and Applications", 3rd Edition, Taylor and Francis Group, 2005.
2. S. Suresh, “Fatigue of Materials”, Cambridge University Press, 2nd Edition, 2004.

Reference Books:

1. Prashant Kumar, "Elements of Fracture Mechanics", Tata McGraw Hill, New Delhi, India, 2009.
2. David Broek, “Elementary Engineering Fracture Mechanics”, 3rd Edition, Martinus Nijhoff Publishers, 1984.

Course Outcomes (COs):

At the end of the course, students will be able to

1. Explain fatigue mechanisms, life stages, and cyclic material behavior (PO-1, PO-2, PO-3, PO-4, PO-11).
2. Apply fatigue life prediction and cumulative damage concepts (PO-1, PO-2, PO-3, PO-4, PO-11).
3. Describe fracture mechanics principles and crack growth behavior (PO-1, PO-2, PO-3, PO-4, PO-11).
4. Analyze cracks using linear elastic fracture mechanics concepts (PO-1, PO-2, PO-3, PO-4, PO-5, PO-11).
5. Evaluate fracture behavior using elastic–plastic fracture mechanics parameters (PO-1, PO-2, PO-3, PO-4, PO-5, PO-11).

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1 &CO-2
Internal test-II	30	CO-3, CO-4 & CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Quiz/Case Study/Mini Project/Surprise Test/ Presentation	10	CO-1, CO-2, CO-3, CO-4, CO-5
Assignment	10	CO-1, CO-2, CO-3, CO-4, CO-5
Semester End Examination (SEE) - 100		
Semester End Examination	100	CO-1, CO-2, CO-3, CO-4 & CO-5

SATELLITE ATTITUDE DYNAMICS	
Course Code: ASE641	**Credits: 3:0:0**
Prerequisite: Nil	**Contact Hours: 45L + 45S**
Course Coordinator: Dr. Vigneswaran C M	

Course Content

Unit I

Attitude Sensors: Relative Attitude sensors – Gyroscopes, Frame conversion, Fundamental of attitude estimation Motion Reference Units, Absolute Attitude sensors – Horizon sensor, Orbital Gyrocompass, Earth sensors, sun sensors (Digital and analog), star sensor- Magnetometer.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos

Unit II

Control Actuators: Fundamental principles of operation of Thrusters, Actuator Bandwidth, First order system, second order system- Momentum Wheel-Control Moment Gyros Reaction wheel-Magnetic Torques- Reaction Jets- Ion Propulsion- Electric propulsion- solar sails

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos

Unit III

Attitude Dynamics, Attitude and Orbital Disturbances: Rigid Body Dynamics - Flexible body Dynamics - Slosh Dynamics- disturbing forces due to Drag, Solar radiation Pressure and forces - Disturbances due to Celestial bodies.

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos

Unit IV

Attitude Stabilization Schemes & Orbit Maneuvers: Spin Control, Dual spin Control - Gravity gradient technique - Zero momentum system – Momentum - Biased system – Reaction wheel control system - Single and Multiple Impulse orbit Adjustment - Hohmann Transfer, Bielliptical transfer, Station Keeping and Fuel budgeting**.**

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos

Unit V

Missile and Launch Vehicle Guidance: Operating principles and design of guidance laws - homing guidance laws- short range – Medium range and BVR missiles - Trajectory/ Mission planning -Optimal staging, Pitch program optimization, Disturbances in stages separation region, Disturbances in High dynamic pressure region, Launch Vehicle- Introduction - Mission requirements- Implicit guidance schemes - Explicit guidance – Q guidance schemes

- Pedagogy/Course delivery tools: Chalk and talk, Power point presentation, animated videos

Text books:

1. Kaplan M, Modern Spacecraft Dynamics and control, Wiley Press, 1979.
2. Marcel J. Sidi, Spacecraft Dynamics and control, A Practical Engineering Approach, Cambridge University Press.2000.
3. Meyer Rudolph X, Elements of Space Technology for Aerospace Engineers, Academic Press, 1999.

Reference books:

1. Vladimir A Chobotov, Spacecraft Attitude Dynamics and Control (Orbit)", Krieger Publishing Company Publishers, 1991.
2. Blake Lock, J.H Automatic control of Aircraft and missiles, John Wiley Sons, New York, 1990.
3. N.V.Kadam, Practical Design of Flight control systems for launch vehicles and Missiles, Allied Publishers,2009.
4. James R Wertz, Spacecraft Attitude Determination and control, Reidel Publications.2001.

Course Outcomes (COs):

At the end of the course, students will be able to:

1. Articulate working principles of attitude sensors and their applications. (PO-3, PO-4, PO-5)
2. Illustrate working principles of control actuators used for satellite applications. (PO-3, PO-4, PO-5)
3. Comprehend the underlying concepts of satellite orbital dynamics (PO-3, PO-4, PO-5)
4. Apply foundational concepts of space mechanics to solve problems on satellite orbital maneuvers (PO-3, PO-4, PO-5)
5. Outline the operational principles and mechanisms of missile and launch vehicle guidance systems (PO-3, PO-4, PO-5)

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE) - 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal test-I	30	CO-1, CO-2
Internal test-II	30	CO-3, CO-4 &CO-5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Quiz	10	CO-1, CO-2, CO-3, CO-4 &CO-5
Assignments	10	CO-1, CO-2, CO-3, CO-4 &CO-5
Semester End Examination (SEE) - 100		
Semester End Examination	100	CO-1, CO-2, CO-3, CO-4 &CO-5

AEROELASTICITY	
Course Code: ASE642	**Credits: 3:0:0**
Prerequisite:	**Contact Hours: 45L + 45S**
Course Coordinator: Dr. Senthamilselvi A	

Course Content

Unit I

Introduction to Aeroelasticity: Fundamentals of aeroelastic phenomena - Static aeroelastic problems: divergence, control effectiveness, control reversal - Importance of aeroelasticity in aerospace structures.

- Pedagogy/Course delivery tools: -Chalk and talk, animated videos.

Unit II

Flutter Analysis: Basic concepts of flutter - Two-dimensional airfoil flutter (binary flutter) - Torsional and bending flutter of wings - Methods of flutter analysis: analytical and experimental approaches.

- Pedagogy/Course delivery tools: -Chalk and talk, animated videos, simulation software, MATLAB/NASTRAN demos

Unit III

Dynamic Aeroelasticity: Coupled oscillations in aircraft structures - Aeroelastic response to gust loads and turbulence - Buffeting and dynamic stability - Case studies: wing flutter, tail plane oscillations.

- Pedagogy/ Course delivery tools: -Chalk and talk, Power point presentation, animated videos, design case studies.

Unit IV

Aeroelasticity & Flight Applications: Coupled vibration and flutter phenomena in wings and control surfaces - Divergence and control reversal in aircraft structures - Seismic and gust load response for aerospace structures - Dynamic stability and aeroelastic design considerations.

- Pedagogy/ Course delivery tools: -Chalk and talk, Power point presentation, animated videos, aeroelastic case studies

Unit V

Computational Methods in Aeroelasticity: Numerical methods for aeroelastic analysis - Finite element method in Aeroelasticity - Time-domain and frequency-domain approaches -Software applications: ANSYS, NASTRAN, MATLAB.

- Pedagogy/ Course delivery tools: -Chalk and talk, Power point presentation, animated videos, software demonstrations.

Text Books:

1. R.L. Bisplinghoff, H. Ashley & R.L. Halfman, Aeroelasticity, Dover Publications, 1996.
2. Y.C. Fung, An Introduction to the Theory of Aeroelasticity, Dover Publications, 2008.
3. D.J. Inman, Engineering Vibration, Pearson, 4th Edition, 2014.

Reference Books:

1. R.L. Bisplinghoff & H. Ashley, Principles of Aeroelasticity, Dover Publications, 2013.
2. Howard D. Curtis, Fundamentals of Aerospace Structural Dynamics, Springer, 2015.
3. Hodges & Pierce, Introduction to Structural Dynamics and Aeroelasticity, Cambridge University Press, 2nd Edition, 2011.

Course Outcomes (COs):

1. Understand fundamental aeroelastic phenomena in aerospace structures.
2. Analyze static aeroelastic problems such as divergence and control reversal.
3. Evaluate flutter and dynamic aeroelastic responses in aircraft structures.
4. Apply aeroelastic design principles for modern aerospace vehicles.
5. Use computational tools for aeroelastic analysis and design.

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal Test-I	30	CO1 &CO2
Internal Test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1 to CO5
Quiz	10	CO1 to CO5
Semester End Examination (SEE): 100		
Semester End Examination (SEE):	100	CO1 to CO5

CRYOGENIC TECHNOLOGY	
Course Code: ASE643	**Credits: 3:0:0**
Prerequisite:	**Contact Hours: 45L + 45S**
Course Coordinator: Dr. Anand M Raikar	

Course Content

Unit I

Introduction: Introduction to cryogenic engineering, definition of cryogenic temperature range, and major applications. Thermodynamic principles relevant to cryogenic systems; Joule–Thomson effect and inversion temperature. Thermo-physical properties of cryogenic fluids (N_2, O_2, H_2, He) and properties of materials at cryogenic temperatures, including thermal contraction and mechanical behavior.

- https://nptel.ac.in/courses/112101004
- Pedagogy/Course delivery tools:- Chalk and talk, animated videos

Unit II

Principles: Principles of gas liquefaction and refrigeration; ideal and real gas behavior at low temperatures. Gas liquefaction cycles: Linde–Hampson cycle, Claude cycle, Brayton cycle, and cascade liquefaction systems. Performance analysis of liquefaction systems: efficiency, figure of merit, refrigeration capacity.

- Pedagogy/Course delivery tools:- Chalk and talk, animated videos

Unit III

Cryocoolers: Introduction to cryocoolers and classification of refrigeration systems. Working principles and performance characteristics of Stirling, Gifford–McMahon, and Pulse Tube cryocoolers.

Advanced refrigeration methods: dilution refrigerator and adiabatic demagnetization refrigeration (ADR).

- Pedagogy/Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Unit IV

Heat transfer at cryogenic temperatures: conduction, radiation, and residual gas convection. Cryogenic insulation techniques: vacuum insulation, multilayer insulation (MLI), powder and foam insulation.

Fundamentals of vacuum technology: vacuum pumps, vacuum gauges, leak detection, and vacuum system design for cryogenic applications.

- Pedagogy/Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Unit V

Design principles of cryostats: thermal design, structural considerations, and material selection.

Storage and transfer of cryogenic fluids: dewars, transfer lines, super-insulated vessels.

Cryogenic instrumentation: temperature, pressure, level, and flow measurement; safety aspects including oxygen-deficiency hazard, material embrittlement, and pressure relief systems**.**

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Text Books:

1. Randall F. Barron, "Cryogenics Systems", Second Edition Oxford University Press New York, Clarendon Press, Oxford, 1985.

2. Timmerhaus, Flynn, "Cryogenics Process Engineering", Plenum Press, New York.

Reference Books:

1. Pipkov, "Fundamentals of Vacuum Engineering", Meer Publication.
2. G.M Walker. "Cryocooler-Part 1 Fundamentals" Plenum Press, New York and London.
3. G.M Walker. "Cryocooler-Part 2" Plenum Press, New York and London.

Course Outcomes (COs):

1. Understand the fundamentals of cryogenic engineering, cryogenic temperature ranges, and thermo-physical properties of cryogenic fluids and materials.
2. Analyze gas liquefaction and cryogenic refrigeration cycles, including Joule–Thomson effect and performance parameters of liquefaction systems.
3. Explain the working principles and applications of cryocoolers and advanced low-temperature refrigeration techniques.
4. Evaluate cryogenic insulation methods, heat transfer mechanisms, and vacuum systems used in cryogenic applications.
5. Design basic cryogenic systems such as cryostats and storage vessels, and assess safety issues and instrumentation requirements in cryogenic engineering.

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE):50Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal Test-I	30	CO1 & CO2
Internal Test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components - 20 Marks		
Assignment	10	CO1 to CO5
Quiz	10	CO1 to CO5
Semester End Examination (SEE):100Marks		
Semester End Examination (SEE):	100	CO1 to CO5

HELICOPTER AERODYNAMICS	
Course Code: ASE644	**Credits: 3:0:0**
Prerequisite:	**Contact Hours: 45L + 45S**
Course Coordinator: Dr. Inamul Hasan	

Course Content

Unit I

Introduction: Historical Development, Helicopter configurations, Specifics of helicopters, Fundamentals of Rotor Aerodynamics, Momentum theory analysis in hovering flight. Disk loading, power loading, thrust and power coefficients. Figure of merit, rotor solidity and blade loading coefficient. Power required in flight. Axial climb, descent, and autorotation.

- Pedagogy/Course delivery tools:-Chalk and talk, animated videos

Unit II

Blade Element Analysis: Blade element analysis in hovering and forward flight. Rotating blade motion. Types of rotors. Concept of blade flapping, lagging and coning angle. Equilibrium about the flapping hinge, lead/lag hinge, and drag hinge.

- Pedagogy/Course delivery tools:-Chalk and talk, animated videos

Unit III

Basic Helicopter Performance: Forces acting on helicopters in forward flight. Methods of achieving translatory flight. Controlling cyclic pitch: Swash-plate system. Lateral tilt with and without conning. Lateral and longitudinal asymmetry of lift in forward flight. Forward flight performance- total power required, effect of gross weight, effect of density altitude. Speed for minimum power, and speed for maximum range. Factors affecting forward speed, and ground effects.

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Unit IV

Rotor Airfoil Aerodynamics: Rotor airfoil requirements, effects of Reynolds number and Mach number. Airfoil shape definition, Airfoil pressure distribution. Pitching moment. Maximum lift and stall characteristics, high angle of attack range.

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Unit V

Helicopter Stability and Control: Introductory concepts of stability. Forward speed disturbance, vertical speed disturbance, pitching angular velocity disturbance, side-slip disturbance, yawing disturbance. Static stability of helicopters: longitudinal, lateral directional and directional. Dynamic stability aspects. Main rotor and tail rotor control. Flight and Ground Handling Qualities-General requirements and definitions. Control characteristics, Levels of handling qualities.

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Text Books:

1. J. Gordon Leishman, Principles of Helicopter Aerodynamics, Cambridge University Press, 2002

2. W Z Stepniewski and C N Keys, Rotary Wing Aerodynamics, Dover Publications, Inc, New York, 1984
3. ARS Bramwell, George Done, and David Balmford, Helicopter Dynamics, 2nd Edition, Butterworth- Heinemann Publication, 2001

Reference Books:

1. John Seddon, Simon Newman, Basic Helicopter Aerodynamics, 3rd Edition, John Wiley & Sons, Ltd., 2011.
2. Rathakrishnan E., Helicopter Aerodynamics, PHI Learning Private Limited, Delhi, 2019.

Course Outcomes (COs):

1. Describe the basic concepts of helicopter configurations, rotor aerodynamics, and helicopter performance.
2. Calculate rotor thrust, power, and other performance parameters using momentum theory and blade element methods.
3. Assess helicopter performance during hovering, climbing, descending, autorotation, and forward flight.
4. Explain the aerodynamic behavior of rotor airfoils and the effects of Reynolds number, Mach number, lift, pitching moment, and stall.
5. Interpret the basic principles of helicopter stability, control, and handling qualities during different flight conditions.

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal Test-I	30	CO1 &CO2
Internal Test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1 to CO5
Quiz	10	CO1 to CO5
Semester End Examination (SEE): 100		
Semester End Examination (SEE):	100	CO1 to CO5

BOUNDARY LAYER THEORY	
Course Code: ASE645	**Credits: 3:0:0**
Prerequisite:	**Contact Hours: 45L + 45S**
Course Coordinator: Dr. Inamul Hasan	

Course Content

Unit I

Fundamental Equations of Viscous Flow: Fundamental equations of viscous flow, Conservation of mass, Conservation of Momentum- Navier-Stokes equations, Energy equation, Mathematical character of basic equations, Dimensional parameters in viscous flow, Non-dimensionalisation, the basic equations and boundary conditions, vorticity considerations, creeping flow and boundary layer flow.

- Pedagogy/Course delivery tools:-Chalk and talk, animated videos

Unit II

Solutions of Viscous Flow Equations: Solutions of viscous flow equations, Couette flows, Hagen–Poiseuille flow, Flow between rotating concentric cylinders, Combined Couette-Poiseuille Flow between parallel plates, Creeping motion, Stokes solution for an immersed sphere, Development of boundary layer, Displacement thickness, momentum and energy thickness

- Pedagogy/Course delivery tools:-Chalk and talk, animated videos

Unit III

Laminar Boundary Layer: Laminar boundary layer equations, Flat plate Integral analysis of Karman – Integral analysis of energy equation – Laminar boundary layer equations – boundary layer over a curved body-Flow separation- similarity solutions, Blasius solution for flat-plate flow, Falkner–Skan wedge flows, Boundary layer temperature profiles for constant plate temperature – Reynold's analogy – Pohlhausen method.

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Unit IV

Turbulent Boundary Layer: Turbulence-physical and mathematical description, Two-dimensional turbulent boundary layer equations – Velocity profiles – The law of the wall – The law of the wake – Turbulent flow in pipes and channels – Turbulent boundary layer on a flat plate – Boundary layers with pressure gradient, Eddy Viscosity and mixing length

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Unit V

Boundary Layer Control: Boundary layer control in laminar flow-Methods of Boundary layer control: Acceleration of the boundary layer-Suction- Injection of a different gas-Prevention of transition - Cooling of the wall- Boundary layer suction- Practical examples of Boundary Layer Control

- Pedagogy/ Course delivery tools:-Chalk and talk, Power point presentation, animated videos

Text Books:

1. White, F. M., Viscous Fluid Flow, McGraw-Hill Education; 3rd edition, 2005.
2. Reynolds, A, J., Turbulent Flows Engineering, John Wiley and Sons, 1980

.**Reference Books:**

1. Schlichting, H., Boundary Layer Theory, Springer publishers, 8th edition, 2000

Course Outcomes (COs):

1. Use fundamental equations of the viscous flow for practical examples.
2. Solve viscous flow problems for solutions.
3. Appreciate the importance of viscosity and shear flow adjacent to the airframe of the aerospace vehicles.
4. Gain knowledge on the laminar boundary layer concepts and solution methods.
5. Gain insights on the importance of turbulence boundary layer in an aerospace engineering problem.

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal Test-I	30	CO1 &CO2
Internal Test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1 to CO5
Quiz	10	CO1 to CO5
Semester End Examination (SEE): 100		
Semester End Examination (SEE):	100	CO1 to CO5

FUNDAMENTALS OF FLIGHT	
Course Code: ASOE01	**Credits: 3:0:0**
Prerequisite:	**Contact Hours: 45L + 45S**
Course Coordinator: Dr. Senthamilselvi A	

Course Content

Unit I

Fundamentals of Flight: Properties of the atmosphere, standard atmosphere - Basic aerodynamic forces: lift, drag, thrust, weight - Airfoil nomenclature, angle of attack, camber, chord, aspect ratio - Pressure distribution over airfoils, lift generation.

- Pedagogy/Course delivery tools: -Chalk and talk, animated videos.

Unit II

Airplane Performance: Drag polar, variation of lift and drag with speed - Power required and available, thrust required and available -Performance curves for propeller and jet aircraft - Range and endurance of aircraft.

- Pedagogy/Course delivery tools: -Chalk and talk, animated videos, MATLAB demos

Unit III

Stability and Control: Static stability: longitudinal, lateral, directional - Dynamic stability: short period and phugoid modes - Control surfaces: elevators, ailerons, rudders -Trim conditions and control effectiveness.

- Pedagogy/ Course delivery tools: -Chalk and talk, Power point presentation, animated videos., Case Studies.

Unit IV

High-Speed Flight: Compressibility effects, critical Mach number - Shock waves, wave drag, transonic and supersonic flight regimes - Lift and drag characteristics at high Mach numbers - Design considerations for supersonic aircraft.

- Pedagogy/ Course delivery tools: -Chalk and talk, Power point presentation, animated videos

Unit V

Flight Mechanics Applications: Climb, cruise, and descent performance - Take-off and landing performance analysis - Turning performance, load factor, maneuverability -Case studies: fighter aircraft, transport aircraft, UAVs.

- Pedagogy/ Course delivery tools: -Chalk and talk, Power point presentation, animated videos, software demonstrations (MATLAB, XFLR5).

Text Books:

1. John D. Anderson, Introduction to Flight, McGraw Hill, 8th Edition, 2016.
2. E.L. Houghton & P.W. Carpenter, Aerodynamics for Engineering Students, Butterworth-Heinemann, 7th Edition, 2017.
3. A.C. Kermode, Flight Without Formulae, Pearson, 5th Edition, 2006.

Reference Books:

1. Bernard Etkin & Lloyd Duff Reid, Dynamics of Flight: Stability and Control, Wiley, 3rd Edition, 1996.
2. John D. Anderson, Fundamentals of Aerodynamics, McGraw Hill, 6th Edition, 2017.
3. Louis B. Gratzer, Principles of Aircraft Flight, Reston Publishing, 1982.

Course Outcomes (COs):

1. Understand the fundamentals of flight and aerodynamic forces.
2. Analyze airplane performance under various flight conditions.
3. Evaluate stability and control characteristics of aircraft.
4. Apply principles of high-speed aerodynamics to aerospace vehicles.
5. Use flight mechanics concepts in performance analysis of aircraft and UAVs.

Course Assessment and Evaluation:

Continuous Internal Evaluation (CIE): 50 Marks		
Assessment tool	**Marks**	**Course outcomes addressed**
Internal Test-I	30	CO1 &CO2
Internal Test-II	30	CO3, CO4 & CO5
Average of the two internal tests will be considered for evaluation of 30 Marks		
Other components- 20 Marks		
Assignment	10	CO1 to CO5
Quiz	10	CO1 to CO5
Semester End Examination (SEE): 100		
Semester End Examination (SEE):	100	CO1 to CO5