III to VIII Semester Scheme & Syllabus

(2023-2024)

Department of

Aeronautical Engineering

# SCHEME AND SYLLABUS


## Aeronautical Engineering

GLOBAL ACADEMY OF TECHNOLOGY

**(Autonomous Institution affiliated to VTU Belagavi)**

**Accredited by NAAC with 'A' grade,**

**NBA Accredited CS, E&C, E&E, MECH and IS branches)**

**Ideal Homes Township,**

**Raja Rajeshwari Nagar, Bengaluru-560098.**

# PREAMBLE

**There has been a lot of discussion on the current mode of engineering education in our country and its impact on employability of fresh engineering graduates. Employability rating of fresh graduates is far from being satisfactory and industries are running short of trained and skilled manpower.**

**The demands of the society are dynamic, complex and keep changing at a rapid pace. Technological advancement is providing several innovations and breakthroughs exponentially in IT related domains like Artificial intelligence, Internet of Things, Machine learning, Automation and Robotics. These interventions are changing further the expectations of the society on products and services. In view of this, it becomes imperative to equip students to learn the art of linking science and engineering to the needs of the industry and society. The students must relate their learning to provide solutions to complex and real-life problems faced by the society. Engineering education needs to focus on how to apply knowledge to complex, unstructured problems in a global platform. The herculean task ahead of the engineering institutions is to produce graduates who are employable. Employability does not mean that a student should be placed in an industry before he/she leaves the portals of an institution. Employability means equipping engineering graduates with necessary technical skills, communication skills, leadership qualities, soft skills, professional ethics, and a social responsibility.**

**The onus of providing graduates with the attributes mentioned above lies with the institutions. Institutes should create a conducive atmosphere where students learn to stimulate their creativity and develop their talents. The graduates must be trained to work in teams and must be exposed to interdisciplinary areas to establish better links with present generation industries. The domain boundaries have collapsed and most of the engineering streams are getting integrated and blended. It is therefore crucial that the graduates must be made to understand the nuances of the engineering education and the importance of creative thinking, innovation and being sensitive to societal changes.**

**Global Academy of Technology (GAT) has understood the importance of broad-based education and has created a conductive environment for the students to blossom into complete individuals. A true broad-based education prepares students for life, without losing their areas of specialization and competence. Our aim is to become a premier institution imparting quality education in engineering and management to meet the changing needs of the industry and society. The entire team at GAT is committed to realize the dream of making GAT an institution of eminence and creating an indelible impression in the area of engineering education.**

**The present focus of the institute is to improve the laboratory infrastructure by bringing new industry relevant technology to enable higher level of learning in students, foster integrated learning by providing multiple industry relevant interfaces, enable students to take up industry relevant projects and encourage faculty to take up research by providing ability to add customer logic.**

**With changing times and emergence of disruptive technologies, GAT stands strong in adapting and encompassing these into the mainstream in shaping students' career, thus contributing directly to society and nation building.**

## Contents

# 1. Global Academy of Technology

**(Autonomous Institution under Visvesvaraya Technological University, Belagavi)**

## An Overview

1.1 Vision of the Institute:

**Become a premier institution imparting quality education in engineering and management to meet the changing needs of society.**

1 .2 Mission of the Institute:

- **Create environment conducive for continuous learning through quality teaching and learning processes supported by modern infrastructure.**
- **Promote Research and Innovation through collaboration with industries.**
- **Inculcate ethical values and environmental consciousness through holistic education programs.**

1.3 Objectives:

- **With a very firm resolve, Global Academy of Technology is continuously investing untiring efforts to enable students to:**
- **Develop careers in Government and Private engineering organizations and other**
- **professionally related domains.**
- **Pursue higher studies and research to develop innovative solutions and technologies in engineering and other multi-disciplinary areas.**
- **Improve professional and personal traits oriented towards professional ethics and environmental compulsions.**
- **Inculcate professional leadership and successful entrepreneurship qualities.**
- **Help society in raising the quality of life.**

1.4 Quality Policies:

- **Providing Excellent Education Through High Quality, Experienced and Committed Faculty.**
- **Evolving creative processes for optimal Knowledge and Skill Transfer.**
- **Building up state-of-the-art infrastructure at par with international standards.**
- **Creating an environment for holistic personality development and developing**

- 1.5 Hallmarks of Global Academy of Technology:

- **Proactive management determined to build the institute as a Centre of Excellence in engineering education.**
- **Qualified and dedicated faculty in all the departments.**
- **State of the art Infrastructure and up to date laboratory and Library facilities.**
- **Lush green campus with an environment of tranquillity and harmony.**
- **Student centric teaching-learning processes banking on Outcome Based Education.**
- **students' friendly learning atmosphere.**
- **Emphasis on Project based learning throughout the course.**
- **Strong Industry-Institute interface with more than twenty Memorandum of Understanding**
- **(MOUs) signed with leading industries and institutions of repute.**
- **Indian Institute of Information Technology (IIIT), Allahabad, has signed a MOU for providing internships to students of GAT, research assistance to faculty, and conducting Faculty Development Programs in key areas of IT - Big Data, Cloud Computing, Artificial Intelligence, and Machine Learning.**
- **Mahatma Gandhi University, Kottayam, has signed a MOU to facilitate research in Nano Technology and provide research assistance to faculty of GAT.**
- **Industrial consultancy is undertaken in many departments.**
- **Excellent Placement with more than 80% of the eligible students placed in leading IT**
- **companies, core industries and Start-up companies.**
- **Holistic and integrated training modules covering communication skills, leadership skills, soft skills and technical skills through professional trainers.**
- **On campus and off campus internship facilities.**
- **Robust parent connects and Student counselling system.**
- **In-house technical skill training programs/add on courses to enhance the employability of the students.**
- **Strong and growing alumni connect in place**

- **Exclusive Research and Development, Industry–Institute Interaction Cell and Teaching and Learning Centre in place.**
- **Rainwater harvesting facility in the campus.**

**The following academic processes are implemented on a regular basis to sustain a meaningful and proactive teaching-learning environment:**

- **Emphasis on continuous revision of the curriculum, based on feedback from the students**

  **and input from industry, alumni, and other stakeholders.**
- **Conduction of regular training programmer for faculty, technical & supporting staff.**
- **Conducting Academic Audit of each department annually.**
- **Under open electives students have the options to study subjects offered by other departments to augment their interdisciplinary knowledge.**
- **Students must do value added courses, mandatory courses, certificate courses, and become members of professional bodies, etc.**
- **Advanced and enrichment courses are offered as Electives during the final year UG and PG Degree Programmes.**
- **Self-Learning is encouraged in students through MOOCs, NPTEL/SWAYAM, Coursera, Edex etc. Credit shall be awarded to students for completion of such courses**

## 2.0 Department of Aeronautical Engineering

### 2.1 Vision of the Department:

**To emerge as an excellent canter for imparting quality education and research to produce competent Aeronautical Engineers to meet global challenges.**

### 2.2 Mission of the Department:

**M1: Empower the students with the fundamental knowledge and skill for a successful career in the field of Aeronautical Engineering and facilitating them to continue their education through higher studies and Research & Development activities.**

**M2**: **Providing state of the art laboratories and infrastructure for academics and research in the areas of Aerodynamics, Structures, Propulsion and control systems.**

**M3**: **Enhancing industry-institute interaction leading to interdisciplinary research with social concern to become leaders in industries and/or become entrepreneurs with good ethics.**

**2.3** About theDepartment:

**The Department of Aeronautical Engineering was established in the year 2020, affiliated to VTU, Belagavi, Karnataka, approved by AICTE. The department offers a 4-year undergraduate programme, B.E. in Aeronautical Engineering. The department has a team of highly qualified, dedicated and motivated young and experienced faculties. The Department of Aeronautical Engineering has laboratories catering to students, scholars and faculty members for their academic and research activities. The curriculum is designed to impart engineering knowledge in topics such as Aerodynamics, Aircraft structures, Propulsion, Flight dynamics & Controls and UAVs. Further provision exists to acquire additional engineering knowledge through electives. The department prepares the graduates to undertake design, analysis, experimental and research activities as their careers in aeronautical engineering. The institution is located very close to many leading aeronautical industries (ISRO, NAL, HAL, ADA, ADE etc.) and IT industries which will benefit the students in terms of collaboration.**

**The department activities are being monitored by the Department Advisory Board (DAB) and Program advisory committee (PAC) whose members are eminent personalities from industries, government organizations and R&D Sectors. The new initiative of establishing Research Centre in Aeronautical Engineering, GAT would provide researchers a good opportunity for enhancing their Research knowledge and Problem-solving.**

# 3 Salient Features of Autonomy

**Autonomous institutions occupy pivotal positions and are the key interfaces between the industry and academia. Autonomous institutions can create the key channels required for scientific and industrial research and innovation, inclusive teaching and training, and initiatives to develop the eco system for creating more employment.**

**Autonomy means freedom and authority in academic matters. Autonomy bestows the teacher with the right to decide what to teach, how to teach, how much to teach and whom to teach.**

**Autonomy gives the privilege to:**

- **Run courses relevant to the requirements of industries and society at large.**
- **Design Teaching-Learning methodologies, Assessment Tools and Methods, and Admission policies.**

- **Create an eco- system for holistic development of the individuals.**
- **Build strong academic and industry interface.**
- **Build the reputation of the institution through quality education.**
- **Industry relevant value-added courses during vacations.**
- **Internships in Industry/ R&D establishments in summer holidays.**
- **Building leadership qualities including spirit of tolerance and teamwork.**
- **There will be a lot of scope for industry- oriented skill development built-in into the system.**
- **Deliver engineering graduates who can effectively shoulder the responsibility of building a strong and vibrant INDIA.**

**GAT has Board of Governance, Academic Council, Boards of Studies, Boards of Examination, Finance Committee, and Institute Steering Committee. Stakeholders in these bodies comprise of Academicians, Researchers, Industry Experts, Faculty and Alumni. Governing Body of the autonomous college lays down policies and procedures for Governance of the college carried out through the principal of the college. Academic Council is the apex academic body of the college responsible for approval of schemes of study, syllabi, examinations and evaluation methods, declaration of results, recommendation of candidates to the University for Award of degrees etc. The college constitutes different Boards of Studies for different branches of engineering. The BOS's are responsible for framing schemes of study and detailed curricula, academic rules etc. Other bodies like Finance Committee, Recruitment Committee help in administration of the college.**

## 3.1 Outcome Based Education (OBE):

**Outcome based education (OBE) is student-centered instruction model that focuses on measuring student performance through outcomes. Outcomes include knowledge, skills and attitude. Its focus remains on evaluating the program's outcomes by stating the knowledge, skill and behavior a graduate is expected to attain upon completion and 4 to 5 years after graduation.**

**The induction of India in the Washington Accord in 2014 with the permanent signatory status of The National Board of Accreditation (NBA) is considered a big leap forward for the higher-education system in India. It means that an Engineering graduate from India can be employed in any one of the other countries who have signed the accord. For Indian Engineering Institutions to get accredited by NBA according to the pacts of the accord, it is compulsory that engineering institutions follow the Outcome Based Education (OBE) model. So, for an Engineering Institution to be accredited by NBA it should compulsorily follow the OBE model.**

**The OBE model measures the progress of the graduate in three parameters, which are:**

- **Program Educational Objectives (PEO)**
- **Program Outcomes (PO)**
- **Course Outcomes (CO)**

**Outcome Based Education assesses students' performance, knowledge and skills through quizzes, solving puzzles, giving an online presentation, modelling something, and taking up a multiple-choicece assessment. Assessments are criterion-focused which the students achieve during the learning period. Students are expected to go with the flow and think out of the box to implement – outcome**

**based education.**

**Students studying in an accredited program of an institution in India can be confident of getting an education which is of assured quality comparable to global standards. They can compete with their global counterparts for securing jobs in Multi-National Companies and other enterprises across the world. Students can also have global mobility- can work anywhere -in any corner of the globe. In addition, students will have access to the state-of-the-art facility, infrastructure, and access to highly qualified teaching faculty in an accredited program. Students would have acquired "graduate attributes" at the end of the course and will be industry ready. A student can also get into post- graduation and research**.

3.2 Advantages of Outcome Based Education:

- **Student-cantered - It is an approach by which the learner's mastery over a particular skill is demonstrated and measured.**
- **Clarity in focus - A learning outcome must be made obvious to the learner even at the outset of learning. This outcomes-based model works on bringing out the specific outcomes from the learners.**
- **The curriculum is designed with a clear definition, outlining the expected outcomes. This will pave a way to achieve expanded opportunities in the student's performance.**
- **Exceeding expectations - All students can deliver the highest level of performance. The only kick start needed is to make them believe and encourage, the only way to attain high expectation.**
- **Expanded opportunities - It means giving countless chances and ways to show the students that they have met with their objective. Not all learners learn the same thing, the same way, and at the same time. However, extended opportunities can help achieve high standards. They help students to learn what is mostly needed for the time and hour.**

## 3.3 Program Outcomes (POs) as prescribed by National Board of Accreditation (NBA):

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

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

**PO3-** Design/development of solutions: **Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.**

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

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

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

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

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

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

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

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

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

## 3.4 Program Specific Outcomes

**PSO1: Apply the fundamental knowledge of Aerodynamics, Propulsion, Structures and Flight controls to solve core contemporary problems.**

**PSO2: Develop and use modern engineering tools to design and analyze the simple and complex problems in Aeronautical Engineering.**

## 3.5 Some Definitions:

**"Course" is a unit of teaching, which encompasses various topics, that typically lasts one semester, is led by one or more faculty and has a fixed registered student. Course means a subject either theory or practical identified by its title and code number.**

**"Program" – cohesive arrangements of courses, co- curricular extra-curricular activities to accomplish predetermined objectives leading to award of a degree.**

**"Degree"- Academic award conferred upon a student on successful completion of a program designed to achieve the defined attributes.**

## 3.6 Choice Based Credit System (CBCS):

**Major Benefits: Major benefits accruing by adopting the Credit System are listed below:**

- **Quantification and uniformity in the listing of courses for all programmes at a college, like core (hard/soft), electives and project work.**
- **Ease of allocation of courses under different heads by using their credits to meet national/international practices in technical education.**
- **Convenience to specify the minimum/ maximum limits of course load and its average per semester in the form of credits to be earned by a student.**
- **Flexibility in programme duration for students by enabling them to pace their course load within minimum/maximum limits based on their preparation and capabilities.**
- **Wider choice of courses available from any department of the same College or even from other similar Colleges, either for credit or for audit.**
- **Improved facility for students to optimize their learning by availing of transfer of credits earned by them from one College to another.**

**As the Credit System has many advantages over the conventional system of organizing academic programs, GAT has introduced an appropriate Choice Based Credit System (CBCS) for the various programs. This will be of great benefit to the students in their preparations to meet the challenging opportunities ahead. In the Credit System, the**

**course work of students is unitized, and each unit is assigned one credit after a student completes the teaching-learning process as prescribed for that unit and is successful in its assessment. However, there are different definitions followed in academic circles for the size of a unit and in turn, for a credit.**

## 3.7 Credit Definition:

**As it is desirable to have uniformity in the definition of credit across all Autonomous Colleges under the University, the following widely accepted definition for credit shall be followed at GAT. This can provide flexibility to the students and strengthen CBCS under the University. Here, one unit of course work and its corresponding one credit (while referring to a Main Semester) shall be equal to:**

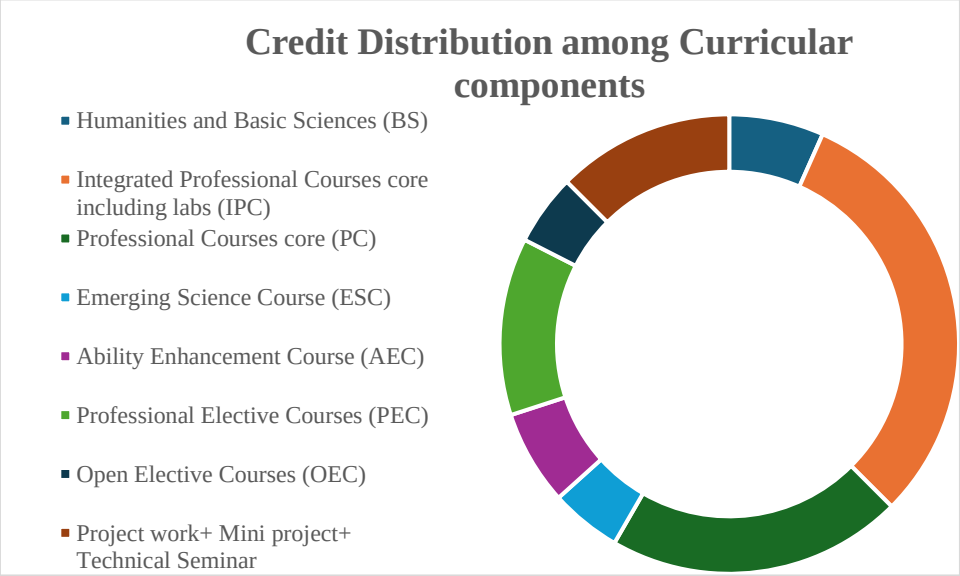
1) **Theory course conducted for 1 hour/week/ semester.**
2) **Laboratory course or Tutorial conducted for 2 hours/week/semester. The following additional factors may also be noted in this connection:**
3) **The above figures shall be multiplied by a factor of 2 in the case of the Supplementary Semester,**
4) **Other student activities which are not demanding intellectually, or which do not lead to effective assessment, like practical training, study tours, attending guest lectures shall not carry any credit.**

**Audit Courses: In Addition, a student can register for courses for audit only with a view to supplement his/her knowledge and/or skills. Here also, the student's grades will have to be reflected in the Grade Card. These courses shall not be considered in determining the student's academic performance in the semester. In view of this, it may not be necessary for the college to issue any separate transcript covering the audit courses to the registrants at these courses.**

**For more details on the academic regulations, students are advised to refer Academic Rules and regulations document available on the college website www.gat.ac.in.**

## 3.8. Credit Distribution among Curricular components:

| Sl. No. | Curricular Component | Credits allocated | Percentage of allocation |
|---|---|---|---|
| 1. | Humanities and Basic Sciences (BS) | 8 | 7 |
| 2. | Integrated Professional Courses core including labs (IPC) | 32 | 31 |
| 3. | Professional Courses core (PC) | 20 | 21 |
| 4. | Emerging Science Course (ESC) | 6 | 5 |
| 5. | Ability Enhancement Course (AEC) | 8 | 7 |
| 6. | Professional Elective Courses (PEC) | 12 | 13 |
| 7. | Open Elective Courses (OEC) | 9 | 5 |
| 8. | Project work+ Mini project+ Technical Seminar | 15 | 13 |
| 9. | **Total** | 110 | 100 |



# Department of Aeronautical Engineering

# III – VIII Semester

# SCHEME AND SYLLABUS

# Scheme of UG Autonomous Program – 2023 batch

## (3rd to 8th Semester)

### III SEMESTER

| Sl. No. | Course Code | Course Title | Course Type | Teaching Dept. | Teaching Hours/Week | | | Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | CIE | SEE | Total | |
| 1 | MAT23301 | Complex variables and probability | BS | MAT | 2 | 2 | 0 | 50 | 50 | 100 | 3 |
| 2 | ANE23302 | Mechanics of Materials | IPC | AE Dept | 3 | 0 | 2 | 50 | 50 | 100 | 4 |
| 3 | ANE23303 | Fluid Mechanics | IPC | | 3 | 0 | 2 | 50 | 50 | 100 | 4 |
| 4 | ANE23304 | Aero Engineering Thermodynamics | PC | | 2 | 2 | 0 | 50 | 50 | 100 | 3 |
| 5 | ANE23305 | Elements Of Aeronautics | ESC/ETC/PLC | | 3 | 0 | 0 | 50 | 50 | 100 | 3 |
| 6 | SCK23306 | Social Connect and Responsibility | Any Department | | 0 | 0 | 2 | 100 | --- | 100 | 1 |
| 7 | ANE23307x | Ability Enhancement Course/Skill Enhancement Course - III | AEC | | 2 | 0 | 0 | 50 | 50 | 100 | 2 |
| 8 | NSK23308 | National Service Scheme (NSS) | MC | NSS coordinator | 0 | 0 | 2 | 100 | --- | 100 | 0 |
| | PEK23308 | Physical Education (PE) (Sports and Athletics) | | Physical Education Director | | | | | | | |
| | YOK23308 | Yoga | | Yoga Teacher | | | | | | | |
| 9 | ANEL23309 | CADD | | AE Dept | | 0 | 2 | 100 | --- | 100 | 0 |
| **Total** | | | | | | | | **300** | **300** | **600** | **20** |

### IV SEMESTER

| Sl. No. | Course Code | Course Title | Course Type | Teaching Department (TD)and Question Paper Setting Board (PSB) | Teaching Hours/Week | | | Examination | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | L | T | P | CIE | SEE | Total | |
| 1 | MAT23401 | Transform Calculus and Numerical Techniques | BS | MAT | 2 | 2 | 0 | 50 | 50 | 100 | 3 |
| 2 | ANE23402 | Low Speed Aerodynamics | IPC | AE Dept | 3 | 0 | 2 | 50 | 50 | 100 | 4 |
| 3 | ANE23403 | Aircraft Propulsion | IPC | | 3 | 0 | 2 | 50 | 50 | 100 | 4 |
| 4 | ANE23404 | Aircraft Structures -I | PC | | 2 | 2 | 0 | 50 | 50 | 100 | 3 |
| 5 | ANE23405 | Aircraft Control Engineering | ESC/ETC/PLC | | 2 | 2 | 0 | 50 | 50 | 100 | 3 |



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|---|---|---|---|---|---|---|---|---|---|---|---|
| **6** | ANE23406x | Ability Enhancement Course/Skill Enhancement Course - IV | AEC | | 3 | 0 | 0 | 50 | 50 | 100 | 3 |
| **7** | NSK23407 | National Service Scheme (NSS) | MC | NSS coordinator | 0 | 0 | 2 | 100 | --- | 100 | 0 |
| | PEK23407 | Physical Education (PE) (Sports and Athletics) | | Physical Education Director | | | | | | | |
| | YOK23407 | Yoga | | Yoga Teacher | | | | | | | |
| **8** | ANEL23408 | Advanced CADD Lab | | AE Dept | 0 | 0 | 2 | 100 | --- | 100 | 0 |
| **Total** | | | | | | | | **400** | **300** | **700** | **20** |

## V SEMESTER

| **Sl. No.** | **Course Code** | | **Course Title** | **Teaching Department (TD)and Question Paper Setting Board (PSB)** | **Teaching Hours/Week** | | | | **Examination** | | | | **Credits** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **Theory Lecture** | **Tutorial** | **Practical / Drawing** | **Self - Study** | **Duration in hours** | **CIE Marks** | **SEE Marks** | **Total** | |
| | | | | | **L** | **T** | **P** | **S** | | | | | |
| **1** | HSMS | ANE23501 | Aviation Management | TD: AE PSB: AE | 3 | 0 | 0 | | 03 | 50 | 50 | 100 | 3 |
| **2** | IPCC | ANE23502 | Aircraft Structures - II | | 2 | 2 | 2 | | 03 | 50 | 50 | 100 | 4 |
| **3** | PCC | ANE23503 | High-Speed Aerodynamics | | 3 | 2 | 0 | | 03 | 50 | 50 | 100 | 4 |
| **4** | PCCL | ANEL23504 | Modelling and analysis lab | | 0 | 0 | 2 | | 03 | 50 | 50 | 100 | 1 |
| **5** | PEC | ANE23505X | Professional Elective – I | | 3 | 0 | 0 | | 03 | 50 | 50 | 100 | 3 |
| **6** | PROJ | ANEP23506 | Mini Project | | 0 | 0 | 4 | | 03 | 100 | | 100 | 2 |
| **7** | AEC | RMIK23507 | Research Methodology | | 3 | 0 | 0 | | 03 | 50 | 50 | 100 | 3 |
| **8** | MC | CIVK23508 | Environmental Studies | TD:CV/Env/ Chem, PSB:CV | 2 | 0 | 0 | | 02 | 50 | 50 | 100 | 2 |
| **9** | MC | UHK23509 | National Service Scheme (NSS) | NSS coordinator | 0 | 0 | 2 | | | 100 | | 100 | 0 |
| | | PEK23509 | Physical Education (PE) (Sports and Athletics) | Physical Education Director | | | | | | | | | |
| | | YOK23509 | Yoga | Yoga Teacher | | | | | | | | | |
| **10** | | ANE23510 | Technical Authoring in Aircraft Manuals | AE Dept | 0 | 0 | 2 | | | 100 | | 100 | 0 |
| **Total** | | | | | | | | | | **500** | **300** | **800** | **22** |



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## VI SEMESTER

| Sl. No. | Course Code | | Course Title | Teaching Department (TD)and Question Paper Setting Board (PSB) | Teaching Hours/Week | | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory Lecture | Tutorial | Practic / Drawing | Self - Study | Duration in hours | CIE Marks | SEE Marks | Total | |
| | | | | | L | T | P | S | | | | | |
| 1 | IPCC | ANE23601 | Aircraft Design | TD: AE, PSB:AE | 2 | 2 | 2 | | 03 | 50 | 50 | 100 | 4 |
| 2 | PCC | ANE23602 | Flight Mechanics | | 3 | 2 | 0 | | 03 | 50 | 50 | 100 | 4 |
| 3 | PEC | ANE23603X | Professional Elective – II | | 3 | 0 | 0 | | 03 | 50 | 50 | 100 | 3 |
| 4 | OEC | ANE23604X | Open Elective -I | | 3 | 0 | 0 | | 03 | 50 | 50 | 100 | 3 |
| 5 | PROJ | ANEP23605 | Major Project Phase – I | | 0 | 0 | 4 | | 03 | 100 | -- | 100 | 2 |
| 6 | PCCL | ANEL23606 | Flight Simulation Lab | | 0 | 0 | 2 | | 03 | 50 | 50 | 100 | 1 |
| 7 | AEC / SDC | ANE23607X | Ability Enhancement Course/ Skill Development Course – III | | If the course is offered as a Theory: 1 | 0 | 0 | | 01 | 50 | 50 | 100 | 1 |
| | | | | | If course is offered as a practical: 0 | 0 | 2 | | | | | | |
| 8 | MC | UHK23608 | National Service Scheme (NSS) | NSS coordinator | 0 | 0 | 2 | | | 100 | --- | 100 | 0 |
| | | PEK23608 | Physical Education (PE) (Sports and Athletics) | Physical Education Director | | | | | | | | | |
| | | YOK23608 | Yoga | Yoga Teacher | | | | | | | | | |
| 9 | IKS | BIKK23609 | Indian Knowledge System | | 1 | 0 | 0 | | 01 | 50 | 50 | 100 | 0 |
| 11 | UHV | UHV23511 | Universal Human Values | | 1 | 0 | 0 | | 03 | 50 | 50 | 100 | 0 |
| | | | | | | | | Total | | 500 | 300 | 800 | 18 |

## VII SEMESTER

| Sl. No. | Course Code | | Course Title | Teaching Department (TD)and Question Paper Setting Board (PSB) | Teaching Hours/Week | | | | Examination | | | | Credits |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Theory Lecture | Tutorial | Practical / Drawing | Self - Study | Duration in hrs | CIE Marks | SEE Marks | Total | |
| | | | | | L | T | P | S | | | | | |
| 1 | IPCC | ANE23701 | Avionics and Systems To be Completed in 5th/6th Semester | | 3 | 0 | 2 | | 03 | 50 | 50 | 100 | 4 |



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|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2** | IPCC | ANE23702 | Computational Fluid Dynamics To be Completed in the 5th/6th Semester | TD: AE, PSB: AE | 3 | 0 | 2 | | 03 | 50 | 50 | 100 | 4 |
| **3** | PCC | ANE23703 | Space Mechanics To be Completed in 6th Semester | | 3 | 2 | 0 | | 03 | 50 | 50 | 100 | 4 |
| **4** | PEC | ANE23704x | Professional Elective-III (Online Courses) | | 3 | 0 | 0 | | 03 | 50 | 50 | 100 | 3 |
| **5** | OEC | ANE23705x | Open Elective- II (Online Courses) | | 3 | 0 | 0 | | 01 | 50 | 50 | 100 | 3 |
| **6** | PROJ | ANEP 23706 | **Major Project Phase-II** | TD: AE, PSB: AE | 0 | 0 | 12 | | 03 | 100 | 100 | 200 | 6 |
| **Total** | | | | | | | | | | **400** | **300** | **700** | **24** |

## VIII SEMESTER

| **Sl. No.** | **Course Code** | | **Course Title** | **Teaching Department (TD)and Question Paper Setting Board (PSB)** | **Teaching Hours/Week** | | | | **Examination** | | | | **Credits** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **Theory Lecture** | **Tutorial** | **Practic / Drawing** | **Self - Study** | **Duration in hours** | **CIE Marks** | **SEE Marks** | **Total** | |
| | | | | | **L** | **T** | **P** | **S** | | | | | |
| **1** | PEC | ANE23801x | **Professional Elective -IV (Online Courses)** | TD: AE, PSB:AE | 3 | 0 | 0 | | 03 | 50 | 50 | 100 | 3 |
| **2** | OEC | ANE23802x | **Open Elective - III (Online Courses)** | TD: AE, PSB:AE | 3 | 0 | 0 | | 03 | 50 | 50 | 100 | 3 |
| **3** | INT | ANEI23803 | **Internship + Technical Seminar (Industry/Research) (14 - 20 weeks)** | TD: | 0 | 0 | 12 | | 03 | 100 | 100 | 200 | 10 |
| **Total** | | | | | | | | | | **200** | **200** | **400** | **16** |

*__NPTEL for Credit transfer__: Students can take 12 weeks NPTEL course as an equivalent to a Program elective. The NPTEL courses of duration less than 12 weeks will not be considered for credit transfer. The courses (only technical) NPTEL should not exceed a maximum of 40% of the courses being registered by the student. The NPTEL course needs to be completed before the registration of the elective. Any certificate obtained after the registration of elective would not



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be considered. The validity of NPTEL certificate is for two years and it cannot be used more than once to avail the benefit. The student is eligible to transfer a maximum of nine credits in the entire duration of the program. The grades will be awarded as equivalent to the grades obtained in the NPTEL course.

# Program Elective, Open Elective and Ability Enhancement Course

| **Ability Enhancement Course/Skill Enhancement Course – III** | | |
|---|---|---|
| **Sl. No.** | **Course Code** | **Course Title** |
| 1 | ANE23307A | Aerospace Materials and Digital Manufacturing |
| 2 | ANE23307B | Development of Soft Skills for Engineers |
| 3 | ANE23307C | Ethics, Technology and Engineering |
| 4 | ANE23307D | Digitalization in Aeronautics |
| **Ability Enhancement Course/Skill Enhancement Course - IV** | | |
| **Sl. No.** | **Course Code** | **Course Title** |
| 1 | ANE23406A | AI&ML in Aerospace Applications |
| 2 | ANE23406B | Spreadsheet-Basic for Engineers |
| 3 | ANE23406C | Introduction to programming with MATLAB and Python |
| 4 | ANE23406D | Introduction to Augmented Reality |
| **Professional Elective Course – I*** | | |
| **Sl. No.** | **Course Code** | **Course Title** |
| 1 | ANE23505A | Finite Element Methods |
| 2 | ANE23505B | Aero Propulsion-II |
| 3 | ANE23505C | Helicopter Dynamics |
| 4 | ANE23505D | Airframe Structural Design |
| **Professional Elective Course - II*** | | |
| **Sl. No.** | **Course Code** | **Course Title** |
| 1 | ANE23603A | Composite Materials and Structures |
| 2 | ANE23603B | Rockets and Missiles |
| 3 | ANE23603C | Guidance & Control |



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| | | |
|---|---|---|
| 4 | ANE23603D | Flight Testing |
| **Open Elective Course-I*** | | |
| **Sl. No.** | **Course Code** | **Course Title** |
| 1 | ANE23604A | Introduction to Aeronautics |
| 2 | ANE23604B | History of aviation |
| 3 | ANE23604C | Airport planning and management |
| 4 | ANE23604D | Introduction to Flight Simulator |
| **Ability Enhancement Course / Skill Enhancement Course –V** | | |
| **Sl. No.** | **Course Code** | **Course Title** |
| 1 | ANE23607A | System Engineering for Aeronautical Engineers |
| 2 | ANE23607B | Virtual Aircraft Simulation |
| 3 | ANE23607C | Introduction to Swarm Drone |
| 4 | ANE23607D | Multi-disciplinary Research in Aeronautical Engineering |
| **Professional Elective Course-III*** | | |
| **Sl. No.** | **Course Code** | **Course Title** |
| 1 | ANE23704A | Aircraft Maintenance, Repair and Overhaul |
| 2 | ANE23704B | Wind Tunnel Techniques |
| 3 | ANE23704C | Theory of Vibration |
| 4 | ANE23704D | Civil Aviation Rules and Regulation |
| **Open Elective Course-II*** | | |
| 1 | ANE23705A | Drone Technology |
| 2 | ANE23705B | Air Traffic and Weather |
| 3 | ANE23705C | Space Technology |
| 4 | ANE23705D | Aviation and Internet Infrastructure |



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# SEMESTER – III SYLLABUS

# SEMESTER – III SYLLABUS

## COURSE: COMPLEX VARIABLES AND PROBABILITY (COMMON FOR ME/AE)

| | | | |
|---|---|---|---|
| **Course Code** | **MAT23301** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **2:2:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Course Objectives:** To enable students to apply the knowledge of mathematics in the field of engineering by making them to learn:

| | |
|---|---|
| **CLO1** | Analytic functions and complex line integrals |
| **CLO2** | Probability distributions |
| **CLO3** | Joint probability distributions |
| **CLO4** | Sampling distributions and testing of hypothesis |

| **Content** | **No. of Hours/ RBT levels** |
|---|---|
| **Module 1**<br>Function of complex variables, Analytic functions, Cauchy-Riemann equations, construction of analytic functions using Milne Thomson method, Properties of analytic functions. | **08 Hours**<br>**L2, L3** |
| **Module 2**<br>Conformal mapping, Bilinear transformations. Complex line integrals, Cauchy's theorem, Cauchy's integral formula, Singularities, poles, residues, Cauchy's residue theorem. | **08 Hours**<br>**L2, L3** |
| **Module 3**<br>Probability, Conditional probability, Bayes theorem, Discrete and continuous random variables, Binomial, Uniform, Poisson, Exponential, Normal distributions. | **08 Hours**<br>**L2, L3** |
| **Module 4**<br>Joint distributions of two discrete random variables, Marginal distributions, Expectation and Covariance. Transformation of random variables, Central limit theorem and law of large numbers. | **08 Hours**<br>**L2, L3** |



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| Module 5 | 08 Hours |
|---|---|
| Sampling, Sampling distributions, standard error, test of hypothesis for means and proportions, student's t-distribution, chi-square distribution as a test of goodness of fit. | L2, L3 |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO301.1** | • Apply Cauchy Riemann equations in Cartesian as well as in polar coordinates to study properties of analytic functions<br>• Apply the Milne-Thomson method to construct analytic functions |
| **CO301.2** | • Define conformal and bilinear transformation and discuss their properties<br>• Apply Cauchy's theorem and Cauchy's integral formula to solve problems in complex analysis<br>• Apply the residue theorem to evaluate complex line integrals |
| **CO301.3** | • Describe the properties and characteristics of random variables, including their probability distributions, probability mass/density functions, and cumulative distribution functions.<br>• Solve problems using binomial, Poisson, exponential and normal distributions |
| **CO301.4** | • Compute joint probabilities, marginal probabilities, and expectations and covariance using joint distributions.<br>• Understand the concept of a transformed random variable and the associated probability distributions.<br>• Solve problems that involve the use of the central limit theorem and the law of large numbers. |
| **CO301.5** | • Determine the appropriate test statistic (z-test or t-test), Conduct hypothesis tests for population means and proportions, and interpret the results.<br>• Conduct chi-square tests of goodness of fit and interpret the results |

**Textbooks:**


1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers 44th Edition, 2017
2. T Veerarajan, Probability, Statistics and Random Processes for Engineers, Tata McGraw Hill, 3rd Edition, 2008


**Reference books:**


1. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill, 2006
2. N.P.Bali and Manish Goyal, A Textbook of Engineering Mathematics, Laxmi Publications 6 th Edition, 2014
3. Richard H Williams, Probability, Statistics and Random Processes for Engineers, Cengage Learning, 1st Edition, 2003.


**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a

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maximum of three sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. Average of Marks scored in all three tests is added to test component. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests. **Some possible AATs:** seminar/assignments/ mini projects / concept videos/ partial reproduction of research work/ group activity/ any other.

**Typical Evaluation pattern for regular courses is shown in Table 2.**

**Table 2: Distribution of weightage for CIE & SEE of Regular courses**

| Component | | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | **40** | |
| | CIE Test-3 | **40** | |
| | Assignments | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO** | PO1 | PO2 | PO3 | PO12 |
|---|---|---|---|---|
| **CO301.1** | 3 | 2 | 1 | 3 |
| **CO301.2** | 3 | 2 | 1 | 3 |
| **CO301.3** | 3 | 2 | 1 | 3 |
| **CO301.4** | 3 | 2 | 1 | 3 |
| **CO301.5** | 3 | 2 | 1 | 3 |
| **Average** | 3 | 2 | 1 | 3 |

**Low-1: Medium-2: High-3**

# SEMESTER – III

**COURSE: MECHANICS OF MATERIALS**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23302** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:2** | **SEE Marks** | **50** |
| **No. of Credits** | **4** | **Examination Hours** | **03** |

**Course Objectives:** To enable students to apply the knowledge of Mechanics of Material in broad domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CLO1** | To understand the concepts of stress and strain. |
| **CLO2** | To study the concept of shearing force and bending moment due to external loads. |
| **CLO3** | To determine stresses and deformation under bending and shear load. |
| **CLO4** | To determine stresses and deformation in circular shafts due to torsion, also to determine deflection in beams. |
| **CLO5** | To study the stresses and deformations induced in thin and thick shells. |

| **Content** | **No. of Hours/ RBT levels** |
|---|---|
| **Module 1**<br>**Stresses and Strains:** Introduction to Stress, Types of stress, Strain, Types of Strain, Modulus of Elasticity, True Stress, True Strain, Simple problems, Stress Strain Diagram of Ductile, Brittle, Visco- Elastic, Linear & Non-linear Elastic materials, Bars with varying sections, Bars of composite sections, Simple problems, Thermal stresses, Simple problems, Elastic constants and its relation, volumetric stains, Simple problems. | **08 Hours** |
| **Module 2**<br>**Compound Stresses:** Methods of Determining stresses in oblique sections, Principal planes and stresses, Simple problems, Construction of Mohr's circle, simple problems.<br>**Shear Force and Bending Moment Diagram:** Introduction to shear force, bending moment, Types of Beams and loads, sign convention for shear force and bending moment, Shear force and bending moment diagram for various beams. Relation between shear force and bending moment. | **08 Hours** |
| **Module 3**<br>**Bending Stresses and shear stress in Beams:** Introduction, Pure Bending and Simple Bending, Expression of Bending stress, Neutral axis and Moment of resistance, bending stress in symmetrical sections, Section modulus, Section modulus for various shapes of the beam section. Introduction to shear stress, shear stress distribution for different section | **08 Hours** |

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| | |
|---|---|
| **Module 4**<br>**Torsion of Shafts:** Introduction to torsion, Derivation of shear stress produced in a circular shaft subjected to Torsion, Expression of Torque in terms of polar moment of Inertia, Power transmitted by shaft, simple problem. | **08 Hours** |
| **Module 5**<br>**Column and struts:** Introduction to columns and struts, Failure of a column, Expression of crippling load when (a) both ends are hinged (b) One end of the column is fixed and the other end is free (c) both ends are fixed (d) One end is fixed and the other end is hinged. Simple problems to be solved used Euler's formula and Rankine formula.<br>**Thick and Thin cylinders:** Thin cylinders subjected to internal pressure. Stresses in a thin cylinder subjected to internal pressure, Expression of circumferential stress and hoop stress, Simple problems Thick Cylinder: Lame's theorem, Stresses in a thick cylinder, Simple problems to be solved. | **08 Hours** |

## LIST OF EXPERIMENTS

1. Brinell hardness test on various specimens.
2. Rockwell hardness test on various specimens.
3. Vicker's hardness test on various specimens.
4. Izod test on various specimens using impact-testing machines.
5. Charpy test on various specimens using impact-testing machines.
6. Preparation and study of the Microstructure of pure metals Mild Steel, Low Carbon steel and High Carbon Steel.
7. To study the defects of cast and welded components using non-destructive tests:

a. Magnetic crack detection.
b. Dye penetration testing.

8. Tensile test of metallic and non-metallic specimen using Universal Testing Machine.
9. Compression test of metallic and non-metallic specimen using Universal Testing Machine.
10. Shear and Bending tests of metallic and non-metallic specimen using Universal Testing Machine.
11. Torsion test on metallic specimen using torsion testing machine.
12. To study the wear characteristics of metals and non-metal materials under different parameters.
13. Fatigue Test (demonstration only).

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO302.1** | Understand and apply the principles of stresses and strains. |
| **CO302.2** | Proficient in determining stresses in oblique sections and analysing principal planes and stresses |

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| | |
|---|---|
| **CO302.3** | Demonstrate a deep understanding of Bending Stresses and Shear Stress in Beams |
| **CO302.4** | Evaluate torsional behaviour of shaft material and the hardness of the ferrous and non-ferrous materials. |
| **CO302.5** | Analyse the behaviour of columns and struts, understanding the failure of columns, and calculating the crippling load under various conditions. Also, the stress distribution in thick and thin cylinder. |

**Textbooks:**


1. R K Bansal, Strength of Materials, Laxmi Publication Pvt Ltd., New Delhi, 2004.
2. Ramamrutham, Strength of Materials, Vikas Publication, New Delhi, Eighth edition (2014).
3. Gere and Timoshenko, Mechanics of materials, CBS Publishers & Distributors, 2nd edition, 2006.


**Reference books:**


1. Egor P. Popov, Engineering Mechanics of Solids, PHI publications 2nd edition.
2. R.c Hibbeler , Mechanics of materials, Pearson publications, 9th edition. 2016
3. B.C. Punmia, Ashok Kumar Jain & Arun Kumar Jain, Mechanics of Materials, Laxmi publications, New Delhi, 2006


**Web references/ links**

**https://freevideolectures.com/course/96/strength-ofmaterials**

**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of three sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. Average of Marks scored in all three tests is added to test component. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests. **Some possible AATs:** seminar/assignments/ mini projects/ concept videos/ partial reproduction of research work/ group activity/ any other.



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**Typical Evaluation pattern for regular courses is shown in Table 2.**

**Table 2: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **30** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Laboratory | **20** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO302.1** | 3 | 3 | 2 | 2 | - | - | - | - | 1 | - | - | 1 | 3 | - |
| **CO302.2** | 3 | 3 | 2 | 2 | - | - | - | - | 1 | - | - | 1 | 3 | - |
| **CO302.3** | 3 | 3 | 2 | 2 | - | - | - | - | 1 | - | - | 1 | 3 | - |
| **CO302.4** | 3 | 3 | 2 | 2 | - | - | - | - | 1 | - | - | 1 | 3 | - |
| **CO302.5** | 3 | 3 | 2 | 2 | - | - | - | - | 1 | - | - | 1 | 3 | - |
| **Average** | **3** | **3** | **2** | **2** | **-** | **-** | **-** | **-** | **1** | **-** | **-** | **1** | **3** | **-** |

**Low-1: Medium-2: High-3**

# SEMESTER – III

## COURSE: FLUID MECHANICS

| **Course Code** | **ANE23303** | **CIE Marks** | **50** |
|---|---|---|---|
| **Hours/Week (L: T: P)** | **3:0:2** | **SEE Marks** | **50** |
| **No. of Credits** | **4** | **Examination Hours** | **03** |

**Course Objectives:** To enable students to apply the knowledge of Fluid Mechanics in broad domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CLO1** | The properties of fluids and its Characteristic are studied |
| **CLO2** | To understand the importance of dimensional analysis |
| **CLO3** | The applications of the conservation laws to flow through pipes are studied |

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| | |
|---|---|
| **CLO4** | To understand the importance of Flow Measuring devices. |
| **CLO5** | To understand the importance of turbo machines. |

| Content | No. of Hours/RBT levels |
|---|---|
| **Module 1**<br>**Fluids**: Introduction, Properties of fluids, Viscosity, Types of fluids, Compressibility and Bulk Modulus.<br><br>**Fluid Statics**: Fluid Pressure at a Point, Pascal's law, Pressure variation in a Static fluid, Absolute, Gauge, Atmospheric and Vacuum Pressures. Simple Manometer and Differential Manometer. | **08 Hours** |
| **Module 2**<br>**Fluid Kinematics:** Types of Fluid Flow, Continuity Equation in 2D and 3D Velocity and Acceleration. Velocity Potential Function and Stream Function, Flow net, Fundamentals of flow visualization streamlines, stream tube, timeline, path lines, streak lines, flow visualization techniques. Vortex Flow - Free and Forced Vortex. | **08 Hours** |
| **Module 3**<br>**Dimensional Analysis:** Introduction, Derived Quantities, Dimensions of Physical Quantities, Dimensional Homogeneity, Rayleigh's Method, Buckingham's Π Theorem, Types of Similarities and Dimensionless Numbers, Similitude and model studies. | **08 Hours** |
| **Module 4**<br><br>**Fluid Dynamics**: Introduction, Equation of motion, Euler's equation of Motion, Bernoulli's equation from first principles, limitations of Bernoulli's equation. Venturi meter, Orifice meter, V-Notch and Rectangular notches.<br><br>**Flow through pipes**: Minor Energy losses through pipes. Darcy's and Chezy's equation for loss of head due to Friction in pipes. | **08 Hours** |
| **Module 5**<br><br>**Turbines:** Impact of jets - Velocity Triangles Classification of turbines - Working principles - Modern Francis turbine - Kaplan turbine<br><br>**Pumps:** Classification of pumps - Centrifugal pumps - Working principle - Heads and efficiencies– Velocity triangles - Work done by the impeller. | **08 Hours** |

**LIST OF EXPERIMENTS**

1. Determine the flow of fluid using Venturi meter and

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coefficient of discharge of Venturi meter.

2. Determine the flow of fluid using Orifice-meter and determine the coefficient of discharge.
3. Determine the coefficient of discharge of Notches (V-type and rectangular types)
4. Determination of Vane Coefficient for Flat Vane and Semi-circular Vane.
5. Determination of Minor Losses in Flow through pipes.
6. Determination of Coefficient of Friction of flow in a pipe.
7. Experimental Validation of Bernoulli's Equation through Fluid Flow.
8. Performance Characteristics of single stage Centrifugal Pump.
9. Performance testing of a Single stage Reciprocating Pumps.
10. Performance test of a two stage Reciprocating Air Compressor.
11. Performance Characteristics of Kaplan Turbine.
12. Performance Characteristics of Francis Turbine.

**COURSE OUTCOMES:** Upon completion of this course, student will be able to:

| | |
|---|---|
| **CO303.1** | Apply Fundamental knowledge to Predict the Properties and Characteristics of fluid. |
| **CO303.2** | Understand the Kinematics of fluid flow and Continuity Equation. |
| **CO303.3** | Apply principle of dimensional analysis & similitude to simple engineering problems. |
| **CO303.4** | Analyze the Forces and energy for the fluid flow in a conduit and compare the different flow Measuring devices. |
| **CO303.5** | Analyse the Performance & efficiency of Turbo machines. |

**Textbooks:**

1. R K Bansal, "Fluid Mechanics and Hydraulic machines", Lakshmi Publications, revised 9th Edition 2015.
2. Frank M. White "Fluid Mechanics", Seventh Edition, McGraw-Hill Companies,Inc. Publications, New York 2011.

**Reference books:**

1. Graebel W.P, "Engineering Fluid Mechanics", Taylor & Francis, Indian Reprint, 2011
2. Kumar K. L., "Engineering Fluid Mechanics", Eurasia Publishing House(p) Ltd., New Delhi 2016

**Web references/ links**

Mod-01 Lec-01 Introduction and Fundamental Concepts – I

Scheme of Examination:

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will beproportionately reducedto 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20

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marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. The average of the three tests are taken for computation of CIE-on a scale of 30, the CIE would also include laboratory evaluation for 20 marks. The laboratory marks of 20 would comprise of 10 marks for regular laboratory assessment to include lab record and observation. 10 marks would be exclusive for laboratory internal assessment test to be conducted at the end of the semester

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **30** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Laboratory | **20** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO303.1** | 3 | 3 | 1 | 2 | - | - | - | 1 | 2 | 2 | - | 1 | 3 | - |
| **CO303.2** | 3 | 3 | 1 | 2 | - | - | - | 1 | 2 | 2 | - | 1 | 3 | - |
| **CO303.3** | 3 | 3 | 1 | 2 | - | - | - | 1 | 2 | 2 | - | 1 | 3 | - |
| **CO303.4** | 3 | 3 | 1 | 2 | - | - | - | 1 | 2 | 2 | - | 1 | 3 | - |
| **CO303.5** | 3 | 3 | 1 | 2 | - | - | - | 1 | 2 | 2 | - | 1 | 3 | - |
| **Average** | 3 | 3 | 1 | 2 | - | - | - | 1 | 2 | 2 | - | 1 | 3 | - |

**Low-1: Medium-2: High-3**

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# SEMESTER – III

**COURSE: AERO ENGINEERING THERMODYNAMICS**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23304** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **2:2:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Course Learning Objectives:** To enable students to apply the knowledge of

| | |
|---|---|
| **CLO1** | Basic knowledge on the fundamental concepts of thermodynamics |
| **CLO2** | The First law of thermodynamics and its application in Various flow systems |
| **CLO3** | The second law of thermodynamics applies to systems and the concept of entropy. |
| **CLO4** | Basic knowledge on standard air cycles |
| **CLO5** | To get exposure to the basic concepts of Heat and Mass transfer. |

Aero Thermodynamics in broad domain of Aeronautical Engineering by making them to learn:

| **Content** | **No. of Hrs /RBT Levels** |
|---|---|
| **Module-1**<br>**Fundamental Concepts:** Continuum and macroscopic approach; Thermodynamic Systems: open, closed and isolated; Thermodynamic properties and equilibrium; State of a system, state postulate for simple compressible substances, state diagrams, paths and processes on state diagrams; zeroth law of thermodynamics; concept of temperature. | **08Hours** |
| **Module-2**<br>**First Law of Thermodynamics:** Concept of energy and various forms of energy; concepts of heat and work, different modes of work; internal energy, enthalpy; specific heats; first law applied to elementary processes, closed systems and control volumes, steady flow analysis of nozzles, diffusers, throttling devices, mixing, turbines and compressors; unsteady flow analysis. | **08 Hours** |
| **Module-3**<br>**Second Law of Thermodynamics and Entropy:** Limitations of the first law of thermodynamics, concepts of heat engines and heat pumps/refrigerators, Kelvin-Planck and Clausius statements and their equivalence; reversible and irreversible processes. Carnot cycle and Carnot theorems; thermodynamic temperature scale; Clausius inequality and concept of entropy; the principle of increase of entropy, T-s diagrams; availability and irreversibility | **08 Hours** |
| **Module-4**<br>**Air Standard Cycles:** Otto, Diesel, Dual, Ericsson, Atkinson, Stirling and Brayton cycles - air standard efficiency - Mean effective Pressure. | **08 Hours** |
| **Module-5**<br>**Basics of Heat and Mass Transfer:** Modes of heat transfer, Basic laws governing Heat transfer, combined heat transfer mechanism. Boundary | **08Hours** |

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| | |
|---|---|
| conditions of 1st, 2nd and 3rd kind. Introduction to mass transfer, definition and terms used in mass transfer, Fick's law of diffusion, Numerical. | |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO304.1** | Apply the laws of thermodynamics in various engineering problems. (L3) |
| **CO304.2** | Identify thermodynamic work and heat (L3) |
| **CO304.3** | Analyze the feasibility of design variables using thermodynamics principles. (L4) |
| **CO304.4** | Analyze the different types of air standard cycles. (L4) heat |
| **CO304.5** | Identify the modes of heat transfer involving several heat transfer mechanisms. (L3) |

**Textbooks:**


1. Yunus A. Cengel and Michael A. Boles, "Thermodynamics: An Engineering Approach" 9th ed., McGraw Hill Publishing Company Limited.
2. Yunus A Cengel, Heat and Mass Transfer - A Practical Approach, 5th ed., McGraw Hill Publishing Company Limited.
3. Nag.P.K., "Engineering Thermodynamics", Tata McGraw-Hill, New Delhi, 2013.
4. Rathakrishnan E., "Fundamentals of Engineering Thermodynamics", Prentice-Hall India, 2005.


**Reference books:**


1. Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2003.
2. Holman.J.P., "Thermodynamics", 3rd Edition, McGraw-Hill, 2007.
3. Merala C, Pother, Craig W, Somerton, "Thermodynamics for Engineers", Schaum Outline Series,Tata McGraw-Hill, New Delhi, 2004.
4. Ramalingam K.K. "Thermodynamics", Sci-Tech Publications, 2006
5. Venwylen and Sontag, "Classical Thermodynamics", Wiley Eastern, 1987.
6. Incropera, DeWitt, "Fundamentals of Heat and mass transfer", John Wiley and Sons, 6 th Edition, 2005.
7. Hegde, R.K., Heat and Mass Transfer - Basic Approach, Sapna book House, Bangalore


**Web references/ Additional online information (related to module if any):**

1. https://nptel.ac.in/courses/101/104/101104067/
2. https://nptel.ac.in/courses/101/104/101104067/
3. https://nptel.ac.in/courses/101/104/101104067/
4. https://nptel.ac.in/courses/101/104/101104067/
5. https://nptel.ac.in/courses/101/104/101104067/
6. https://nptel.ac.in/courses/112201097/

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**Practical knowledge references**

1. https://www.youtube.com/watch?v=suuTC9uGLrI
2. https://www.youtube.com/watch?v=suuTC9uGLrIhttps://www.youtube.com/watch?v=7bJywbP7ZIU
3. https://www.youtube.com/watch?v=7OJGZHrbD8
4. https://www.youtube.com/watch?v=7OJG-ZHrbD8https://www.youtube.com/watch?v=7bJywbP7ZIU
5. https://www.youtube.com/watch?v=7bJywbP7ZIUhttps://www.youtube.com/watch?v=2vHLJjlinjw
6. https://www.youtube.com/watch?v=Juz9pVVsmQQhttps://www.youtube.com/watch?v=Juz9pVVsmQQ
7. https://www.youtube.com/watch?v=L1AHGHRvv9s
   Scheme of Examination:
   Semester End Examination (SEE):

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes/ Alternate Assessment Tools (AATs) for 10 marks. Typical Evaluation pattern for regular courses is shown in Table 1.

Table1: Distribution of weightage for CIE & SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quiz 1/AAT | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO304.1** | 3 | 2 | - | - | - | - | 1 | - | 1 | 1 | - | 1 | 3 | - |

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| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO304.2** | 3 | 2 | - | - | - | - | 1 | - | 1 | 1 | - | 1 | 3 | - |
| **CO304.3** | 3 | 2 | 2 | - | - | - | 1 | - | 1 | 1 | - | 1 | 2 | - |
| **CO304.4** | 2 | 2 | 2 | - | - | - | 1 | - | 1 | - | - | 1 | 3 | - |
| **CO304.5** | 3 | 2 | - | - | - | - | 1 | - | 1 | 1 | - | 1 | 3 | - |
| **Average** | 3 | 2 | - | - | - | - | 1 | - | 1 | 1 | - | 1 | 3 | - |

## SEMESTER – III

**COURSE: ELEMENTS OF AERONAUTICS**

| **Course Code** | **ANE23305** | **CIE Marks** | **50** |
|---|---|---|---|
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Course Objectives:** To enable students to apply the knowledge of Introduction to Aeronautical Engineering in broad domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CLO1** | Understand the Historical evaluation of Airplanes & different structures & construction |
| **CLO2** | Understand the basic properties and principles behind the flight |
| **CLO3** | Study the various types of power plants used in aircrafts |
| **CLO4** | Study of the aircraft Stability |
| **CLO5** | Study the different component systems and functions |

| **Content** | **No. of Hours/ RBT levels** |
|---|---|
| **Module 1**<br>**Introduction to Aircrafts**<br>History of aviation; Atmosphere and its properties; Classification of aircrafts; Basic components of an aircraft; structural members; aircraft axis system; aircraft motions; control surfaces and high lift devices; conventional design configurations; Helicopters, their parts and functions.<br>**Aircraft Structures and Materials**<br>Introduction; general types of construction; monocoque, semi monocoque and geodesic structures; typical wing and fuselage structure; metallic and non-metallic materials for aircraft application. | **08 Hours L3** |



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| | |
|---|---|
| **Module 2**<br>**Aerodynamics**<br>Basic principles of flight – significance of speed of sound; airspeed and groundspeed; Bernoulli's theorem; forces over wing section, aero foil nomenclature, pressure distribution over a wing section. Lift and drag components, lift curve, drag curve, types of drag, factors affecting lift and drag; Centre of pressure and its significance; aerodynamic Centre, aspect ratio, Mach number and supersonic flight. | **08 Hours L3** |
| **Module 3**<br>**Aircraft Propulsion**<br>Aircraft power plants, classification based on power plant and principle of operation. Turboprop, turbojet and turbofan engines; ramjets and scramjets; performance characteristics. Aircraft power plants – basic principles of piston, turboprop and jet engines; Brayton cycle and its application to gas turbine engines; use of propellers and jets for production of thrust; comparative merits and limitations of different types of propulsion engines; principle of thrust augmentation. | **08 Hours L3** |
| **Module 4**<br>**Aircraft Stability**<br>Forces on an aircraft in flight; static and dynamic stability; longitudinal, lateral and roll stability; necessary conditions for longitudinal stability; basics of aircraft control systems. Performance of aircraft – power curves, maximum and minimum speeds for horizontal flight at a given altitude; effect of changes in engine power and altitude on performance; correct and incorrect angles of bank; aerobatics. | **08 Hours L3** |
| **Module 5**<br>**Aircraft Systems**<br>Mechanical systems and their components; hydraulic and pneumatic systems; oxygen System; environmental Control System; fuel system. Electrical systems, flight deck and cockpit systems; navigation system, communication system. Flight control system, cockpit instrumentation and displays; communication systems; navigation systems; power generation systems – engine driven alternators, auxiliary power Module, ram air turbine; power conversion, distribution and management. | **10 Hours L3** |

**COURSE OUTCOMES:Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO305.1** | Learn the history of aircraft & developments over the years, acquire knowledge on Aircraft differentiate types and constructions |
| **CO305.2** | Understand the basic concepts of flight & Physical properties of Atmosphere |
| **CO305.3** | Understand the Different types of Engines and principles of Rocket |
| **CO305.4** | Understand the Basics of aircraft Stability |
| **CO305.5** | Ability to identify the types & classifications of components and control systems |

**Textbooks:**

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1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition, 2015
2. Handbooks of Airframe and Power Plant Mechanics, US dept. of Transportation, Federal, Aviation Administration, the English Book Store, New Delhi, 1995.
3. Mekinley, J.L. and R.D. Bent, Aircraft Power Plants, McGraw Hill 1993.
4. Pallet, E.H.J. Aircraft Instruments & Principles, Pitman & Co 1993.
5. Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

**Reference books:**

1. Kermode, A.C. Flight without Formulae, Pearson Education; Eleven edition, 2011 2. McKinley, J.L. and Bent R.D. Aircraft Maintenance & Repair, McGraw Hill, 1993.

**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| CO/PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO305.1** | 3 | 3 | - | - | - | - | - | - | - | - | - | 3 | 3 | - |
| **CO305.2** | 3 | 3 | - | - | - | - | - | - | - | - | - | 3 | 3 | - |
| **CO305.3** | 3 | 3 | - | - | - | - | - | - | - | - | - | 3 | 3 | - |
| **CO305.4** | 3 | 3 | - | - | - | - | - | - | - | - | - | 3 | 3 | - |
| **CO305.5** | 3 | 3 | - | - | - | - | - | - | - | - | - | 3 | 3 | - |

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| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Average** | 3 | 3 | - | - | - | - | - | - | - | - | - | 3 | 3 | - |

**Low-1: Medium-2: High-3**

## SEMESTER – III

**COURSE: SOCIAL CONNECT AND RESPONSIBILITY**

| | | | |
|---|---|---|---|
| **Course Code** | **SCK23306** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **0:0:2** | **SEE Marks** | **50** |
| **No. of Credits** | **1** | **Examination Hours** | **03** |

**Course Objectives:** To enable students to apply the knowledge of Introduction to Aeronautical Engineering in broad domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CLO1** | Provide a formal platform for students to communicate and connect to the surrounding. |
| **CLO2** | . create a responsible connection with the society. |
| **CLO3** | Understand the community in general in which they work. |
| **CLO4** | Identify the needs and problems of the community and involve them in problem – solving. |
| **CLO5** | Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems. |
| **CLO6** | . Develop competence required for group-living and sharing of responsibilities & gain skills in mobilizing community participation to acquire leadership qualities and democratic attitude |

| **Content** | **No. of Hours/ RBT levels** |
|---|---|
| **Module 1**<br>Plantation and adoption of a tree: Plantation of a tree that will be adopted for four years by a group of BE / B.Tech students. (ONE STUDENT ONE TREE) They will also make an excerpt either as a documentary or a photo blog describing the plant's origin, its usage in daily life, its appearance in folklore and literature - – Objectives, Visit, case study, report, outcomes. | **08 Hours**<br>**L3** |
| **Module 2**<br>Heritage walk and crafts corner: Heritage tour, knowing the history and culture of the city, connecting to people around through their history, knowing the city and its craftsman, photo blog and documentary on evolution and practice of various craft forms - – Objectives,Visit, case study, report, outcomes. | **08 Hours**<br>**L3** |
| **Module 3** | **08 Hours** |

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| | |
|---|---|
| Organic farming and waste management: Usefulness of organic farming, wet waste management in neighboring villages, and implementation in the campus- Objectives,Visit, case study, report, outcomes. | **L3** |
| **Module 4**<br>Water conservation: Knowing the present practices in the surrounding villages and implementation in the campus, documentary or photoblog presenting the current practices – Objectives, Visit, case study, report, outcomes. | **08 Hours**<br>**L3** |
| **Module 5**<br>Food walk: City's culinary practices, food lore, and indigenous materials of the region used in cooking – Objectives, Visit, case study, report, outcomes | **08 Hours**<br>**L3** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO306.1** | Communicate and connect to the surrounding. |
| **CO306.2** | Create a responsible connection with the society. |
| **CO306.3** | Involve in the community in general in which they work. |
| **CO306.4** | Notice the needs and problems of the community and involve them in problem – solving. |
| **CO306.5** | : Develop among themselves a sense of social & civic responsibility & utilize their knowledge in finding practical solutions to individual and community problems. |

## SEMESTER-III

## ABILITY ENHANCEMENT COURSE

**COURSE: AEROSPACE MATERIALS AND DIGITAL MANUFACTURING**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23307A** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **2:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **2** | **Examination Hours** | **03** |

**Course Objectives:** To enable students to apply the knowledge of Aircraft Materials and Production in broad domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CLO1** | Learn about the basic properties of the materials used in aerospace industries |
| **CLO2** | Know about ferrous and non-ferrous materials used in aerospace industry |
| **CLO3** | Understand the significance of composites in aircraft industry |
| **CLO4** | Familiarize with the sheet metal and riveting process |
| **CLO5** | To study about the additive manufacturing technology |



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| Content | No. of Hours/RBT levels |
|---|---|
| **Module 1**<br>**Mechanical Behavior of Engineering Materials**: Introduction to aerospace materials and their classification, Linear and non-linear elastic properties, various material testing machines.<br>**Non-ferrous materials in aircraft construction**: Aluminum and its alloys: Types and identification. Properties -Castings- Heat treatment processes - Surface treatments. Magnesium and its alloys: Cast and Wrought alloys - Aircraft application, features specification, fabrication problems, Special treatments.<br>Titanium and its alloys: Applications, machining, forming, welding and heat treatment, other alloys used in aircrafts. | **08 Hours/ L2** |
| **Module 2**<br>**Aircraft Composites:** Polymer composites, metal matrix composites and ceramic composites in aerospace industry-Basics, Types, significance, properties, advantages, disadvantages and application in aero industry. C-C composites, ablative materials, Ultra high temperature ceramics. Composite repairing. | **08 Hours/ L2** |
| **Module 3**<br>**Sheet Metal Processes in Aircraft Industry** Sheet metal operations: shearing, punching, super plastic forming; operations in bending like stretch forming spinning drawing. Riveting, types and techniques, equipment, fasteners, integral tanks, Jigs and Fixtures. | **08 Hours/ L2** |
| **Module 4**<br>**Additive Manufacturing Technology:** Principle, Advantages of additive manufacturing, General limitation of additive manufacturing, development of additive manufacturing technology: Lasers, Printing Technologies, Programmable Logic Controllers, Materials, Computer Numerically Controlled Machining. Fused deposition Modeling (FDM): Principle, details of processes. | **10 Hours/ L2** |
| **Module 5**<br>**Solid Based Additive Manufacturing Systems:** Fused deposition Modeling (FDM): Principle, details of processes.<br>**Liquid Based Additive Manufacturing Systems**: Stereolithographic Apparatus (SLA): Principle.<br>**Powder Based Additive Manufacturing Systems:** SLS process description, Powder fusion mechanisms | **08Hours/ L2** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO307A.1** | Apply knowledge to grasp the fundamental properties of aerospace materials. |
| **CO307A.2** | Analyze and select appropriate composites for specific aircraft applications |
| **CO307A.3** | Differentiate and describe the sheet metal and fabrication processes employed in the aircraft industry. |

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| | |
|---|---|
| **CO307A.4** | Comprehensively analyze additive manufacturing processes and their applications in aerospace. |
| **CO307A.5** | Comprehend the additive manufacturing processes |

**Textbooks:**


1. Aircraft Material and Processes Titterton G F Lienhard V English Book Store, New Delhi 5th Ed.,1998
2. S. Kalpakjian, Steven R. Schmid, "Manufacturing Engineering and Technology", Addison Wesley, 5th Edition, 1991.
3. Gibson l D. W. Rosen l B. Stucker, Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.


**Reference books:**


1. Autar Kaw, Mechanics of Composites, CRC Press, II edition,2006
2. O. P. Khanna, M. Lal, "Production technology", Dhanpat Rai Publications, 5th Edition, 1997


**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |



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| CO/PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO307A.1** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.2** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.3** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.4** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.5** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **Average** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |

**Low-1: Medium-2: High-3**

# SEMESTER-III

## ABILITY ENHANCEMENT COURSE

### COURSE: DEVELOPMENT OF SOFT SKILLS FOR ENGINEERS

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23307B** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **2:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **2** | **Examination Hours** | **03** |

**Course Objectives:** This course will enable students to

| | |
|---|---|
| **CLO1** | Understand the significance of soft skills for engineers |
| **CLO2** | Acquire verbal and non-verbal communication skills |
| **CLO3** | Get the essence of personal and professional leadership skills |

| Content | No. of Hours/RBT levels |
|---|---|
| **Module 1**<br>Foundations of everyday leadership, Emotional intelligence, Leadership and collaborative abilities, Listening skills, Research and analytical skills | **08Hours** |
| **Module 2**<br>Verbal and non-verbal communication, Stress Management and Tolerance, Email Writing, Public speaking and presentation | **08 Hours** |
| **Module 3**<br>Negotiation skills, and diffusing project conflict, managing project risks and | |

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| | |
|---|---|
| changes, scope , time and cost management, Strategic Planning | **08 Hours** |
| **Module 4**<br>Creativity and vision, Problem-solving, writing code and cross-functional skill digital product management | **08 Hours** |
| **Module 5**<br>Adaptability and staying positive, Applications of everyday leadership, Teamwork and people skills | **08Hours** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO307B.1** | Apply soft skills for engineering profession. |
| **CO307B.2** | Practise both verbal and non-verbal communication skills effectively. |
| **CO307B.3** | Use personal and professional leadership skills |

**Suggested Learning Resources: Books**

1. Fast-Tracking Your Career: Soft Skills for Engineering and IT Professionals 1st Edition by Wushow Chou (Author)
2. Soft Skills 3rd Edition: Personality Development for Life Success Paperback – 30 October 2021 by Prashan Sharma (Author)

**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |

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| | |
|---|---|
| **Grand Total** | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO307A.1** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.2** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.3** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.4** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.5** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **Average** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |

**Low-1: Medium-2: High-3**

## SEMESTER-III

## ABILITY ENHANCEMENT COURSE

### COURSE: ETHICS, TECHNOLOGY AND ENGINEERING

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23307C** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **2:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **2** | **Examination Hours** | **03** |

**Course Objectives:** This course will enable students to

| | |
|---|---|
| **CLO1** | Learn ethical values in engineering |
| **CLO2** | Understand how ethics are followed in technology and engineering. |
| **CLO3** | Share the ethical practices |

| **Content** | **No. of Hours/RBT levels** |
|---|---|
| **Module 1**<br>**Moral sensibility**: the ability to recognize social and ethical issues in engineering | **08Hours** |
| **Module 2**<br>**Moral analysis skills**: the ability to analyse moral problems in terms of facts, values, stakeholders and their interests; | **08 Hours** |

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| | |
|---|---|
| | |
| **Module 3**<br>**Moral creativity**: the ability to think out different options for action in the light of (conflicting) moral values and the relevant facts; | **08 Hours** |
| **Module 4**<br>**Moral judgement skills:** the ability to give a moral judgement on the basis of different ethical theories or frameworks including professional ethics and common sense morality; | **08 Hours** |
| **Module 5**<br>**Moral decision-making skills:** the ability to reflect on different ethical theories and frameworks and to make a decision based on that reflection. | **08Hours** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO307C.1** | Develop Ethical values in engineering and Technology |
| **CO307C.2** | Adopt ethical practices |
| **CO307C.3** | Assimilate the ethics in Engineering and Technology |

**Suggested Learning Resources: Books**

1. Ethics, Technology and Engineering , An Introduction- Wiley-Blackwell (an imprint of John Wiley & Sons Ltd)
2. Ethics in Engineering | 4th Edition Paperback – 1 July 2017by Mike W. Martin (Author)

**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |



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| | | | |
|---|---|---|---|
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO307A.1** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.2** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.3** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.4** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.5** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **Average** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |

**Low-1: Medium-2: High-3**

# SEMESTER-III

# ABILITY ENHANCEMENT COURSE

## COURSE: DIGITALIZATION IN AERONAUTICS

| **Course Code** | **ANE23307D** | **CIE Marks** | **50** |
|---|---|---|---|
| **Hours/Week (L: T: P)** | **2:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **2** | **Examination Hours** | **03** |

**Course Objectives:** This course will enable students to

| | |
|---|---|
| **CLO1** | To become familiar with digitalization in Aeronautics |
| **CLO2** | To understand the importance of digitalization |
| **CLO3** | To accelerate the learning of digitalization in Aeronautics |

| **Content** | **No. of Hours/RBT levels** |
|---|---|
| **Module 1**<br>Digitalisation and the Future of the Aerospace Industry, Digitization in Production, Human Factors 4.0: Requirements and challenges for humans, teams and organizations | **08Hours** |
| **Module 2**<br>Managing Maintenance, Repair and Overhaul for Civil Aircraft, The psycho- | |



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| | |
|---|---|
| social implications of digitalization, Collaborative Aircraft Design | **08 Hours** |
| **Module 3**<br>The Significance of Testing concerning Maintenance of Aircraft, Maintenance in the Age of Digitalisation | **08 Hours** |
| **Module 4**<br>Digital Avionics Networks, Mil-STD, Modeling and Simulation of Aerospace Systems, Digital Models | **08 Hours** |
| **Module 5**<br>Efficient Order Reduction of Parametric Models, Parametric Model Order Reduction for Structural Analysis | **08Hours** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO307D.1** | Develop Ethical values in engineering and Technology |
| **CO307D.2** | Adopt ethical practices |
| **CO307D.3** | Assimilate the ethics in Engineering and Technology |

**Suggested Learning Resources: Books**

1. Aerospace and Digitalization: A Transformation Through Key Industry 4.0 Technologies (Springer Briefs in Applied Sciences and Technology) 1st ed. 2021 Edition by Diego Carou (Author)
2. Digitalisation in Aeronautics and Space by coursera
3. Mastering The Digital World : A Guide To Understanding, Using And Exploiting Digital Media by Peter Cope

**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| | CIE Test-1 | | |

| | | | |
|---|---|---|---|
| CIE | CIE Test-2 | **40** | **50** |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO307A.1** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.2** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.3** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.4** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.5** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **Average** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |

**Low-1: Medium-2: High-3**



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## SEMESTER – III

## PROFESSIONAL COURSE

### COURSE: COMPUTER AIDED AIRCRAFT DRAWING (CAAD)

| | | | |
|---|---|---|---|
| **Course Code** | **ANEL23309** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **0:0:2** | **SEE Marks** | **50** |
| **No. of Credits** | **0** | **Examination Hours** | **3** |

**Prerequisites:** Computer Aided Engineering Drawing.

**Course Objectives:** To enable students to apply the knowledge of Computer Aided Aircraft Drawing in broad domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CLO1** | Acquire the knowledge of basic commands and tools using CATIA software and produce drawings using orthographic projections. |
| **CLO2** | Draw the 3D part Model from the 2D sketches using CATIA software. |
| **CLO3** | Develop Part Models and create assembly using CATIA software. |
| **CLO4** | Convert Assembly drawing into 2D drafting and generate Bill of materials for assembled drawing. |
| **CLO5** | Create exploded views, rendering using CATIA. |

| **Content** | **No. of Hours/RBT levels** |
|---|---|
| **PART-A: INTRODUCTION TO PART DESIGN**<br><br>Perform various options of Sketcher environment. GUI of Part Design workbench. Create and Constrain 2D sketches. Create 3D models using Reference Elements.<br><br>Conversion of 2D aeronautical components to 3D parts and sectional views of simple aeronautical components (Detailed 2D part drawings will be given).<br><br>**ASSEMBLY DESIGN**<br><br>CATIA Assembly. Assembly Relationships<br><br>The Assemble commands and features<br><br>**Introduction to assembly drawing:** | **15 Hours/ L6** |



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| | |
|---|---|
| Assembly of propeller and hub assembly,<br>Wing assembly, Fuselage assembly,<br>Engine mounts assembly, Landing gear assembly.<br>(Detailed 2D part drawings will be given). Students need to complete at least three of the assembly drawings.<br>**PART B: DRAFTING**<br>Creating detailed drawings. Drawing creation. Dimensions, Annotations and Parts Lists. Detailing a drawing. Bill of Materials. Exploded View and rendering<br>**Conversion of Assembled view to 2D drafting.** | **10 Hours/ L6** |

**COURSE OUTCOMES:** Upon completion of this course, student will be able to:

| | |
|---|---|
| **CO309.1** | Sketch the orthographic views of machine components from pictorial view. |
| **CO309.2** | Develop 3D model of machine parts with the knowledge of Modelling Commands. |
| **CO309.3** | Build 3D geometric model of assembly by reading the blueprint of each part. |
| **CO309.4** | Convert assembled 3D model to 2D drafting, Bill of Materials and of components using<br>CAD software. |
| **CO309.5** | Represent an Exploded view and rendering Environment. |

**Textbooks:**


1. K R Gopalakrishna, Machine Drawing in First angle of Projection, Subhas Publications, 23, 2017.
2. N. D. Bhatt, Machine Drawing, Charotar Publication, 50th Edition 2016.


**Reference books:**


1. KL Narayana, P Kannaiah, K V Reddy, Machine Drawing, New Age International Publishers, 6th Edition, 2019.
2. Sidheshwar, Machine Drawing, Tata McGraw-Hill Education, 33 reprint 2006.
3. R. K. Dhawan, Machine Drawing, S Chand Publishing reprint, 2006.


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**Scheme of Examination:**

Semester End Examination (SEE): Distribution of weightage for SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| SEE | PART- A | **20** | **50** |
| | PART- B | **30** | |
| **SEE Total** | | | **50** |

Continuous Internal Evaluation (CIE): Distribution of weightage for CIE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | MANUAL /RECORD | **20** | **50** |
| | CIE Test-1 | **30** | |
| **CIE Total** | | | **50** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO309.1** | 3 | 1 | 3 | - | 3 | - | 2 | - | - | - | - | - | - | 3 |
| **CO309.2** | 3 | 1 | 3 | - | 3 | - | 2 | - | - | - | - | - | - | 3 |
| **CO309.3** | 3 | 1 | 3 | - | 3 | - | 2 | - | - | - | - | - | - | 3 |
| **CO309.4** | 3 | 1 | 3 | - | 3 | - | 2 | - | - | - | - | - | - | 3 |
| **CO309.5** | 3 | 1 | 3 | - | 3 | - | 2 | - | - | - | - | - | - | 3 |
| **Average** | 3 | 1 | 3 | - | 3 | - | 2 | - | - | - | - | - | - | 3 |

**Low-1: Medium-2: High-3**

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# SEMESTER IV SYLLABUS

## SEMESTER IV

### COURSE: TRANSFORMS CALCULUS AND NUMERICAL TECHNIQUES

| Course Code | MAT23401 | CIE Marks | 50 |
|---|---|---|---|
| Hours/Week (L: T: P) | 2:2:0 | SEE Marks | 50 |
| No. of Credits | 3 | Examination Hours | 03 |

**Course Objectives:** To enable students to apply the knowledge of Mathematics in various fields of engineering by making them to learn:

| | |
|---|---|
| **CLO1** | Laplace Transforms |
| **CLO2** | Fourier series and Fourier Transforms |
| **CLO3** | Numerical Methods |

| Content | No. of Hours/ RBT levels |
|---|---|
| **Module 1**<br>Laplace transforms of elementary functions, Unit-step and Dirac delta functions. Inverse Laplace Transforms, Solution of second order linear differential equations using Laplace transforms. | **08Hours** |
| **Module 2**<br>Fourier series of periodic functions, half range Fourier sine and cosine series. Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms. | **08 Hours** |
| **Module 3**<br>Solution of algebraic and transcendental equations: Regula-Falsi and Newton-Raphson method. Finite differences: Newton's forward and backward difference formulae. Newton's divided difference formula and Lagrange's interpolation formula. Numerical integration: Simpson's 1/3rd, 3/8th, Weddle's rule. | **08 Hours** |
| **Module 4**<br>Numerical solution of ordinary differential equations of first order and first degree using Modified Euler method, Runge-Kutta method of fourth order, Milne's and Adam-Bashforth predictor and corrector methods. Numerical | **08 Hours** |



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| | |
|---|---|
| solution of second order ordinary differential equations: Runge-Kutta method and Milne's method. | |
| **Module 5**<br><br>One dimensional wave and heat equation. Solution of heat and wave equation by method of separation of variables. Two-dimensional heat flow, Solution of Laplace's equation, Two-dimensional wave equation. Numerical solution of heat and wave equations. | **08Hours** |

**Textbooks:**

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers 44th Edition, 2017
2. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill, 2006

**Reference books:**

1. E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons 10th Edition, 2016
2. N.P.Bali and Manish Goyal, A Textbook of Engineering Mathematics, Laxmi Publications 6th Edition, 2014

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO401.1** | • Determine Laplace and inverse Laplace transforms of given functions<br>• Solve linear differential equations using Laplace transforms |
| **CO401.2** | • Determine Fourier series including half range sine and cosine series of a given periodic function<br>• Determine infinite Fourier transform including sine and cosine transform of a given function. |
| **CO401.3** | • Solve algebraic and transcendental equations using Regula-Falsi and Newton Raphson methods.<br>• Apply numerical techniques for interpolation of data<br>• Evaluate definite integrals using numerical techniques. |
| **CO401.4** | • Solve ordinary differential equations of first and second order using single step and multistep numerical methods |
| **CO401.5** | • Derive the one-dimensional heat and wave equations and understand their physical meaning.<br>• Apply the method of separation of variables to solve one-dimensional heat and wave equations<br>• Implement numerical schemes, such as the explicit and implicit methods, to solve the heat and wave equations. |

**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of three sub questions) from

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each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. Average of Marks scored in all three tests is added to test component. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests. **Some possible AATs:** seminar/assignments/ mini-projects/ concept videos/ partial reproduction of research work/ group activity/ any other.

Typical Evaluation pattern for regular courses is shown in Table 2.

**Table 2: Distribution of weightage for CIE & SEE of Regular courses**

| Component | | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | **40** | |
| | CIE Test-3 | **40** | |
| | Assignments | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO** | PO1 | PO2 | PO3 | PO12 |
|---|---|---|---|---|
| **CO41.1** | 3 | 2 | 1 | 3 |
| **CO41.2** | 3 | 2 | 1 | 3 |
| **CO41.3** | 3 | 2 | 1 | 3 |
| **CO41.4** | 3 | 2 | 1 | 3 |
| **CO41.5** | 3 | 2 | 1 | 3 |
| **Average** | 3 | 2 | 1 | 3 |

**Low-1: Medium-2: High-3**

# SEMESTER IV

## COURSE: LOW SPEED AERODYNAMICS

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23402** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:2** | **SEE Marks** | **50** |
| **No. of Credits** | **4** | **Examination Hours** | **03** |

**Pre-requisite: Fluid Mechanics**

**Course Objectives:** To enable students to apply the knowledge of aerodynamics in broaddomain of aeronautical engineering by making them to learn:

| | |
|---|---|
| **CO1** | The governing equations of fluid flow for incompressible inviscid flow |
| **CO2** | Understand the concept of superposition of elementary flows for inviscid, incompressible flow |
| **CO3** | Methods for describing airflow around airfoils and calculating Aerodynamic Coefficients |
| **CO4** | Understand the flow behavior over a finite wing and calculating the aerodynamic forces |
| **CO5** | Viscous Flow: boundary layer, velocity profile, thickness and friction coefficient. |

| **Content** | **No. of Hours/ RBT levels** |
|---|---|
| **Module 1**<br>**REVIEW OF BASIC DEFINITIONS & EQUATIONS:** Importance of Aerodynamics, Fundamental aerodynamics, variables and dimensional analysis leading to Forces & Moments coefficient and dimensionless similarity parameters such as Reynolds number, Mach number, Incompressible flow, Compressible flow and Types of Flows. Models of the Fluid: Control volume, and Fluid Elements. Continuity, Momentum and Energy Equations. | **08Hours** |
| **Module 2**<br>**INVISID, INCOMPRESSIBLE FLOW:** Path lines, Streamlines, Streak lines, Angular Velocity, Vorticity, Stream Function and Velocity Potential function and Circulation. Basic flows – Uniform parallel flow, Source and Sink, Doublet, Vortex Flow and Combinations of basic flows. Non lifting flow and Lifting flow over circular cylinder, Kutta Joukowski's theorem and generation of lift. D' Alembert Paradox and Magnus effects. | **08 Hours** |
| **Module 3**<br>**INCOMPRESSIBLE FLOW OVER AIRFOILS:** Complex potential, methodology of conformal transformation, Blasius theorem, Kutta condition, Airfoils Nomenclature and NACA series, Airfoil Characteristics, Stall condition and Flow separation. Vortex sheet, Kelvin Circulation theorem and the Starting Vortex. Classical Thin airfoil theory: The Symmetrical airfoil and its applications. | **08 Hours** |

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| | |
|---|---|
| **Module 4**<br>**INCOMPRESSIBLE FLOW OVER FINITE WING:** Introduction to Finite wing, Downwash and Induced Drag, Vortex Filament, the Biot -Savart law and Helmholtz's theorems, Horseshoe vortex, Prandtl's Classical Lifting line theory and its limitations, Elliptical lift distribution. | **08 Hours** |
| **Module 5**<br>**VISCOUS FLOW:** Boundary layer, Laminar & Turbulent layer, Boundary layer Thickness, Displacement Thickness, Momentum Thickness, Energy Thickness, Boundary layer equation for a steady, two-dimensional incompressible flow, Boundary layer growth over a Flat Plate, Blasius Solution. | **08Hours** |

**LIST OF EXPERIMENTS**

| | |
|---|---|
| **1** | Wind tunnels and its Specifications |
| **2** | Calibration of a Low Subsonic Speed Wind Tunnel |
| **3** | Smoke flow visualization on a Two-Dimensional Circular Cylinder At various air Speeds |
| **4** | Smoke flow visualization studies on a two-dimensional symmetric airfoil at different angle of incidence |
| **5** | Smoke flow visualization studies on a two-dimensional cambered airfoil at different angle of incidence |
| **6** | Tuft flow visualization studies on a two-dimensional airfoil at different angle of incidence at low speeds |
| **7** | Surface pressure distributions on a two-dimensional smooth circular cylinder at low speeds and calculation of pressure drag |
| **8** | Surface pressure distributions on a two-dimensional symmetric airfoil at low speeds and calculation of pressure drag |
| **9** | Surface pressure distributions on a two-dimensional cambered airfoil at various angles of attack and calculation of pressure drag |
| **10** | Calculation of total drag of a two-dimensional circular cylinder at low speeds using pitot-static probe wake survey |
| **11** | Calculation of Total drag of a three-dimensional rough circular cylinder/sphere at low speeds using pitot-static probe wake survey |
| **12** | Calculation of Total drag of a two-dimensional symmetrical airfoil at low speeds using pitot-static probe wake survey |

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| | |
|---|---|
| **13** | Measurement of a typical boundary layer velocity profile on the tunnel wall (at low speeds) using a pitot probe and calculation of boundary layer displacement and momentum thickness |
| **14** | Calculation of aerodynamic coefficients and forces acting on a model aircraft using 6 –component force balance at various angles of incidence and speed |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO402.1** | Apply the Fundamental Conservative Principles of Nature to Obtain the Governing Equations in Fluid Flows. |
| **CO402.2** | Calculate the Basic Flow Properties of 2 - D geometries by using Potential flow theory and Superposition Principles. |
| **CO402.3** | Determine the Aerodynamic force and Moment coefficients using Thin airfoil theory. |
| **CO402.4** | Analyze the Lift and Drag Forces of a Finite wing using Lifting Line Theory. |
| **CO402.5** | Understand the Transport Properties of fluid due to Viscosity, Thermal Conductivity and Mass Diffusivity. |

**Textbooks:**

1. **J. D. Anderson**, "Fundamentals of Aerodynamics", 5th Edition, McGraw HillEducation India Private Limited, 2010.
2. **L J Clancy**,"Aerodynamics" Paperback 2006

**Reference books:**

1. **E. L. Houghton**, "Aerodynamics for Engineering students", 6th edition, Elsevier, 2012.
2. **Ethirajan Radhakrishnan**, "Theoretical Aerodynamics", 1st Edition, Wiley Publications, 2013.

**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Two Tests are to be conducted for 40 marks each. Marks scored in each test is reduced to 30 and added to test component.

CIE is executed by way of Three tests.

Laboratory CIE is conducted for 20 Marks and Added to CIE component

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**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **30** |
| | CIE Test-2 | **40** | |
| | CIE Test-3 | **40** | |
| | LAB CIE | **20** | **20** |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO1** | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | 2 |
| **CO2** | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | 2 |
| **CO3** | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | 2 |
| **CO4** | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | 2 |
| **CO5** | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | 2 |
| **Average** | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | 2 |

**Low-1: Medium-2: High-3**

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# SEMESTER – IV

## COURSE: AIRCRAFT PROPULSION

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23403** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:2** | **SEE Marks** | **50** |
| **No. of Credits** | **4** | **Examination Hours** | **03** |

**Course Learning Objectives:** To enable students to apply the knowledge of Aircraft Propulsion in broad domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CLO1** | Basic knowledge on the classifications of aircraft engines, their operations, fundamental components and their functions in engines. |
| **CLO2** | The functions of inlets and nozzles for subsonic and supersonic flow regimes. |
| **CLO3** | The basic operation of compressors, their types, the design of compressor blades, and their performance characteristics. |
| **CLO4** | The process of combustion, types of combustion chambers, and their respective applications |
| **CLO5** | To understand the turbine, their limitations, design of turbine blades, their performance and cooling methods. |

| CONTENT | No. of Hrs /RBT Levels |
|---|---|
| **MODULE 1**<br>**FUNDAMENTALS OF AIR BREATHING ENGINES**<br>Classification of aircraft power plants, Principles of aircraft propulsion, working of gas turbine engines, Thermodynamic cycle analysis, thrust equation, Factors affecting thrust, Methods of thrust augmentation, Performance characteristics of gas turbine engines and their comparisons, Numerical Problems | **08Hours** |
| **MODULE 2**<br>**INLETS AND NOZZLES**<br>Internal flow and Stall in Subsonic inlets, Boundary layer separation, Major features of external flow near a subsonic inlet, Diffuser performance. Supersonic inlets: Supersonic inlets, starting problem in supersonic inlets, Shock swallowing by area variation, External deceleration, Modes of inlet operation, Numerical Problems<br>Nozzles: Theory of flow in isentropic nozzles, Convergent nozzles, Convergent Divergent nozzle, nozzle choking, Nozzle throat conditions, Nozzle efficiency, Losses in nozzles. Over-expanded and under-expanded nozzles, Ejector and variable area nozzles, thrust reversal, Thrust Vectoring, Numerical Problems | **08 Hours** |
| **MODULE 3**<br>**COMPRESSORS:** Centrifugal compressors: Operation of centrifugal compressors, Work done and pressure rise, Velocity diagrams, Diffuser vane design considerations, performance characteristics. Axial flow compressors: Elementary theory of axial flow compressor, Velocity triangles, Degree of reaction, | **08 Hours** |

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| | |
|---|---|
| Compressor blade design, Axial compressor performance characteristics, Numerical Problems | |
| **MODULE 4**<br>**COMBUSTION CHAMBERS:** Classification of combustion chambers, Combustion process, Important factors affecting combustion chamber design, Combustion chamber performance, Effect of operating variables on performance – Flame tube cooling – Flame stabilization – Use of flame holders | **08 Hours** |
| **MODULE 5**<br>**TURBINES:** Turbine stage, multi-staging of turbine, Principle of operation of axial flow turbines, Work done and pressure rise, Velocity diagrams, Degree of reaction, Stage efficiency calculations, Basic blade profile design considerations, Turbine blade cooling methods, Matching of compressor and turbine, Numerical Problems | **08Hours** |

**LIST OF EXPERIMENTS**

| Ex. No | Title of Experiment | RBT Level |
|---|---|---|
| 1 | Study of an aircraft piston engine. (includes the study of the assembly of subsystems, various components, their functions, and operating principles). | L4 |
| 2 | Study of an aircraft jet engine (includes the study of the assembly of subsystems various components, their functions, and operating principles). | L4 |
| 3 | Study of free convective heat transfer over a surface. | L4 |
| 4 | Study of forced convective heat transfer over a surface. | L4 |
| 5 | Determination of Performance characteristics of a fixed/variable pitch propeller. | L4 |
| 6 | Flame Stabilization Studies using the conical flame holder. | L4 |
| 7 | Measurement of burning velocity of the premixed flame | L4 |
| 8 | Pressure measurement in Ramjet engine | L4 |
| 9 | Temperature measurement in Ramjet Engine | L4 |

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| | | |
|---|---|---|
| 10 | Measurement of Pressure and velocity distribution over the compressor cascade | L4 |
| 11 | Measurement of Pressure and velocity distribution over the turbine cascade | L4 |
| 12 | Performance studies on mini gas turbine engines | L4 |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CLO403.1** | Explicate the principles of operation of aircraft propulsion and the fundamental components and their functions in engines. |
| **CLO403.2** | Realize the functions of the aircraft inlet and nozzle, their advantages and limitations. |
| **CLO403.3** | Assess the compressor's efficiency based on the blade design and the pressure requirements. |
| **CLO403.4** | Examine the processes of combustion and combustor and choose the suitable chamber based on their applications. |
| **CLO403.5** | Design the turbine stage and turbine blade angles based on the requirements of the compressor. |

**Textbooks:**


1. P.G. Hill and C.R. Peterson, "Mechanics & Thermodynamics of Propulsion", Addison - Wesley Longman INC, 2015.
2. M. L. Mathur and R. P. Sharma, "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers & Distributors, Delhi, 2nd edition 2014
3. Ahmed F. EL-Sayed, "Aircraft Propulsion and Gas turbine engines", CRC press, 2017.


**Reference books:**


1. Cohen, H. Rogers, G.F.C. and Saravana muttoo, H.I.H. "Gas Turbine Theory", Longman, 1989.
2. Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAA Education Series, New York, 1985.
3. Rathakrishnan., E, "Gas Dynamics", Fifth edition Published by PHI Learning, 2014.


**Web references/ Additional online information (related to module if any):**

1. https://onlinecourses.nptel.ac.in/noc22_me125/preview
2. https://archive.nptel.ac.in/courses/101/101/101101002/

**Practical knowledge reference**

1. https://www.linkedin.com/posts/thuwin_aerospace-engineering-job-activity-7081738421739614208-q2me

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2. https://www.infosys.com/services/engineering-services/service-offerings/turbomachinery-propulsion.html
3. https://www.youtube.com/watch?v=PcPBYh6Cfao

Scheme of Examination:

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

### Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes/ Alternate Assessment Tools (AATs) for 10 marks. Typical Evaluation pattern for regular courses is shown in Table 1.

**Table1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | 30 | 50 |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Laboratory | 20 | |
| SEE | Semester End Examination | 50 | 50 |
| Grand Total | | | 100 |

| COURSE OUTCOMES | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CLO403.1 | 3 | 2 | 2 | - | - | - | - | - | - | 1 | - | 1 | 3 | - |
| CLO403.2 | 3 | 2 | 2 | - | - | - | - | - | - | 1 | - | 1 | 3 | - |
| CLO403.3 | 3 | 2 | 2 | - | - | - | - | - | - | 1 | - | 1 | 2 | - |
| CLO403.4 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | - | 1 | 3 | - |
| CLO403.5 | 3 | 2 | 2 | - | - | - | - | - | - | 1 | - | 1 | 3 | - |
| Average | **3** | **2** | **2** | **-** | **-** | **-** | **-** | **-** | **-** | **1** | **-** | **1** | **3** | **-** |

**Low-1: Medium-2: High-3**

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## SEMESTER – IV

**COURSE: AIRCRAFT STRUCTURES-I**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23404** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **2:2:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Course Objectives:** To enable students to apply the knowledge of Aircraft Structures-I in broad domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CO1** | Understand the types of loads experienced by aircraft structure and materials used for aircraft structures |
| **CO2** | Acquire knowledge on different methodologies to analyze statically determinate and indeterminate structures under various loading conditions |
| **CO3** | Apply the energy method concept to determine the strain energy using various methods |
| **CO4** | Discuss about the theory of failure for aircraft structures |
| **CO5** | Solve aircraft structural problems to determine the deflection of beams. |

| **Content** | **No. of Hours/ RBT levels** |
|---|---|
| **Module 1**<br><br>**Statically Determinate & Indeterminate Structures:** Plane truss analysis – method of joints – method of sections – method of shear – 3-D trusses – principle of super position, Clapeyron's 3 moment equation and moment distribution method for indeterminate beams | **08Hours** |
| **Module 2**<br><br>**Energy Methods:** Strain Energy in axial, bending, torsion and shear loadings. Castigliano's theorems and their applications. Energy theorems – dummy load & unit load methods – energy methods applied to statically determinate and indeterminate beams, frames, rings & trusses. | **08 Hours** |
| **Module 3**<br><br>**Deflection of Beams:** Deflection of beams using Double integration method, McCauley's method, Area moment method, Conjugate beam method, Maxwell reciprocal theorem. | **08 Hours** |
| **Module 4** | |

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| | |
|---|---|
| **Failure Theories:** Ductile and brittle materials – maximum principal stress theory - maximum principal strain theory - maximum shear stress theory - distortion energy theory – octahedral shear stress theory | **08 Hours** |
| **Module 5**<br>**Theory of Elasticity:** Concept of stress and strain, derivation of Equilibrium equations, strain displacement relation, compatibility conditions and boundary conditions. Plane stress and Plane strain problems in 2D elasticity. structural health monitoring of aircraft. | **08Hours** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO404.1** | comprehensive understanding of aircraft structures, encompassing topics such as structural layout, major components, loads |
| **CO404.2** | Proficiently apply different methodologies to analyze statically determinate and indeterminate structures under various loading conditions |
| **CO404.3** | Apply strain energy principles in diverse loadings and effectively utilize Castigliano's theorems and its applications |
| **CO404.4** | Apply advanced material theories for optimal material selection and structural design under varying loading conditions. |
| **CO404.5** | Solve aircraft structural problems to determine the beam deflections |

**Textbooks:**


1. 'Mechanics of Materials' by James M. Gere & Barry J Goodno, cengage Learning Custom Publishing; 8th edition, 2012.
2. Megson T M G, `Aircraft Structures for engineering students' Butterworth-Heinemann publisher, 5th edition, 2012.
3. N.C. Pandya, C.S. Shah, "Elements of Machine Design", Charotar Publishing House, 15th edition, 2009.


**Reference books:**


1. Bruhn E F, 'Analysis and Design of Flight Vehicle Structures', Tri-State Off-set Company, USA, 1985
2. Donaldson, B.K., 'Analysis of Aircraft Structures - An Introduction' Cambridge University Press publishers, 2nd edition , 2008
3. Peery, D.J., and Azar, J.J., Aircraft Structures, 2nd edition, McGraw – Hill, N.Y., 1999


**Scheme of Examination:**

**Semester End Examination (SEE):**

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**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reducedto 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **onefull question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO404.1** | 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | 3 | - |
| **CO404.2** | 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | 3 | - |
| **CO404.3** | 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | 3 | - |
| **CO404.4** | 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | 3 | - |
| **CO404.5** | 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | 3 | - |
| **Average** | 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | 3 | - |

**Low-1: Medium-2: High-3**

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## SEMESTER – IV

**COURSE: AIRCRAFT CONTROL ENGINEERING**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23405** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **2:2:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Pre-requisite:** Engineering Mathematics

**Course Objectives:** To enable students to apply the knowledge of Control engineering and Microprocessors in broad domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CLO1** | Open and Closed Loop Systems, Feedback Control systems and Mathematical Models. |
| **CLO2** | Transfer Functions, Block Diagrams and Signal flow graphs |
| **CLO3** | System stability and types of controllers |
| **CLO4** | Basics about linear and digital IC's |
| **CLO5** | Architecture of Microprocessor and its application |

| **Content** | **No. of Hours/RBT levels** |
|---|---|
| **Module 1**<br>**MATHEMATICAL MODELLING OF CONTROL SYSTEMS:** Concept of system and its types, control system- Open loop and closed loop systems with examples, Concepts of feedback and basic structure of feedback control system. DC and AC motors in control systems, Transfer functions definition and its properties - Transfer function models of mechanical systems, electrical circuits -Analogous systems: Force voltage and Force current analogy, Torque voltage and Torque current. | **08Hours** |
| **Module 2**<br>**BLOCK DIAGRAMS AND SIGNAL FLOW GRAPHS:** Block representation of control systems and terminologies, block diagram algebra and reduction of block diagrams, Signal flow graph method, Mason's gain formula and its applications. | **08 Hours** |
| **Module 3**<br>**STABILITY AND CONTROL:** System stability analysis using Routh's – Hurwitz Criterion, Root locus, Time response and frequency response - Bode plot, Digital controllers and its types, application-Compensation methods – Series and feedback compensation, Lead, Lag and Lead-Lag Compensators | **08 Hours** |

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| | |
|---|---|
| **Module 4**<br>**LINEAR AND DIGITAL IC'S:** Comparison Between Analog and Digital Systems - Number Representation - Binary, Octal and Hexadecimal Number Systems- Half Adder and Full Adder -Multiplexers- Demultiplexers - Decoders – Encoders. | **08 Hours** |
| **Module 5**<br>**MICROPROCESSORS:** Architecture of Intel 8085- Instruction Formats - Addressing Modes - Simple Assembly Language Programs - Architecture and Functioning of Intel 8086 Processor - Instruction Formats – Addressing Modes. Microprocessor Applications in aerospace | **08Hours** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO405.1** | Comprehend the open loop & closed loop systems and Mathematical Models. |
| **CO405.2** | Solve the complex physical systems using Block diagrams and Signal Flow Graphs and obtain Transfer function |
| **CO405.3** | Apply the feedback control systems for stability and Controllers |
| **CO405.4** | Summarize the basic knowledge on Linear and Digital ICs. |
| **CO405.5** | Outline the architectures of Microprocessor and its application |

**Textbooks:**


1. Control Engineering- U.A. Bakshi and V.U. Bakshi, Technical Publications Autar Kaw,
2. Control Systems Engineering, A. NagoorKani, RBA Publications 2014 edition,2006.


**Reference books:**


1. Modern Control Engineering, Katsuhiko Ogatta, Pearson Education 2004
2. Control Systems Engineering, I.J. Nagrath and M. Gopal, New Age Publishers 2017
3. Modern Control Systems, Richard. C. Dorf and Robert.H. Bishop Addison Wesley 1999


Scheme of Examination:

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

Typical Evaluation pattern for regular courses is shown in Table 1.

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**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO405.1** | 3 | 3 | 2 | 2 | 1 | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| **CO405.2** | 3 | 3 | 2 | 2 | 1 | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| **CO405.3** | 3 | 3 | 2 | 2 | 1 | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| **CO405.4** | 3 | 3 | 2 | 2 | 1 | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| **CO405.5** | 3 | 3 | 2 | 2 | 1 | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| **Average** | **3** | 3 | **2** | **2** | **1** | **-** | **-** | **-** | **1** | **1** | **1** | **-** | **1** | **1** |

**Low-1: Medium-2: High-3**



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## SEMESTER – IV
## ABILITY ENHANCEMENT COURSE

**COURSE: AI AND ML FOR AEROSPACE APPLICATIONS**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23406A** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **2:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **2** | **Examination Hours** | **03** |

**Pre-requisite:** Nil

**Course objectives:** This course will enable students to

| | |
|---|---|
| **CLO1** | Understand the basics of Artificial Intelligence and Machine Learning |
| **CLO2** | Acquire the knowledge of the foundations of AI and AL |
| **CLO3** | Gather the information on its different algorithms and their applications in Aerospace Engineering |

| Content | No. of Hours/RBT levels |
|---|---|
| **Module-1**<br>**Introduction:** Data Science, AI & ML, Scientific Method, Modelling Concepts CRISP-DM methods, Programming: Commands and Syntax, Packages and Libraries, Introduction to Data Types, Data Structures in R - Vectors, Matrices, Arrays, Lists, Factors, Data Frames, Importing and Exporting Data, Control structures and Functions | **08 Hours** |
| **Module-2**<br>**Descriptive Statistics Data exploration:** Qualitative and Quantitative Data, Measure of Central Tendency, Measure of Positions, Measure of Dispersion Anscombe's quartet, Statistical Analysis Initial Data Analysis, Probability | **08Hours** |
| **Module-3**<br>**Data Acquisition:** Data Quality and Transformation, Handling Text Data, Principles of Big Data, Data Visualization, Sampling and Estimation, Inferential Statistics | **08 Hours** |
| **Module-4**<br>**Linear Regression:** Multiple Linear Regression, Non-Linear Regression, Forecasting models, Foundations for ML, Clustering, Naïve Bayes Classifier, K-Nearest Neighbors, Support Vector Machines, Support Vector Machines | **08 Hours** |
| **Module-5**<br>**Foundations for AI:** Application areas, AI Basics (Divide and Conquer Greedy, Branch and Bound, Gradient Descent), NN basics | **08Hours** |

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| | |
|---|---|
| (Perceptron and MLP, FFN, Back propagation), Convolution Neural Networks<br>Recurrent Neural Networks,<br>Deep Learning | |
| Web links and Video Lectures (e-Resources): | |
| https://nptel.ac.in/courses/106106198 | |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO406A.1** | Apply the basics of Artificial Intelligence and Machine Learning |
| **CO406A.2** | Use the knowledge of the foundations of AL and AL |
| **CO406A.3** | Implement the information on its different algorithms and their applications in Aerospace Engineering |

**Textbooks:**

1. The Hundred-Page Machine Learning Book by Andriy Burkov
2. Machine Learning by Tom M Mitchell
3. Artificial Intelligence: A Modern Approach, 4th US ed. by Stuart Russell and Peter Norvig

**Reference books:**

1. Machine Learning and Data Mining in Aerospace Engineering by Aboul Ella Hassanien
2. Applications of Machine Learning by Jitendra Kumar Verma
3. Artificial Intelligence and Machine Learning for Business for Non-Engineers by CRC Press

**Web links and Video Lectures (e-Resources):**

https://nptel.ac.in/courses/106106198

**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |

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| | | | |
|---|---|---|---|
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO307A.1** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.2** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.3** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.4** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.5** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **Average** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |

**Low-1: Medium-2: High-3**



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# SEMESTER – IV
# ABILITY ENHANCEMENT COURSE

## COURSE: SPREADSHEET-BASIC FOR ENGINEERS

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23406B** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **2:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **2** | **Examination Hours** | **03** |

**Course Objectives:** This course will enable students to

| | |
|---|---|
| **CLO1** | To create different plots and charts |
| **CLO2** | To compute different functions, conditional functions and make regression analysis |
| **CLO3** | To carryout iterative solutions for roots, multiple roots, optimization and non-linear regression analysis |
| **CLO4** | To Understand VBA and UDF |
| **CLO5** | To understand VBA subroutines and Macros |
| **CLO6** | To carryout numerical integration and solving differential equations using different methods |

| Sl.NO | Experiments |
|---|---|
| 1 | **Charting:** Create an XY scatter graph, XY chart with two Y-Axes, add error bars to your plot, create a combination chart |
| 2 | **Functions:** Computing Sum, Average, Count, Max and Min, Computing Weighted Average, Trigonometric Functions, Exponential Functions, Using The CONVERT Function to Convert Units |
| 3 | **Conditional Functions:** Logical Expressions, Boolean Functions, IF Function, Creating a Quadratic Equation Solver, Table VLOOKUP Function, AND, OR and XOR functions. |
| 4 | **Regression Analysis:** Trendline, Slope and Intercept, Interpolation and Forecast, The LINEST Function, Multilinear Regression, Polynomial Fit Functions, Residuals Plot, Slope and Tangent, Analysis ToolPack. |
| 5 | **Iterative Solutions Using Excel:** Using Goal Seek in Excel, Using The Solver To Find Roots, Finding Multiple Roots, Optimization Using The Solver, Minimization Analysis, NonLinear Regression Analysis. |
| 6 | **Matrix Operations Using Excel:** Adding Two Matrices, Multiplying a Matrix by a Scalar, Multiplying Two Matrices, Transposing a Matrix, Inverting a Matrix and Solving System of Linear Equations. |
| 7 | **VBA User-Defined Functions (UDF):** The Visual Basic Editor (VBE), The IF Structure, The Select Case Structure, The For Next Structure, The Do Loop Structure, Declaring Variables and Data Types, An Array Function The Excel Object Model, For Each Next Structure. |

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| | |
|---|---|
| 8 | **VBA Subroutines or Macros:** Recording a Macro, Coding a Macro Finding Roots by Bisection, Using Arrays, Adding a Control and Creating User Forms. |
| | **Demonstration Experiments ( For CIE )** |
| 9 | **Aerospace equations:** Many of the aerospace equations, such as lift and drag coefficients, can be calculated using custom formulas in Excel |
| 10 | **Wind tunnel correction functions:** To correct wind tunnel data based on atmospheric conditions.("ISBLANK" and "IF" functions can be used) |
| 11 | **Flight trajectory functions:** To look up flight path parameters based on any given conditions.("Vlookup" and "Match" functions can be used) |
| 12 | **Launch vehicle functions:** To look up rocket performance parameters based on any given conditions.( "INDEX" and "MATCH" functions can be used) |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO406B.1** | To create different plots and charts |
| **CO406B.2** | To compute different functions, conditional functions and make regression analysi |
| **CO406B.3** | To carryout iterative solutions for roots, multiple roots, optimization and non-linea regression analysis □ |
| **CO406B.4** | To Understand VBA and UDF |
| **CO406B.5** | To understand VBA subroutines and Macros |
| **CO406B.6** | To carryout numerical integration and solving differential equations using differen methods |

**Suggested Learning Resources: Books**

McFedries PaulMicrosoft Excel 2019 Formulas And Functions Microsoft Press, U.S, 2019 Edition

**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| | CIE Test-1 | | |



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| | | | |
|---|---|---|---|
| CIE | CIE Test-2 | **40** | **50** |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO307A.1** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.2** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.3** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.4** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.5** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **Average** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |

**Low-1: Medium-2: High-3**



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# SEMESTER – IV
# ABILITY ENHANCEMENT COURSE
## COURSE: INTRODUCTION TO PROGRAMMING WITH MATLAB AND PYTHON

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23406C** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **2:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **2** | **Examination Hours** | **03** |

**Course Objectives:** This course will enable students to

| | |
|---|---|
| **CLO1** | Learn how to programme with MATLAB and Python |
| **CLO2** | Be familiar with programming environments of MATLAB and Python |
| **CLO3** | Carry out lab sessions using MATLAB and Python |

| Sl.NO | Experiments |
|---|---|
| 1 | Write a MATLAB program to obtain linear convolution of the given sequences. |
| 2 | Write a MATLAB program to perform amplitude-scaling, time-scaling and time-shifting on a given signal. |
| 3 | Write a MATLAB program to obtain Cross correlation of sequence x(n) and y(n) & autocorrelation of a sequence x (n) of the given sequences & verify the property. |
| 4 | Write a MATLAB program to generate Fourier series of a Square Wave. |
| 5 | Write a Python Program to find the square root of a number by Newton's Method. |
| 6 | Write a python program to search an element in an array using Linear search technique & Binary search technique. |
| 7 | Write a Python program to sort the elements using selection sort & insertion sort. |
| 8 | Write a python program to check whether the given string is palindrome or not. |
| | **Demonstration Experiments ( For CIE )** |
| 9 | Write a MATLAB program to Calculate and plot using MATLAB Fourier Transform and Z-Transform of a given signal. |
| 10 | Checking linearity/non-linearity of a system using SIMULINK Build a system that amplifies a sine wave by a factor of two. |
| 11 | Demonstrate a Python program to sort all the elements in proper order using the logic of Merge sort. |
| 12 | Demonstration of working with PDF and word files |



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**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO406C.1** | Program with MATLAB and Python |
| **CO406C.2** | Develop basic to complex code in the programming environments of MATLAB and Python |
| **CO406C.3** | Modify and Maintain codes written using MATLAB and Python |

**Suggested Learning Resources: Books**


1. Allan Fowler-AR Game Development‖, 1st Edition, A press Publications, 2018, ISBN 978-1484236178
2. Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494 **Reference Books:**
3. Designing for Mixed Reality, Kharis O'Connell Published by O'Reilly Media, Inc., 2016, ISBN: 9781491962381
4. Sanni Siltanen- Theory and applications of marker-based augmented reality. Julkaisija – Utgivare Publisher. 2012. ISBN 978-951-38-7449-0


**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** |
|---|



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| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO307A.1** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.2** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.3** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.4** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.5** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **Average** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |

**Low-1: Medium-2: High-3**

# SEMESTER – IV
# ABILITY ENHANCEMENT COURSE

**COURSE: INTRODUCTION TO AUGMENTED REALITY**

| **Course Code** | **ANE23406D** | **CIE Marks** | **50** |
|---|---|---|---|
| **Hours/Week (L: T: P)** | **2:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **2** | **Examination Hours** | **03** |

**Course Objectives:** This course will enable students to

| | |
|---|---|
| **CLO1** | Describe how AR systems work and list the applications of AR. |
| **CLO2** | Understand and analyze the hardware requirement of AR. |
| **CLO3** | Use computer vision concepts for AR and describe AR techniques |
| **CLO4** | Analyze and understand the working of various state of the art AR devices Acquire knowledge of mixed reality |
| **CLO5** | Describe how AR systems work and list the applications of AR. |

| **Content** | **No. of Hours/RBT levels** |
|---|---|
| **Module 1**<br>**Introduction to Augmented Reality (A.R):** Defining augmented reality, history of augmented reality, The Relationship between Augmented Reality | **08 Hours/ L2** |



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| | |
|---|---|
| and Other Technologies-Media, Technologies, Other Ideas Related to the Spectrum between Real and Virtual Worlds, applications of augmented reality **Augmented Reality Concepts**- Concepts Related to Augmented Reality, Ingredients of an Augmented Reality Experience. | |
| **Module 2**<br>**Augmented Reality Hardware:** Displays – Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception , Requirements and Characteristics, Spatial Display Model. **Processors –** Role of Processors, Processor System Architecture, Processor Specifications. **Tracking & Sensors -** Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion. | **08 Hours/ L2** |
| **Module 3**<br>**Computer Vision for Augmented Reality & A.R. Software: Computer Vision for Augmented Reality -** Marker Tracking, Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, Outdoor Tracking **Augmented Reality Software -** Introduction, Major Software Components fo Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application. | **08 Hours/ L2** |
| **Module 4**<br>**AR Techniques- Marker based & Markerless tracking: Marker-based approach-** Introduction to marker-based tracking, types of markers, marker camera pose and identification, visual tracking, mathematical representation o matrix multiplication **Marker types-** Template markers, 2D barcode markers, imperceptible markers. **Marker-less approach-** Localization based augmentation, real world examples **Tracking methods-** Visual tracking, feature based tracking, hybrid tracking, and initialization and recovery. | **08 Hours/ L2** |
| **Module 5**<br>**AR Devices & Components : AR Components –** Scene Generator, Tracking system, monitoring system, display, Game scene **AR Devices –** Optical See- through HMD, Virtual retinal systems, Monitor bases systems, Projection displays, and Video see-through systems | **08 Hours/ L2** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO406D.1** | Describe how AR systems work and list the applications of AR. |
| **CO406D.2** | Understand and analyse the hardware requirement of AR. |
| **CO406D.3** | Use computer vision concepts for AR and describe AR techniques |
| **CO406D.4** | Analyse and understand the working of various state of the art AR devices |
| **CO406D.5** | Acquire knowledge of mixed reality |

**Suggested Learning Resources: Books**

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1. Allan Fowler-AR Game Development‖, 1st Edition, A press Publications, 2018, ISBN 978-1484236178
2. Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494

**Reference Books:**

3.Designing for Mixed Reality, Kharis O'Connell Published by O'Reilly Media, Inc., 2016, ISBN: 9781491962381
4.Sanni Siltanen- Theory and applications of marker-based augmented reality. Julkaisija – Utgivare Publisher. 2012. ISBN 978-951-38-7449-0

**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO307A.1** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.2** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.3** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.4** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO307A.5** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **Average** | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |

**Low-1: Medium-2: High-3**

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## SEMESTER – IV

**Course: ADVANCED CAAD LAB**

| | | | |
|---|---|---|---|
| **Course Code** | **ANEL23408** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **0:0:2** | **SEE Marks** | **50** |
| **No. of Credits** | **0** | **Examination Hours** | **3** |

**Prerequisites: Prerequisites:** Computer Aided Aircraft Drawing-CATIA 3D Experience

**Course Objectives:** To enable students to apply the knowledge of Advanced Computer Aided Aircraft Drawing in broad domain of Aeronautical engineering by making them to learn:

| | |
|---|---|
| **CLO1** | Knowledge of Surface design and wireframes |
| **CLO2** | Sheetmetal design using CATIA 3D experience |
| **CLO3** | Detailed Drafting from conversion of 3D components and its assembly |
| **CLO4** | Geometrical dimensioning and tolerances |
| **CLO5** | Rendering exploded view |

| Content | No. of Hours/RBT levels |
|---|---|
| **PART-A**<br><br>**INTRODUCTION TO SURFACE DESIGN:** Introduction to Surface Design and concept of Hybrid Design. GUI of Surface Design workbench. Create Curves and Wireframes using 3D Lines, Points, Planes and Spline. Create advanced Swept Surfaces and Blend features. Create wireframe features using existing curves and surfaces. Assemble, Re-limit and connect surfaces smoothly using Split, Trim, Join and Disassemble. Convert Surface to Solid<br><br>**INTRODUCTION TO SHEET METAL DESIGN:** Terminology and Design process for creating Sheet Metal part. GUI of Sheet Metal Design workbench. Create Sheet Metal part using Wall, User Flange, Hole and Rectangular Pattern, Wall On Edge with Bend, Corner Relief, Louver, Bead, Bridge and Flanged Cut-out, Extrusion, Cylindrical Bend and Cut-out<br><br>**PART B**<br><br>**INTRODUCTION TO FUNCTIONAL TOLERANCE AND ANNOTATIONS:** Define various GD&T options. Create Annotation Planes. Add and manage 3D. Annotations on these planes. Create 3D Views. Manage | **CO1, L2** |

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| | |
|---|---|
| 3D Geometry associated with 3D Annotations. Add Dimensions with Tolerances | |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO408.1** | Use different feature-based tools to build 3D model |
| **CO408.2** | Create part and product detailed drawing |
| **CO408.3** | Create wireframes and surfaces |
| **CO408.4** | Create Sheet Metal part using the standard features |
| **CO408.5** | Annotate 3D part and create 3D views |

**Textbooks:**


1. **Gopalakrishna, K. R.** (2017). Machine Drawing in First Angle of Projection. Subhas Publications.
2. **Bhatt, N. D.** (2016). Machine Drawing. Charotar Publishing, 50th Edition.


**Reference Books:**


1. **Narayana, K. L., Kannaiah, P., & Reddy, K. V.** (2019). Machine Drawing. New Age International Publishers, 6th Edition.
2. **Sidheshwar.** (2006). Machine Drawing. Tata McGraw-Hill Education, 33rd Reprint.
3. **Dhawan, R. K.** (2006). Machine Drawing. S Chand Publishing, Reprint Edition.


**Scheme of Examination:**

Semester End Examination (SEE): Distribution of weightage for SEE of Regular courses

| | **Component** | **Marks** | **Total Marks** |
|---|---|---|---|
| SEE | PART- A | **20** | **50** |
| | PART- B | **30** | |
| **SEE Total** | | | **50** |

Continuous Internal Evaluation (CIE): Distribution of weightage for CIE of Regular courses

| | **Component** | **Marks** | **Total Marks** |
|---|---|---|---|
| CIE | MANUAL /RECORD | **20** | **50** |
| | CIE Test-1 | **30** | |
| **CIE Total** | | | **50** |

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| CO/PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO408.1** | 3 | 1 | 3 | - | 3 | - | 2 | - | - | - | - | - | - | 3 |
| **CO408.2** | 3 | 1 | 3 | - | 3 | - | 2 | - | - | - | - | - | - | 3 |
| **CO408.3** | 3 | 1 | 3 | - | 3 | - | 2 | - | - | - | - | - | - | 3 |
| **CO408.4** | 3 | 1 | 3 | - | 3 | - | 2 | - | - | - | - | - | - | 3 |
| **CO408.5** | 3 | 1 | 3 | - | 3 | - | 2 | - | - | - | - | - | - | 3 |
| **Average** | 3 | 1 | 3 | - | 3 | - | 2 | - | - | - | - | - | - | 3 |

**Low-1: Medium-2: High-3**



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# V SEMESTER SYLLABUS



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## SEMESTER –V

**COURSE: AVIATION MANAGEMENT**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23501** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Course objectives: Introduction to the Aviation Industry and Global Aviation Economics**

| | |
|---|---|
| **CLO1** | **Understand the history and structure of the aviation industry.** |
| **CLO2** | **Explore the economic significance of air transport both Globally and within India.** |
| **CLO3** | **Understand Airport Operations, Infrastructure Planning, and Development.** |
| **CLO4** | **Acquire the general aviation management practices** |
| **CLO5** | **Grasp the broad disciplines of management at different levels of Aviation Industry** |

| **Content** | **No. of Hours RBT levels** |
|---|---|
| **Module 1**<br>**Introduction to the Aviation Industry and Global Aviation Economics:** History and Evolution of the Aviation Industry, Overview of Global Aviation Economics, Indian Aviation Industry Structure, Impact of Aviation on India's Economy, Aviation and Tourism in India, Regional Connectivity UDAN | **08 Hours L1,L2** |
| **Module 2**<br>**Airline Operations, Fleet Management, and Strategic Planning:** Airline Operations, Fleet Management, Airline Network Planning, Strategic Planning in Airlines: Cost control strategies, Competitive positioning: Low-cost carriers (LCCs) vs. full-service airlines, Impact of government policies and regulations on airline strategy. | **08Hours/ L2,L3** |
| **Module 3**<br>**Airport Management and Infrastructure Development in India:** Airport Operations and Management, Airport Infrastructure and Development in India, Regulatory and Policy Framework: Role of the Airports Authority of India (AAI). Foreign Direct Investment (FDI) in Indian Airports Economic Impacts of Airports: Airport revenue models: Aeronautical and non-aeronautical revenues**.** | **08Hours/ L3** |



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| | |
|---|---|
| **Module 4**<br>**Aviation Safety, Regulations, and Environmental Economics:** Role of Directorate General of Civil Aviation (DGCA) in India, International aviation regulations (ICAO, IATA) and their impact on Indian aviation, Safety management systems and accident investigation, Environmental impacts: Noise pollution, air quality, carbon emissions, Sustainable aviation practices and green technologies, India's National Civil Aviation Policy (NCAP) | **08Hours/ L3** |
| **Module 5**<br>**Financial Management and Marketing in Aviation:** Financial Management in Aviation, Revenue Management and Pricing Strategies: Airline branding and customer loyalty programs. Marketing in Aviation, Economic Analysis of Aviation Marketing. Impact of government regulations and taxes on airline profitability. | **08Hours/ L3** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO501.1** | Analyse customer need and perceptions of design feedback systems |
| **CO501.2** | Infer the customer perception of quality |
| **CO501.3** | Apply the foundational knowledge of airline and airport operation, scheduling and management |
| **CO501.4** | Implement the general aviation management practices |
| **CO501.5** | Prepare for the management at different levels of aviation industry |

**Textbooks:**

1. "Managing Airports: An International Perspective" 6th Edition by Anne Graham, Publisher - Taylor & Francis Ltd; 6th edition
2. DGCA Guidelines and Policy Documents (Available on the official DGCA website)
3. "Airline Operations and Management" A Management Textbook by Gerald N. Cook an Bruce G. Billig, Published by Routledge; 2nd edition
1. Aviation Industry: Strategic Management & Development" by P.K. Jain and R.S. Gupta (Indian perspective).

**Reference books:**

1. Aviation Economics and Policy" by D. L. LeCompte and John H. Leow.
2. Aviation Industry: Strategic Management & Development" by P.K. Jain and R.S. Gupta (Indian perspective).

**Web links and Video Lectures (e-Resources):**

- https://www.youtube.com/watch?v=6Uk8F3_9ywY

**Scheme of Examination:**
**Semester End Examination (SEE):**

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**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any five full questions choosing at least one full question from each module.**
**Continuous Internal Evaluation (CIE):**
**Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.**
**Typical Evaluation pattern for regular courses is shown in Table 1.**

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | 40 | 50 |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | 10 | |
| SEE | Semester End Examination | 50 | 50 |
| Grand Total | | | 100 |

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO501.1 | 3 | 3 | 2 | 2 | 1 | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| CO501.2 | 3 | 3 | 2 | 2 | 1 | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| CO501.3 | 3 | 3 | 2 | 2 | 1 | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| CO501.4 | 3 | 3 | 2 | 2 | 1 | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| CO501.5 | 3 | 3 | 2 | 2 | 1 | - | - | - | 1 | 1 | 1 | - | 1 | 1 |
| Average | 3 | 3 | 2 | 2 | 1 | - | - | - | 1 | 1 | 1 | - | 1 | 1 |

**Low-1: Medium-2: High-3**

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# SEMESTER V

**COURSE: AIRCRAFT STRUCTURES -II**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23502** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **2:2:2** | **SEE Marks** | **50** |
| **No. of Credits** | **4** | **Examination Hours** | **03** |

**Pre-requisite:** Aircraft structural mechanics

**Course Learning Objectives: To enable students to apply the knowledge of Aircraft Structural Analysis in broad** domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CLO1** | Assess the Bending stresses in thin-walled beams |
| **CLO2** | Analyze the Shear Flow in open and closed beams |
| **CLO3** | Evaluate the forces on Joints and fittings |
| **CLO4** | Apply the Structural Idealization to various structural components of an aircraft |
| **CLO5** | Analyze the stresses in wings and fuselage structures |

| Content | No. of Hours/RBT levels |
|---|---|
| **Module 1**<br>**BENDING OF OPEN AND CLOSED THIN-WALLED BEAMS:** Symmetrical bending, unsymmetrical bending, direct stress distribution due to bending, position of the neutral axis, load intensity, shear force, and bending moment relationships, calculation of section properties, approximation for thin-walled sections. | **08Hours/ L3** |
| **Module 2**<br>**SHEAR FLOW IN OPEN SECTIONS:** Thin-walled beams, Concept of shea flow, shear centre, Elastic axis. With one axis of symmetry, with wall effectiv and ineffective in bending, unsymmetrical beam sections.<br>**SHEAR FLOW IN CLOSED SECTIONS:** Bredt – Batho formula, Single an multi – cell structures, approximate methods. Shear flow in single and multi-ce under bending -with walls effective and ineffective. | **08 Hours/ L3** |
| **Module 3**<br>**JOINTS AND FITTINGS:** Bolted or riveted joints, accuracy of fitting analysis, eccentrically loaded connections, welded joints, and concept of effective width. | **08 Hours/ L3** |



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| | |
|---|---|
| **Module 4**<br>**STRUCTURAL IDEALIZATION:** Structural idealization Principle, Idealization of a panel, effect of idealization on the analysis of open and closed section beams. Bending of open and closed section idealized beams, shear of open section and closed section idealized beams. | **08 Hours / L3** |
| **Module 5**<br>**STRESS ANALYSIS IN WING SPARS AND BOX BEAMS:** Tapered wing spar, open and closed section beams, beams having variable stringer areas, three- boom shell, tapered wings, cut-outs in wings.<br>**STRESS ANALYSIS IN FUSELAGE FRAMES:** Bending, shear, torsion, cut-outs in fuselages, principles of stiffeners construction, fuselage frames, shear flow distribution. | **08 Hours / L3** |

| Sl.No | LIST OF EXPERIMENTS | RBT levels |
|---|---|---|
| 1. | Deflection of a Simply Supported, Cantilever, Fixed and Continuous Beam | **L3** |
| 2. | Verification of Maxwell's Reciprocal Theorem. | **L3** |
| 3. | Determination of Young's Modulus and Poisson's Ratio | **L3** |
| 4. | Verification of Superposition Theorem | **L3** |
| 5. | Buckling load of slender Eccentric Columns and Construction of South well Plot | **L3** |
| 6. | Determination of forces in the Truss structure | **L3** |
| 7. | Determination of Unsymmetrical Bending stresses | **L3** |
| 8. | Determination of fundamental frequency of a cantilever beam and harmonics and Frequency spectrum analysis for a cantilever beam. | **L3** |
| 9. | Determination of Shear Centre for open section and Closed section | **L3** |
| 10. | Composite hand layup/ Vacuum Bagging process | **L3** |
| 11. | Determining the stress patterns and stress concentration using Photo elastic apparatus | **L3** |
| 12. | Determining the stress, strain in Constant Strength Beam | **L3** |

**LIST OF EXPERIMENTS**

1. Deflection of a Simply Supported, Cantilever, Fixed and Continuous Beam
2. Verification of Maxwell's Reciprocal Theorem.
3. Determination of Young's Modulus and Poisson's Ratio
4. Verification of Superposition Theorem
5. Buckling load of slender Eccentric Columns and Construction of South well Plot
6. Determination of forces in the Truss structure

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7. Determination of Unsymmetrical Bending stresses
8. Determination of fundamental frequency of a cantilever beam and harmonics and Frequency spectrum analysis for a cantilever beam.
9. Determination of Shear Centre for open section and Closed section
10. Composite hand layup/ Vacuum Bagging process
11. Determining the stress patterns and stress concentration using Photo elastic apparatus
12. Determining the stress, strain in Constant Strength Beam

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO502.1** | Evaluate the direct bending stresses exhibited in both open and closed sections, employing advanced analytical techniques to comprehend their structural implications. |
| **CO502.2** | Examine and assess the intricate patterns of shear flow within both open and closed sections employing advanced analytical methodologies to grasp their structural ramifications. |
| **CO502.3** | Determine loads on riveted and welded joints for optimized structural performance. |
| **CO502.4** | Applying idealization concepts to simplify complex structural sections to understand how they behave, under given loading conditions. |
| **CO502.5** | Analyze the stresses in wings and fuselage structures |

**Textbooks:**


1. T.M.G Megson, Aircraft Structures for Engineering Students, Edward Arnold, 44th Edition, 1995.
2. Peery, D.J., and Azar, J.J, Aircraft Structures, McGraw– Hill, N.Y., 2nd edition, 1993


**Reference books:**


1. Bruhn. E.H, Analysis and Design of Flight Vehicles Structures, Tristate off set company, USA, 1985.
2. Rivello, R.M, Theory and Analysis of Flight Structures, McGraw- Hill, 1993.


**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks. Typical Evaluation pattern is shown in Table 1.

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| Component | | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |

| | | | |
|---|---|---|---|
| | CIE Test-3 | | |
| | Quiz 1/AAT | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO502.1** | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 1 | 3 | - |
| **CO502.2** | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 1 | 3 | - |
| **CO502.3** | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 1 | 3 | - |
| **CO502.4** | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 1 | 3 | - |
| **CO502.5** | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 1 | 3 | - |
| **Average** | 3 | 3 | 2 | - | - | - | - | - | - | - | - | 1 | 3 | - |

**Low-1: Medium-2: High-3**



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## SEMESTER -V

**COURSE: HIGH-SPEED AERODYNAMICS**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23503** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:2:0** | **SEE Marks** | **50** |
| **No. of Credits** | **4** | **Examination Hours** | **03** |

**Prerequisite: Aerodynamics I**

**Course Learning Objectives:** To enable students to apply the knowledge of Aerodynamics in broad domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CLO1** | To Introduce the Concepts of compressibility |
| **CLO2** | To make the student understand the theory behind the formation of Shocks and Expansion waves in supersonic flows. |
| **CLO3** | To know the calculations of flow properties across oblique shock wave |
| **CLO4** | To linearization of governing equations using small perturbation theory |
| **CLO5** | To understand the transonic flow over wing bodies |

| **Content** | **No. of Hours/ RBT levels** |
|---|---|
| **Module 1**<br>**ONE DIMENSIONAL COMPRESSIBLE FLOW:** Review of Thermodynamics and State Equations, Compressibility, Velocity of Sound, Adiabatic Steady-State flow Equations, Flow-through Convergent- Divergent Passage. | **8 Hours/ L3** |
| **Module 2**<br>**NORMAL SHOCK WAVES:** Alternative form of the One-dimensional Energy Equation, Prandtl Meyer Equation and Rankine – Hugonoit Relation, Normal Shock Equations, Velocity measurements in Subsonic and Supersonic flows, Pitot Static Tube, Rayleigh and Fanno Flow. | **8 Hours/ L3** |
| **Module 3**<br>**OBLIQUE SHOCK WAVE & EXPANSION WAVES:** Oblique Shocks and Corresponding Equations, Flow past wedges and concave corners, Flow past Convex corners, Strong & weak Shocks, Attached & Detached Shocks. Reflection, and Interaction of Shocks, Expansion waves. | **8 Hours/ L3** |

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| | |
|---|---|
| **Module 4**<br>**LINEARIZED FLOW:** Velocity Potential equation, Small Perturbation Potential Theory, Linearized Subsonic and Supersonic Pressure Co-efficient, Mach waves and Mach angles, Prandtl - Glauert compressibility Correction. | **8 Hours/**<br>**L3** |
| **Module 5**<br>**TRANSONIC FLOW OVER WING:** Lower and upper Critical Mach numbers, Lift and Drag Divergence Mach number, Shock induced separation, Characteristics of Swept wings, Transonic Area rule. Introduction to Hypersonic Aerodynamics. | **8 Hours/**<br>**L3** |

**LIST OF EXPERIMENTS**

| | |
|---|---|
| 1 | Calibration of Supersonic Wind Tunnel at different Mach Number. |
| 2 | Shock Wave analysis on Aero Spike Model at M=2 |
| 3 | Shock Wave analysis on Aero Spike Model at M=3 |
| 4 | Oblique Shock Wave analysis on a 2D Wedge. |
| 5 | Supersonic Flow analysis over a 3D Cone structure. |
| 6 | Bow Shock Wave analysis over a Hemispherical Model. |
| 7 | Expansion wave analysis over a Double wedge. |
| 8 | Shock wave analysis over a Double wedge. |
| 9 | Flow Visualization of Under Expanded Nozzle. |
| 10 | Schlieren image Visualization of Over Expanded Nozzle. |
| 11 | Stagnation Pressure Measurement for Optimized Nozzle. |
| 12 | Study of Shock Wave Boundary Layer Interaction. |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO503.1** | Calculate the Thermodynamic state variables in Compressible Flow. |
| **CO503.2** | Estimate the flow Properties across Normal Shock Waves. |
| **CO503.3** | Evaluate and analyze the flow Properties across Oblique Shock Waves |
| **CO503.4** | Understand the Linearization of the governing equations in compressible flow. |
| **CO503.5** | Predict the flow Properties of Transonic and Hypersonic flows. |

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**Textbooks:**

1. J. D. Anderson, "**Modern Compressible Flow**", 3rd Edition, McGraw Hill Education 16 August 2002.
2. Rathakrishnan, E., "**Gas Dynamics**", 6th Edition, Prentice Hall of India, 2017.

**Reference books:**

1. J. D. Anderson, "**Fundamentals of Aerodynamics**", 5th Edition, McGraw Hill Education India Private Limited, 2010.
2. V. Babu**, "Fundamentals of Gas Dynamics**", 2nd Edition, John Wiley & Sons Ltd, (2015)
3. Shapiro, A.H., "**Dynamics and Thermodynamics of Compressible Fluid Flow**", Ronald Press, 1982

**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Two Tests are to be conducted for 40 marks each. Marks scored in each test are reduced to 30 and added to test component. CIE is executed by way of Three tests. Laboratory CIE is conducted for 20 Marks and Added to CIE component

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **30** |
| | CIE Test-2 | **40** | |
| | CIE Test-3 | **40** | |
| | LAB CIE | **20** | **20** |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

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| CO/PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO503.1 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | 2 |
| CO503.2 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | 2 |
| CO503.3 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | 2 |
| CO503.4 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | 2 |
| CO503.5 | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | 2 |
| **Average** | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | 2 |

**Low-1: Medium-2: High-3**

## SEMESTER -V

**COURSE: MODELLING AND ANALYSIS LAB**

| | | | |
|---|---|---|---|
| **Course Code** | **ANEL23504** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **0:0:2** | **SEE Marks** | **50** |
| **No. of Credits** | **1** | **Examination Hours** | **03** |

**Course Learning Objectives:** To enable students to apply the knowledge of Flight dynamics in broad domain of aeronautical engineering by making them to learn:

| | |
|---|---|
| **CLO1** | Understand about the concept of mesh generation. |
| **CLO2** | Learn about how to apply boundary conditions. |
| **CLO3** | To analyze the stress of different structural components in aircraft. |

**LIST OF EXPERIMENTS**

| Content | RBT levels |
|---|---|
| 1. Geometric Modeling and Mesh Generation of symmetric Airfoil Geometry. | **L3** |
| 2. Geometric Modeling and Mesh Generation of unsymmetrical Airfoil Geometry | **L3** |
| 3. Computations and Analysis of 2-D Incompressible and Inviscid Flow ove symmetric and unsymmetrical Airfoil. | **L3** |

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| | |
|---|---|
| 4. Geometric Modeling, Mesh Generation and flow analysis of 2-D Convergent- Divergent Nozzle. | **L3** |
| 5. Generation of body fitting hexagonal mesh and flow analysis of serpentin inlet duct | **L3** |
| 6. Structural Modeling of Sandwich Beam of Rectangular Cross-Section and Analyses for Stresses. | **L3** |
| 7. Structural Modeling of a Three-Dimensional Wing. | **L3** |
| 8. Structural Modeling and Stress Analysis of a Fuselage Bulkhead. | **L3** |
| 9. Structural Modeling and Stress Analysis of a Simply Supported Rectangular Plate Uniformly Compressed in one Direction. | **L3** |
| 10. Structural Modeling and Stress Analysis of a Simply Supported Rectangular Plate Uniformly Compressed In one Direction with a Cut-Out in Center. | **L3** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO504.1** | Model and analyze symmetric and unsymmetrical Aero foil Geometry. |
| **CO504.2** | Model and analyze 2D Convergent- Divergent Nozzle and 3Dserpentine inle duct. |
| **CO504.3** | Analyze Sandwich Beam, 3D Wing and bulkhead. |
| **CO504.4** | Perform Structural Modeling and Stress Analysis of a Simply Supported. |
| **CO504.5** | Model and analyze symmetric and unsymmetrical Aero foil Geometry. |

**Scheme of Examination:**

**Semester End Examination (SEE):** Distribution of weightage for SEE of Regular courses

| | **Component** | **Marks** | **Total Marks** |
|---|---|---|---|
| SEE | PART- A | **20** | **50** |
| | PART- B | **20** | |
| | VIVA-VOCE | **10** | |
| **SEE Total** | | | **50** |

**Continuous Internal Evaluation (CIE):** Distribution of weightage for CIE of Regular courses

| | **Component** | **Marks** | **Total Marks** |
|---|---|---|---|
| CIE | MANUAL / RECORD | **20** | **50** |
| | CIE Test-1 | **20** | |
| | VIVA-VOCE | **10** | |
| **CIE Total** | | | **50** |

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| CO/PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO504.1** | 3 | 3 | 3 | 2 | - | - | - | - | 3 | 2 | - | - | 3 | - |
| **CO504.2** | 3 | 3 | 3 | 2 | - | - | - | - | 3 | 2 | - | - | 3 | - |
| **CO504.3** | 3 | 3 | 3 | 2 | - | - | - | - | 3 | 2 | - | - | 3 | - |
| **CO504.4** | 3 | 3 | 3 | 2 | - | - | - | - | 3 | 2 | - | - | 3 | - |
| **CO504.5** | 3 | 3 | 3 | 2 | - | - | - | - | 3 | 2 | - | - | 3 | - |
| **Average** | 3 | 3 | 3 | 2 | | | | | 3 | 2 | | | 3 | |

# SEMESTER -V

**COURSE: MINI-PROJECT**

| | | | |
|---|---|---|---|
| **Course Code** | **ANEP23506** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **0:0:4** | **SEE Marks** | **50** |
| **No. of Credits** | **2** | **Examination Hours** | **03** |

**Mini-project work:** 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 an individual student or to a group having not more than 4 students. Individual student performance is evaluated based on the following COs:

| | |
|---|---|
| **CO1** | Able to make comprehensive use of the technical knowledge gained from previous courses |
| **CO2** | Able to understand technologies concerned with the project |
| **CO3** | Able to apply project management skills (scheduling work, procuring parts and documenting expenditures and working within the confines of a deadline). |
| **CO4** | Able to analyze, develop and demonstrate the proposed work |
| **CO5** | Able to communicate technical information by means of ethical writing and presentation. |

**CIE procedure for Mini-Project:**

a. **Single discipline:** The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the Mini-project work shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.



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b. **Interdisciplinary:** Continuous Internal Evaluation shall be group wise at the college level with the participation of all the guides of the college. The CIE marks awarded for the MiniProject shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

**SEE for Mini-Project:**

a. **Single discipline:** Contribution to the Mini-project and the performance of each group member shall be assessed individually in the semester end examination (SEE) conducted at the department.

b. **Interdisciplinary:** Contribution to the Mini-project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong.

Typical Evaluation pattern for regular courses is shown in Table 1.

Table 1: Distribution of weightage for CIE & SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | Review-1 | **50** | **50** |
| | Review-2 | | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO506.1** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO506.2** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO506.3** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO506.4** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |
| **CO506.5** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 |

**Low-1: Medium-2: High-3**



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## SEMESTER -V

**COURSE: RESEARCH METHODOLOGY**

| | | | |
|---|---|---|---|
| **Course Code** | **RMIK23507** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Pre-requisite:** NIL

**Course Learning Objectives:** To enable students to apply the knowledge of Research Methodology in broad domain of aeronautical engineering by making them to learn:

| | |
|---|---|
| **CLO1** | To make the student understand the foundations of Research and problem solution |
| **CLO2** | Knowledge in Research design, Qualitative and Quantitative Research |
| **CLO3** | Knowledge to formulate and derive static and dynamic aero elastic equations of motion. |
| **CLO4** | To understand the different types of IPR |

| Content | No. of Hours/ RBT levels |
|---|---|
| **Module 1**<br>**RESEARCH METHODOLOGY:** Introduction, Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research and Scientific Method, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India.<br>**DEFINING THE RESEARCH PROBLEM:** Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration | **8 Hours/ L3** |
| **Module 2**<br>**REVIEWING THE LITERATURE:** Place of the literature review in research, bringing clarity and focus to research problem, improving research methodology, broadening knowledge base in research area, enabling contextual findings, Review of the literature, searching the existing literature, reviewing the selected literature, developing a theoretical framework, developing a conceptual framework, writing about the literature reviewed.<br>**RESEARCH DESIGN**: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs | **8 Hours/ L3** |

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| | |
|---|---|
| **Module 3**<br>**DESIGN OF SAMPLE SURVEYS:** Design of Sampling: Introduction, Sample Design, Sampling and Non-Sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.<br>**MEASUREMENT AND SCALING:** Qualitative and Quantitative Data,<br>**DATA COLLECTION:** Introduction, Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. | **8 Hours/ L3** |
| **Module 4**<br>**TESTING OF HYPOTHESES:** Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis.<br>**INTERPRETATION AND REPORT WRITING:** Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. | **8 Hours/ L3** |
| **Module 5**<br>**INTELLECTUAL PROPERTY**: Principles of IPR, Kinds of IPR, Patent- Concepts, Novelty, Utility Inventiveness/Non-obviousness, Procedure for granting and obtaining patents; Copyright- conditions for grant of copyright, Copyright in Literary, Dramatic and Musical ,Works, Sound Recording, Cinematograph Films, Copyright in Computer Programme, Author Special Rights, Right of Broadcasting and performers, Trademark Law and Practices - Procedure of registration of trademark; Emerging Issues and Challenges; Few Future Aspects of Intellectual Property Rights; | **8 Hours/ L3** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO507.1** | Understand the research problem by literature review to solve problems |
| **CO507.2** | Develop skills in qualitative and quantitative data analysis and presentation. |
| **CO507.3** | Develop advanced critical thinking skills. |
| **CO507.4** | Understand to write the report writing and awareness about IPR |

**Textbooks:**


1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma


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Bell, Oxford University Press.
3. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
4. Lionel Bently., Brad Sherman-Intellectual Property Law, 3rd Edition

**Reference books:**

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
3. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
4. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.

## SEMESTER – V

**Course: ENVIRONMENTAL STUDIES**

| | | | |
|---|---|---|---|
| **Course Code** | **CIVK23508** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **2:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **2** | **Examination Hours** | **3** |

**Prerequisites:**

**Course Objectives:** Students will be taught:

| | |
|---|---|
| **CLO1** | To understand ecosystem functions and 17 SDG's for sustainable development |
| **CLO2** | To understand advanced energy systems and natural resource management. |
| **CLO3** | To understand global environmental issues, related policies and solutions. |
| **CLO4** | To understand key environmental legislation related to water, air, waste and environmental protection. |
| **CLO5** | To understand e-waste management. |

| **Content** | **No. of Hours/ RBT levels** |
|---|---|
| **Module 1 – Ecosystem and Sustainability**<br>Ecosystem: Structure of Ecosystem, Types: Forest, Desert, Wetlands, Riverine, Oceanic ecosystems. Sustainability: 17SDG targets and possible actions. Self-Study **Component (SSC): Components of the environment.** | **6 Hours L2** |
| **Module 2 - Natural Resource Management**<br>Natural Resources: Water resources – Availability & Quality aspects, Energy: | **6 Hours L2** |

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| | |
|---|---|
| Different types of energy, Conventional sources & non-conventional sources of Energy, Solar energy, OTEC Wind Energy, Hydrogen as an alternative energy Self-Study Component (SSC): Alternative Energy sources Disaster Management, Sustainable Mining - case studies and Carbon Trading<br>**Self-Study Component (SSC): Alternative Energy sources.** | |
| **Module 3 – Environmental Pollution & Waste Management**<br>Environmental Pollution: Environmental Pollution (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies): Water Pollution, Water borne diseases & water induced diseases, Noise pollution, Soil Pollution, Air pollution (Sources, Impacts, Preventive measures and Public Health Aspects.<br>Waste Management: Bio-medical Wastes; Solid waste; Hazardous wastes; Industrial and Municipal Sludge Solid Waste Management , types and sources, functional elements of SWM, Biomedical Waste Management - Sources, Characteristics<br>**Self-Study Component (SSC): Case studies of air pollution episodes.** | **6 Hours L2** |
| **Module 4 - Global Environmental Issues and Environmental Legislation**<br>Global Environmental Concerns (Concept, policies and case-studies): Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Radon and Fluoride problem in drinking water; Resettlement and rehabilitation of people, Environmental Toxicology<br>**Environmental Legislation**<br>Environmental Legislation: Water Act 1974, Air Act 1981, Environmental Protection Act 1984, Solid Waste Management Rules-2016, E- Waste management Rule - 2022, Biomedical Waste management- 2016<br>**Self-Study Component (SSC): Case studies on waste management options** | **6 Hours L2** |
| **Module 5 - E - Waste Management**<br>E - Waste Management Introduction of E- waste; composition and generation. Global context in e- waste; E-waste pollutants, E waste hazardous properties, Effects of pollutant (E- waste) on human health and surrounding environment, domestic e-waste disposal, Basic principles of E waste management, Component of E waste management. E-waste (Management and Handling) Rules, 2011; and E-Waste (Management) Rules, 2022 - Salient Features and its implications.<br>**Self-Study Component (SSC): E-Waste (Management) Amendment Rules, 2023, 2024** | **6 Hours L2** |

**COURSE OUTCOMES:**

**Upon completion of this course, student will be able to:**



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| | |
|---|---|
| **CIVK23508.1** | **Analyze** ecosystem dynamics to formulate strategies for addressing sustainability challenges and implementing the SDGs. |
| **CIVK23508.2** | **Evaluate** energy technologies to design effective resource management strategies. |
| **CIVK23508.3** | **Evaluate** the impacts of pollution to develop effective waste management strategies. |
| **CIVK23508.4** | **Evaluate** global environmental issues to design solutions for sustainable management. |
| **CIVK23508.5** | **Interpret** environmental laws and regulations for sustainable management practices. |
| **CIVK23508.6** | **Understand** e-waste management in a global scenario. |

Suggested Learning Resources:

Textbooks


1. S M Prakash , "Environmental Studies" 3rd Edition, Elite Publishing House, Mangalore, 2018.
2. Hester R.E., and Harrison R.M, Electronic Waste Management. Science, 2009.


Reference Books:


1. EarchBarucha, "Environmental Studies for UG students", 2004.
2. Benny Joseph (2005), "Environmental Studies" , Tata McGraw – Hill Publishing Company Limited.
3. R. Rajagopalan, "Environmental Studies- From Crisis to Cure" , 2nd Edition, Oxford university press, New Delhi, 2013.
4. Johri R., E-waste: implications, regulations, and management in India and current global best practices, TERI Press, New Delhi.
5. Raman Sivakumar, "Principles of Environmental Science and Engineering", 2nd edition, Cengage learning Singapur, 2005.
6. G. Tyler Miller Jr., "Environmental Science – working with the Earth", Eleventh Edition, Thomson Brooks /Cole, 2006
7. Dr. Pratiba Singh, Dr.Anoop Singh and Dr. PiyushMalaviya, "Text Book of Environmental and Ecology", Acme Learning Pvt. Ltd. New Delhi.


**Web Reference:**

1. https://www.hzu.edu.in/bed/E%20V%20S.pdf
2. https://onlinecourses.nptel.ac.in/noc23_hs155/preview
3. https://onlinecourses.swayam2.ac.in/cec19_bt03/preview
4. https://sdgs.un.org/goals
5. https://kspcb.karnataka.gov.in/waste-management/biomedical-waste E Waste (Management) Rules, 2022:

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6. https://kspcb.karnataka.gov.in/sites/default/files/inlinefiles/E%20Waste%20%28Management%29%20Rules%2C%202022.pdf

**Scheme of Examination:**

**Semester End Examination (SEE):**
SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of three sub questions) from each module carrying 20 marks each. Students are required to answer any five full questions choosing at least one full question from each module.

**Continuous Internal Evaluation (CIE):**
Three Tests are to be conducted for 40 marks each. Average of three test marks will be added to test component. CIE is executed by way of two quizzes/Alternate Assessment Tools(AAT's), some possible AAT's: Seminar/ assignments/ mini-projects/ concept videos/ partial reproduction of research work/ group activity/ any other.

Typical Evaluation pattern is shown in Table 1.

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| Component | | Marks | Total Marks |
|---|---|---|---|
| **CIE** | CIE Test-1 | 40 | **50** |
| | CIE Test-2 | 40 | |
| | CIE Test-3 | 40 | |
| | **Average of CIE** | **40** | |
| | Quiz 1/AAT | **05** | |
| | Quiz 2/AAT | **05** | |
| **SEE** | **Semester End Examination** | **100** | **50** |
| **Grand Total** | | | **100** |

**Understand** e-waste management in a global scenario.

| **CO/PO Mapping** | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 | PSO3 |
| **CIVK23508.1** | 2 | | | | | 1 | 1 | 1 | | | | 2 | | | 3 |
| **CIVK23508.2** | 2 | 2 | 2 | | | 1 | 3 | 1 | | | | 1 | | | 3 |
| **CIVK23508.3** | | 2 | 2 | 2 | | 1 | 3 | 1 | | | | | | | 2 |
| **CIVK23508.4** | | 2 | 2 | 2 | | 1 | 3 | 1 | | | | 1 | | | 2 |
| **CIVK23508.5** | 1 | 2 | 2 | 2 | | 1 | 2 | 1 | | | | | | 1 | 2 |
| **CIVK23508.6** | 2 | 2 | 1 | | | 2 | 2 | 1 | | | | 1 | | | 2 |
| **Average** | 1.75 | 2 | 1.8 | 2 | | 1.16 | 2.3 | 1 | | | | 1.25 | | 1 | 2.33 |

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## SEMESTER -V

### COURSE: TECHNICAL AUTHORING IN AIRCRAFT MANUALS

| Course Code | ANE23510 | CIE Marks | 100 |
|---|---|---|---|
| Hours/Week (L: T: P) | 0:0:2 | SEE Marks | --- |
| No. of Credits | 0 | Examination Hours | 03 |

**Pre requisite: Nil**

**COURSE LEARNING OUTCOMES**

By the end of this course, students will be able to:

| | |
|---|---|
| **CLO1** | Explain the importance of technical authoring in the aerospace industry and differentiate between various types of aircraft manuals. |
| **CLO2** | Identify and gather relevant technical information from multiple sources, including subject matter experts, to support manual development. |
| **CLO3** | Develop a logical and user-friendly structure for aircraft manuals, including the effective use of visual aids. |
| **CLO4** | Produce well-organized, clear, and concise technical documents that adhere to industry standards and style guides. |
| **CLO5** | Demonstrate knowledge of quality control processes for technical documentation and understand the importance of user feedback in improving manual content. |

| CONTENT | No. of Hours/RBT levels |
|---|---|
| **Module 1**<br>**Introduction to Technical Authoring:** Overview of Technical Authoring**,** Type of Aircraft Manuals**,** Regulatory Standards | **08 Hours/ L2** |
| **Module 2**<br>**Research and Information Gathering:** Understanding the Audience-Information Sources-Conducting Interviews and Workshops | **08 Hours/ L2** |
| **Module 3**<br>**Structuring and Organizing Content:** Document Structure and Layout, Creating Effective Outlines, Visual Aids and Graphics | **08 Hours/ L2** |

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| | |
|---|---|
| **Module 4**<br>**Writing and Style Guidelines:** Writing Techniques for Technical Manuals, Editing and Reviewing, Adhering to Style Guides | **08 Hours/ L2** |
| **Module 5**<br>**Quality Assurance and Publication:** Quality Control Processes, Publication and Distribution, Feedback and Continuous Improvement | **08 Hours/ L2** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO510.1** | Describe the critical role of technical manuals in aviation safety and compliance. |
| **CO510.2** | Execute effective research methods, including interviewing engineers an collaborating with SMEs, to gather necessary information for manual creation. |
| **CO510.3** | Design and produce a comprehensive technical manual outline, integrating relevar graphics and visuals to enhance user understanding. |
| **CO510.4** | Write and revise technical documents that meet professional standards for clarity precision, and style, utilizing appropriate editing techniques. |
| **CO510.5** | Apply quality assurance techniques to evaluate and validate technical manuals demonstrating an understanding of compliance requirements and feedbac mechanisms for continuous improvement. |

**Textbooks:**

1. **Kroes, M., & Watkins, W. (2017). Aircraft Maintenance and Repair. McGraw-Hill Education.**
2. **Wise, J. A., Hopkin, V. D., & Garland, D. J. (2009). Handbook of Aviation Human Factors. CRC Press.**

**Reference books:**

1. Moir, I., & Seabridge, A. (2012). Writing Aircraft Maintenance Manuals. Wiley.
2. Markel, M. (2018). Technical Communication. Bedford/St. Martin's.
3. Microsoft Corporation. (2012). Microsoft Manual of Style for Technical Publications. Microsoft

**Scheme of Examination:**

**Continuous Internal Evaluation (CIE):**

CIE is executes by way of two quizzes/Alternate Assessment Tools (AATs) and two tests. Two Tests are to be conducted for 40 marks each. Two quizzes/ Alternate Assessment Tools (AATs) will be conducted, and each quiz/AAT is evaluated doe 10 marks adding up to 20 marks for 10 marks**.**

Some possible AATs: Seminar/assignments/term paper/open ended experiments/mini projects/ concept videos/partial reproduction of research work/oral presentation of research work/group activity/developing a generic toolbox for problem

solving/report based on participation in create –a-thon/make –a-thon/code –a-thon/ hack-a-thon conducted by reputed organizations/any other.

Table1: Distribution of weightage for CIE& SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **100** |
| | CIE Test-2 | **40** | |
| | Quiz 1/AAT | **10** | |
| | Quiz 2/AAT | **10** | |
| SEE | Semester End Examination | **0** | **0** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO510.1** | 2 | - | - | - | - | - | 3 | - | - | - | - | - | - | - |
| **CO510.2** | 2 | - | - | - | - | - | 3 | - | - | - | - | - | - | - |
| **CO510.3** | 2 | - | 2 | - | - | 2 | 3 | - | - | - | - | - | - | - |
| **CO510.4** | 2 | 2 | - | - | - | 2 | 3 | - | - | - | - | - | - | - |
| **CO510.5** | 2 | - | - | - | - | 2 | 3 | - | - | - | - | - | - | |

**Low-1: Medium-2: High-3**



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# SEMESTER -V
# PROFESSIONAL ELECTIVE 1

**COURSE: FINITE ELEMENT METHODS**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23505A** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Pre-requisite:** Aircraft Structures

**Course Learning Objectives:** To enable students to apply the knowledge of finite element methods in broad domain of aeronautical engineering by making them to learn:

| | |
|---|---|
| **CLO1** | To give exposure to various methods of solution, in particular the finite element method. |
| **CLO2** | To expose the student to a wide variety of problems involving discrete and continuum elements |
| **CLO3** | To impart knowledge in the basic theory of finite element formulation |
| **CLO4** | To allow the student to learn and understanding how element characteristic matrices are generated |
| **CLO5** | To impart knowledge in assembly of finite element equations and solve for the unknowns |

| Content | No. of Hours/ RBT levels |
|---|---|
| **Module 1**<br>**INTRODUCTION TO FEM:** Introduction to FEM, FDM and FVM, Review of various approximate methods – Raleigh Ritz's, Galerkin and finite difference methods Governing equation and convergence criteria of finite element method. | **08 Hours/ L3** |
| **Module 2**<br>**DISCRETE ELEMENTS:** Bar elements, uniform sections, mechanical and thermal loading, varying sections, truss analysis. Beam element with various loadings and boundary conditions - longitudinal and lateral vibration. Use of local and natural coordinates. | **10 Hours/ L3** |
| **Module 3**<br>**CONTINUUM ELEMENTS:** Plane stress, Plane strain and axisymmetric problems, constant and linear strain triangular elements, stiffness matrix, axisymmetric load vector, shape functions of Hexahedron and tetrahedron (3D Elements) | **08 Hours/ L3** |
| **Module 4**<br>**ISOPARAMETRIC ELEMENTS:** Definitions, Shape function for 4, 8 and 9 nodal quadrilateral elements, Stiffness matrix and consistent load vector, Gaussian integration. | **08 Hours/ L3** |

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| Module 5 | |
|---|---|
| **FIELD PROBLEM:** Heat transfer problems, Steady state fin problems, Derivation of element matrices for two dimensional problems, Torsion problems. | **08 Hours/ L3** |

**LIST OF EXPERIMENTS**

1. Structural modeling and analysis of simply supported beam with central point load.
2. Structural modeling and analysis of cantilever beam with point loading
3. Structural modeling and analysis of simply supported beam with uniformly varying load.
4. Structural modeling and analysis of aircraft landing gear strut
5. Structural modeling and analysis of circular and rectangular cutout sections.
6. Structural modeling of sandwich beam of rectangular cross-section and analyses for stresses.
7. Structural modeling of a three-dimensional wing.
8. Structural modeling and stress analysis of a fuselage bulkhead.
9. Structural modeling and stress analysis of a simply supported rectangular plate uniformly compressed in one direction.
10. Structural modeling and stress analysis of a simply supported rectangular plate uniformly compressed in one direction with a cut- out in center.

**COURSE OUTCOMES:**

**Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO505A.1** | Understand the approximate methods used for solving structural mechanics problems and formulation of governing equation for the finite element method |
| **CO505A.2** | Solve 1-D problems related to static analysis of structural members |
| **CO505A.3** | Formulate the elemental matrices for 2-D problems. |
| **CO505A.4** | Exposure to iso-parametric element formulations and importance of numerical integration. |
| **CO505A.5** | Solve Eigen value problems and scalar field problems. |

**Textbooks:**


1. Dhanaraj. R and K.Prabhakaran Nair, "Finite Element Method ", Oxford university press, India, 2015.
2. Rao. S.S., The Finite Element Methods in Engineering, Butterworth and Heinemann, 5th edition, 2010.
3. Reddy J.N. – An Introduction to Finite Element Method – McGraw Hill, 3rd edition, 2005.
4. Tirupathi.R. Chandrapatha and Ashok D. Belegundu – Introduction to Finite Elements in Engineering – Prentice Hall India, 3rd Edition, 2003.

5. **Reference books:**

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1. Bathe K.J. and Wilson, E.L., Numerical Methods in Finite Elements Analysis, Prentice Hall of India, 1985.
2. Krishnamurthy, C.S., Finite Element Analysis, Tata McGraw Hill, 2nd edition, 2001.
3. Larry J Segerlind, 'Applied Finite Element Analysis', 2nd Edition, John Wiley and Sons, Inc. 1985.
4. Robert D Cook, David S Malkus, Michael E Plesha, 'Concepts and Applications of Finite Element Analysis', 4th edition, John Wiley and Sons, Inc., 2003.

Scheme of Examination:

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks

Table 1: Distribution of weightage for CIE & SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Laboratory | **20** | **20** |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO505A.1** | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | - |
| **CO505A.2** | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | - |
| **CO505A.3** | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | - |
| **CO505A.4** | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | - |
| **CO505A.5** | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | - |
| **Average** | 3 | 3 | 2 | 2 | 2 | - | - | - | - | - | - | 1 | 3 | - |

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# SEMESTER -V
# PROFESSIONAL ELECTIVE 1

**COURSE: AERO PROPULSION -II**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23505B** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:2** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

| | |
|---|---|
| **CLO1** | The basic functions and challenges in design and development of ramjet and scramjet engines |
| **CLO2** | The classification and fundamentals of rocket propulsion and their systems |
| **CLO3** | The design and development of solid rocket propulsion and their applications |
| **CLO4** | The different types of liquid propellants, their merits and demerits. Development of hybrid rocket and their applications |
| **CLO5** | The elementary principles of electric rockets, their types, functions and future rocket engines |

Course Learning Objectives: To enable students to apply the knowledge of Rocket Propulsion in broad domain of Aeronautical Engineering by making them to learn:

| **CONTENT** | **No. of Hrs /RBT Levels** |
|---|---|
| **MODULE 1**<br>**RAMJET AND SCRAMJET:** Operating Principles of ramjet engine, ramjet components and their functions, modes of inlet operations, combustion in ramjet, design of ramjet, performance characteristics.<br>Introduction to scramjet, need for supersonic combustion, problems associated with supersonic combustion salient features of scramjet engine and its applications, Numerical problems | **08Hours /L2** |
| **MODULE 2**<br>**FUNDAMENTALS OF ROCKET PROPULSION:** History of rocket engines, basic principles of rocket propulsion, types of rocket engines, applications of rocket, ideal rocket engine, thrust equation, rocket nozzle classifications, performance parameters, staging in rockets, Numerical problems | **8 Hours /L3** |
| **MODULE 3**<br>**SOLID ROCKET PROPULSION:** Solid propellant rocket, Selection criteria of solid propellants, burning rate of propellants, propellant grain design considerations, erosive burning, homogeneous propellants, heterogeneous propellants, igniters, types of igniters, Numerical problems | **8 Hours /L3** |

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| | |
|---|---|
| **MODULE 4**<br>**LIQUID ROCKET PROPULSION:** Liquid propellant rocket, monopropellants, bipropellants, selection of liquid propellants, liquid fuels and oxidizers, types of feed systems for liquid rockets, thrust control in liquid rockets, cooling in liquid rockets, hybrid propulsion, limitations of hybrid propulsion, Numerical Problems | **8 Hours /L3** |
| **MODULE 5**<br>**NON-CHEMICAL ROCKET ENGINE:** Principles of electrical rocket engine, Classifications of electrical rockets, Electrothermal thrusters, Electrostatic thrusters, Electromagnetic thrusters,<br>Nuclear rocket engines, Solar energy rockets, Numerical Problems | **8 Hours /L3** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO505B.1** | Outline the functions and challenges in design and development of ramjet and scramjet engines |
| **CO505B.2** | Develop and demonstrate a rocket propulsion and their systems |
| **CO505B.3** | Build a solid rocket and to examine their propellants and thrust performance. |
| **CO505B.4** | Categorize the liquid propellants based on their merits and demerits for a selected mission profile |
| **CO505B.5** | Model and exhibit an opposite electric rocket system based the mission requirements |

**Textbooks:**


1. George P. Sutton and Oscar Biblarz, "Rocket propulsion elements", John Wiley & Sons Inc., Hoboken, New Jersey, 2017
2. D.P Mishra, "Fundamentals of Rocket Propulsion", CRC Press, Taylor & Francis Group, 2017


**Reference books:**


1. K Ramamurthi, “Rocket propulsion”, Macmillan publishers india ltd, 2010.
2. William J. Emrich Jr., “Principles of Nuclear Rocket Propulsion”, second edition, Butterworth Heinemann publications, 2023.
3. By Stephen D. Heister, William E. Anderson, Timothée L. Pourpoint, Joe Cassady, R. Joseph Cassady, "Rocket Propulsion”, Cambridge university press, 2019


Web references/ Additional online information (related to module if any):

1. https://archive.nptel.ac.in/courses/101/106/101106082/
2. https://archive.nptel.ac.in/courses/112/106/112206073/

Practical knowledge references

1. https://study.com/academy/lesson/rocket-propulsion-definition-principles.html
2. https://spectra.mhi.com/rocket-engines-the-history-future-of-a-test-facility

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3. https://www.grc.nasa.gov/www/k-12/rocket/TRCRocket/rocket_principles.html

**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reducedto 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **onefull question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks

Table 1: Distribution of weightage for CIE & SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| CO/PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO505B.1** | 3 | 2 | 2 | - | - | - | - | - | - | 1 | - | 1 | 3 | - |
| **CO505B.2** | 3 | 2 | 1 | - | - | 1 | - | - | - | 1 | - | 1 | 3 | - |
| **CO505B.3** | 3 | 2 | 2 | - | - | 1 | - | - | - | 1 | - | 1 | 3 | - |
| **CO505B.4** | 2 | 2 | 2 | - | - | 1 | - | - | - | 1 | - | 1 | 3 | - |
| **CO505B.5** | 2 | 2 | 2 | - | - | 1 | - | - | - | 1 | - | 1 | 3 | - |
| **Average** | 3 | 1 | 2 | - | - | 1 | - | - | - | 1 | - | 1 | 3 | - |

**Low-1: Medium-2: High-3**

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## SEMESTER -V
## PROFESSIONAL ELECTIVE 1

**COURSE: HELICOPTER DYNAMICS**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23505C** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **2:2:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Pre-requisite:** Basics of Aeronautical Engineering

**Course Objectives:**

To make the student familiarize with the principals involved in helicopters and to study the performance and stability aspects of Helicopter under different operating conditions.

| | |
|---|---|
| **CLO1** | Understand how helicopters work and their historical development |
| **CLO2** | Apply the concept of momentum theory and Blade element theory to analyse helicopter aerodynamics |
| **CLO3** | Understand the basics of blade element theory and its application in designing the blade profiles |
| **CLO4** | Evaluate the helicopters performance. |
| **CLO5** | Explore the dynamics and vibration aspects of helicopters |



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| Content | No. of Hours/ RBT levels |
|---|---|
| **Module 1**<br>**Brief overview and basics of Helicopter:** Historical development of rotorcraft, comparison of helicopter with fixed wing aircraft, features, roles, parts of helicopter, propulsion & power transmission, basic controls, reaction torque, anti-torque mechanisms, Autorotation concept, different helicopter configurations. Helicopter complexities – Rotor wake, Dissymmetry of Lift in forward flight, Control mechanism, ground resonance, stability & control issues. | **08 Hours / L2** |
| **Module 2**<br>**Momentum theory in hover and axial flight:** Modeling rotor as an actuator disc, momentum theory, concept of induced velocity, development of simplified models for induced velocity, induced power, and figure of merit, momentum theory in vertical climb, flow states in climb, descent and vortex ring state. | **08 Hours / L2** |
| **Module 3**<br>**Blade element theory in hover and vertical climb:** Combined momentum and blade element theory, Ideal twist and taper distribution, rotor solidity, general equation for induced velocity, thrust & torque equations, tip losses, ground effect and autorotation in vertical descent. | **08 Hours / L2** |
| **Module 4**<br>**Helicopter in forward flight & performance Analysis:** Momentum theory, induced velocity & induced power variation with forward speed. Blade motion in forward flight, reverse flow region, blade element theory, expression for thrust, torque and H-force.<br>Hover performance, Hover in ground Effect, hover out of ground effect, hover ceiling, forward flight performance and power required | **08 Hours/ L2** |
| **Module 5**<br>**Rotor Dynamics & Vibration:** Dissymmetry of Lift, flapping Hinge, flapping motion in hover: flapping equilibrium, coning – Causes & Effects, static & dynamic stability of flapping motion in hover. Rotor as Gyroscope – Gyroscopic Effect on Rotor response, Rotor Pitch Control: Collective & Cyclic. Rotor dynamics with Flap- Hinge Offset and Flapping Dynamics, Brief introduction to helicopter vibration. | **10 Hours/ L3** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO505C.1** | Explain the Parts of Helicopters and their functionality |
| **CO505C.2** | Apply the Momentum theory for Analysis of Helicopter Aerodynamics |
| **CO505C.3** | Apply the Blade Element theory for Analysis of Helicopter Aerodynamics |
| **CO505C.4** | Calculate the performance parameters in various flight Conditions |
| **CO505C.5** | Understand the complexity of rotor dynamics and helicopter vibrations |

**Textbooks:**

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1. Alfred Gessow & Garry C. Myers, Jr, Aerodynamics of the helicopter, 8th printing, 1895, Frederick Ungar Publishing Co. New York.
2. R. W. Prouty, Helicopter Aerodynamics, Sterling Book House
3. J.Gordon Leishman, Principles of Helicopter Aerodynamics, Second Edition, Cambridge University Press.

**Reference books:**

1. John Seddon and Simon Newmann Basic Helicopter Aerodynamics, 3rd Edition, Wiley Aerospace Series, London.
2. 2.A.R.S. Bramwell, George Done and Davis Balmford, Bramwell's Helicopter Dynamics, 2nd Edition, Butterworth-Heinemann (Reed Educational & Professional Publishing Ltd.), 2001. 3. 3.Helicopter Flying Handbook, 2012 by U.S. Department of Transportation, FAA

**Scheme of Examination: Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

Table 1: Distribution of weightage for CIE & SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO505C.1** | 3 | 2 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| **CO505C.2** | 3 | 3 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | 1 |
| **CO505C.3** | 3 | 3 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| **CO505C.4** | 3 | 3 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| **CO505C.5** | 3 | 3 | - | - | - | - | - | - | - | - | - | 1 | 1 | 1 |
| **Average** | 3 | 3 | 1 | | | | | | 1 | 1 | | 1 | 1 | 1 |

**Low-1: Medium-2: High**

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## SEMESTER -V
## PROFESSIONAL ELECTIVE 1

### COURSE: AIRFRAME STRUCTURAL DESIGN

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23505D** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Pre-requisite: Aircraft Structure I and II**
**Course Objectives:** This course will enable students to

| | |
|---|---|
| **CLO1** | Understand the concepts of open and closed thin-walled beams. |
| **CLO2** | Acquire the knowledge of buckling of plates, joints and fittings. |
| **CLO3** | Comprehend the stress analysis on wings and fuselage. |
| **CLO4** | Able to understand the structural impact of rigid bodies |

| Content | No. of Hours/ RBT levels |
|---|---|
| **Module-1**<br>**Shear and Torsion of Open and Closed Thin-Walled Beams:** General stress, strain, and displacement relationship for open and single-cell closed section thin-walled beams, shear of open section beams, shear centre, shear of closed section beams. Torsion of close section beam, and displacement associated with the Bredt-Batho shear flow. Torsion of open section beam. Combined bending, shear, torsion. | **08 Hours / L2** |
| **Module-2**<br>**Buckling of Plates, Joints and Fittings:** Buckling of Isotropic flat plates in compression, ultimate compressive strength of Isotropic flat sheet, plastic buckling of flat sheet, columns subjected to local crippling failure, Needham & Gerard method for determining crippling stress, curved sheets in compression, elastic buckling of curved rectangular plates. Pure tension field beams, angle of diagonal tension in web.<br>**Joints and Fittings**- bolted or riveted joints, accuracy of fitting analysis, eccentrically loaded connections, welded joints, and concept of effective width. | **08 Hours / L2** |



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| | |
|---|---|
| **Module-3**<br>**Design Criteria and Structural Idealization:** Design Criteria, Safety Factor, Design life criteria, Analysis method, Life Assessment procedures, Design Principle, Two bay crack criteria, Widespread Fatigue damage.<br>**Structural Idealization**<br>Structural idealization Principle, Idealization of a panel, effect of idealization on the analysis of open and closed section beams. Bending of open and closed section idealized beams, shear of open section and closed section idealized beams. Deflection of open and closed section idealized beams. | **08 Hours / L2** |
| **Module-4**<br>**Stress Analysis in Wing Spars and Box beams:** Tapered wing spar, open and closed section beams, beams having variable stringer areas, three- boom shell, torsion and shear, tapered wings, cut-outs in wings. **Stress Analysis in Fuselage Frames**<br>Bending, shear, torsion, cut-outs in fuselages, principles of stiffeners construction, fuselage frames, shear flow distribution. | **08 Hours / L2** |
| **Module-5**<br>**Introduction to Structural Impact:** Introduction to Structural Impact, Rigid Body Impact Mechanics, Coefficient of Restitution, Oblique Impact, One Dimensional Impact Mechanics of Deformable Bodies,1-D Wave Propagation in Solids Induced by Impact. | **08 Hours / L2** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO505D.1** | Utilize the concepts of thin-walled beams. |
| **CO505D.2** | Calculate the buckling of plates. |
| **CO505D.3** | Analysis the stress in wings and fuselage frames. |
| **CO505D.4** | Comprehend the structural impact of rigid bodies |

**Textbooks:**


1. Megson, T. H. G, Aircraft Structures for Engineering Students, Edward Arnold, 1995
2. Peery D J & Azar J J, Aircraft Structures, McGraw Hill N.Y, 2nd edition,1993
3. W.J.Stronge, Impact Mechanics, Cambridge University Press January 2010 doi.org/10.1017/CBO9780511626432


**Reference books:**


1. Bruhn E. F, Analysis & Design of Flight Vehicles Structures, Tri-State offset Co, USA, 1985
2. Megson, T. H. G, Introduction to Aircraft Structural Analysis, Elsevier, 2nd Edition, 2014


**Scheme of Examination: Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

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Table 1: Distribution of weightage for CIE & SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

**CO/PO Mapping**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO505D.1** | 3 | 2 | - | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| **CO505D.2** | 3 | 3 | 1 | - | - | - | - | - | - | - | - | 1 | 1 | 1 |
| **CO505D.3** | 3 | 3 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| **CO505D.4** | 3 | 3 | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 1 | 1 |
| **Average** | 3 | 3 | 1 | | | | | | 1 | 1 | | 1 | 1 | 1 |

**Low-1: Medium-2: High**



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# VI SEMESTER SYLLABUS

## SEMESTER -VI

**COURSE: AIRCRAFT DESIGN**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23601** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **2:2:2** | **SEE Marks** | **50** |
| **No. of Credits** | **4** | **Examination Hours** | **03** |

**Pre-requisite:** Low speed and high-speed Aerodynamics, Aircraft Structures, Propulsion

**Course Learning Objectives:** To enable students to apply the knowledge of Flight Vehicle Design in broad domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CLO1** | Conceptual design process of an aircraft, Airfoil and wing geometry. |
| **CLO2** | Analyzing of design geometry, thrust to weight ratio and wing loading of an aircraft. |
| **CLO3** | Overview of Initial sizing and configuration layout. |
| **CLO4** | Outline of aerodynamics, propulsion w.r.t design. |
| **CLO5** | Design aspects of sub systems in flight vehicles. |

| **Content** | **No. of Hours/RBT levels** |
|---|---|
| **Module 1**<br>**OVERVIEW OF DESIGN PROCESS:** Introduction, Typical requirements for a civil transport and a military fighter aircraft, Phases of design, Aircraft conceptual design process, Take-off weight build up, Empty weight estimation, Fuel fraction estimation, Take- off weight calculation, Trade studies. Airfoil geometry, Airfoil lift and drag, Airfoil families, Airfoil design, Airfoil lift coefficient, Airfoil thickness, Camber, Stall, Reynolds number effects. | **08 Hours/ L3** |
| **Module 2**<br>**GEOMETRY AND WEIGHT ESTIMATION:** Wing geometry, Aspect ratio, Sweep, Taper ratio, Twist, Incidence, Dihedral, Wing vertical location of wings, Wing tips, Biplane wings, Tail geometry and arrangement. Thrust to weight definitions, Power loading, Statistical estimate of T/W. Wing Loading for Cruise, Loiter, Endurance, Instantaneous Turn rate, Sustained Turn rate, Climb, & Glide, Maximum ceiling, Selection of Thrust to Weight Ratio & Wing Loading | **08 Hours/ L3** |
| **Module 3**<br>**INITIAL SIZING AND CONFIGURATION:** Rubber engine sizing, Fixed engine sizing, Geometry sizing – Fuselage, Wing, Tail volume coefficient, and Control surface sizing. Conic lofting, Conic fuselage development, Conic shape parameter, Wing-tail layout & Loft. Wetted area determination. Special considerations in configuration layout: Aerodynamic, Structural, Detectability. Crew station, Passenger, and Payload arrangements. | **08 Hours/ L3** |

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| | |
|---|---|
| **Module 4**<br>**AERODYNAMICS & PROPULSION:** A brief overview of aerodynamic coefficients and forces, Types of propulsion systems, Jet engine thrust considerations, Thrust-drag book keeping, installed thrust methodology, Piston engine performance – propeller performance and piston-prop thrust correction, Turboprop performance. | **08 Hours/ L3** |
| **Module 5**<br>**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, Safety constraints, Material selection criteria. | **08 Hours/ L3** |

**LABORATORY EXPERIMENTS**

1. Aircraft Weight Estimation for Civil Transport Aircraft
2. Airfoil Design and Performance Analysis Using Design Software
3. Analysis of Wing Geometry: Aspect Ratio, Sweep, and Taper
4. Calculating Thrust-to-Weight Ratio and Wing Loading for Various Flight Phases
5. Fuselage Lofting Techniques and Wetted Area Determination
6. Designing Wing-Tail Layout and Sizing Control Surfaces
7. Thrust-Drag Analysis for Jet Engine Performance Evaluation
8. Evaluation of Piston-Prop and Turboprop Performance Characteristics
9. Landing Gear Design and Integration with Aircraft Subsystems
10. Simulation of Flight Control Systems and Response Analysis
11. Integration of Fuel System and Air Pressurization in Aircraft Design
12. Design and Simulation of Avionics and Electrical Systems for Aircraft

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO601.1** | Comprehend aircraft design fundamentals, including introduction, requirements, phases conceptual design, weight calculations, trade studies, and airfoil principles. |
| **CO601.2** | Estimate the design geometry, thrust to weight ratio and wing loading of an aircraft. |
| **CO601.3** | Discuss initial sizing and configuration layout. |
| **CO601.4** | Acquire a thorough understanding of aerodynamic coefficients, propulsion systems, jet engine thrust, thrust-drag analysis, and piston and turboprop engine performance. |
| **CO601.5** | Discuss the design aspects of sub systems in flight vehicles. |

**Textbooks:**


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


**Reference books:**


1. J Roskam, "**Introduction to Aircraft Design** ", DAR corporation 2016.
2. John Fielding, "**Introduction to Aircraft Design**", Cambridge University Press, 2009.


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3. Editor Mark Davies, "**Standard Handbook for Aeronautical & Astronautical Engineers**", Tata McGraw Hill 2000

**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Two Tests are to be conducted for 40 marks each. Marks scored in each test are reduced to 30 and added to test component. CIE is executed by way of Three tests. Laboratory CIE is conducted for 20 Marks and Added to CIE component

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **30** |
| | CIE Test-2 | **40** | |
| | CIE Test-3 | **40** | |
| | LAB CIE | **20** | **20** |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO601.1** | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO601.2** | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO601.3** | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO601.4** | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO601.5** | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **Average** | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - |

**Low-1: Medium-2: High-3**

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## SEMESTER – VI

**COURSE: FLIGHT MECHANICS**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23602** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:2:0** | **SEE Marks** | **50** |
| **No. of Credits** | **4** | **Examination Hours** | **03** |

**Pre-requisite:** Elements of Aeronautics

**Course Learning Objectives:** To enable students to apply the knowledge of airplane performance and stability in broad domain of aeronautical engineering by making them to learn:

| | |
|---|---|
| **CLO1** | Understand the aircraft performance in steady unaccelerated and accelerated flight |
| **CLO2** | . Understand the airplane performance parameters and acquire the knowledge on aircraft maneuvers performance. |
| **CLO3** | Understand the basics of aircraft stability and control |
| **CLO4** | Understand the static longitudinal and static directional stability. |

| Content | No. of Hours/ RBT levels |
|---|---|
| **Module 1**<br>**The Equations of Motion Steady Unaccelerated Flight:** Introduction, four forces of flight, General equation of motion, Power available and power required curves. Thrust available and thrust required curves. Conditions for power required and thrust required minimum. Thrust available and maximum velocity, Power available and maximum velocity, Altitude effects on power available and power required; thrust available and thrust required. Steady Performance – Level Flight, Climb & Glide<br>Performance: Equation of motion for Rate of climb- graphical and analytical approach -Absolute ceiling, Service ceiling, Time to climb – graphical and analytical approach, climb performance graph (hodograph diagram); maximum climb angle and rate of climb Gliding flight, Range during glide, minimum rate of sink and shallowest angle of glide. | **8 Hours / L4** |
| **Module 2**<br>**Fundamental Airplane Performance Parameters:** The fundamental Parameters: Thrust – to – weight ratio, Wing loading, drag polar, and lift-to – drag ratio. Minimum velocity. Aerodynamic relations associated with lift-to-drag ratio.<br>**Range and Endurance:** | **8 Hours / L3** |

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| | |
|---|---|
| **Propeller driven Airplane:** Physical consideration, Quantitative formulation, Breguet equation for Range and Endurance, Conditions for maximum range and endurance.<br>**Jet Airplane:** Physical consideration, Quantitative formulation, Equation for Range and Endurance, Conditions for maximum range and endurance, Effect of head wind tail wind. | |
| **Module 3**<br>**Aircraft Performance in Accelerated Flight**<br>**Take-off Performance:** Calculation of Ground roll, Calculation of distance while airborne to clear obstacle, Balanced field length<br>**Landing Performance and Accelerated Climb:** Calculation of approach distance, Calculation of flare distance, Calculation of ground roll, ground effects. Acceleration in climb.<br>**Maneuvers Performance**<br>**Turning performance:** Level turn, load factor, Constraints on load factor, Minimum turn radius, Maximum turn rate. Pull-up and Pull-down maneuvers: (Turning rate, turn radius). Limiting case for large load factor. The V-n diagram. Limitations of pull up and push over. | **8 Hours / L5** |
| **Module 4**<br>**Static Longitudinal Stability and Control-Stick Fixed:** Historical perspective, Aerodynamic Nomenclature, Equilibrium conditions, Definition of static stability, Definition of longitudinal static stability, stability criteria, Contribution of airframe components: Wing contribution, Tail contribution, Fuselage contribution, Power effects- Propeller airplane and Jet airplane 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. | **8 Hours / L4** |
| **Module 5**<br>**Static Longitudinal Stability& Static Directional Stability and Control-Stick free:** Introduction, Hinge moment parameters, Control surface floating characteristics and aerodynamic balance, Estimation of hinge moment parameters, The trim tabs, Stick-free Neutral point, Stick force gradient in unaccelerated flight, Restriction on aft C.G. Introduction, Definition of directional stability, Static directional stability rudder fixed, Contribution of airframe components, Directional control. Rudder power, Stick-free directional stability, Requirements for directional control, Rudder lock, Dorsal fin. One engine inoperative condition. Weather cocking effect. | **8 Hours / L3** |



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**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | | |
|---|---|---|
| **CO602.1** | Apply the basic airplane performance parameters. | L4 |
| **CO602.2** | Differentiate the aircraft performance in steady unaccelerated and accelerated flight. | L3 |
| **CO602.3** | Apply the basic concepts of aircraft stability and control. | L5 |
| **CO602.4** | Differentiate the static longitudinal and static directional stability. | L4 |

**Textbooks:**


1. John D. Anderson, Jr. "Aircraft Performance and Design", McGraw-Hill International Editions, Aerospace Science/ Technology Editions, 1999.
2. John D. Anderson, Jr., "Introduction to flight" McGraw-Hill International Editions, Aerospace Science/ Technology Editions, 2000.
3. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley Son Inc, New York, 1988.
4. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 2007.


**Reference books:**


1. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley Son Inc, New York, 1988.
2. Barnes W. McCormick, ` Aerodynamics, Aeronautics, and Flight Mechanics`, John Wiley& Sons, Inc. 1995.
3. Bandu N. Pamadi, `Performance, Stability, Dynamics and Control of Airplanes`, AIAA 2nd Edition Series, 2004.
4. John D. Anderson, Jr., "Introduction to flight" McGraw-Hill, International Editions, Aerospace Science Technology Editions, 2000.

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


Scheme of Examination:

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**



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| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO602.1** | 3 | 3 | 2 | 2 | - | 1 | 1 | 1 | - | - | - | 1 | 3 | 1 |
| **CO602.2** | 3 | 3 | 2 | 2 | - | 1 | 1 | 1 | - | - | - | 1 | 3 | 1 |
| **CO602.3** | 3 | 3 | 2 | 2 | - | 1 | 1 | 1 | - | - | - | 1 | 3 | 1 |
| **CO602.4** | 3 | 3 | 2 | 2 | - | 1 | 1 | 1 | - | - | - | 1 | 3 | 1 |
| **Average** | **3** | **3** | 2 | 2 | - | 1 | 1 | 1 | - | - | - | **1** | **3** | 1 |

**Low-1: Medium-2: High-3**

# SEMESTER VI

## COURSE: MAJOR PROJECT PHASE 1

| | | | |
|---|---|---|---|
| **Course Code** | **ANEP23605** | **CIE Marks** | **100** |
| **Hours/Week (L: T: P)** | **0:0:4** | **SEE Marks** | **-** |
| **No. of Credits** | **2** | **Examination Hours** | **-** |

| **Content** | **No. of Hours/RBT levels** |
|---|---|
| **Project work phase 1:** | |

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| | |
|---|---|
| Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary project can be assigned to an individual student or to a group having not more than 4 students. In extraordinary cases, like the funded projects requiring students from different disciplines, the project student strength can be 5 or 6.<br>CIE procedure for Project Work Phase - 1:<br><br>**a. Single discipline:** The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.<br><br>The CIE marks awarded for the project work phase -1, shall be based on the evaluation of the project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology) using Rubrics, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the Project report shall be the same for all the batchmates.<br><br>**b. Interdisciplinary:** Continuous Internal Evaluation shall be group wise at the<br>college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.<br><br>The CIE marks awarded for the project work phase -1, shall be based on the evaluation of project work phase -1 Report (covering Literature Survey, Problem identification, Objectives and Methodology), project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates as per Rubrics covering all Program Outcomes. | **08 Hours** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO605.1** | Able to make comprehensive use of the technical knowledge gained from previous courses |
| **CO605.2** | Able to understand technologies concerned with the project |
| **CO605.3** | Able to apply project management skills (scheduling work, procuring parts and documenting expenditures and working within the confines of a deadline). |
| **CO605.4** | Able to analyze, develop and demonstrate the proposed work |
| **CO605.5** | Able to communicate technical information by means of ethical writing and presentation. |

Table 1: Distribution of weightage for CIE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| | Review-1 | | |



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| | | | |
|---|---|---|---|
| CIE | Review-2 | **100** | **100** |
| SEE | Semester End Examination | -- | -- |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO605.1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO605.2** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO605.3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO605.4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO605.5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

**Low-1: Medium-2: High-3**

## SEMESTER VI

**COURSE: FLIGHT SIMULATION LAB**

| | | | |
|---|---|---|---|
| **Course Code** | **ANEL23606** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **0:0:2** | **SEE Marks** | **50** |
| **No. of Credits** | **1** | **Examination Hours** | **03** |

**Course Learning Objectives:**

| | |
|---|---|
| **CLO1** | Be acquainted with basic principles of Matlab using different |
| **CLO2** | Acquire the knowledge on Sims cape |
| **CLO3** | Understand the procedures for using Simulink |

| **LIST OF EXPERIMENTS** | **RBT LEVELS** |
|---|---|
| 1. Plot root locus with variables in transfer function through MATLAB | **L3** |
| 2. Draw Bode plot from a transfer function in MATLAB and explain the gain and phase margins | **L3** |
| 3. Model mass-spring damper system in MATLAB | **L3** |
| 4. Model mass-spring damper in Simulink and Sims cape | **L3** |

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| | |
|---|---|
| 5. Simulate a DC motor in Simulink and Sims cape | **L3** |
| 6. Simulate a DC motor with PID controller and tune the PID | **L3** |
| 7. Simulate a package drop from an aircraft | **L3** |
| 8. Simulate and visualize aircraft take off | **L3** |
| 9. Model an UAV package delivery | **L3** |
| 10. Estimate G forces for flight data | **L3** |
| 11. Simulate aircraft longitudinal motion and demonstrate the effect of static margin variation for a doublet input in pitch | **L3** |
| 12. Simulate a rotor-flying manipulator | **L3** |
| 13. Model Maneuver stabilization for a mini drone | **L3** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | | |
|---|---|---|
| **CO606.1** | CO1 | Plot the root locus and bode plot |
| **CO606.2** | CO2 | Calculate the dynamic response of aircraft and uav |
| **CO606.3** | CO3 | Build physical component models based on physical connections that directly integrate with block diagrams and other modeling paradigms. |

**Scheme of Examination:**

Semester End Examination (SEE): Distribution of weightage for SEE of Regular courses

| | **Component** | **Marks** | **Total Marks** |
|---|---|---|---|
| SEE | PART- A | **20** | **50** |
| | PART- B | **20** | |
| | VIVA-VOCE | **10** | |
| **SEE Total** | | | **50** |

**Continuous Internal Evaluation (CIE):** Distribution of weightage for CIE of Regular courses

| | **Component** | **Marks** | **Total Marks** |
|---|---|---|---|
| CIE | MANUAL / RECORD | **20** | **50** |
| | CIE Test-1 | **20** | |
| | VIVA-VOCE | **10** | |
| **CIE Total** | | | **50** |

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| CO/PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO606.1 | 3 | 2 | 2 | - | 3 | - | - | - | - | - | - | - | - | 2 |
| CO606.2 | 3 | 2 | 2 | - | 3 | - | - | - | - | - | - | - | - | 2 |
| CO606.3 | 3 | 2 | 2 | - | 3 | - | - | - | - | - | - | - | - | 2 |
| Average | 3 | 2 | 2 | - | 3 | - | - | - | - | - | - | - | - | 2 |

**Low-1: Medium-2: High-3**

# SEMESTER VI
# PROFESSIONAL ELECTIVE II
## COURSE: COMPOSITE MATERIALS AND STRUCTURES

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23603A** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Pre-requisite:** Materials and Manufacturing Process

**Course Objectives:** To enable students to apply the knowledge of Composite Materials and Structures in broad domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CLO1** | Understand the behavior of constituents in the composite materials and i applications |
| **CLO2** | Understand the various manufacturing processes of Composite materials |
| **CLO3** | Apply constitutive equations of composite materials and understand mechanical behavior at micro level. |
| **CLO4** | Evaluate the elastic stresses and strains in composites considering different laminate configurations |
| **CLO5** | Inspection & Quality Control, Applications of composites in different fields of engineering. |

| Content | No. of Hours/RBT levels |
|---|---|

| | |
|---|---|
| **Module 1**<br><br>**Introduction to Composite Materials:** Definition, classification of composite materials, classification of reinforcement - particulate, short fiber, whiskers, long fibers composites. matrix materials – metals, ceramics, polymers (including thermoplastics and thermosets), Carbon-Carbon Composites Metal.<br>**Matrix Composites:** MMC with particulate and short fiber reinforcement, liquid and solid-state processing of MMC – stir casting, squeeze casting. Properties of MMCs, Applications of Al, Mg, Ti based MMC. | **08 Hours / L2** |
| **Module 2**<br><br>**Processing of Polymer Matrix Composites:** Thermoset Polymers, Hand layup Process, Vacuum Bagging Process, Post Curing Process, Filament winding, Pultrusion, Autoclave Process, VARTM, resin film infusion.<br>**Processing of Polymer Matrix Composites:** Thermoplastic Polymers, Extrusion process, Injection Moulding Process, Thermo-forming process. Post Processing of Composites – Adhesive bonding, drilling, cutting processes | **08 Hours / L2** |
| **Module 3**<br><br>**Micromechanics:** Introduction – advantages and application of composite materials – types of reinforcements and matrices – micro mechanics – mechanics of materials approach, elasticity approach- bounding techniques – fiber volume ratio – mass fraction – density of composites. Effect of voids in composites. | **08 Hours / L3** |
| **Module 4**<br><br>**Macro mechanics:** Generalized Hooke's Law – elastic constants for anisotropic, orthotropic and isotropic materials – macro mechanics – stress-strain relations with respect to natural axis, arbitrary axis – determination of in plane strengths of a lamina – experimental characterization of lamina.<br><br>**Failure Theory:** Tsai-Hill, Tsai-Wu, Max Stress and Max Strain | **10 Hours / L3** |
| **Module 5**<br><br>**Inspection & Quality Control:** Destructive & Non-Destructive Testing, Tensile, Compression, Flexural, Shear, Hardness; ultrasonic testing – A-B-C scan<br>**Repairs of Composite Materials and Applications:** Automobile, Aircrafts, missiles, Space hardware, Electrical and electronics, marine, recreational and Sports equipment, future potential of composites. | **08 Hours / L3** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO603A.1** | Understanding the mechanics of composite materials. |
| **CO603A.2** | Understand the processing methods in composite materials. |
| **CO603A.3** | Apply the characterization methods for various engineering materials. |
| **CO603A.4** | Comprehend and apply theories of structures for engineering problems. |

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| | |
|---|---|
| **CO603A.5** | Understand the inspection techniques used for composite and various application of composite in different fields of engineering. |

**Textbooks:**


1. K.K Chawla, Composite Materials- Science and Engineering, Springer Verlag, II edition,1998.
2. Autar Kaw, Mechanics of Composites, CRC Press, II edition,2006.


**Reference books:**


1. Mein Schwartz, Composite Materials Handbook, Department of Defense, USA, 2002
2. Ajay Kapadia, Non-Destructive Testing of Composite Materials, TWI Publications, 2006.
3. R M Jones, Mechanics of Composite Materials, Taylor & Francis, 2nd Edn,2015


**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |

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| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO603A.1** | 3 | 3 | - | - | - | - | - | - | | - | - | - | 3 | - |
| **CO603A.2** | 3 | 3 | - | - | - | - | - | - | | - | - | - | 3 | - |
| **CO603A.3** | 3 | 3 | - | - | - | - | - | - | | - | - | - | 3 | - |
| **CO603A.4** | 3 | 3 | - | - | - | - | - | - | | - | - | - | 3 | - |
| **CO603A.5** | 3 | 3 | - | - | - | - | - | - | | - | - | - | 3 | - |
| **Average** | 3 | 3 | - | - | | | | | | - | | | 3 | |

**Low-1: Medium-2: High-3**

# SEMESTER VI
# PROFESSIONAL ELECTIVE II

**COURSE: ROCKET AND MISSILES**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23603B** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Pre-requisite: low speed and high-speed Aerodynamics and Propulsion Objectives**:
To give revelation on basic concepts of rocket motion, rocket aerodynamics, staging & control of rockets, materials and propulsion systems of rockets and missiles to students to augment their knowledge in the region of rockets and missile flight.

| | |
|---|---|
| **CLO1** | Understand the historical development of rockets and missiles and their significance in aerospace technology. |
| **CLO2** | Analyze the Aerodynamic Characteristics of Rockets and Missiles. |
| **CLO3** | Gaining knowledge about the Trajectory Motion of Rockets and Missiles. |
| **CLO4** | Gain the knowledge on the separation of stages of rocket and its control |
| **CLO5** | Understand the Materials used in Rockets and Missiles |

| **Content** | **No. of Hours/ RBT levels** |
|---|---|
| **Module 1**<br>**CLASSIFICATION OF ROCKETS AND MISSILES:** History of rockets and missiles, Various methods of classification of missiles and rockets – Basic aerodynamic characteristics of surface to surface, surface to air, air to surface and air to air missiles – Examples of various Indian space launch vehicles and missiles – Current status of Indian rocket and missile program. | **08 Hours/ L2** |

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| | |
|---|---|
| **Module 2**<br>**AERODYNAMICS OF ROCKETS AND MISSILES** Forces Acting on a Missile While Passing Through atmosphere, methods of Describing Aerodynamic Forces and Moments – Lateral Aerodynamic Moment – Lateral Damping Moment and Longitudinal Moment of a Rocket – lift and Drag Forces. | **08 Hours/ L3** |
| **Module 3**<br>**ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD:** One Dimensional and Two-Dimensional Rocket Motions in Free Space and Homogeneous Gravitational Fields – description of Vertical, Inclined and Gravity Turn Trajectories – Determination of range and Altitude. | **08 Hours/ L3** |
| **Module 5**<br>**MATERIALS FOR ROCKETS AND MISSILES:** Criteria for selection of materials for rockets and missiles, requirements for choice of materials for propellant tanks, liners, insulators, inhibitors, at cryogenic temperatures, requirements of materials at extremely high temperatures, requirements of materials for thermal protection and for pressure vessels. | **08 Hours/L2** |

**COURSE OUTCOMES**: **Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO603B.1** | Classify rockets and missiles based on various methods and explain the basic aerodynamic characteristics of different types. |
| **CO603B.2** | Analyze the Motion of Rocket and Missiles in free space and gravitational field |
| **CO603B.3** | Analyze the Aerodynamic Forces and Moments of Rockets and Missiles. |
| **CO603B.4** | Describe the Stage separation of Multi staging rocket and various aerodynamic & jet control methods |
| **CO603B.5** | Assess and choose appropriate Materials for Rockets and Missiles. |

**Textbooks:**


1. Cornelisse, J.W., "**Rocket Propulsion and Space Dynamics**", J.W., Freeman & Co. Ltd. London, 1982.
2. Sutton, G.P., et al., "**Rocket Propulsion Elements**", 8th edition John Wiley & Sons Inc., New York.


**Reference books:**


1. Mathur, M., and Sharma, R.P., "**Gas Turbines and Jet and Rocket Propulsion**", Standard Publishers, New Delhi 1998.
2. Parker, E.R., "**Materials for Missiles and Spacecraft**", McGraw-Hill Book Co. Inc., 1982


Scheme of Examination:

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full**

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**questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

Typical Evaluation pattern for regular courses is shown in Table 1.

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO641.1 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| CO641.2 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| CO641.3 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| CO641.4 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| CO641.5 | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **Average** | 3 | 3 | - | - | - | - | - | - | - | - | - | - | 2 | - |

**Low-1: Medium-2: High-3**

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# SEMESTER VI
# PROFESSIONAL ELECTIVE II
## COURSE: GUIDANCE AND CONTROL

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23603C** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Pre-requisite:** Control engineering

**Course Learning Objectives:** To enable students to apply the knowledge of guidance & control in broad domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CLO1** | Comprehend the basic concepts of navigation, guidance and control. |
| **CLO2** | Acquire the knowledge of radar systems and other guidance systems |
| **CLO3** | Understand the missile guidance and |
| **CLO4** | summarize missile control system. |
| **CLO5** | Describe the flight control and fire control of the system |

| Content | No. of Hours/RBT levels |
|---|---|
| **Module 1**<br>**Introduction to Guidance and Controls:** Concepts of navigation, guidance, and control. Introduction to basic principles. Air data information**.**<br>Principle of working of radar. MTI and Pulse Doppler radar. Moving target detector. Limitation of MTI performance. MTI from a moving platform (AMTI) | **8 Hours/ L3** |
| **Module 2**<br>**Tracking with Radar and Guidance Systems:** Mono pulse tracking. Conical scan and sequential lobbing. Automatic tracking with surveillance radar (ADT).<br>Gyros and stabilized platforms. Inertial guidance and Laser based guidance. Components of Inertial Navigation System. Imaging Infrared guidance. Satellite navigation. GPS | **08 Hours/ L3** |
| **Module 3**<br>**Transfer Functions and Missile Control System:** Input-output Transfer function. Basic altitude reference. Concepts of Open loop and Close Loop.<br>Guided missile concept. Roll stabilization. Control of aerodynamic missiles. Missile parameters for dynamic analysis. Missile autopilot schematics. Acceleration command and root locus | **08 Hours/ L3** |
| **Module 4**<br>**Missile Guidance:** Proportional navigation guidance; command guidance. Comparison of guidance system performance. Bank to turn missile guidance | **08 Hours/ L3** |
| **Module 5**<br>**Integrated Flight/Fire Control System:** Director fire control system. Tracking control laws. Longitudinal flight control system. Lateral flight control system. | **08 Hours/ L3** |

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| | |
|---|---|
| Rate of change of Euler angle, Auto Pilot. | |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO603C.1** | Comprehend the basic concepts of navigation, guidance and control. |
| **CO603C.2** | Acquire the knowledge of radar systems and other guidance systems |
| **CO603C.3** | Understand the missile guidance and |
| **CO603C.4** | summarize missile control system. |
| **CO603C.5** | Describe the flight control and fire control of the system |

**Textbooks:**

1. Fundamentals of Aerospace Navigation and Guidance P.T. Kabamba and A.R. Girard Cambridge Aerospace Series 2014
2. Automatic control of Aircraft & Missiles, John H Blakelock Wile –Inter Science Publication 2nd edition.

**Reference books:**

1. Navigation, R.B. Underdown& Tony Palmer Black Well Publishing 2001
2. Introduction to Radar Systems Merrilh I. Skolnik Tata Mc Graw Hill 3 rd edition,2001
3. Missile Guidance and Control Systems George M. Siouris Springer 2004 Editor

Scheme of Examination:

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module**Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

Typical Evaluation pattern for regular courses is shown in Table 1.

Table 1: Distribution of weightage for CIE& SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quiz 1/AAT | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

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| CO/PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO603C.1** | 3 | 3 | - | - | - | - | - | - | 2 | - | - | 2 | 2 | 1 |
| **CO603C.2** | 3 | 3 | - | - | - | - | - | - | 2 | - | - | 2 | 2 | 1 |
| **CO603C.3** | 3 | 3 | - | - | - | - | - | - | 2 | - | - | 2 | 2 | 1 |
| **CO603C.4** | 3 | 3 | - | - | - | - | - | - | 2 | - | - | 2 | 2 | 1 |
| **CO603C.5** | 3 | 3 | - | - | - | - | - | - | 2 | - | - | 2 | 2 | 1 |
| **Average** | 3 | 3 | - | - | - | - | - | - | 2 | - | - | 2 | 2 | 1 |

**Low-1: Medium-2: High-3**

## SEMESTER VI
## PROFESSIONAL ELECTIVE II

**COURSE: FLIGHT TESTING**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23603D** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Pre-requisite:** Aircraft Performance, Aircraft Stability and control

**Course Learning Objectives:** To enable students to apply the knowledge of Flight Testing in broad domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CLO1** | Scope of flight testing, its types and reducing uncertainty. |
| **CLO2** | Purpose, scope and working of various instruments employed for flight-testing. |
| **CLO3** | Performance of flight at different operating conditions. |
| **CLO4** | Stability and control aspects at various flight condition. |
| **CLO5** | Various regulations and recovery techniques. |



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| Content | No. of Hours/RBT levels |
|---|---|
| **Module 1**<br>**INTRODUCTION TO FLIGHT TESTING:** Purpose and scope of flight-testing, basic definition, types of flight tests, sequence of flight testing, planning the test program, governing regulations. Aircraft weight and center of gravity, flight testing tolerances. Method of reducing data uncertainty in flight test data -sources and magnitudes of error, avoiding and minimizing errors. | **08 Hours/ L6** |
| **Module 2**<br>**FLIGHT TEST INSTRUMENTATION:** Planning flight test instrumentation, sensing and transducing techniques. Measurement of linear and angular displacements, velocities and accelerations, vibration, force, temperature - onboard and ground-based data acquisition system. Radio telemetry | **08 Hours/ L5** |
| **Module 3**<br>**PERFORMANCE FLIGHT TESTING - RANGE, ENDURANCE AND CLIMB:** Airspeed –in flight calibration. Level flight performance for propeller driven aircraft and for Jet aircraft - Techniques and data reduction. Range and endurance estimation of propeller and jet aircraft. Climb performance methods. Turning performance limitations. Drag estimation. Take-off and landing - methods, procedures and data reduction. | **08 Hours/ L5** |
| **Module 4**<br>**STABILITY AND CONTROL:** Flight test Methods: Static longitudinal stability; Dynamic longitudinal stability. Lateral and directional static stability: Lateral and directional dynamic stability, Data reduction. Maneuvering stability methods, Regulations and data reduction. | **08 Hours/ L4** |
| **Module 5**<br>**FLYING QUALITIES:** MIL and FAR regulations. Cooper-Harper scale. Pilot Rating. Flight test procedures. Hazardous flight testing: Stall and spin-regulations, test and recovery techniques. Test techniques for flutter, vibration and buffeting. | **08 Hours/ L6** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | | |
|---|---|---|
| **CO603D.1** | Develop a flight test program by integrating the purpose, scope, and regulations governing flight testing along with managing aircraft weight and center of gravity considerations. | L6 |
| **CO603D.2** | Appraise the scope and working of various instruments employed for flight testing by minimizing errors. | L5 |
| **CO603D.3** | Evaluate the performance of flight at different operating conditions. | L5 |

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| | | |
|---|---|---|
| **CO603D.4** | Infer the longitudinal, lateral and directional stability and control aspects at various flight conditions. | L4 |
| **CO603D.5** | Conclude various regulations and recovery techniques of flying and handling qualities. | L6 |

**Textbooks:**

1. Ralph D Kimberlin, "**Flight Testing of Fixed Wing Aircraft**", AIAA educational Series, 2003.

**Reference books:**

1. AGARD," **Flight Test Manual** ", Vol. I to IV.

**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes/ Alternate Assessment Tools (AATs) for 10 marks.
Typical Evaluation pattern for regular courses is shown in Table 1.

Table1: Distribution of weightage for CIE& SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quiz 1/AAT | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

**CO/PO Mapping**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO603D.1** | 3 | 3 | 2 | 2 | - | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 |
| **CO603D.2** | 3 | 3 | 2 | 2 | - | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 |
| **CO603D.3** | 3 | 3 | 2 | 2 | - | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 |
| **CO603D.4** | 3 | 3 | 2 | 2 | - | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 |
| **CO603D.5** | 3 | 3 | 2 | 2 | - | 1 | 1 | 1 | 2 | 2 | 1 | 1 | 2 | 1 |
| **Average** | **3** | **3** | **2** | **2** | **-** | **1** | **1** | **1** | **2** | **2** | **1** | **1** | **2** | **1** |

**Low-1: Medium-2: High-3**

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## SEMESTER VI
## OPEN ELECTIVE -I

**COURSE: INTRODUCTION TO AERONAUTICS**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23604A** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Course Objectives:** To enable students to apply the knowledge of Introduction to Aerospace Engineering in broad domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CLO1** | To provide with a historical perspective on aviation and space technology, including the pioneers of aeronautical engineering |
| **CLO2** | To introduce fundamental principles of aerodynamics, and the forces acting on an aircraft. |
| **CLO3** | To explore the properties of materials used in flight vehicles, emphasizing the importance and introducing composite materials |
| **CLO4** | To introduce various aircraft power plants, and provide an overview of propulsion principles |
| **CLO5** | To familiarize with flight instruments and navigation instruments, and gyroscopic instruments, explaining their principles of operation |

| Content | No. of Hours/ RBT levels |
|---|---|
| **Module 1**<br>**HISTORY OF AVIATION AND SPACE TECHNOLOGY:** First Aeronautical Engineers, Atmosphere and its properties - The International Standard Atmosphere, the Physical Properties of Air, classification of aircrafts- lighter than aircraft, heavier than aircraft, basic components of an aircraft, roles of aircrafts development in military aviation | **08 Hours/ L3** |
| **Module 2**<br>**BASIC AERODYNAMICS:** Bernoulli's Principle, Airfoils, nomenclature, wing planform, angle of attack, forces over wing section-lift, drag, Thrust, weight and moments, measurement of airspeed, aircraft motions, control surfaces and high lift devices. | **08 Hours/ L3** |
| **Module 3**<br>**AIRCRAFT STRUCTURES AND MATERIALS:** Properties of flight vehicle Materials; importance of strength to weight ratio, classification and characteristics of composite materials. | **08 Hours / L3** |

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| | |
|---|---|
| **Module 4**<br>**AIRCRAFT PROPULSION:** Aircraft power plants, classification based on power plant engine and principle of operation. Turboprop, turbojet and turbofan engines; ramjets and scramjets, use of propellers, Introduction to types of rockets, missiles. | **10 Hours / L3** |
| **Module 5**<br>**AIRCRAFT INSTRUMENTS**: Flight instruments and navigation instruments – accelerometers, air speed indicators – Mach meters – altimeters – gyroscopic instruments. Principles and operation. | **08 Hours/ L3** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO604A.1** | Have a foundational knowledge of the history of aviation, an understanding of the atmosphere's properties, and the ability to classify different types of aircraft |
| **CO604A.2** | Capable of applying Bernoulli's Principle to understand lift and drag, describe airfoil nomenclature, and analyze forces |
| **CO604A.3** | Assess the properties of materials used in aviation, recognize the significance |
| **CO604A.4** | Categorizing and describing different types of aircraft engines, explaining their operational principles |
| **CO604A.5** | Have a comprehensive understanding of various flight and navigation instruments, including their principles of operation |

**Textbooks:**


1. A.C. Kermode, "**Flight without formulae**", Pearson Education India, 1989. ISBN: 9788131713891.
2. John D. Anderson, "**Introduction to Flight**", McGraw-Hil Education, 2011. ISBN 9780071086059.


**Reference books:**


1. Nelson R.C., "**Flight stability and automatic control**", McGraw-Hill International Editions, 1998. ISBN 9780071158381.
2. Ian Moir, Allan Seabridge, "**Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration**", John Wiley & Sons, 2011. ISBN 978111965006.


Scheme of Examination:

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

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Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO604A.1** | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 1 | - |
| **CO604A.2** | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| **CO604A.3** | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| **CO604A.4** | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| **CO604A.5** | 3 | 2 | | | | | | | | | | 1 | 2 | |

**Low-1: Medium-2: High-3**

# SEMESTER VI
# OPEN ELECTIVE -I

## COURSE: THE HISTORY OF AVIATION

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23604B** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Course Objectives:** To enable students to apply the knowledge of history of aviation Engineering in broad domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CLO1** | Explore the historical origins of human flight, from early dreamers to early inventors and pioneers |
| **CLO2** | Examine the Wright brothers' journey to achieve powered, controlled flight and understand the principles they applied |
| **CLO3** | Investigate the rapid advancements in aviation during the early 20th century, including the impact of World War I |



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| | |
|---|---|
| **CLO4** | Analyze the role of aviation during World War II, including developments in military aircraft and the Cold War-era arms race |
| **CLO5** | Explore the jet age, supersonic flight, and contemporary advancements in aviation technology and sustainability |

| Content | No. of Hours/ RBT levels |
|---|---|
| **Module 1**<br>**EARLY PIONEERS OF FLIGHT:** The pre-history of aviation and early dreams of flight.The contributions of inventors and pioneers like Leonardo da Vinci, the Montgolfier brothers, and Sir George Cayley.The development of balloons and gliders in the 18th and 19th centuries | **08 Hours/ L3** |
| **Module 2**<br>**THE WRIGHT BROTHERS AND THE BIRTH OF POWERED FLIGHT:** The Wright brothers' background and their journey to Kitty Hawk. The principles of controlled powered flight. The significance of the Wright brothers' first powered, controlled, sustained flight in 1903. | **08 Hours/ L3** |
| **Module 3**<br>**THE GOLDEN AGE OF AVIATION:** The rapid advancements in aviation technology during the early 20th century.The impact of World War I on aviation development. The era of aviation pioneers like Charles Lindbergh and Amelia Earhart.<br>The growth of commercial aviation and the birth of major airlines. | **08 Hours / L3** |
| **Module 4**<br>**AVIATION DURING WORLD WAR II AND THE COLD WAR:** The role of aviation during World War II, including the development of fighter planes and bombers. The Cold War-era arms race and the development of military aircraft. The space race and the early days of human spaceflight. | **08 Hours / L3** |
| **Module 5**<br>**MODERN AVIATION AND FUTURE TRENDS**: The jet age and the introduction of commercial jetliners.The development of supersonic and hypersonic aircraft.The impact of technology on aviation, including automation, navigation systems, and air traffic control.Environmental challenges and the future of sustainable aviation. | **08 Hours/ L3** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO604B.1** | Gain an understanding of the contributions of historical figures and the evolution of ideas leading to the development of aviation |
| **CO604B.2** | Appreciate the significance of the Wright brothers' historic flight and their pioneering contributions to aviation |
| **CO604B.3** | Recognize the achievements of aviation pioneers like Charles Lindbergh and the growth of commercial aviation |

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| | |
|---|---|
| **CO604B.4** | Understand the critical role of aviation in global conflicts and the transition into the Cold War era. |
| **CO604B.5** | Gain insights into modern aviation technology, environmental challenges, and emerging trends shaping the future of flight |

**Textbooks:**


1. James Tobin's "To Conquer the Air: The Wright Brothers and the Great Race for Flight", Free Press, 2003
2. Garvey, William and David Fisher, The Age of Flight - A History of America's Pioneering Airline, Pace Communications, Inc., 2002
3. Tom Lewis, Empire of the Air: The Men Who Made Radio, 2021 by Three Hills


**Reference books:**


1. Jay Spenser. The Airplane: How Ideas Gave Us Wings, Harper Collins, 2009
2. Steven Gaines, The Sky's the Limit: Passion and Property in Manhattan, Non-fiction, 2005


Scheme of Examination:

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| CO/PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |

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| CO/PO | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO604B.1** | 2 | 2 | - | - | - | - | - | - | - | - | - | - | 1 | - |
| **CO604B.2** | 2 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO604B.3** | 2 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO604B.4** | 2 | 2 | - | - | - | - | - | - | - | - | - | - | 2 | - |
| **CO604B.5** | | | | | | | | | | | | | | |
| **Average** | 2 | 2 | | | | | | | | | | | 2 | |

**Low-1: Medium-2: High-3**

## SEMESTER- VI
## OPEN ELECTIVE 1

### COURSE: AIRPORT PLANNING & MANAGEMENT

| **Course Code** | **ANE23604C** | **CIE Marks** | **50** |
|---|---|---|---|
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Course Objectives:** To enable students to apply the knowledge of Airport Planning and Management by making them to learn typical operations of airport operations, economic, political and social role of airports and its management.

| | |
|---|---|
| **CLO1** | To gain knowledge of the typical operations of airports from a management perspective |
| **CLO2** | To provide insights of economic, political and social role of airports |
| **CLO3** | Acquire the knowledge of airport operations |
| **CLO4** | Acquire the knowledge airport financial management |
| **CLO5** | Provide insights into the operational delay and capacity management |



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| Content | No. of Hours/ RBT levels |
|---|---|
| **Module 1**<br>**AIRPORTS AND AIRPORT SYSTEMS:** Introduction: Airport management on an international level; The national plan of integrated airport systems; The nation's airport system plan; The rules that govern airport management; Organizations that influence airport regulatory policies; A historical and legislative perspective: Introduction the formative period of aviation and airports, Airport growth: World War-II and the postwar period airport modernization: The early jet age. | **08 Hours/ L4** |
| **Module 2**<br>**COMPONENTS OF THE AIRPORT:** The components of an airport, the airfield. Navigational aids (NAVAIDS) located on airfields; Air traffic control and surveillance facilities located on the airfield; Weather reporting facilities located on airfields; Security infrastructure on airfields; Airspace and air traffic control: Brief history of air traffic control; The basics of air traffic control; Current and future enhancements to air traffic control; Airport terminals and ground access: The historical development of airport terminals; Components of the airport terminal; Airport ground access | **08 Hours/ L5** |
| **Module 3**<br>**AIRPORT OPERATIONS AND FINANCIAL MANAGEMENT:** Airport operations management: Introduction, pavement management, aircraft rescue and firefighting (ARFF); Snow and ice control, safety inspection programs. Bird and wildlife hazard management; Airport security: Security at commercial service airports, security at general aviation airports; the future of airport security | **08 Hours/ L3** |
| **Module 4**<br>**AIRPORT FINANCIAL MANAGEMENT:** Airport financial accounting, revenue strategies at commercial airports, pricing of airport facilities and services, variation in the sources of operating revenues, rise in airport financial burdens, airport funding, grant programs, airport financing, private investment sale of the airport. | **10 Hours/L3** |
| **Module 5**<br>**AIRPORT CAPACITY AND DELAY:** Defining capacity, factors affecting capacity and delay, estimating capacity, analytical estimates of delay: The queuing diagram; The future of airport management: Introduction, restructuring of commercial air carriers, new large aircraft and small aircraft transportation systems. restructuring of commercial air carriers, new large aircraft and small aircraft transportation systems. | **08 Hours/ L5** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | | |
|---|---|---|
| **CO604C.1** | Analyse the historical, legislative, and regulatory frameworks of airport management on both national and international levels | L4 |

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| | | |
|---|---|---|
| **CO604C.2** | Appraise the key components of airport infrastructure, including airfield navigational aids, air traffic control, weather reporting facilities, and security measures etc | L5 |
| **CO604C.3** | Apply the airport operations effectively, including pavement management, aircraft rescue and firefighting, snow and ice control, safety inspections, and wildlife hazard management, for ensuring compliance with security protocols in airports | L3 |
| **CO604C.4** | Apply financial management principles to airport operations, including financial accounting, revenue generation strategies, pricing of facilities and services, and understanding various funding and investment mechanisms to ensure sustainable airport financial health. | L3 |
| **CO604C.5** | Estimate airport capacity and delays using analytical methods, factors influencing capacity and delay, including the impact of new aircraft technologies and the restructuring of commercial air carriers. | L5 |

**Textbooks:**

1.Alexander T Wells, Ed. D Seth Young ''Airport planning and Management' McGraw-Hill Education 6th Edition, 2011.

**Reference books:**

1. Norman J. Ashford, H. P. Martin Stanton, Clifton A. Moore, Pierre Coutu "Airport Operations", McGraw Hill 3rd Edition, 2013.

**Scheme of Examination: Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

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| CO/PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO604C.1** | 3 | 3 | 1 | 1 | - | 1 | 1 | 1 | - | - | - | 1 | 1 | 1 |
| **CO604C.2** | 3 | 3 | 1 | 1 | - | 1 | 1 | 1 | - | - | - | 1 | 1 | 1 |
| **CO604C.3** | 3 | 3 | 1 | 1 | - | 1 | 1 | 1 | - | - | - | 1 | 1 | 1 |
| **CO604C.4** | 3 | 3 | 1 | 1 | - | 1 | 1 | 1 | - | - | - | 1 | 1 | 1 |
| **CO604C.5** | 3 | 3 | 1 | 1 | - | 1 | 1 | 1 | - | - | - | 1 | 1 | 1 |
| **Average** | **3** | **3** | 1 | 1 | - | 1 | 1 | 1 | - | - | - | **1** | 1 | 1 |

**Low-1: Medium-2: High-3**



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## SEMESTER- VI
## OPEN ELECTIVE 1

### COURSE: INTRODUCTION TO FLIGHT SIMULATOR

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23604D** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Course Objectives:**

| | |
|---|---|
| **CLO1** | Understand the basic principle of working of flight components |
| **CLO2** | Remember the names of components and their functions |
| **CLO3** | Think to simulate a flight |

| Content | No. of Hours/ RBT levels |
|---|---|
| **Module 1**<br>Historical Perspectives, The case for simulation, Engineering Flight Simulation, The changing role of simulation, | **08 Hours/ L4** |
| **Module 2**<br>The organization of flight simulator, Equation of Motion, Aerodynamic model, Engine Model, Engine model, data acquisition model, Gear Model, weather model, Visual System, Sound System, Motion System, Controls, Instrument Display, Navigation Systems, Maintenance | **08 Hours/ L5** |
| **Module 3**<br>Principles of Flight Modeling, Newtonian Mechanics, Differential Equations, Numerical Integration, Real-time computing, Flight Data | **08 Hours/ L3** |
| **Module 4**<br>The atmosphere, forces, moments, Axes System, Quaternions, Equations of Motions, propulsion-Piston Engine, Jet Engine, the landing gear | **10 Hours/L3** |
| **Module 5**<br>Simulation of flight control systems, the Laplace transform, PID control systems, Trimming, Aircraft Displays, Attitude Indicator, Altimeter, Airspeed Indicator, compass card, Automatic Direction Finding (ADF), VHF omnidirectional Range(VOR), Distance Measuring Equipment(DME),Instrument Landing Systems(ILS), GPS, Inertial Navigation System | **08 Hours/ L5** |

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**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | | |
|---|---|---|
| **CO604D.1** | Apply the basic principle of working of flight components | L4 |
| **CO604D.2** | Practise the names of components and their functions 3. Simulate a flight | L5 |

**Textbooks**

1. Principles of Flight Simulation by David Allerton, Wiley Publisher
2. Flight Dynamics, Simulation, and Control by Ranjan Vepa, CRC press

**Reference Books**

1. Flight Simulation by JM Rolfe and K J Staples, Cambridge University Press

In-flight Simulation-theory and Application by Edwin A. Kidd, Gifford Bull, Robert P. Harper

**Scheme of Examination: Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

**CO/PO Mapping**

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO604D.1** | 3 | 3 | 1 | 1 | - | 1 | 1 | 1 | - | - | - | 1 | 1 | 1 |
| **CO604D.2** | 3 | 3 | 1 | 1 | - | 1 | 1 | 1 | - | - | - | 1 | 1 | 1 |
| **Average** | **3** | **3** | 1 | 1 | **-** | 1 | 1 | 1 | **-** | **-** | **-** | **1** | 1 | 1 |

**Low-1: Medium-2: High-3**

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# SEMESTER – VI
# ABILITY ENHANCEMENT COURSE

## COURSE: SYSTEMS ENGINEERING FOR AERONAUTICAL ENGINEERS

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23607A** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **1:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **1** | **Examination Hours** | **03** |

**Pre-requisite:**

| | |
|---|---|
| **CO1** | Understand the Life Cycle of Systems. |
| **CO2** | Explain the role of Stake holders and their needs in organizational systems. |
| **CO3** | Develop and Document the knowledge base for effective systems engineering processes. |
| **CO4** | Apply available tools, methods and technologies to support complex high technology systems. |
| **CO5** | Create the frameworks for quality processes to ensure high reliability of systems. |

| Content | No. of Hours/ RBT levels |
|---|---|
| **Module 1**<br>**System Engineering and the World of Systems:** What is System Engineering? Origins of System Engineering, Examples of Systems Requiring Systems Engineering, System Engineering viewpoint, Systems Engineering as a Profession, The power of Systems Engineering, problems. **Structure of Complex Systems:** System building blocks and interfaces, Hierarchy of Complex systems, System building blocks, The system environment, Interfaces and Interactions.<br>**The System Development Process:** Systems Engineering through the system Life Cycle, Evolutionary Characteristics of the development process, the system engineering method, Testing throughout system development, problems. Introduction to V Model, Model Based Systems Engineering. | **08 Hours/ L2** |
| **Module 2**<br>**Systems Engineering Management:** Managing systems development and risks, Work breakdown structure (WBS), System Engineering Management Plan (SEMP), Risk Management, Organization of Systems Engineering,<br>**Identify the system:** stakeholder identification and management, boundary diagram and context diagram, affinity diagram, converging and diverging view-point analysis, functional analysis, Functional flow diagram. | **08 Hours/ L3** |

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| | |
|---|---|
| **Requirement Management:** Holistic Requirement Model: Operational Requirement Systems Requirements, Functional Requirements, Non -Functional Performance requirements, Non-Functional Implementation requirements. System Textual analysis, Writing requirements.<br><br>**Requirement Analysis:** Requirement Uncertainty, Failure Model Effect Analysis, Risks and Mitigation plan | |
| **Module 3**<br>**Concept Definition and Selection:** Selecting the system concept, Concept selection, Concept validation, System Development planning, System Functional Specifications. Functional Means Analysis, Analytical Hierarchy Process. Pugh Matrix. P-Diagram and Design of Experiment<br><br>**Advanced Development:** Reducing program risks, functional Safety risks, Risk reduction, Prototype development, Development testing, Introduction to Safety Critical System Design – SAE ARP 4754, RTCA DO-178 Standards. problems. | **08 Hours/ L3** |
| **Module 4**<br>**Engineering Design:** Implementing the System Building blocks, requirements analysis, Requirement flow at subsystem and component level, Functional breakdown, Detailed design - Functional analysis and design, Component design, Design validation, Configuration Management, problems.<br><br>**SystemVerification & Validation:** Verification & Validation, Methods of verification,Verify by Design, Verify by numerical assessment, Verify by component testing,Verify by Integration testing, Verify by System testing. | **08 Hours/L2** |
| **Module 5**<br>**Production:** Introduction to DFX (DFM, DFR, DFC, DFT etc), Systems Engineering in the factory, Engineering for production, Transition from development to production, Production operations, Acquiring a production knowledge base, problems. | **08 Hours/L2** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO607A.1** | Understand the Life Cycle of Systems. |
| **CO607A.2** | Explain the role of Stake holders and their needs in organizational systems. |
| **CO607A.3** | Develop and Document the knowledge base for effective systems engineering processes. |
| **CO607A.4** | Apply available tools, methods and technologies to support complex high technology systems. |
| **CO607A.5** | Create the frameworks for quality processes to ensure high reliability of systems. |

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| Reference Books: | |
|---|---|
| 1. | Systems Engineering – Principles and Practice, Alexander Kossoaikoff, William N Sweet, 2012,<br>John Wiley & Sons, Inc, ISBN: 978-81-265-2453-2 |
| 2. | Handbook of Systems Engineering and Management, Andrew P. Sage, William B. Rouse, 1999,<br>John Wiley & Sons, Inc., ISBN 0-471-15405-9 |
| 3. | General System Theory: Foundation, Development, Applications, Ludwig von Bertalanffy, 1973,<br>Penguin University Books, ISBN: 0140600043, 9780140600049. |
| 4. | Systems Engineering and Analysis, Blanchard, B., and Fabrycky, W., 5th edition, 2010,<br>Prentice<br>Hall, Saddle River, NJ, USA |

**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

Typical Evaluation pattern for regular courses is shown in Table 1.

Table 1: Distribution of weightage for CIE & SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| **CIE** | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quiz /AAT | **10** | |
| **SEE** | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

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| CO-PO mapping | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO607A.1** | 1 | - | - | - | - | 1 | - | - | - | - | - | 1 |
| **CO607A.2** | - | 2 | 3 | - | 1 | - | - | 1 | - | - | 2 | - |
| **CO607A.3** | - | 3 | - | - | - | 2 | 2 | 1 | - | 3 | 2 | - |
| **CO607A.4** | - | - | 2 | 1 | - | - | - | - | - | - | - | - |
| **CO607A.5** | 1 | 1 | - | 2 | - | 1 | 2 | - | 3 | - | - | - |
| **Average** | 1 | 3 | 3 | 2 | 1 | 2 | 2 | 1 | 3 | 3 | 2 | 1 |

**High-3: Medium-2: Low-1**

# SEMESTER – VI
# ABILITY ENHANCEMENT COURSE

## COURSE: VIRTUAL AIRCRAFT SIMULATION

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23607B** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **1:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **1** | **Examination Hours** | **03** |

**Pre-requisite:**

| | |
|---|---|
| **CO1** | Remember the terminologies of virtual aircraft simulation |
| **CO2** | Understand the virtual aircraft simulation environment and settings Implement the skills of virtual flying |

| **Content** | **No. of Hours/ RBT levels** |
|---|---|
| **Module 1**<br>Introduction to virtual Aviation, Aviation rules and Organization | **08 Hours/ L2** |
| **Module 2**<br>Air Traffic Control, Radio Communication from Pilot | **08 Hours/ L2** |
| **Module 3**<br>Flight Mode Annunciator mode English, Flight Instruments and their working principles | **08 Hours/ L2** |
| **Module 4**<br>Flight Instrument Essentials, Aviation Meteorology | **08 Hours/ L2** |

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| Module 5<br>Practice of Flight Simulator X installation and Settings | 08 Hours/ L2 |
|---|---|

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO607B.1** | Use the settings and controls of virtual aircraft simulation |
| **CO607B.2** | Plan the new flying path for a specific situation |
| **CO607B.3** | Fly an aircraft virtually |

**Suggested Learning Resources:**

**Books**

1. Flight Simulation Virtual Environments in Aviation By Alfred T. Lee, ISBN 9781138246195 Published September 9, 2016 by Routledge
2. Principles of Flight Simulation, David Allerton, ISBN: 978-0-470-75436-8

**Web links and Video Lectures (e-Resources):**

- https://www.flightsimulator.com/
- https://www.youtube.com/watch?v=EOeDTr1x3XI

**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

Typical Evaluation pattern for regular courses is shown in Table 1.

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Table 1: Distribution of weightage for CIE & SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| **CIE** | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quiz /AAT | **10** | |
| **SEE** | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO-PO mapping** | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO607B.1** | 1 | - | - | - | - | 1 | - | - | - | - | - | 1 |
| **CO607B.2** | - | 2 | 3 | - | 1 | - | - | 1 | - | - | 2 | - |
| **CO607B.3** | - | 3 | - | - | - | 2 | 2 | 1 | - | 3 | 2 | - |
| **Average** | 1 | 3 | 3 | | 1 | 2 | 2 | 1 | | 3 | 2 | 1 |

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## SEMESTER – VI
## ABILITY ENHANCEMENT COURSE

### COURSE: INTRODUCTION TO SWARM DRONE

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23607C** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **1:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **1** | **Examination Hours** | **03** |

**Pre-requisite:**

| | |
|---|---|
| CO1 | Understand what is Swarm Drone |
| CO2 | Learn the construction of Swarm |
| CO3 | Acquire skill of assembly and flying swarm |

| Content | No. of Hours/ RBT levels |
|---|---|
| **Module 1**<br>Introduction of swarm or fleet of Unmanned Aerial Vehicles (UAVs), Classification, Fully autonomous, semiautonomous, single layered, multi-layered | **08 Hours/ L2** |
| **Module 2**<br>Vertically hover, take-off, and land (VTOL), remote control operations, or autonomously by using processors deployed on the drones, Military and Civil Application, Innovative Research and commercial application of Swarm | **08 Hours/ L2** |
| **Module 3**<br>Application Areas, Security, Survey, Monitoring, and Surveillance, Leisure Pursuit, Disaster Management, Environmental Mapping, Search and Rescue (S&R) | **08 Hours/ L2** |
| **Module 4**<br>Description of Sensors, Existing Control Approaches, Autonomous Swarms | **08 Hours/ L2** |
| **Module 5**<br>Battery Swapping/Recharging, Surveillance Systems, Swarm Design, Management, and Optimization | **08 Hours/ L2** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO607C.1** | Apply the concept of swarm drone design |
| **CO607C.2** | Develop swarm of drone |
| **CO607C.3** | Test fly the drone |

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| **Books** |
|---|
| 1. UAV Swarm Networks: Models, Protocols, and Systems, Edited By Fei Hu, Dong Xiu Ou, Xin-lin Huang, ISBN 9780367519988<br>2. Swarm Engineering, https://spie.org/news/swarm-engineering?SSO=1 |
| **Web links and Video Lectures (e-Resources):** |
| • https://www.coursera.org/learn/robotics-flight<br>• https://www.geopoliticalmonitor.com/warfare-evolved-drone-swarms/<br>• https://www.forbes.com/sites/davidhambling/2021/03/01/what-are-drone-swarms-and-whydoes-everyone-suddenly-want-one/ |

**Scheme of Examination:**

**Semester End Examination (SEE):**
**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**
Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.
Typical Evaluation pattern for regular courses is shown in Table 1.

Table 1: Distribution of weightage for CIE & SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| **CIE** | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quiz /AAT | **10** | |
| **SEE** | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

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| CO-PO mapping | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO607C.1** | 1 | - | - | - | - | 1 | - | - | - | - | - | 1 |
| **CO607C.2** | - | 2 | 3 | - | 1 | - | - | 1 | - | - | 2 | - |
| **CO607C.3** | - | 3 | - | - | - | 2 | 2 | 1 | - | 3 | 2 | - |
| **Average** | 1 | 2 | 3 | | 1 | 1 | | 1 | | | 2 | 1 |

# SEMESTER – VI
# ABILITY ENHANCEMENT COURSE

## COURSE: MULTI-DISCIPLINARY RESEARCH IN AERONAUTICAL ENGINEERING

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23607D** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **1:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **1** | **Examination Hours** | **03** |

**Pre-requisite:**

| | |
|---|---|
| **CO1** | Understand the multi-disciplinary research |
| **CO2** | Gather knowledge on multi-disciplinary research |
| **CO3** | Articulate on the data collection, analysis and interpretation |

| **Content** | **No. of Hours/ RBT levels** |
|---|---|
| **Module 1**<br>Introduction to multi-disciplinary research<br>What to research and how to find out more, What is a research objective and a research question, How to formulate a research objective and a research question? | **08 Hours/ L2** |
| **Module 2**<br>Phases and methods of scientific research, Experimental/Study design, Data collection, Evaluation, validation and verification, Research ethics and human resource research ethics | **08 Hours/ L2** |
| **Module 3**<br>**Research method selection and study design:** Qualitative methods, Quantitative methods, Mixed method approaches | **08 Hours/ L2** |
| **Module 4**<br>**Data collection and analysis:** Data collection and data management, Data analysis (qualitative and quantitative), Data interpretation, how to validate and verify data | **08 Hours/ L2** |

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| Module 5<br>Research management, documentation and publishing, Research plan writing | 08 Hours/ L2 |
|---|---|

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO607D.1** | Apply the concepts of the multi-disciplinary research |
| **CO607D.2** | Examine the data collected |
| **CO607D.3** | Implement the multi-disciplinary research |

**Suggested Learning Resources:**

**Books**

1. Multi-Disciplinary Research & Innovation by Dr. Gajanan S. Futane (Author)
2. Contemporary Multi-Disciplinary Research Dimension by Wakil Kumar Yadav (Author)

**Web links and Video Lectures (e-Resources):**

- https://www.lawctopus.com/academike/multidisciplinary-research/
- https://research.ncsu.edu/rdo/the-difference-between-multidisciplinary-interdisciplinary-andconvergence-research/

**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

Typical Evaluation pattern for regular courses is shown in Table 1.

Table 1: Distribution of weightage for CIE & SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| **CIE** | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quiz /AAT | **10** | |
| **SEE** | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

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| CO-PO mapping | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** |
| **CO607D.1** | 1 | - | - | - | - | 1 | - | - | - | - | - | 1 |
| **CO607D.2** | - | 2 | 3 | - | 1 | - | - | 1 | - | - | 2 | - |
| **CO607D.3** | - | 3 | - | - | - | 2 | 2 | 1 | - | 3 | 2 | - |
| **Average** | 1 | 3 | 3 | | 1 | 2 | 2 | 1 | | 3 | 2 | 1 |

## SEMESTER – VI

**COURSE: INDIAN KNOWLEDGE SYSTEM**

| | | | |
|---|---|---|---|
| **Course Code** | **BIKK23609** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **1:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **0** | **Examination Hours** | **03** |

**Pre-requisite:** Nil

**Course objectives:** This course will enable students to

| | |
|---|---|
| **CLO1** | To facilitate the students with the concepts of Indian traditional knowledge and to make them understand the Importance of roots of knowledge system |
| **CLO2** | To make the students understand the traditional knowledge and analyse it and apply it to their day-to-day life. |

| | |
|---|---|
| **Module-1**<br>Introduction to Indian Knowledge Systems (IKS): Overview, Vedic Corpus Philosophy, Character scope and importance, traditional knowledge vis-a-vi indigenous knowledge, traditional knowledge vs. western knowledge. | **No. of Hours/RBT levels** |
| **Module-2**<br>Traditional Knowledge in Humanities and Sciences: Lingistics, Number an measurements- Mathematics, Chemistry, Physics, Art, Astronomy, Astrology, Craft and Trade in India and Engineering and Technology | **10 Hours/L3** |
| **Module-3**<br>Traditional Knowledge in Professional domain: Town planning and architectur Construction, Health, wellness and Psychology-Medicine, Agriculture, Governanc and public administration, United Nations Sustainable development goals. | **10 Hours/L3** |

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**Reference Books:**


1. Introduction to Indian Knowledge System- concepts and applications, B Mahadevan, Vinayak Rajat Bhat, Nagendra Pavana R N, 2022, PHI Learning Private Ltd, ISBN-978-93-91818-21-0
2. Traditional Knowledge System in India, Amit Jha, 2009, Atlantic Publishers and Distributors (P) Ltd., ISBN13: 978-8126912230,
3. Knowledge Traditions and Practices of India, Kapil Kapoor, Avadesh Kumar Singh, Vol. 1, 2005, DK Print World (P) Ltd., ISBN 81-246-0334,


**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO609.1** | **Provide an overview of the concept of the Indian Knowledge System and it importance.** |
| **CO609.2** | **Appreciate the need and importance of protecting traditional knowledge.** |
| **CO609.3** | **Recognize the relevance of Traditional knowledge in different domains.** |
| **CO609.4** | **Establish the significance of Indian Knowledge systems in the contemporary world** |

**Scheme of Examination:**

**Semester End Examination (SEE):**

SEE paper shall be set for 50 questions, each of the 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is 01 hour.

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. Average of Marks scored in all three tests is added to test component. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs), and three tests.

**Typical Evaluation pattern for regular courses is shown in Table 2.**

**Table 2: Distribution of weightage for CIE & SEE of Regular courses**

| Component | | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | 40 | 50 |
| | CIE Test-2 | 40 | |
| | CIE Test-3 | 40 | |
| | Assignments | 10 | |
| SEE | Semester End Examination | 50 | 50 |
| Grand Total | | | 100 |

| CO/PO | PO6 |
|---|---|
| CO 1 | 3 |
| CO 2 | 3 |
| CO 3 | 3 |
| CO 4 | 3 |
| Average | 3 |

**Low-1: Medium-2: High-3**

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# SEMESTER -V

**COURSE: UNIVERSAL HUMAN VALUES**

| | | | |
|---|---|---|---|
| **Course Code** | **UHV23511** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **1:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **0** | **Examination Hours** | **03** |

**Course Objectives:**

| | |
|---|---|
| **CLO1** | To create an awareness on Engineering Ethics and Human Values. |
| **CLO2** | To understand social responsibility of an engineer. |
| **CLO3** | To appreciate ethical dilemma while discharging duties in professional life. |

| Content | No. of Hours |
|---|---|
| **Module 1**<br>**INTRODUCTION TO VALUE EDUCATION:** Value Education, Definition, Concept and Need for Value Education. The Content and Process of Value Education. Basic Guidelines for Value Education. Self-exploration as a means of Value Education. Happiness and Prosperity as parts of Value Education. | **05 Hours** |
| **Module 2**<br>**HARMONY IN THE HUMAN BEING:** Human Being is more than just the Body. Harmony of the Self ('I') with the Body. Understanding Myself as Co-existence of the Self and the Body. Understanding Needs of the Self and the needs of the Body. Understanding the activities in the Self and the activities in the Body. | **05 Hours** |
| **Module 3**<br>**HARMONY IN THE FAMILY AND SOCIETY AND HARMONY IN THE NATURE:** Family as a basic unit of Human Interaction and Values in Relationships. The Basics for Respect and today's Crisis: Affection, e, Guidance, Reverence, Glory, Gratitude and Love. Comprehensive Human Goal: The Five Dimensions of Human Endeavour. Harmony in Nature: The Four Orders in Nature. The Holistic Perception of Harmony in Existence. | **05 Hours** |
| **Module 4**<br>**SOCIAL ETHICS:** The Basics for Ethical Human Conduct. Defects in Ethical Human Conduct. Holistic Alternative and Universal Order. Universal Human Order and Ethical Conduct. Human Rights violation and Social Disparities. | **05 Hours** |
| **Module 5**<br>**PROFESSIONAL ETHICS:** Value based Life and Profession. Professional Ethics and Right Understanding. Competence in Professional Ethics. Issues in Professional Ethics The Current Scenario. Vision for Holistic Technologies, Production System and Management Models. | **05 Hours** |

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**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO511.1** | Understand the significance of value inputs in a classroom and start applying them in their life and profession |
| **CO511.2** | Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc. |
| **CO511.3** | Understand the role of a human being in ensuring harmony in society and nature. |
| **CO511.4** | Distinguish between ethical and unethical practices and start working out the strategy to actualize a harmonious environment wherever they work. |

**Textbooks:**


1. A.N Tripathy, New Age International Publishers, 2003.
2. Bajpai. B. L, New Royal Book Co, Lucknow, Reprinted, 2004
3. Bertrand Russell Human Society in Ethics & Politics


**Reference Books:**


1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. Corliss Lamont, Philosophy of Humanism Gaur. R.R. , Sangal. R, Bagari G.P, A Foundation Course in Value Education, Excel Books, 2009.
4. Gaur. R.R. , Sangal R , Bagaria G.P, Teachers Manual, Excel Books, 2009.
5. I.C. Sharma, Ethical Philosophy of India, Nagin & co, Julundhar William Lilly- Introduction to Ethics -Allied Publisher


## Scheme of Examination:

There is no Semester End Examination for this course. The assessment is based on Continuous Internal Evaluation only.

## Continuous Internal Evaluation (CIE):

CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests. Two quizzes are to be conducted and each quiz is evaluated for 5 marks adding up to 10 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. Typical Evaluation pattern for this course is shown in Table 1.

Table 1: Distribution of weightage for CIE

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | 40 | 100 |
| | CIE Test-2 | 40 | |
| | Quiz 1/AAT | 10 | |
| | Quiz 2/AAT | 10 | |
| Grand Total | | | 100 |

CO/PO Mapping

| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO511.1** | - | - | - | - | - | 2 | 3 | 3 | 3 | 3 | - | - | - | - |
| **CO511.2** | - | - | - | - | - | 2 | 3 | 3 | 3 | 3 | - | - | - | - |
| **CO511.3** | - | - | - | - | - | 2 | 3 | 3 | 3 | 3 | - | - | - | - |
| **CO511.4** | - | - | - | - | - | 2 | 3 | 3 | 3 | 3 | - | - | - | - |
| **Average** | - | - | - | - | - | 2 | 3 | 3 | 3 | 3 | - | - | - | |

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# VII SEMESTER

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## SEMESTER VII

**COURSE: AVIONICS AND SYSTEMS**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23701** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:2** | **SEE Marks** | **50** |
| **No. of Credits** | **4** | **Examination Hours** | **03** |

**Pre-requisite:** NIL

**Course Objectives:** To enable students to apply the knowledge of Avionics in broad domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CLO1** | To know about the basics of avionics and its need for civil and military aircrafts |
| **CLO2** | To impart knowledge about the avionic architecture and various avionics data buses |
| **CLO3** | Knowledge on various avionics subsystems |
| **CLO4** | Learn about different navigation systems |
| **CLO5** | Learn about air data systems and auto pilot |

| Content | No. of Hours/RBT levels |
|---|---|
| **Module 1**<br>**Introduction to Avionics Buses:** Avionics Bus Architecture-Digital Data Buses, Fibre Optic Buses. | **08 Hours/L2** |
| **Module 2**<br>**Flight Sensors and Displays:** Air Data Sensing, Air Data Computer, Magnetic Sensing – Magnetic Heading Reference System (MHRS), Inertial Sensing, Radar Altimeter (RADALT), Doppler Radar, Weather Radar - Cathode Ray Tube (CRT), Active-Matrix Liquid Crystal Display (AMLCD), Head Down Display (HDD), Head Up Display (HUD), Helmet Mounted Display (HMD), Integrated Standby Instrument System (ISIS). Direct voice input (DVI), Touch Screen, HOTAS. | **08 Hours/L2** |
| **Module 3**<br>**Digital Electronics** & **Antennas:** Introduction to VLSI, Frequency and its types, Antenna-types, radiation pattern, voltage and current distribution, polarization and its application in navigation and communication. | **08 Hours/L2** |
| **Module 4**<br>**Communication and Automatic Flight Control:** Satellite Communication, Terrain communication, Air Traffic Control (ATC) Transponder, Traffic Collision & | **08 Hours/L2** |

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| | |
|---|---|
| Avoidance System (TCAS), Identification of Friend & Foe (IFF). Emergency locator transmitters Longitudinal, Lateral & Direction Autopilot. | |
| **Module 5**<br>**Navigation:** Automatic Direction Finding, Very High Frequency Omni-Range (VOR), Distance Measuring Equipment (DME), Tactical Air Navigation (TACAN), VORTAC (VOR+TACAN), Hyperbolic navigation, Satellite Navigation System-Global Positioning System (GPS), Differential GPS, Instrument Landing System (ILS), Transponder Landing System (TLS), Microwave Landing System (MLS), Laser based landing and RF based landing system, Astronavigation. | **10 Hours/L2** |

## List of Experiments

1. Determination of velocity and range of the target using radar.
2. Estimation of RPM and time period of oscillation using radar.
3. Display the orientation of the control surface & change the orientation of control surface to stabilize the aircraft.
4. Sense the temperature and pressure of cabin and provide alarm during emergency.
5. Configuration and Data transfer using MIL-STD-1553.
6. Configuration and Data transfer using ARINC 429.
7. Configuration and Data transfer using AFDX.
8. Perform on board communication using satellite communication.
9. Determination of aircraft attitude using Inertial navigation system.
10. Demonstrate the application of GPS system.
11. Estimation of distance or altitude measurement of the aircraft.
12. Study of different types of Antennas.

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO701.1** | Describe the avionics buses and their application in aircraft. |
| **CO701.2** | Understand modern Aviation sensors and display system. |
| **CO701.3** | Familiarize about antenna technologies used for aviation |
| **CO701.4** | Describe about the different communication and automatic flight control systems |
| **CO701.5** | Identify and understand the use of navigation |

**Textbooks:**

1.Albert Helfrick.D., "Principles of Avionics", Avionics Communications Inc., 2004.
2.Collinson.R.P.G. "Introduction to Avionics", Chapman and Hall, 1996.

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**Reference books:**


1. Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989.
2. Pallet.E.H.J., "Aircraft Instruments and Integrated Systems", Pearsons, Indian edition 2011.
3. Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J., U.S.A. 1993.
4. Spitzer. C.R. "The Avionics Handbook", CRC Press, 2000.
5. S Nagabhushana and N Prabhu, "Principles of Modern Avionics", I. K. International Pvt Ltd, distributed by Wiley, Edition 2019.


## Scheme of Examination:

### Semester End Examination (SEE):

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reducedto 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are requiredto answer any **five full questions** choosing at least **one full question from each module.**

### Continuous Internal Evaluation (CIE):

Two Tests are to be conducted for 50 marks each. Marks scored in each test is reducedto 20 andadded to test component.

CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and twotests.

Two quizzes are to be conducted and each quiz is evaluated for 5 marks adding up to 10Marks.

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **20** | **50** |
| | CIE Test-2 | **20** | |
| | Quiz 1/AAT | **05** | |
| | Quiz 2/AAT | **05** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

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| CO/PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO701.1** | 2 | 2 | 1 | - | - | - | - | - | - | 1 | - | 1 | 2 | 1 |
| **CO701.2** | 2 | 2 | 1 | - | - | - | - | - | - | 1 | - | 1 | 2 | 1 |
| **CO701.3** | 2 | 2 | 1 | - | - | - | - | - | - | 1 | - | 1 | 2 | 1 |
| **CO701.4** | 2 | 2 | 1 | - | - | - | - | - | - | 1 | - | 1 | 2 | 1 |
| **CO701.5** | 2 | 3 | 1 | - | - | - | - | - | - | 1 | - | 1 | 2 | 1 |
| **Average** | 2 | 2 | 1 | | | | | | | 1 | | 1 | 2 | 1 |

**Low-1: Medium-2: High-3**

## SEMESTER VII

**COURSE: COMPUTATIONAL FLUID DYNAMICS**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23702** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:2** | **SEE Marks** | **50** |
| **No. of Credits** | **4** | **Examination Hours** | **03** |

**Course Learning Objectives:** Enable students to gain a comprehensive understanding of CFD theory, its mathematical foundations, and practical applications, enabling them to solve complex fluid dynamics problems using computational methods.

| | |
|---|---|
| **CLO1** | Understand the Fundamentals of CFD, Derive the Governing Equations, Explore Shock Capturing and Shock Fitting methods |
| **CLO2** | Classify Partial Differential Equations (PDEs), Analyse their Case Studies |
| **CLO3** | Understand Finite Difference Methods, Explore Time and Space Marching, Implement Numerical Schemes |
| **CLO4** | Recognize Grid Generation Methods, Explore Structured/Unstructured Grids, Evaluate Grid Quality and Adaptive Grids: |
| **CLO5** | Understand finite volume techniques, applications and their solution schemes |

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| CONTENT | No. of Hrs /RBT Levels |
|---|---|
| **MODULE 1**<br>**INTRODUCTION AND GOVERNING EQUATIONS:** CFD ideas to understand, CFD Application, Need for high-speed Parallel Computing, Substantial derivative, Divergence of velocity, Flow models, Continuity Equation, Momentum Equation, and Energy Equations in various forms. Physical Boundary conditions. Shock capturing, Shock fitting. | **8 Hours L5** |
| **MODULE 2**<br>**MATHEMATICAL BEHAVIOUR OF PARTIAL DIFFERENTIAL EQUATIONS:** Classification of partial differential equations – Cramer Rule, Eigenvalue method. Hyperbolic, parabolic, and elliptic form of equations. Impact of classification on physical and computational fluid dynamics. Case studies-steady inviscid supersonic flow, unsteady inviscid flow, steady boundary layer flow, unsteady thermal conduction, and steady subsonic inviscid flow. | **8Hours L4** |
| **MODULE 3**<br>**DISCRETIZATION TECHNIQUES:** Finite differences methods, and difference equations. Explicit and Implicit Approach Errors and stability analysis Time marching and space marching. Reflection boundary condition. Relaxation techniques. Successive over relaxation/under relaxation. Second order Lax-Wendroff method, mid-point Leap frog method, Alternating Direction Implicit (ADI) Method, upwind scheme, numerical viscosity, and artificial viscosity. | **8 Hours L4** |
| **MODULE 4**<br>**GRID GENERATION AND ADAPTIVE GRID METHODS:** Need for grid generation and Body-fitted coordinate system. Structured Grids-essential feature Structured Grid generation techniques- algebraic and numerical methods. Unstructured Grids-essential features. Unstructured Grid generation techniques-Delaunay-Voronoi diagram, Advancing Front Method (AFM). multi-block gride generation, Surface grid generation, multi-block grid generation, and meshless methods. Grid quality, adaptive grids and Adaptive Structured Grid Generation, Unstructured adaptive grid Methods. | **8 Hours L5** |
| **MODULE 5**<br>**FINITE VOLUME TECHNIQUES AND APPLICATIONS:** Spatial discretization- cell centered and cell vertex techniques (overlapping control volume,dual control volume). Temporal discretization- Explicit time stepping, and implicit time stepping. Time step calculation.<br>Applications: Aspects of numerical dissipation & dispersion. Approximate factorization, Flux Vector splitting. Diffusion problem | **8 Hours L3** |

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**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | | |
|---|---|---|
| **CO702.1** | Appraise the concepts of CFD and derive the related Governing Equations. | L5 |
| **CO702.2** | Classify the PDEs based on their mathematical behavior vis a vis nature of flow | L4 |
| **CO702.3** | Analyze FDM techniques for Time/Space marching and numerical schemes. | L4 |
| **CO702.4** | Evaluate the Grid generation and utilization techniques used in CFD | L5 |
| **CO702.5** | Apply Spatial/Temporal discretization in FVM applications. | L3 |

**Textbooks:**


1. Anderson, J.D., "Computational Fluid Dynamics – the basics with applications", McGraw-Hill, 1995.
2. Versteeg, H.K. and Malalasekara, W. "Introduction to Computational Fluid Dynamics: The Finite Volume Method". Second Edition (Indian Reprint) Pearson Education.
3. Dale A. Anderson, John C. Tannehill, Richard H. Pletcher, Munipalli Ramakanth, Vijaya Shankar,"Computational Fluid Mechanics and Heat Transfer", 4th edition, CRC Press, https://doi.org/10.1201/9781351124027, eBook ISBN9781351124027, 2020


**Reference books:**


1. John F. Wendt, "Computational Fluid Dynamics: An Introduction" third edition, Springer, 2008
2. Suhas V. Patankar, "Numerical Heat Transfer and Fluid Flow", McGraw-Hill, reprint 2017.
3. Ferziger, J. H. and Peric, M. Computational Methods for Fluid Dynamics. Third Edition, Springer Verlag, Berlin
4. S. C Gupta, "Applied Computational Fluid Dynamics" Publisher-Wiley, 2019 ; ISBN, 8126587571, 9788126587575


**Web references/ Additional online information (related to module if any):**

1. https://nptel.ac.in/courses/112/105/112105045/.
2. https://nptel.ac.in/courses/112/105/112105254/.

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Scheme of Examination:

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

Table1: Distribution of weightage for CIE & SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

**CO/PO Mapping**

| **COURSE OUTCOMES** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO702.1** | 3 | 3 | 2 | 2 | 1 | - | - | - | 1 | 1 | - | 1 | 2 | 2 |
| **CO702.2** | 3 | 3 | 2 | 2 | 1 | - | - | - | 1 | 1 | - | 1 | 2 | 2 |
| **CO702.3** | 3 | 3 | 2 | 2 | 1 | - | - | - | 1 | 1 | - | 1 | 2 | 2 |
| **CO702.4** | 3 | 3 | 2 | 2 | 1 | - | - | - | 1 | 1 | - | 1 | 2 | 2 |
| **CO702.5** | 3 | 3 | 2 | 2 | 1 | - | - | - | 1 | 1 | - | 1 | 2 | 2 |
| **Average** | **3** | 3 | **2** | **2** | **1** | **-** | **-** | **-** | **1** | **1** | **-** | **1** | **2** | **2** |

**Low-1: Medium-2: High-3**

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# SEMESTER VII

## COURSE: SPACE MECHANICS

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23703** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:2:0** | **SEE Marks** | **50** |
| **No. of Credits** | **4** | **Examination Hours** | **03** |

## COURSE LEARNING OBJECTIVES:

| | |
|---|---|
| **CLO1** | To introduce the basic concepts of astronomy |
| **CLO2** | To understand the motion of the space craft in their relative gravitational filed |
| **CLO3** | Learn about the satellite injection and perturbation in various orbits |
| **CLO4** | To provide insight of interplanetary spacecraft mission. |
| **CLO5** | Understand the Ballistic Missile Trajectories and Re-entry phase. |

| Content | No. of Hours/ RBT levels |
|---|---|
| **Module 1**<br>**INTRODUCTION TO SPACE MECHANICS:** Basic concepts: The solar system, Reference frames and coordinate systems, The celestial sphere, The ecliptic, Motion of vernal equinox, Sidereal time, Solar Time, Standard Time, The earth 's atmosphere. | **08 Hours/L3** |
| **Module 2**<br>**THE GENERAL N- BODY PROBLEM:** Conic Sections, Two-Body Problem, Conservation of Angular Momentum and Energy, Kepler's laws of planetary motion and proof of the laws, Trajectory Equation, Elliptical Orbit, Circular Orbit, Parabolic Trajectory, Hyperbolic Trajectory, the circular restricted three body problem– the general N-body problem. | **10 Hours/L3** |
| **Module 3**<br>**SATELLITE INJECTION AND SATELLITE PERTURBATIONS:** Classical Orbital Elements, Time of Flight, General aspects of satellite injection – satellite orbit transfer, Hohmann Transfer – orbit deviations due to injection errors – special and general perturbations – method of variations of orbital elements. | **08 Hours/L3** |

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| | |
|---|---|
| **Module 4**<br>**INTERPLANETARY TRAJECTORIES:** Introduction, Patched-Conic Method, concept of sphere of influence – launch of interplanetary spacecraft – trajectory estimation about the target planet, Phase Angle at Departure, Planetary Arrival, Gravity Assists. | **08 Hours/L3** |
| **Module 5**<br>**ATMOSPHERIC ENTRY:** Introduction to ballistic missile trajectories – Entry Flight Mechanics– Ballistic Entry– Gliding Entry– Skip Entry– Entry Heating– Space Shuttle Entry. | **08 Hours/L3** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO703.1** | Understand the basic Concepts in Orbital Mechanics and Attitude Dynamics. |
| **CO703.2** | Analyze the Orbital motion of a satellite relative to their gravitational body. |
| **CO703.3** | Understand the Orbital elements to define the shape, size and orientation of an orbit for satellite injection. |
| **CO703.4** | Estimate the trajectory/orbit of a space vehicle or a satellite in a suitable coordinate system. |
| **CO703.5** | Understand the Ballistic Missile Trajectories and Re-entry phase. |

Textbooks:


1. David A. Vallado., "**Fundamentals of Astrodynamics and Applications"** Microcosm Press Hawthorne, CA.
2. Craig A. Kluever, **"Space Flight Dynamic"** John Wiley & Sons, Inc, 2018.


**Reference books:**


1. Cornelisse, J.W., "**Rocket Propulsion and Space Dynamics**", J.W. Freeman & Co.,Ltd, London,1982
2. Howard D. Curtis., **"Orbital Mechanics for Engineering Students"** Second Edition, Elsevier Ltd


Scheme of Examination:

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reducedto 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

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Table 1: Distribution of weightage for CIE & SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO703.1** | 3 | 3 | 2 | - | 1 | - | - | - | - | - | - | - | 3 | - |
| **CO703.2** | 3 | 3 | 2 | - | 1 | - | - | - | - | - | - | - | 3 | - |
| **CO703.3** | 3 | 3 | 2 | - | 1 | - | - | - | - | - | - | - | 3 | - |
| **CO703.4** | 3 | 3 | 2 | - | 1 | - | - | - | - | - | - | - | 3 | - |
| **CO703.5** | 3 | 3 | 2 | - | 1 | - | - | - | - | - | - | - | 3 | - |
| **Average** | 3 | 3 | 2 | - | 1 | - | - | - | - | - | - | - | 3 | |

**Low-1: Medium-2: High-3**

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# SEMSTER VII

**Project Phase II**

| | | | |
|---|---|---|---|
| **Course Code** | **ANEP23706** | **CIE Marks** | **100** |
| **Hours/Week (L: T: P)** | **0:0:12** | **SEE Marks** | **100** |
| **No. of Credits** | **6** | **Examination Hours** | **03** |

| CONTENT | No. of Hours/ RBT levels |
|---|---|
| **CIE procedure for Project Work Phase - II**<br><br>**a. Single discipline:** The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.<br><br>The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates using Rubrics.<br><br>**b. Interdisciplinary:** Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.<br><br>The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates as per Rubrics covering all Program Outcomes.<br><br>**SEE for Project Work Phase - II**<br>**a. Single discipline**: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department.<br>**b. Interdisciplinary:** Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong. | **08 Hours** |

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**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO706.1** | Able to make comprehensive use of the technical knowledge gained from previous courses |
| **CO706.2** | Able to understand technologies concerned with the project |
| **CO706.3** | Able to apply project management skills (scheduling work, procuring parts and documenting expenditures and working within the confines of a deadline). |
| **CO706.4** | Able to analyze, develop and demonstrate the proposed work |
| **CO706.5** | Able to communicate technical information by means of ethical writing and presentation. |

Table 1: Distribution of weightage for CIE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | Review-1 | **100** | **100** |
| | Review-2 | | |
| SEE | Semester End Examination | **100** | **100** |
| **Grand Total** | | | **200** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO706.1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO706.2** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO706.3** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO706.4** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **CO706.5** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |

**Low-1: Medium-2: High-3**

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# SEMSTER VII
# PROFESSIONAL ELECTIVE III

## COURSE: AIRCRAFT MAINTENANCE, REPAIR AND OVERHAUL

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23704A** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**COURSE LEARNING OBJECTIVES:** To enable students to apply the knowledge of aircraft maintenance, overhaul and repairs in broad domain of aeronautical engineering by making them to learn:

| | |
|---|---|
| **CLO1** | Explain about ground handling procedures and precautions, engine starting procedures. |
| **CLO2** | Gain thorough understanding about the ground servicing of sub systems in Aircraft and shop safety during maintenance |
| **CLO3** | Get a clear idea about the FAA airworthiness regulations and the checklist involved in each inspection of aircraft |
| **CLO4** | About the welding in aircraft structural components & sheet metal repair and maintenance |
| **CLO5** | Explain about various tools used, terminology and specifications involved in Aircraft hardware selection and fluid line fittings. |

| Content | No. of Hours/ RBT levels |
|---|---|
| **Module 1**<br>**AIRCRAFT GROUND HANDLING AND SUPPORT EQUIPMENT:** Mooring jacking, leveling and towing operations - Preparation - Equipment - precautions Engine starting procedures - Piston engine, turboprops and turbojets - Engine fi extinguishing - Ground power units. | **08 Hours/ L2** |
| **Module 2**<br>**GROUND SERVICING OF VARIOUS SUB SYSTEMS AND SAFET MAINTENANCE:** Air conditioning and pressurization - Oxygen and oil systems Ground units and their maintenance. Shop safety - Environmental cleanliness Precautions | **08 Hours/ L2** |
| **Module 3**<br>**INSPECTION:** Process - Purpose - Types - Inspection intervals - Techniques Checklist - Special inspection - Publications, bulletins, various manuals - FAR A worthiness directives - Type certificate Data Sheets - ATA specifications | **08 Hours/ L2** |
| **Module 4**<br>**WELDING AND REPAIR IN AIRCRAFT STRUCTURAL COMPONENTS** Equipment used in welding shop and their maintenance - Ensuring quality welds Welding jigs and fixtures - Soldering and brazing. Inspection of damage - Classificatic - Repair or replacement - Sheet metal inspection - N.D.T. Testing - Riveted repa design, Damage investigation - reverse technology. Reliable quality. | **08 Hours/ L2** |



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| Module 5 | |
|---|---|
| **AIRCRAFT HARDWARE, MATERIALS, SYSTEMS PROCESSES:** Hand tools - Precision instruments - Special tools and equipment in an airplar maintenance shop - Identification terminology - Specification and correct use of variou aircraft hardware (i.e. nuts, bolts, rivets, screws etc.) - identification of all types of flui line fittings. Materials, metallic and non-metallic - Plumbing Connectors - Cables Swaging procedures, tests, Advantages of swaging over splicing | **10 Hours/ L2** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO704A.1** | understand ground handling procedures and precautions, engine starting procedures |
| **CO704A.2** | understand about the ground servicing of sub systems in Aircraft and safety precautions |
| **CO704A.3** | To know about the FAA airworthiness regulations and the checklist involved in each inspection of aircraft |
| **CO704A.4** | Describe welding process sheet metal repair used I aircraft maintenance |
| **CO704A.5** | understand various tools used, terminology and specifications involved in Aircraft hardware selection and fluid line fittings |

**Textbooks:**


1. Michael J. Kroes, William A. Watkins, Frank Delp, Ronald Sterkenburg, "Aircraft Maintenance and Repair", McGraw-Hill, Seventh Edition, 2013.
2. Kinnison H A, "Aviation Maintenance Management", McGraw-Hill, Second Edition, 2013.
3. McKinley J L, Bent R D, "Maintenance and Repair of Aerospace Vehicles", Northrop Institute of Technology, McGraw-Hill, 1967.


**Reference books:**


1. Friend, C H, "Aircraft Maintenance Management", Longman, 1992.
2. Patankar M S and Taylor J C, "Risk Management and Error Reduction in Aviation Maintence", Ashgate ISBN 0-7546-1941-9, 2004.


Scheme of Examination:

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.



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**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO704A.1** | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| **CO704A.2** | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| **CO704A.3** | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| **CO704A.4** | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| **CO704A.5** | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| **Average** | 3 | 2 | | | | | | | | | | 1 | 2 | |

**Low-1: Medium-2: High-3**



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# SEMSTER VII
# PROFESSIONAL ELECTIVE III

## COURSE: WIND TUNNEL TECHNIQUES

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23704B** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**COURSE LEARNING OBJECTIVES:**

| | |
|---|---|
| **CLO1** | Understand the basic of wind tunnel testing. |
| **CLO2** | Understand the types and functions of wind tunnel. |
| **CLO3** | Acquire the knowledge on conventional measurement techniques and special wind tunnel |

| Content | No. of Hours/ RBT levels |
|---|---|
| **Module 1**<br>**Principles of Model Testing:** Buckingham Theorem, Non-dimensional numbers, Sca effect, Geometric Kinematic and Dynamic similarities. | **08 Hours/ L2** |
| **Module 2**<br>**Wind Tunnels:** Classification - Special problems of testing in subsonic, transonic, supersonic and hypersonic speed regions – Water tunnels: Advantages, limitations and configurations for aeronautical and non-aeronautical applications – Layouts -Sizing, design parameters and loss estimation. Model making; Use of CFD in wind tunnel and water tunnel design. | **08 Hours/ L2** |
| **Module 3**<br>**Calibration of Wind Tunnels:** Test section speed, Horizontal buoyancy, Flo angularities, Flow uniformity & turbulence measurements, Associated instrumentatio Calibration of subsonic & supersonic tunnels. | **08 Hours/ L2** |
| **Module 4**<br>**Conventional Measurement Techniques:** Force measurements and measurin systems, Multi component internal and external balances, Pressure measureme system, Steady and Unsteady Pressure, single and multiple measurements, Velocit measurements, Intrusive and Non-intrusive methods, Flow visualization technique surface flow, oil and tuft, flow field visualization, smoke and other optical an nonintrusive techniques. | **08 Hours/ L2** |
| **Module 5**<br>**Special Wind Tunnel Techniques:** Intake tests, store carriage and separation test Unsteady force and pressure measurements, wind tunnel model design. | **10 Hours/ L2** |



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**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO704A.1** | Apply the principles and procedures for model testing in the wind tunnel. |
| **CO704A.2** | Classify the types and functions of wind tunnel. |
| **CO704A.3** | Distinguish the conventional measurement techniques and special wind tunnel techniques |

**Textbooks**

1. Rae W.H. and Pope. A, "Low Speed Wind Tunnel Testing", John Wiley Publication, 3rd edition, 2010, ISBN-13: 978-8126525683.
2. Pope. A and Goin. L, "High Speed Wind Tunnel Testing", John Wiley, 1985.

**Reference Books**

1. E. Radhakrishnan, Instrumentation, Measurements, and Experiments in Fluids, CRC Press, 2007.
2. Bradsaw "Experimental Fluid Mechanics", Pergamon Press, 2nd revised edition, 1970, ISBN-13: 9780080069814.
3. Short term course on Flow visualization techniques, NAL, 2009.
4. Lecture course on Advanced Flow diagnostic techniques, NAL.

NAL-UNI Lecture Series 12:" Experimental Aerodynamics", NAL SP 98 01 April 1998.

Scheme of Examination:

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |



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| CO/PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| CO704B.1 | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| CO704B.2 | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| CO704B.3 | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| Average | 3 | 2 | | | | | | | | | | 1 | 2 | |

**Low-1: Medium-2: High-3**



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## SEMSTER VII
## PROFESSIONAL ELECTIVE III
### COURSE: THEORY OF VIBRATION

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23704C** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Pre requisite: Aircraft Structures-I,II**

**Course Learning Objectives:** To enable students to apply the knowledge Theory of Vibration in broad domain of aeronautical engineering by making them to learn:

| | |
|---|---|
| **CLO1** | Basic concepts of vibrations, types of vibrations. |
| **CLO2** | Understand the working principle of vibration measuring instruments. |
| **CLO3** | Differentiate types of vibrations - according to dampness and particle motion. |
| **CLO4** | Acquire the knowledge of numerical methods for multi-degree freedom systems. |
| **CLO5** | To study the aero elastic effects of aircraft wing. |

| **Content** | **No. of Hours/ RBT levels** |
|---|---|
| **Module 1**<br><br>**INTRODUCTION:** Types of vibrations, S.H.M, principle of super position applied to Simple Harmonic Motions, Fourier theorem and simple problems. | **08 Hours/**<br><br>**L3** |
| **Module 2**<br>**UNDAMPED FREE VIBRATIONS:** Single degree of freedom systems. Undamped free vibration, natural frequency of free vibration, Spring and Mass elements, effect of mass of spring, Compound Pendulum.<br><br>**DAMPED FREE VIBRATIONS:** Single degree of freedom systems, different types of damping, concept of critical damping and its importance, study of response of viscous damped systems for cases of under damping, critical and over damping, Logarithmic decrement. | **08 Hours/**<br><br>**L3** |
| **Module 3** | **08 Hours/** |



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| | |
|---|---|
| **FORCED VIBRATION:** Single degree of freedom systems, steady state solution with viscous damping due to harmonic force. Solution by Complex algebra, reciprocating and rotating unbalance, vibration isolation, transmissibility ratio due to harmonic excitation and support motion**.** | **L3** |
| **Module 4**<br>**SYSTEMS WITH TWO DEGREES OF FREEDOM:** Introduction, principle modes and Normal modes of vibration, co-ordinate coupling, generalized and principal co-ordinates, Free vibration in terms of initial conditions. Applications: Vehicle suspension, Dynamic vibration absorber and Dynamics of reciprocating Engines. | **08 Hours/**<br>**L3** |
| **Module 5**<br>**MULTI DEGREES OF FREEDOM SYSTEMS:** Introduction, Influence coefficients, Maxwell reciprocal theorem, Dunkerley's equation. Orthogonality of principal modes, Method of matrix Iteration-Method of determination of all the natural frequencies using sweeping matrix and Orthogonality principle. Holzer's method, Stodola method. | **08 Hours/**<br>**L3** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO704C.1** | Understand the basic concepts of vibrations. |
| **CO704C.2** | Formulate the mathematical models for Undamped and damped mechanical vibrations Systems. |
| **CO704C.3** | Formulate the mathematical models for forced vibrations Systems |
| **CO704C.4** | Predict the frequency response for mechanical vibration systems under loading conditions |
| **CO704C.5** | Analyze the multi-degree freedom systems. |

**Textbooks:**


1. Grover. G.K., "Mechanical Vibrations", 7th Edition, Nem Chand Brothers, Roorkee, India, 2003.
2. V.P. Singh., "Mechanical Vibrations", DhanpatRai & Company Pvt. Ltd, 2016.




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**Reference books:**


1. Thomson W T, 'Theory of Vibration with Application' - CBS Publishers, 1990.
2. Bisplinghoff R.L., Ashely H and Hogman R.L., "Aeroelasticity", Dover Publication, New York, 1983.
3. Leonard Meirovitch, "Elements of Vibration Analysis". McGraw Hill International Edition, 2007.


**Scheme of Examination:**

**Semester End Examination (SEE):**

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any five full questions choosing at least one full question from each module.

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 mark

**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | 40 | 50 |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | 10 | |
| SEE | Semester End Examination | 50 | 50 |
| Grand Total | | | 100 |



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**CO-PO MAPPING**

| CO/PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO704C.1** | 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | 3 | - |
| **CO704C.2** | 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | 3 | - |
| **CO704C.3** | 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | 3 | - |
| **CO704C.4** | 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | 3 | - |
| **CO704C.5** | 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | 3 | - |
| Average | 3 | 3 | 1 | - | - | - | - | - | - | - | - | - | 3 | - |

**Low-1: Medium-2: High-3**

# SEMSTER VII
# PROFESSIONAL ELECTIVE III
## CIVIL AVIATION RULES AND REGULATION

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23704D** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Pre requisite: NIL**

**Course Learning Objectives:** To enable students to apply the knowledge of Civial aviation requirements in broad domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CLO1** | knowledge of Indian Aircraft Rules 1937 and related publication |
| **CLO2** | knowledge CAR series B and C (MEL, cockpit and emergency check list and Defects rectification and analysis) |
| **CLO3** | knowledge CAR series E for approval of organizations: in various categories and CAR series M. |
| **CLO4** | The knowledge CAR145, CAR -21 Type certificate and Noise certificate |

| | |
|---|---|
| **CLO5** | The knowledge C.A.R. series F airworthiness and continued airworthiness, Registration / deregistration of aircraft, Micro light and Hot air balloons, Issue/Renewal and Suspension of Special Certificate of Airworthiness |

| **Content** | **No. of Hours/RBT levels** |
|---|---|
| **Module 1**<br><br>**INDIAN AIRCRAFT RULES 1937 AND RELATED PUBLICATIONS:**<br><br>Knowledge of aircraft act, 1934, aircraft rules, 1937 as far as they related to airworthiness and safety of aircraft. Knowledge of civil airworthiness requirements, aeronautical information circulars, aeronautical information publications- (relating to airworthiness), advisory circulars & A.M.E. notices (NOTAMS) by DGCA | **08 Hours/ L3** |
| **Module 2**<br><br>C.A.R. SERIES "B "and "C": C.A.R. series "B" Minimum Equipment List (MEL), preparation and use of cockpit check list and emergency check list. C.A.R. series 'C' – Defect recording, reporting, investigation, rectification and analysis | **08 Hours/ L3** |
| **Module 3**<br><br>**C.A.R. SERIES "E": C.A.R. Series E- approval of organizations:** Approval in categories E & G;CAR M- Objective, Definitions, Continuing Airworthiness Requirement. | **08 Hours/ L3** |
| **Module 4**<br><br>C.A.R. SERIES CAR 145 : General, Scope, Terms of Approval, Facility Requirement, Personnel Requirement, Certifying Staff, Safety and Quality policy, maintenance procedures and quality system. CAR -21, Type certificate, Noise certificate. | **08 Hours/ L3** |
| **Module 5**<br><br>C.A.R. SERIES "F ": C.A.R. SERIES "F" Airworthiness and continued airworthiness: Procedure relating to Registration / deregistration of aircraft, , Issue/validation and suspension of Certificate of Airworthiness, Special Flight permits, Airworthiness requirements for Gliders , Design, Manufacture, Registration and Operation of Micro light Aircraft., Requirements for | **08 Hours/ L3** |



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| | |
|---|---|
| manufacture, registration and airworthiness control of hot air balloons, Age of Aircraft to be imported for Scheduled / Non-Scheduled including Charter,<br><br>General Aviation and other Operations, Issue/Renewal and Suspension of Special Certificate of Airworthiness. | |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO704D.1** | Should be able to have the knowledge of Indian Aircraft Rules 1937 and related publication |
| **CO704D.2** | Should be able to have the knowledge CAR series B and C (MEL, cockpit and emergency check list and Defects rectification and analysis) |
| **CO704D.3** | Should be able to have the knowledge CAR series E for approval of organizations: in various categories and CAR series M. |
| **CO704D.4** | Should be able to have the knowledge CAR145, CAR -21 Type certificate and Noise certificate |
| **CO704D.5** | Should be able to have the knowledge C.A.R. series F airworthiness and continued<br><br>airworthiness, Registration / deregistration of aircraft, Micro light and Hot air balloons, Issue/Renewal and Suspension of Special Certificate of Airworthiness |

**Textbooks:**

1. Aircraft manual (India) volume – latest edition, the English book store, 17-l, Connaught circus, New Delhi.

**Reference books:**

1. Civil aviation requirements with latest amendment (section 2 airworthiness) – published by DGCA, the English book store, 17-l, Connaught circus, New Delhi.

**Scheme of Examination:**

**Semester End Examination (SEE):**

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50. There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any five full questions choosing at least one full question from each module.



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**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes/ Alternate Assessment Tools (AATs) for 10 marks.

**Typical Evaluation pattern for regular courses is shown in Table 1. Table1: Distribution of weightage for CIE& SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | 40 | 50 |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quiz 1/AAT | 10 | |
| SEE | Semester End Examination | 50 | 50 |
| Grand Total | | | 100 |

| CO/PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO/PO | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| | | | | | | | | | | | | | | |
| CO704D.1 | 3 | 2 | - | - | - | - | - | - | 2 | 2 | - | - | | 1 |
| CO704D.2 | 3 | 2 | - | - | - | - | - | - | 2 | 2 | - | - | | 1 |
| CO704D.3 | 3 | 2 | - | - | - | - | - | - | 2 | 2 | - | - | | 1 |
| CO704D.4 | 3 | 2 | - | - | - | - | - | - | 2 | 2 | - | - | | 1 |
| CO704D.5 | 3 | 2 | | | | | | | 2 | 2 | | | | 1 |
| Average | 3 | 2 | - | - | - | - | - | - | 2 | 2 | - | - | | 1 |



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# SEMSTER VII
# OPEN ELECTIVE II
## COURSE: DRONE TECHNOLOGY

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23705A** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Course Objectives:** To enable students to apply the knowledge of Introduction to UAV in broad domain of Aeronautical Engineering by making them to learn:

| | |
|---|---|
| **CLO1** | To Identify & select different types of drones, drone rules and regulations |
| **CLO2** | Select different drone parts and to understand aerodynamics |
| **CLO3** | Understand BLDC motors and different type of batteries |
| **CLO4** | Understand different sensors and Flight Control System |

| **Content** | **No.of Hours/ RBT levels** |
|---|---|
| **Module 1**<br>**Introduction:** Different types of Drones, Nomenclatures, History of aerial drones, reputation, airframe, Configurations, basic components, current/future uses of drones. DGCA regulations, Zones, Digital Sky, Type Certification and RPTO | **10 Hours L1, L2, L3** |
| **Module 2**<br>**Air vehicle:** Understanding Aerial platforms. Types of drones. Introduction to aerodynamics, Newton's Laws of Motion, Bernoulli's Principle, four forces of Fight, three axes of Fight, how they apply to drone Flight. Drone Configurations, Launch and Recovery Systems | **8 Hours L1, L2, L3** |
| **Module 3**<br>**Propulsion system:** Introduction to different electric motors like DC, BLDC, servo motors, working, understanding its functioning, speed torque characteristics, degree of freedom in drone. Introduction Electronic Speed Controller. Performing payload calculation, speed control techniques, thrust to weight ratio. | **8 Hours L1, L2, L3** |
| **Module 4**<br>**Battery System:** Introduction of different types of batteries used in drone. Understand different specifications and their significance of batteries. Different charging circuits or batteries, battery management system (BMS) and Building Blocks of BMS. | **8 Hours L1, L2, L3** |



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| Module 5 | |
|---|---|
| **Sensors:** Accelerometers, types, Inertial measurement units, tilt and lidar sensor, gyro sensor. Principle of operation, their roles and characteristics. Introduction to Flight controller system, Auto pilot | **8 Hours L1, L2, L3** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO705A.1** | Select different types of drones and drone rules and regulations |
| **CO705A.2** | Explain the forces acting on Drone during flight |
| **CO705A.3** | Identify the Drone electric motor components |
| **CO705A.4** | Choose the suitable battery for Drone Propulsion |
| **CO705A.5** | Illustrate the different sensors and Flight Control System |

**Textbooks:**


3. The Drone Rules, 2021. The Gazette of India: Extraordinary [Part II—Sec. 3(i)].
4. John Baichtal "Building Your Own Drones" A Beginner's Guide to Drones, UAVs, and ROVs Que Publishing, ISBN - 9780789755988
5. Julio Alberto Mendoza "Drones to Go" A Crash Course for Scientists and Makers, Apress ISBN-978-1-4842-6787-5


**Reference books:**


4. Paul Gerin Fahlstrom, Thomas James Gleason, Introduction to UAV Systems, Wiley Publication John Wiley & Sons, Ltd, 4th Edition 2012.
5. Landen Rosen, Unmanned Aerial Vehicle, Alpha Editions, N.Y., 2012
6. Valavanis, Kimon P, Unmanned Aerial Vehicles, Springer, 2011.
7. Valavanis, K., Vachtsevanos, George J, Unmanned Aerial Vehicles, Springer, 2015.


**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

Typical Evaluation pattern for regular courses is shown in Table 1.

Table 1: Distribution of weightage for CIE & SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| **CIE** | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quiz 1/AAT | **10** | |
| **SEE** | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

**CO/PO Mapping**

| CO/PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO705A.1** | 3 | - | - | - | - | - | 1 | 1 | 1 | 1 | - | 1 | 2 | - |
| **CO705A.2** | 3 | - | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 2 | - |
| **CO705A.3** | 3 | - | 1 | - | - | - | - | - | 1 | 1 | - | 1 | 2 | - |
| **CO705A.4** | 3 | - | 1 | - | - | - | 1 | - | 1 | 1 | - | 1 | 2 | - |
| **CO705A.5** | 3 | - | - | - | - | - | - | - | 1 | 1 | - | 1 | 2 | - |
| **Average** | 3 | | **1** | | | | **1** | **1** | **1** | **1** | | **1** | **2** | |

**Low-1: Medium-2: High-3**



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# SEMSTER VII
# OPEN ELECTIVE II

## COURSE: AIR TRAFFIC AND WEATHER

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23705B** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Course Objectives:** This course will enable students to

| | |
|---|---|
| **CLO1** | Understand the Air Traffic Control |
| **CLO2** | Acquire Knowledge on the weather condition for flight traffic |
| **CLO3** | Remember the symbols of ATC for different weather conditions |

| Content | No. of Hours/RBT levels |
|---|---|
| **Module 1**<br>The earth's atmosphere, Temperature, Atmospheric Pressure and Altimetry, Wind, moisture, cloud formation, precipitation, Stable and Unstable Air, clouds, Air masses and Fonts. | **08 Hours/ L2** |
| **Module 2**<br>Turbulence, Icing, Thunderstorm, High Altitude Weather, Arctic weather, Tropical Weather | **08 Hours/ L2** |
| **Module 3**<br>Problems- Traffic, Weather, Congestion, Air traffic flow management, Airport capacity, Traffic Management<br>Overview<br>Basic Traffic Management Techniques and Terms Ground Delay Programs (GDP) Time-based Flow<br>Management (TBFM) Traffic Management Advisor (TMA) Airspace Flow Programs (AFP) Ground Stops (GS) Adaptive Compression (AC) Integrated Collaborative Rerouting (ICR) Delay Tier Information Operational<br>Information System (OIS) | **08 Hours/ L2** |

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| | |
|---|---|
| **Module-4**<br>Weather Tools De-icing/Anti-icing Severe Weather Avoidance Plan (SWAP) Routes Preferred Routes Coded Departure Routes (CDR) National Playbook Flow Evaluation Area (FEA)/Flow Constrained Area (FCA), Global air-traffic management | **08 Hours/ L2** |
| **Module 5**<br>Call signs, Technology, Air Navigation Service providers and Air traffic service providers, Privatization ATC regulations Weather Conditions Worldwide, METAR, Cloud reporting Abbreviation. | **08 Hours/ L2** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO705B.1** | Implement the knowledge during the Air Traffic Control |
| **CO705B.2** | Analyse the weather condition for flight traffic |
| **CO705B.3** | Apply the symbols of ATC for different weather conditions |

**Suggested Learning Resources:**

**Text Books**

1. Mastering the Systems: Air Traffic Control and Weather by Richard L. Collins
2. Aviation Weather for Pilots and Flight Operation Personnel Gordon Press Publishers

**Reference Books**

1. New Concepts and Methods in Air Traffic Management by Amedeo R Odoni, Springer 2. Air Traffic Control by Max Mulder, published by InTech

**Web links and Video Lectures (e-Resources):**

https://www.ll.mit.edu/about/facilities/air-traffic-control-automation-aviation-weather-decisionsupport-laboratories

Scheme of Examination:

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

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**Table 1: Distribution of weightage for CIE & SEE of Regular courses**

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quizzes /Assignment | **10** | |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO705B.1** | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| **CO705B.2** | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| **CO705B.3** | 3 | 2 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |

**Low-1: Medium-2: High-3**

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# SEMESTER VII
# OPEN ELECTIVE II

## COURSE: SPACE TECHNOLOGIES

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23705C** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Course Objectives:** To enable students to understand the innovations in space technologies

| | |
|---|---|
| **CLO1** | To provide an understanding of space missions, including types and space environment considerations, and to introduce the fundamentals of rocket propulsion |
| **CLO2** | To introduce different re-entry techniques, including steep ballistic, orbital, skip, and "double-dip" re-entries, as well as aero-braking and lifting body re-entries |
| **CLO3** | To provide a foundation in orbital mechanics, covering two-body motion, orbital elements, ground trace, in-plane orbit changes, transfer maneuver's |
| **CLO4** | To explain the dynamics of satellite attitude control, including torque-free axisymmetric rigid body motion, attitude control for spinning and non-spinning spacecraft |
| **CLO5** | To introduce the architecture of supporting ground systems and team interfaces for space missions |

| **Content** | **No. of Hours/ RBT levels** |
|---|---|
| **Module 1**<br>**Fundamentals of Rocket Propulsion and Trajectories:** Space Mission- Types- Space environment-launch vehicle selection.; Introduction to rocket propulsion - fundamentals of solid propellant rockets- Fundamentals of liquid propellant rockets - Rocket equation, Two-dimensional trajectories of rockets and missiles -Multistage Rockets -Single stage to orbit- Sounding Rocket -Aerospace plane Gravity turn trajectories-Impact point calculation-Injection conditions-Flight dispersions | **10 Hours/L2** |
| **Module 2**<br>**Atmospheric Re-entry:** Introduction-Steep ballistic re-entry-Ballistic orbital re-entry-Skip re-entry- "Double- Dip" re-entry - Aero-braking - Lifting body re-entry | **10 Hours/L2** |

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| | |
|---|---|
| **Module 3**<br>**Fundamentals of Orbital Mechanics, Orbital Maneuver's:** Two-body motion-circular, elliptic, hyperbolic, and parabolic orbits-Basic orbital elements-Ground trace. In-Plane orbit changes-Hohmann Transfer-Bi-elliptical transfer-Plane changes- Combined maneuver's Propulsion for maneuvers | **10 Hours/L2** |
| **Module 4**<br>**Satellite Attitude Dynamics:** Torque free axisymmetric rigid body-Attitude control for spinning spacecraft - Attitude control for non-spinning spacecraft - The Yo-Yo mechanism – Gravity – Gradient Satellite-Dual spin spacecraft-Attitude determination | **10 Hours/L2** |
| **Module 5**<br>**Space mission Operations:** Supporting ground system architecture and team interfaces - Mission phases and core operations- Team responsibilities – Mission diversity – Standard operations practices | **10 Hours/L2** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO705C.1** | Comprehend various types of space missions, make informed decisions regarding launch vehicle selection, understand the basics of rocket propulsion |
| **CO705C.2** | Explain the principles and methods of various atmospheric re-entry techniques, and understand their applications in space missions |
| **CO705C.3** | Have a strong grasp of orbital mechanics, be capable of calculating and planning various orbital maneuvers |
| **CO705C.4** | Analyze and control the attitude of satellites in different scenarios, understand the dynamics of various satellite configurations |
| **CO705C.5** | Proficient in understanding the ground systems and team structures necessary for space missions, recognize the roles and responsibilities of team members |

**Textbooks:**


1. Spaceflight Dynamics', W.E. Wiesel, 3rd edition, McGraw-Hill, 2010
2. Elements of Space Technology for Aerospace Engineers', Meyer Rudolph X, Academic Press, 1999
3. Fundamentals of Space Systems', Vincet L. Pisacane, Oxford University Press, 2005


**Reference books:**


1. **'Rocket Propulsion and Space flight dynamics', Cornelisse JW, Schoyer HFR, and Wakker KF, Pitman, 1984**


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2. **Understanding Space: An Introduction to Astronautics', J. Sellers, 2nd edition, McGraw- Hill, 2004**
3. **'Introduction to Space Flight', Francis J Hale, Prentice-Hall, 1994**
4. **'Spacecraft Mission Design', Charles D. Brown, AIAA Education Series, 1998**

**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

Typical Evaluation pattern for regular courses is shown in Table 1.

Table 1: Distribution of weightage for CIE & SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| **CIE** | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quiz 1/AAT | **10** | |
| **SEE** | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

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**CO/PO Mapping**

| CO/PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO705C.1** | 3 | 3 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| **CO705C.2** | 3 | 3 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| **CO705C.3** | 3 | 3 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| **CO705C.4** | 3 | 3 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| **CO705C.5** | 3 | 3 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| **Average** | **3** | **3** | - | - | - | - | - | - | - | - | - | **1** | **1** | **-** |

**Low-1: Medium-2: High-3**

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# SEMESTER VII
# OPEN ELECTIVE II

## COURSE: AVIATION AND INTERNET INFRASTRUCTURE

| | | | |
|---|---|---|---|
| **Course Code** | **ANE23705D** | **CIE Marks** | **50** |
| **Hours/Week (L: T: P)** | **3:0:0** | **SEE Marks** | **50** |
| **No. of Credits** | **3** | **Examination Hours** | **03** |

**Course Objectives:** To enable students to understand the innovations in space technologies

| | |
|---|---|
| **CLO1** | Understand the need for the flight 4.0 |
| **CLO2** | Gain Knowledge on both aviation and its internet infrastructure |
| **CLO3** | Understand the operation and working principle of internet infrastructure |

| Content | No. of Hours/ RBT levels |
|---|---|
| **Module 1**<br>The Aerospace Sector, Aerospace Transformation through Industry 4.0 technologies, Flight 4.0: The changing Technology Landscape, The Internet: An Introduction | **10 Hours/L2** |
| **Module 2**<br>Advances in Avionics Platforms: Multicore systems, Emerging trends in Avionics Networking, Internet Infrastructure working principle | **10 Hours/L2** |
| **Module 3**<br>IoT and Service Oriented Infrastructure for Flight 4.0, Big Data and Data Analytics in Aviation, Ontologies in Aeronautics, TCP/IP, In-Flight Wi-Fi | **10 Hours/L2** |
| **Module 4**<br>Advances in Software Engineering and Aeronautics, Autonomy and Safety of Unmanned Aircraft Systems | **10 Hours/L2** |
| **Module 5**<br>Aerospace Engineering Curricular Expansion in Information Systems, Networking, Web services, Cloud Computing | **10 Hours/L2** |

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO705D.1** | Analyse the need for the flight 4.0 |
| **CO705D.2** | Implement Knowledge on both aviation and its internet infrastructure |
| **CO705D.3** | Modify the operation and working principle of internet infrastructure |

**Suggested Learning Resources:**

**Text Books**

1. Advances in Aeronautical Informatics- Technology towards Flight 4.0 by Umut Durak, Springer
2. Principles of flight 4.0 by ISBN 9788281070318, 8281070315

**Reference Books**

1. Aircraft Technology by Melih Cemal Kushan

**Web links and Video Lectures (e-Resources):**

https://www.coursera.org/lecture/cybersecurity-policy-aviation-internet/l26-internetinfrastructure-vCsja

**Scheme of Examination:**

**Semester End Examination (SEE):**

**SEE Question paper is to be set for 100 marks and the marks scored will be proportionately reduced to 50.** There will be two full questions (with a maximum of four sub questions) from each module carrying 20 marks each. Students are required to answer any **five full questions** choosing at least **one full question from each module.**

**Continuous Internal Evaluation (CIE):**

Three Tests are to be conducted for 40 marks each. CIE is executed by way of quizzes / Alternate Assessment Tools (AATs) for 10 marks.

Typical Evaluation pattern for regular courses is shown in Table 1.

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Table 1: Distribution of weightage for CIE & SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| **CIE** | CIE Test-1 | **40** | **50** |
| | CIE Test-2 | | |
| | CIE Test-3 | | |
| | Quiz 1/AAT | **10** | |
| **SEE** | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

**CO/PO Mapping**

| CO/PO Mapping | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| **CO705D.1** | 3 | 3 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| **CO705D.2** | 3 | 3 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| **CO705D.3** | 3 | 3 | - | - | - | - | - | - | - | - | - | 1 | 2 | - |
| **Average** | **3** | **3** | - | - | - | - | - | - | - | - | - | **1** | **1** | **-** |

**Low-1: Medium-2: High-3**

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## SEMESTER VIII

**COURSE: INTERNSHIP AND TECHNICAL SEMINAR**

| | | | |
|---|---|---|---|
| **Course Code** | **ANE123803** | **CIE Marks** | **100** |
| **Hours/Week (L: T: P)** | **0:0:12** | **SEE Marks** | **100** |
| **No. of Credits** | **10** | **Examination Hours** | **-** |

**Internship:**

All the students admitted to III year of BE/B. Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. Internship examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.

**COURSE OUTCOMES: Upon completion of this course, student will be able to:**

| | |
|---|---|
| **CO803.1** | Analyze and review various research papers to identify Aeronautical related topic |
| **CO803.2** | Understand new trends in Aeronautical field having cutting edge technologies in the selected topic |
| **CO803.3** | Impart skills in preparing detailed report describing the topic and results |
| **CO803.4** | Able to summarize the industrial Exposure and practices |
| **CO803.5** | Able to communicate technical information by means of ethical writing and presentation. |

**CIE procedure for Internship:**

The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the Internship shall be based on the evaluation of Internship report, presentation skill and question and answer session in the ratio 50:25:25.

**SEE for Internship:**

Contribution to the Internship and the performance of each Student shall be assessed individually in the semester end examination (SEE) conducted at the department.

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Typical Evaluation pattern for regular courses is shown in Table 1.

Table 1: Distribution of weightage for CIE & SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | Review-2 | **50** | **50** |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

| **CO/PO Mapping** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO/PO** | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 | PSO1 | PSO2 |
| **CO803.1** | 1 | 1 | 1 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | - | 3 | 3 |
| **CO803.2** | 1 | 1 | 1 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | - | 3 | 3 |
| **CO803.3** | 1 | 1 | 1 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | - | 3 | 3 |
| **CO803.4** | 1 | 1 | 1 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | - | 3 | 3 |
| **CO803.5** | 1 | 1 | 1 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | - | 3 | 3 |
| **Average** | 1 | 1 | 1 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 | - | 3 | 3 |

**Low-1: Medium-2: High-3**

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# SEMESTER -VIII

## COURSE: INTERNSHIP+SEMINAR

| Course Code | 22ANEI83 | CIE Marks | 100 |
|---|---|---|---|
| Hours/Week (L: T: P) | 0:0:4 | SEE Marks | -- |
| No. of Credits | 2 | Examination Hours | 03 |

**Internship:**

All the students admitted to III year of BE/B. Tech shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters.

Internship examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.

**Course Outcomes**

| | |
|---|---|
| **CO86.1** | Analyze and review various research papers to identify Aeronautical related topic |
| **CO86.2** | Understand new trends in Aeronautical field having cutting edge technologies in the selected topic |
| **CO86.3** | Impart skills in preparing detailed report describing the topic and results |
| **CO86.4** | Able to summarize the industrial Exposure and practices |
| **CO86.5** | Able to communicate technical information by means of ethical writing and presentation. |

**CIE procedure for Internship:**

The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the Internship shall be based on the evaluation of Internship report, presentation skill and question and answer session in the ratio 50:25:25.

**SEE for Internship:**

Contribution to the Internship and the performance of each Student shall be assessed individually in the semester end examination (SEE) conducted at the department.

Typical Evaluation pattern for regular courses is shown in Table 1.

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Table 1: Distribution of weightage for CIE & SEE of Regular courses

| | Component | Marks | Total Marks |
|---|---|---|---|
| CIE | Review-2 | **50** | **50** |
| SEE | Semester End Examination | **50** | **50** |
| **Grand Total** | | | **100** |

**CO/PO Mapping**

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

**Low-1: Medium-2: High-3**

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