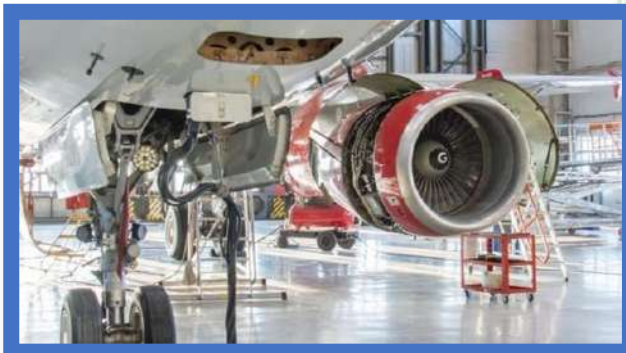
III & VIII Semester
Scheme & Syllabus
(2022-23)
Department of
Aeronautical Engineering

SCHEME AND SYLLABUS



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.

Dean Academic
Global Academy of Technology,
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Head of the Department
Dept. of Aeronautical Engineering
Global Academy of Technology

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 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 develop research temperament.**

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 tranquility 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 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 programme for faculty, technical & supporting staff.**
- **Conduction of Academic Audit of each department on an annual basis.**
- **Under open electives students have the options to study subjects offered by other departments to augment their interdisciplinary knowledge.**
- **Students have to 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 center for imparting quality education and research to produce competent Aeronautical Engineers to meet the 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 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 closer 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 ofAutonomy

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 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 academia 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 of 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 evaluation of outcomes of the program by stating the knowledge, skill and behavior a graduate is expected to attain upon completion of a program and after 4 to 5 years of 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 quiz, solving puzzles, giving an online presentation, modelling something, taking up a multiple - choice assessment. Assessments are criterion-focused which the students achieve during the learning period. Students are expected to go with the flow, think out of the box in order 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-centered - 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 the 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 the 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 the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.**

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

PO9- Individual 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 the good flexibility to the students and also strengthens 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:

I. **Theory course conducted for 1 hour/week/ semester;**

II. **Laboratory course or Tutorial conducted for 2 hours/week/semester. The following additional factors may also be noted in this connection:**

III. **The above figures shall be multiplied by a factor of 2 in the case of the Supplementary Semester,**

IV. **Other student activities which are not demanding intellectually, or which do not lend to effective assessment, like practical training, study tours, attending**

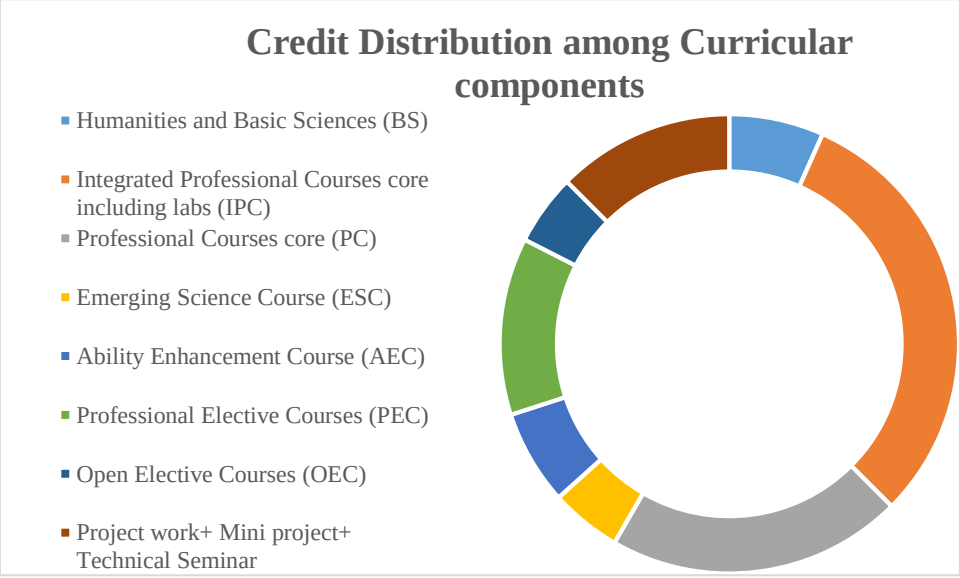
guest lectures shall not carry any credit.

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)	37	31
3.	Professional Courses core (PC)	26	22
4.	Emerging Science Course (ESC)	6	5
5.	Ability Enhancement Course (AEC)	7	6
6.	Professional Elective Courses (PEC)	15	13
7.	Open Elective Courses (OEC)	6	5
8.	Project work+ Mini project+ Technical Seminar	15	13
9.	**Total**	120	100



Department of Aeronautical Engineering

III – VIII Semester

SCHEME AND SYLLABUS

Head of the Department
Dept. of Aeronautical Engineering
Global Academy of Technology
R.R. Nagar, Bengaluru - 560 098.

Scheme of UG Autonomous Program – 2022 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	22MAT31C	Complex Variables and Probability	BS	MAT	2	2	0	50	50	100	3
2	22ANE32	Fluid Mechanics	IPC	Respective Department	3	0	2	50	50	100	4
3	22ANE33	Solid Mechanics	IPC		3	0	2	50	50	100	4
4	22ANE34	Aero Thermodynamics	PC		3	1	0	50	50	100	3
5	22ANE35	Aerospace Materials & Digital Manufacturing	ESC/ETC/PLC		3	0	0	50	50	100	3
6	22ANE36	Ability Enhancement Course – Elements of Aeronautics	AEC		3	0	0	50	50	100	3
				Total				**300**	**300**	**600**	**20**

IV SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	22MAT41C	Transforms Calculus And Numerical Techniques	BS	MAT	2	2	0	50	50	100	3
2	22ANE42	Low Speed Aerodynamics	IPC	Respective Department	3	0	2	50	50	100	4
3	22ANE43	Aircraft Propulsion	IPC		3	0	2	50	50	100	4
4	22ANE44	Aircraft Structures – I	PC		2	2	0	50	50	100	3
5	22ANE45	Advanced Drone Technology	ESC/ETC/PLC		2	2	0	50	50	100	3
6	22ANEL46	Computer Aided Aircraft Drawing Lab	PC		0	0	2	50	50	100	1
7	22ANE47	Ability Enhancement Course – System Engineering for Aeronautical Engineers	AEC		2	0	0		50	50	2
Total								**300**	**300**	**600**	**20**

V SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	22ANE51	Management and Economics	PC	Respective Department	2	2	0	50	50	100	3
2	22ANE52	High Speed Aerodynamics	IPC		3	0	2	50	50	100	4
3	22ANE53	Finite Element Methods	IPC		3	0	2	50	50	100	4
4	22ANE54	Aerospace Propulsion	PC		3	0	0	50	50	100	3
5	22ANE55X	Program Elective 1	PEC		3	0	0	50	50	100	3
	22ANE56	Ability Enhancement Course –Urban Air Mobility	AEC		2	0	0	50	50	100	2
7	22CIV57	Environmental Science	CV	Civil	1	0	0	50	50	100	1
	OR										
	22UHV57	Universal Human Values	BS	Respective Department							
TOTAL								**350**	**350**	**700**	**20**

Program Elective 1*			
22ANE551	Composite materials and structures	22ANE553	Aircraft Systems and Instruments
22ANE552	Air Navigation	22ANE554	Gas Turbine Technology

VI SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	22ANE61	Aircraft Performance	PC	Respective Department	2	2	0	50	50	100	3
2	22ANE62	Aircraft Structures –II	IPC		3	0	2	50	50	100	4
3	22ANE63	Control Engineering and Microprocessors	PC		3	0	2	50	50	100	3
4	22ANE64X	Program Elective 2	PEC		2	2	0	50	50	100	3
5	22ANE65X	Open Elective 1	OEC	Offering Department	3	0	0	50	50	100	3
6	22CIV66	Environmental Science	HSM	Civil	1	0	0	50	50	100	1
	OR										
	22UHV66	Universal Human Values	BS	Respective Department							
7	22ANEL67	Flight Simulation Lab	PC		0	0	2	50	50	100	1
8	22ANEMP68	Mini Project	MP	Respective Department	Two Contact hours per week			50	50	100	2
TOTAL								**350**	**350**	**700**	**20**

Program Elective 2*			
22ANE641	Rocket and Missile	22ANE643	Aircraft Maintenance, overhaul and repairs
22ANE642	Theory of Elasticity	22ANE644	Fuels and combustion
Open Elective 1 (Offered to other branch students)			
22ANE651	Introduction to Aerospace Engineering	22ANE653	Airport Planning and Management
22ANE652	The History of Aviation	22ANE654	Airline Industry

VII SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	22ANE71	Aircraft Stability and Control	PC	Respective Department	2	2	0	50	50	100	3
2	22ANE72	Avionics	PC		3	0	0	50	50	100	3
3	22ANE73	Computational Fluid Dynamics	IPC		3	0	2	50	50	100	4
4	22ANE74X	Program Elective 3	PEC		2	2	0	50	50	100	3
5	22ANE75X	Open Elective 2	OEC	Offering Department	3	0	0	50	50	100	3
6	22ANEP76	Project Phase 1	MP	Two Contact hours per week				100	-	100	2
7	22ANEL77	Avionics Lab	PC		0	0	2	50	50	100	1
				TOTAL				**350**	**250**	**600**	**19**

Program Elective 3*			
22ANE741	Heat Transfer	22ANE743	Experimental Aerodynamics
22ANE742	Space Mechanics	22ANE744	Helicopter Engineering
Open Elective 2 (Offered to other branch students)			
22ANE751	Drone Technology	22ANE753	Innovations in space technologies
22ANE752	Air Traffic Control	22ANE754	Urban air mobility

VIII SEMESTER

Sl. No.	Course Code	Course Title	Course Type	Teaching Dept.	Teaching Hours/Week			Examination			CREDITS
					L	T	P	CIE	SEE	Total	
1	22ANE81	Aircraft Design	PC	Respective Department	4	0	0	50	50	100	4
2	22ANE82X	Program Elective 4	PEC		3	0	0	50	50	100	3
3	22ANE83X	Program Elective 5	PEC		3	0	0	50	50	100	3
4	22ANE84	Project work phase – II	MP	Two Contact hours per week				100	100	200	8
5	22ANES85	Technical Seminar	MP	One Contact hour per week				100	--	100	1
6	22INT85	Internship	INT	Completed during the intervening period of VI and VII Semester				100	--	100	2
				TOTAL				**450**	**250**	**700**	**21**

Program Elective 4*			
22ANE821	Satellite Technology	22ANE823	UAV Artificial Intelligence Systems
22ANE822	Cryogenic Propulsion	22ANE824	Guidance and Control
Program Elective 5*			
22ANE831	Civil Aviation Requirement	22ANE833	Flight Testing
22ANE832	NDT in Aerospace	22ANE834	Total Quality Management

*__NPTEL for Credit transfer__: Students can take 12 weeks NPTEL course as an equivalent to 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 need to be completed before the registration of the elective. Any certificate obtained after the registration of elective would not 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

Program Elective - 1		
Sl. No.	**Course Code**	**Course Title**
1	22ANE551	Composite materials and structures
2	22ANE552	Air Navigation
3	22ANE553	Aircraft Systems and Instruments
4	22ANE554	Gas Turbine Technology
Program Elective - 2		
Sl. No.	**Course Code**	**Course Title**
1	22ANE641	Rocket and Missile
2	22ANE642	Theory of Elasticity
3	22ANE643	Aircraft Maintenance, overhaul and repairs
4	22ANE644	Fuels and combustion
Program Elective - 3		
Sl. No.	**Course Code**	**Course Title**
1	22ANE741	Heat Transfer
2	22ANE742	Space Mechanics
3	22ANE743	Experimental Aerodynamics
4	22ANE744	Helicopter Engineering
Program Elective - 4		
Sl. No.	**Course Code**	**Course Title**
1	22ANE821	Satellite Technology
2	22ANE822	Cryogenic Propulsion
3	22ANE823	UAV Artificial Intelligence Systems
4	22ANE824	Guidance and Control
Program Elective - 5		
Sl. No.	**Course Code**	**Course Title**
1	22ANE831	Civil Aviation Requirement
2	22ANE832	NDT in Aerospace
3	22ANE833	Flight Testing
4	22ANE834	Total Quality Management
Open Elective 1		
1	22ANE651	Introduction to Aerospace Engineering
2	22ANE652	The History of Aviation
3	22ANE653	Airport Planning and Management
4	22ANE654	Airline Industry

Open Elective 2		
1	22ANE751	Drone Technology
2	22ANE752	Air Traffic Control
3	22ANE753	Innovations in space technologies
4	22ANE754	Urban air mobility

SEMESTER – III SYLLABUS

Head of the Department
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Global Academy of Technology
R.R. Nagar, Bengaluru - 560 098.

SEMESTER – III SYLLABUS

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

Course Code	**22MAT31C**	**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 Function of a complex variable, Analytic functions, Cauchy-Riemann equations, construction of analytic functions using Milne Thomson method, Properties of analytic functions.	**08 Hours L2, L3**
Module 2 Conformal mapping, Bilinear transformations. Complex line integrals, Cauchy's theorem, Cauchy's integral formula, Singularities, poles, residues, Cauchy's residue theorem.	**08 Hours L2, L3**
Module 3 Probability, Axioms of probability, Conditional probability, Bayes theorem, Discrete and continuous random variables, Moments, Moment generating functions, Binomial, Uniform, Poisson, Exponential, Normal distributions.	**08 Hours L2, L3**
Module 4 Joint distributions (both discrete and continuous), Marginal and conditional distributions, Expectation and Covariance. Transformation of random variables, Central limit theorem and law of large numbers.	**08 Hours L2, L3**
Module 5 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.	**08 Hours L2, L3**

COURSE OUTCOMES:

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

CO31.1	Apply Cauchy Riemann equations to study different properties of analytic functions
CO31.2	Evaluate complex line integrals
CO31.3	Solve problems associated with random variables using probability distributions
CO31.4	Solve problems related to testing of hypothesis

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 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 Mapping																
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3	PSO4
CO31.1	3	2	1									3				
CO31.2	3	2	1									3				
CO31.3	3	2	1									3				
CO31.4	3	2	1									3				
Average	3	2	1									3				

Low-1: Medium-2: High-3

SEMESTER – III

COURSE: FLUID MECHANICS

Course Code	**22ANE32**	**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
CLO4	To understand the importance of Flow Measuring devices.
CLO5	To understand the importance of Viscous effect.

Content	**No. of Hours/ RBT levels**
Module 1 **Fluids**: Introduction, Properties of fluids, Viscosity, Types of fluids, Compressibility and Bulk Modulus. **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. Total Pressure and center of Pressure on Submerged Plane Surfaces.	**08 Hours L3**
Module 2 **Buoyancy:** Buoyancy, Center of Buoyancy, Meta-Centre and Meta-Centric Height, Conditions of Equilibrium of Floating and Submerged Bodies, Determination of Meta-Centric Height. **Dimensional Analysis:** Introduction, Derived Quantities, Dimensions of Physical Quantities, Dimensional Homogeneity, Rayleigh's Method, Buckingham's Π Theorem, Types of Similarities and Dimensionless Numbers.	**08 Hours L3**
Module 3 **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 stream lines, stream tube, timeline, path lines, streak lines, flow visualization techniques. Vortex Flow - Free and Forced Vortex	**08 Hours L3**
Module 4 **Fluid Dynamics**: Introduction, Equation of motion, Euler's equation of Motion, Bernoulli's equation from first principles, limitations of Bernoulli's equation. **Fluid Flow Measurements:** Venturimeter, Orifice meter, pitot-tube, vertical orifice, V-Notch and Rectangular notches.	**08 Hours L3**
Module 5 **Flow through pipes**: Minor Energy losses through pipes. Darcy's and Chezy's equation f–or loss of head due to Friction in pipes.	**08 Hours L3**

Viscous Flow: Reynolds's number, Critical Reynold's number, Laminar flow, Turbulent flow, Viscous flow through Circular Pipe-Hagen Poiseille's formula, Viscous flow between two parallel plates and, Boundary layer concept.	

Laboratory Exercises

LIST OF EXPERIMENTS

1. Determine the flow of fluid using Venturimeter and coefficient of discharge of Venturimeter.
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. Determination of Reynolds Number.
9. Performance Testing of a Single Stage Reciprocating Pumps.
10. Performance Characteristics of Kaplan Turbine.
11. Performance Characteristics of Francis Turbine.

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

CO32.1	Apply Fundamental knowledge to Predict the Properties and Characteristics of fluid.
CO32.2	Apply principle of dimensional analysis & similitude to simple engineering problems and describe buoyancy force.
CO32.3	Understand the Kinematics of fluid flow and Continuity Equation.
CO32.4	Analyse the Forces and energy for the fluid flow in a conduit and compare the different flow Measuring devices.
CO32.5	Analyse the losses and viscous effects in the flow through pipes.

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 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. 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	**40**	**30**
	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
CO32.1	3	3	-	2	-	-	-	-	2	2	-	1	3	-
CO32.2	3	3	-	2	-	-	-	-	2	2	-	1	3	-
CO32.3	3	3	-	2	-	-	-	-	2	2	-	1	3	-
CO32.4	3	3	-	2	-	-	-	-	2	2	-	1	3	-
CO32.5	3	3	-	2	-	-	-	-	2	2	-	1	3	-
Average	3	3	-	2	-	-	-	-	2	2	-	1	3	-

Low-1: Medium-2: High-3

SEMESTER – III

COURSE: SOLID MECHANICS

Course Code	**22ANE33**	**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 Solid Mechanics in broad domain of Aeronautical Engineering by making them to learn:

CLO1	To understand the concepts of stress, 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	
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 L3**
Module 2 **Compound Stresses:** Methods of Determining stresses in oblique sections, Principal planes and stresses, Simple problems, Construction of Mohr's circle, simple problems. **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 L3**
Module 3 **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 L3**
Module 4 **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 L3**

Module 5	
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. **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 L3**

Laboratory Exercises

LIST OF EXPERIMENTS

1. Brinell, Rockwell and Vicker's hardness test on various specimens.
2. Izod and Charpy test on various specimens using impact-testing machine.
3. Preparation and study of the Micro Structure of pure metals Mild Steel, Low Carbon steel and High Carbon Steel.
4. To study the defects of cast and welded components using non-destructive tests:
    a. Magnetic crack detection.
    b. Dye penetration testing.
5. Tensile test of metallic and non-metallic specimen using Universal Testing Machine.
6. Compression test of metallic and non-metallic specimen using Universal Testing Machine.
7. Shear and Bending tests of metallic and non-metallic specimen using Universal Testing Machine.
8. Torsion test on metallic specimen using torsion testing machine.
9. To study the wear characteristics of metals and non-metal materials under different parameters.
10. Fatigue Test (demonstration only).

COURSE OUTCOMES:

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

CO33.1	Understand and apply the principles of stresses and strains.
CO33.2	Proficient in determining stresses in oblique sections and analyzing principal planes and stresses
CO33.3	Demonstrate a deep understanding of Bending Stresses and Shear Stress in Beams
CO33.4	Evaluate torsional behavior of shaft material and the hardness of the ferrous and non-ferrous materials.
CO33.5	Analyze the behavior 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 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. 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	**40**	**30**
	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
CO33.1	3	3	2	2	-	-	-	-	1	-	-	1	3	-
CO33.2	3	3	2	2	-	-	-	-	1	-	-	1	3	-
CO33.3	3	3	2	2	-	-	-	-	1	-	-	1	3	-
CO33.4	3	3	2	2	-	-	-	-	1	-	-	1	3	-
CO33.5	3	3	2	2	-	-	-	-	1	-	-	1	3	-
Average	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**1**	**-**	**-**	**1**	**3**	**-**

Low-1: Medium-2: High-3

SEMESTER – III

COURSE: AERO THERMODYNAMICS

Course Code	**22ANE34**	**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 Aero Thermodynamics in broad domain of Aeronautical Engineering by making them to learn:

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 applying to systems and the concept of entropy.
CLO4	Basic knowledge on standard air cycles
CLO5	To get exposure on the basic concepts of Heat and Mass transfer.

Content	No. of Hrs /RBT Levels
Module-1 **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 L1, L2**
Module-2 **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.	**10 Hours L2,L3**
Module-3 **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	**8 Hours L2,L3**
Module-4 **Air Standard Cycles** Otto, Diesel, Dual, Ericsson, Atkinson, Stirling and Brayton cycles - air standard efficiency - Mean effective Pressure.	**8 Hours L2,L3**
Module-5 **Basics of Heat and Mass Transfer** Modes of heat transfer, Basic laws governing Heat transfer, combined heat transfer mechanism. Boundary conditions of 1st, 2nd and 3rd kind. Introduction to mass transfer, definition and terms used in mass transfer, Fick's law of diffusion, Numerical.	**8 Hours L2,L3**

COURSE OUTCOMES:

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

CO34.1	Relate laws of thermodynamics in various engineering problems.
CO34.2	Differentiate thermodynamic work and heat and apply I law of thermodynamics to different process
CO34.3	Choose and analyze the feasibility of design variables using thermodynamics principles.
CO34.4	Utilize the different types of air standard cycles
CO34.5	Select and Calculate heat transfer involving several heat transfer mechanisms.

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/

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**

Low-1: Medium-2: High-3

CO/PO Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO34.1	3	2	-	-	-	-	1	-	1	1	-	1	3	-
CO34.2	3	2	-	-	-	-	1	-	1	1	-	1	3	-
CO34.3	3	2	-	-	-	-	1	-	1	1	-	1	2	-
CO34.4	2	2	-	-	-	-	1	-	1	-	-	1	3	-
CO34.5	3	2	-	-	-	-	1	-	1	1	-	1	3	-
Average	3	2	-	-	-	-	1	-	1	1	-	1	3	-

SEMESTER – III

COURSE: AEROSPACE MATERIALS AND DIGITAL MANUFACTURING

Course Code	**22ANE35**	**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 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

Content	**No. of Hours/RBT levels**
Module 1 **Mechanical Behavior of Engineering Materials** Introduction to aerospace materials and their classification, Linear and non-linear elastic properties, various material testing machines. **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. Titanium and its alloys: Applications, machining, forming, welding and heat treatment, other alloys used in aircrafts.	**08 Hours/ L2**
Module 2 **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 **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 **Additive Manufacturing Technology** Principle, Advantages of additive manufacturing, General limitation of additiv manufacturing, development of additive manufacturing technology: Laser Printing Technologies, Programmable Logic Controllers, Materials, Compute Numerically Controlled Machining. Fused deposition Modeling (FDM	**10 Hours/ L2**

Principle, details of processes.	
Module 5 **Solid Based Additive Manufacturing Systems** Fused deposition Modeling (FDM): Principle, details of processes. **Liquid Based Additive Manufacturing Systems** Stereolithographic Apparatus (SLA): Principle. **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:

CO35.1	Apply knowledge to grasp the fundamental properties of aerospace materials.
CO35.2	Analyze and select appropriate composites for specific aircraft applications
CO35.3	Differentiate and describe the sheet metal and fabrication processes employed in the aircraft industry.
CO35.4	Comprehensively analyze additive manufacturing processes and their applications in aerospace.
CO35.5	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 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
CO35.1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO35.2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO35.3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO35.4	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO35.5	3	2	-	-	-	-	-	-	-	-	-	-	2	-
Average	3	2	-	-	-	-	-	-	-	-	-	-	2	-

Low-1: Medium-2: High-3

SEMESTER – III

COURSE: ABILITY ENHANCEMENT COURSE- ELEMENTS OF AERONAUTICS

Course Code	**22ANE36**	**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 **Introduction to Aircrafts** 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. **Aircraft Structures and Materials** 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**
Module 2 **Aerodynamics** 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 **Aircraft Propulsion** 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 **Aircraft Stability** 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 **Aircraft Systems** 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:

CO36.1	Learn the history of aircraft & developments over the years, acquire knowledge on Aircraft differentiate types and constructions
CO36.2	Understand the basic concepts of flight & Physical properties of Atmosphere
CO36.3	Understand the Different types of Engines and principles of Rocket
CO36.4	Understand the Basics of aircraft Stability
CO36.5	Ability to identify the types & classifications of components and control systems

Textbooks:

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 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
CO36.1	3	3	-	-	-	-	-	-	-	-	-	3	3	-
CO36.2	3	3	-	-	-	-	-	-	-	-	-	3	3	-
CO36.3	3	3	-	-	-	-	-	-	-	-	-	3	3	-
CO36.4	3	3	-	-	-	-	-	-	-	-	-	3	3	-
CO36.5	3	3	-	-	-	-	-	-	-	-	-	3	3	-
Average	3	3	-	-	-	-	-	-	-	-	-	3	3	-

Low-1: Medium-2: High-3

SEMESTER IV SYLLABUS

Head of the Department
Dept. of Aeronautical Engineering
Global Academy of Technology
R.R. Nagar, Bengaluru - 560 098.

SEMESTER IV

COURSE: TRANSFORMS CALCULUS AND NUMERICAL TECHNIQUES

Course Code	**22MAT41C**	**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 Laplace transforms of computer ntary functions, Unit-step and Dirac delta functions. Inverse Laplace Transforms, Solution of second order linear differential equations using Laplace transforms.	**08 Hours L2, L3**
Module 2 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 L2, L3**
Module 3 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 L2, L3**
Module 4 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 solution of second order ordinary differential equations: Runge-Kutta method and Milne's method.	**08 Hours L2, L3**
Module 5 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, Laplace's equation in polar coordinates. Two-dimensional wave equation. Numerical solution of heat and wave equations.	**08 Hours L2, L3**

COURSE OUTCOMES:

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

CO41.1	Determine Laplace and inverse Laplace transforms of given functions and solve linear differential equations
CO41.2	Determine Fourier series and Fourier Transform of given function.
CO41.3	Apply numerical techniques to solve algebraic and transcendental equations.
CO41.4	Apply numerical techniques for interpolation and to evaluate definite integrals.

CO41.5	Solve ordinary differential equations of first and second order using single step and multistep numerical methods
CO41.6	Solve problems related to heat and wave equations

Textbooks:

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

Reference books:

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

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO 1	PSO 2	PSO 3	PSO 4
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				
CO41.6	3	2	1									3				
Average	3	2	1									3				

Low-1: Medium-2: High-3

SEMESTER IV

COURSE: LOW SPEED AERODYNAMICS

Course Code	**22ANE42**	**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 broad domain 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 **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.	**10 Hours** **L3**
Module 2 **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.	**10 Hours** **L3**
Module 3 **INCOMPRESSIBLE FLOW OVER AIRFOILS:** 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	**10 Hours** **L3**

theory: The Symmetrical airfoil and its applications.	
Module 4 **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.	**10 Hours** **L3**
Module 5 **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.	**10 Hours** **L3**

Laboratory Exercises

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
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:

CO42.1	Apply the Fundamental Conservative Principles of Nature to Obtain the Governing Equations in Fluid Flows.
CO42.2	Calculate the Basic Flow Properties of 2 - D geometries by using Potential flow theory and Superposition Principles.
CO42.3	Determine the Aerodynamic force and Moment coefficients using Thin airfoil theory.
CO42.4	Analyze the Lift and Drag Forces of a Finite wing using Lifting Line Theory.
CO42.5	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 Hill Education 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

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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PSO 2
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
Average	3	3	2	2	2	-	-	-	-	-	-	1	3	2

Low-1: Medium-2: High-3

SEMESTER – IV

COURSE: AIRCRAFT PROPULSION

Course Code	**22ANE43**	**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 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 **FUNDAMENTALS OF AIR BREATHING ENGINES** 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	**8 Hours L1, L2**
MODULE-2 **INLETS AND NOZZLES** 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 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	**10 Hours L2, L3**
MODULE-3 **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, Compressor blade design, Axial compressor performance characteristics, Numerical Problems	**8 Hours L2, L3**

MODULE-4 **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	**8 Hours** **L2, L3**
MODULE-5 **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	**8 Hours** **L2, L3**

COURSE OUTCOMES:

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

CO1	Explicate the principles of operation of aircraft propulsion and the fundamental components and their functions in engines.
CO2	Realize the functions of the aircraft inlet and nozzle, their advantages and limitations.
CO3	Assess the compressor's efficiency based on the blade design and the pressure requirements.
CO4	Examine the processes of combustion and combustor and choose the suitable chamber based on their applications.
CO5	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):

7. https://onlinecourses.nptel.ac.in/noc22_me125/preview
8. https://archive.nptel.ac.in/courses/101/101/101101002/

Practical knowledge references

1. https://www.linkedin.com/posts/thuwin_aerospace-engineering-job-activity-7081738421739614208-q2me
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	**40**	**50**
	CIE Test-2		
	CIE Test-3		
	Quiz 1/AAT	**10**	
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
CO1	3	2	2	-	-	-	-	-	-	1	-	1	3	-
CO2	3	2	2	-	-	-	-	-	-	1	-	1	3	-
CO3	3	2	2	-	-	-	-	-	-	1	-	1	2	-
CO4	2	2	2	-	-	-	-	-	-	1	-	1	3	-
CO5	3	2	2	-	-	-	-	-	-	1	-	1	3	-
Average	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**1**	**3**	**-**

Low-1: Medium-2: High-3

SEMESTER – IV

COURSE: AIRCRAFT STRUCTURES-I

Course Code	**22ANE44**	**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 by applying the concepts of theory of elasticity

Content	**No. of Hours/ RBT levels**
Module 1 **Introduction to Aircraft Structures:** Structural layout of the Airplane and components, loads acting on major components such as wing, fuselage, tails, landing gear etc. V-n diagram, Concept of allowable stress and margin of safety. Types of loads – load factor – Aerodynamics loads –Symmetric manoeuvre loads –Aircraft Materials.	**08 Hours** **L3**
Module 2 **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	**08 Hours** **L3**
Module 3 **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** **L3**
Module 4 **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** **L3**

Module 5	
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.stuructural health monitoring of aircraft.	**08 Hours** **L3**

COURSE OUTCOMES:

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

CO44.1	comprehensive understanding of aircraft structures, encompassing topics such as structural layout, major components, loads
CO44.2	Proficiently apply different methodologies to analyze statically determinate and indeterminate structures under various loading conditions
CO44.3	Apply strain energy principles in diverse loadings and effectively utilize Castigliano's theorems and its applications
CO44.4	Apply advanced material theories for optimal material selection and structural design under varying loading conditions.
CO44.5	Solve aircraft structural problems by applying the concepts of theory of elasticity.

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):

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
CO44.1	3	3	1	-	-	-	-	-	-	-	-	-	3	-
CO44.2	3	3	1	-	-	-	-	-	-	-	-	-	3	-
CO44.3	3	3	1	-	-	-	-	-	-	-	-	-	3	-
CO44.4	3	3	1	-	-	-	-	-	-	-	-	-	3	-
CO44.5	3	3	1	-	-	-	-	-	-	-	-	-	3	-
Average	3	3	1	-	-	-	-	-	-	-	-	-	3	-

Low-1: Medium-2: High-3

SEMESTER – IV

COURSE: ADVANCED DRONE TECHNOLOGY

Course Code	**22ANE45**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:1**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Course Objectives: To enable students to understand the drone and its functioning

CLO1	Understanding Drone Aerodynamics to make a model glider.
CLO2	Arrange together and using remote control parts for drones.
CLO3	Learn how to check and fix drones to make sure they work right.
CLO4	Build and program drones while following the rules for flying them

Content	No. of Hours / RBT levels
Module 1 **Drone Aerodynamics** Drone Basics & Applications, Drone Forces & Axis - Multirotor & Fixed Wing, Static, Dynamic Stability, Drag Types, Lift Generation, NACA, Wing & Tail Configuration, Winglets, Aspect Ratio, CG/AD Points, Load Factor, Controls, Gliding. Design & Fabrication of Own Model Glider, Wing & Tail design, Testing	**8 Hours** **L3, L4**
Module 2 **RC Avionics introduction & assembling:** RC Avionics, Fixed wing/Multi rotor Avionic Components Demonstration; BLDC Motor -Stator/Rotor, Permanent /Electro Magnet, KV & Series; ESC/BEC, Power Module, PWD, Gyro, Servo Motors, Flight Controller, GPS, Telemetry System, GCS; Transmitter & Receiver - Control	**10 Hours** **L3, L4**
Module 3 **Drone Testing:** Practical Testing - Thrust Checking, CG Balancing, Roll Balancing, Propeller Balancing, Weight Estimation, Laser Vibration Checking, Speed/Velocity Checking, Servo Motor Controls Testing & Trimming, Lipo Testing & Balancing.	**10 Hours** **L3, L4**
Module 4 **Drone Assembling & Programming:** Drone Frame Configurations, Frame Materials, Drone Assembling, Flight Controller Programming (KK 2.1) - Calibration, PI Gain, Receiver Test, Self-Level Testing, Gyro, resetting; Autonomous Systems, Drone Intelligent Modes, DGCA Rules & Regulations; DGCA Norms - UIN, Type Certificate, RPTO, Zones	**10 Hours** **L3, L4**

Module 5	
FPV Systems & Drone Sensors: FPV Camera System, FPV Transmitter & Receiver, FPV goggles, Gimbal Control System, Drone Image Data Processing, GIS, RGB/Photogrammetry Camera for Mapping, Drone Application Sensors, Demonstration & Assembling - Camera Systems, Advanced Drones Image Processing.	**8 Hours** **L1, L2**

COURSE OUTCOMES:

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

CO1	Construct a working model glider by applying your understanding of how drones fly. **(L3)**
CO2	Demonstrate proficiency in configuring and operating remote control parts for drones. **(L2)**
CO3	Experiment with drones to ensure safe and effective operation. **(L3)**
CO4	Apply programming skills to drones and comply with regulations for their operation. **(L3)**
CO5	Comprehend the fundamentals of FPV systems and camera utilization for data capture. **(L2)**

Textbooks:

1. The Drone Rules, 2021. The Gazette of India: Extraordinary [Part II—Sec. 3(i)].
2. John Baichtal "Building Your Own Drones" A Beginner's Guide to Drones, UAVs, and ROVs Que Publishing, ISBN - 9780789755988
3. Julio Alberto Mendoza "Drones to Go" A Crash Course for Scientists and Makers, Apress ISBN-978-1-4842-6787-5
4. "Aerodynamics for Naval Aviators" by H. H. Hurt Jr. Reprint edition, 1979, U.S. Navy
5. "Introduction to Flight" by John D. Anderson Jr. 8th edition, 2018, McGraw-Hill Education
6. "Radio Control for Model Aircraft" by David Boddington (3rd edition, 2014, Special Interest Model Books
7. "Drone Maintenance and Repair" by Col. Patrick Sherman (1st edition, 2017, CreateSpace Independent Publishing Platform
8. "Quadcopters and Drones: A Beginner's Guide to Successfully Flying and Choosing the Right Drone" by Mark D. Thompson, 1st edition, 2015, CreateSpace Independent Publishing Platform
9. "FPV Drone Racing Guide" by Christian Mollica, 1st edition, 2016, CreateSpace Independent Publishing Platform.

Reference books:

1. Paul Gerin Fahlstrom, Thomas James Gleason, Introduction to UAV Systems, Wiley Publication John Wiley & Sons, Ltd, 4th Edition 2012.
2. Landen Rosen, Unmanned Aerial Vehicle, Alpha Editions, N.Y., 2012
3. Valavanis, Kimon P, Unmanned Aerial Vehicles, Springer, 2011.
4. 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 /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**
CO1	3	3	1	-	1	-	1	1	1	1	-	1	1	1
CO2	3	3	1	-	1	-	-	-	1	1	-	1	1	1
CO3	3	3	1	-	1	-	1	-	1	1	-	1	1	1
CO4	3	3	1	-	1	-	1	-	1	1	-	1	1	1
CO4	3	3	1	-	1	-	1	-	1	1	-	1	1	1
Average	**3**	**3**	**1**		**1**		**1**	**1**	**1**	**1**		**1**	**1**	**1**

Low-1: Medium-2: High-3

SEMESTER – IV

COURSE: COMPUTER AIDED AIRCRAFT DRAWING LAB

Course Code	**20ANEL46**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**0: 0: 2**	**SEE Marks**	**50**
No. of Credits	**1**	**Examination Hours**	**03**

Prerequisites: Computer Aided Engineering Drawing.

Course Objectives: Students will be able to,

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	**RBT levels**
PART-A **INTRODUCTION TO PART DRAWING:** Conversion of 2D aeronautical components to 3D parts and sectional views of simple aeronautical components (Detailed 2D part drawings will be given).	**L3**
ASSEMBLY DESIGN 1. CATIA Assembly 2. Assembly Relationships 3. The Assemble commands and features **Introduction to assembly drawing:** ➢ Assembly of propeller and hub assembly, ➢ Wing assembly, ➢ Fuselage assembly, ➢ Engine mounts assembly, ➢ Landing gear assembly. etailed 2D part drawings will be given). Student to complete at least three of the assembly drawings.	**L6**
PART B **DRAFTING:** 1. Creating detailed drawings 2. Drawing creation 3. Dimensions, Annotations and Parts Lists 4. Detailing a drawing 5. Bill of Materials 6. Exploded View and rendering **Conversion of Assembled view to 2D drafting.**	**L6**

COURSE OUTCOMES:

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

CO1	Sketch the orthographic views of machine components from pictorial view.
CO2	Develop 3D model of machine parts with the knowledge of Modelling Commands.
CO3	Build 3D geometric model of assembly by reading the blueprint of each part.
CO4	Convert assembled 3D model to 2D drafting, Bill of Materials and of components using CAD software.
CO5	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, 6thEdition, 2019.
2. Sidheshwar, Machine Drawing, Tata McGraw-Hill Education, 33 reprint 2006.
3. R. K. Dhawan, Machine Drawing, S Chand Publishing reprint, 2006.

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

Low - 1: Medium - 2: High - 3

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**

SEMESTER – IV

COURSE: ABILITY ENHANCEMENT COURSE-SYSTEMS ENGINEERING FOR AERONAUTICAL ENGINEERS

Course Code	**:**	**22ANE47**		**CIE**	**:**	**50Marks**
Credits: L:T:P	**:**	**2:0:0**		**SEE**	**:**	**50 Marks**
Number of credits	**:**	**2**		**SEE Duration**	**:**	**3.00 Hours**

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

UNIT-I	**06 Hrs**
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. **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.	
UNIT – II	**10 Hrs**
Systems Engineering Management: Managing systems development and risks, Work breakdown structure (WBS), System Engineering Management Plan (SEMP), Risk Management, Organization of Systems Engineering, Systems Engineering Capability Maturity Assessment, Systems Engineering standards, Problem. Originating a new system, Functional analysis, Feasibility analysis, Feasibility definition, Needs validation, System operational requirements, problems. **Concept Exploration:** Developing the system requirements, Operational requirements analysis, Performance requirements formulation, Implementation concept exploration, Design of Experiments, Modeling & Simulation, Performance requirements validation, problems.	
UNIT – III	**10 Hrs**
Concept Definition: Selecting the system concept, Performance requirements analysis, Functional analysis and formulation, Concept selection, Concept validation, System Development planning, System Functional Specifications, problems **Advanced Development:** Reducing program risks, functional Safety risks, Requirements analysis, Functional Analysis and Design, Prototype development, Development testing, Risk reduction, Introduction to Safety Critical System Design – SAE ARP 4754, RTCA DO-178 Standards. problems.	
UNIT – IV	**07**

	Hrs
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. **System Integration and Evaluation:** Integrating, Testing and evaluating the total system, Test planning and preparation, System integration, Developmental system testing, and problems.	
UNIT – V	**06 Hrs**
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.	

Course Outcomes: After completing the course, the students will be able to	
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.

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

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

High-3: Medium-2: Low-1

V SEMESTER SYLLABUS

Head of the Department
Dept. of Aeronautical Engineering
Global Academy of Technology
R.R. Nagar, Bengaluru - 560 098.

SEMESTER -V

COURSE: MANAGEMENT AND ECONOMICS

Course Code	**22ANE51**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**2:2:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Pre-requisite: Nil

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

CLO1	Study needs, functions, roles, scope and evolution of Management
CLO2	Learn importance, purpose of Planning and hierarchy of planning
CLO3	Discuss Decision making, Organizing, Staffing, Directing and Controlling

Content	**No. of Hours/RBT levels**
Module 1 **Management:** Introduction - Meaning - nature and characteristics of Management, Scope and Functional areas of management - Management as a science, art of profession - Management & Administration - Roles of Management, Levels of Management, Development of Management Thought - early management approaches – Modern management approaches. **Planning:** Nature, importance and purpose of planning process Objectives - Types of plans (Meaning Only) - Decision making Importance of planning - steps in planning & planning premises - Hierarchy of plans.	**08 Hours / L2**
Module 2 **Organizing and Staffing**: Nature and purpose of organization Principles of organization - Types of organization - Departmentation Committees- Centralization Vs Decentralization of authority and responsibility - Span of control - MBO and MBE (Meaning Only) Nature and importance of staffing- -: Process of Selection & Recruitment (in brief). **Directing & Controlling**: Meaning and nature of directing Leadership styles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of Co Ordination. Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief)	**08 Hours /** L2
Module 3 **Introduction to Engineering and economics:** Problem solving and decision making, Laws of demand and supply, Difference between Microeconomics & Macroeconomics, equilibrium between demand & supply, elasticity of demand, price elasticity, income elasticity. Law of Returns, Interest and interest factors, simple and compound interest, Cash flow diagrams, personal loans and EMI payment calculation with flexible interest rates, Discussion and problems	**08 Hours /** L2

Module 4 **Present, future and annual worth and rate of returns:** Basic present worth comparisons, Present worth-equivalence, Assets with unequal lives and infinites lives, future worth comparisons, payback comparisons, Equivalent annual worth comparisons, situations for annual worth comparisons. Asset life, Rate of return, minimum acceptable rate of return, IRR anomalies and misconceptions, Cost of capital, comparisons of all present future and annual worth with IRR, product costing, Discussions and problems	**08 Hours / L2**
Module 5 **Costing and depreciation:** Components of costs, estimation of selling price, marginal cost, first cost, all kinds of overheads, indirect cost estimation with depreciation, mensuration and estimation of material cost, cost estimation of mechanical process, idling time. Product costing (approaches to product costing), causes of depreciation, methods of computing depreciation charges, straight line method, declining balance method, sum of years method, sinking fund method, service output methods, taxation concepts, personal income taxes and corporate taxes, Discussions and problems.	**08 Hours / L2**

COURSE OUTCOMES:

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

CO51.1	Understand needs, functions, roles, scope and evolution of Management
CO51.2	Understand importance, purpose of Planning and hierarchy of planning and also analyze its types
CO51.3	Enumerate Decision making, Organizing, Staffing, Directing and Controlling
CO51.4	Select the best economic model from various available alternatives
CO51.5	Understand various interest rate methods and implement the suitable one.

Textbooks:

1. Principles of Management by Tripathy and Reddy
2. Mechanical estimation and costing, T.R. Banga & S.C. Sharma, 17th edition 2015
3. Engineering Economy, Riggs J.L. McGraw Hill, 2002

Reference books:

1. Management Fundamentals - Concepts, Application, Skill Development - Robers Lusier - Thomson 2. Basics of Engineering Economy, Leland Blank & Anthony Tarquin, McGraw Hill Publication (India) Private Limited
3. Economics: Principles of Economics, N Gregory Mankiw, Cengage Learning

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
CO51.1	2	2	1	-	-	-	-	-	-	-	-	-	2	-
CO51.2	2	2	1	-	-	-	-	-	-	-	-	-	2	-
CO51.3	2	2	1	-	-	-	-	-	-	-	-	-	2	-
CO51.4	2	2	1	-	-	-	-	-	-	-	-	-	2	-
CO51.5	2	2	1	-	-	-	-	-	-	-	-	-	2	-
Average	2	2	1										2	

Low-1: Medium-2: High-3

SEMESTER V

COURSE: HIGH SPEED AERODYNAMICS

Course Code	**22ANE52**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:2**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

Pre requisite: 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 **ONE DIMENSIONAL COMPRESSIBLE FLOW:** Review of Thermodynamics and State Equations, Compressibility, Velocity of Sound, Adiabatic Steady-State flow Equations, Flow-through Convergent-Divergent Passage.	**10 Hours/ L3**
Module 2 **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.	**10 Hours/ L3**
Module 3 **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.	**10 Hours/ L3**
Module 4 **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.	**10 Hours/ L3**

Module 5 **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.	**10 Hours/ L3**

Laboratory Exercise

List of Experiments

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

COURSE OUTCOMES:

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

CO52.1	Calculate the Thermodynamic state variables in Compressible Flow.
CO52.2	Estimate the flow Properties across Normal Shock Waves.
CO52.3	Evaluate and Analyze the flow Properties across Oblique Shock Waves
CO52.4	Understand the Linearization of the governing equations in compressible flow.
CO52.5	Predict the flow Properties of Transonic and Hypersonic flows.

Textbooks:

1. J. D. Anderson, "**Fundamentals of Aerodynamics**", 5th Edition, McGraw Hill Education India Private Limited, 2010.
2. Rathakrishnan, E., "**Gas Dynamics**", 6th Edition, Prentice Hall of India, 2017.

Reference books:

1. J. D. Anderson, "**Modern Compressible Flow**", 3rd Edition, McGraw Hill Education 16 August 2002.
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**

CO/PO Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO52.1	3	3	2	2	2	-	-	-	-	-	-	1	3	2
CO52.2	3	3	2	2	2	-	-	-	-	-	-	1	3	2
CO52.3	3	3	2	2	2	-	-	-	-	-	-	1	3	2
CO52.4	3	3	2	2	2	-	-	-	-	-	-	1	3	2
CO52.5	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: FINITE ELEMENT METHODS

Course Code	**22ANE53**	**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: 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: 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: 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: ISOPARAMETRIC ELEMENTS Definitions, Shape function for 4, 8 and 9 nodal quadrilateral elements, Stiffness matrix and consistent load vector, Gaussian integration.	**08 Hours/ L3**
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:

CO62.1	Understand the approximate methods used for solving structural mechanics problems and ormulation of governing equation for the finite element method
CO62.2	Solve 1-D problems related to static analysis of structural members
CO62.3	Formulate the elemental matrices for 2-D problems.
CO62.4	Exposure to iso-parametric element formulations and importance of numerical integration.
CO62.5	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.

Reference books:

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
CO62.1	3	3	2	2	2	-	-	-	-	-	-	1	3	-
CO62.2	3	3	2	2	2	-	-	-	-	-	-	1	3	-
CO62.3	3	3	2	2	2	-	-	-	-	-	-	1	3	-
CO62.4	3	3	2	2	2	-	-	-	-	-	-	1	3	-
CO62.5	3	3	2	2	2	-	-	-	-	-	-	1	3	-
Average	3	3	2	2	2	-	-	-	-	-	-	1	3	-

Low-1: Medium-2: High-3

SEMESTER -V

COURSE: AEROSPACE PROPULSION

Course Code	**22ANE54**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:2**	**SEE Marks**	**50**
No. of Credits	**4**	**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 **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. Introduction to scramjet, need for supersonic combustion, problems associated with supersonic combustion salient features of scramjet engine and its applications, Numerical problems	**10Hours /L2**
MODULE-2 **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 **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**
MODULE-4 **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 **NON-CHEMICAL ROCKET ENGINE** Principles of electrical rocket engine, Classifications of electrical rockets, Electrothermal thrusters, Electrostatic thrusters, Electromagnetic thrusters, Nuclear rocket engines, Solar energy rockets, Numerical Problems	**8 Hours /L3**

COURSE OUTCOMES:

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

CO54.1	Outline the functions and challenges in design and development of ramjet and scramjet engines
CO54.2	Develop and demonstrate a rocket propulsion and their systems
CO54.3	Build a solid rocket and to examine their propellants and thrust performance.
CO54.4	Categorize the liquid propellants based on their merits and demerits for a selected mission profile
CO54.5	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
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
CO54.1	3	2	2	-	-	-	-	-	-	1	-	1	3	-
CO54.2	3	2	1	-	-	1	-	-	-	1	-	1	3	-
CO54.3	3	2	2	-	-	1	-	-	-	1	-	1	3	-
CO54.4	2	2	2	-	-	1	-	-	-	1	-	1	3	-
CO54.5	2	2	2	-	-	1	-	-	-	1	-	1	3	-
Average	3	1	2	-	-	1	-	-	-	1	-	1	3	-

Low-1: Medium-2: High-3

SEMESTER V

COURSE: ABILITY ENHANCEMENT COURSE-URBAN AIR MOBILITY

Course Code	**22ANE56**	**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 Urban air mobility in broad domain of aeronautical engineering by making them to learn:

CLO1	To gain knowledge of Urban Air Mobility (UAM).
CLO2	Acquire in-depth knowledge about the classification and operational aspects of UAM vehicles
CLO3	Comprehend the evolving ecosystem and infrastructure developments required to support UAM.
CLO4	Gain an insight to the rules and regulations governing UAM and drones in India,
CLO5	Describe the process and importance of type certification for UAM vehicles

Content	No. of hr / RBT levels
Module 1 **INTRODUCTION:** UAM, the evolving landscape of urban air mobility in india, UAM around the globe and its progress, enabling ecosystem for UAM in India, policy support	**03 Hours / L3**
Module 2 **The Unmanned Aircraft System Rules, 2022**, Category - The unmanned aircraft are classified based on the maximum all up weight including its pay load, DGCA Guidelines for UAS, Operations of UAS, Drone Port	**03 Hours/ L2**
Module 3 **VEHICLE TYPES**, Main Use Cases and Infrastructure, **UDAN-RCS Scheme of Government of India**	**03 Hours/ L3**
Module 4 **UNMANNED AIRCRAFT SYSTEM(UAS)**, Drone Rules 2022, Amendment Rules 2022	**03 Hours/ L3**
Module 5 **Digital sky platform**, type certificate, RPCS details, list of RPTOS, UIN details	**03 Hours/ L3**

COURSE OUTCOMES:

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

CO56.1	Understand UAM and its ecosystem in India
CO56.2	Acquire knowledge on the classification and operations of UAM
CO56.3	Comprehend the ecosystem and infrastructure developments for UAM
CO56.4	Appreciate the UAM and Drone rules and regulation

CO56.5	Describe the type certification for UAM

Textbooks:

1. Paul Gerin Fahlstrom, "Thomas James Gleason, Introduction to UAV Systems", Wiley Publication John Wiley & Sons, Ltd, 4th Edition 2012.
2. Landen Rosen, "Unmanned Aerial Vehicle, Alpha Editions", N.Y., 2012

Reference books:

1. Valavanis, Kimon P, "Unmanned Aerial Vehicles", Springer, 2011.
2. 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):

ThreeTestsaretobeconductedfor40markseach.CIEisexecutedbywayofquizzes/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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO56.1	3	2	-	-	-	-	1	2	-	-	-	1	1	-
CO56.2	3	2	-	-	-	-	1	2	-	-	-	1	1	-
CO56.3	3	2	-	-	-	-	1	2	-	-	-	1	1	-
CO56.4	3	2	-	-	-	-	1	2	-	-	-	1	1	-
CO56.5	3	2	-	-	-	-	1	2	-	-	-	1	1	-
Average	3	2	-	-	-	-	1	2	-	-	-	1	1	-

Low-1: Medium-2: High-3

SEMESTER -V

COURSE: ENVIRONMENTAL SCIENCE

Course Code	**22CIV57**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**1:0:0**	**SEE Marks**	**50**
No. of Credits	**1**	**Examination Hours**	**01**

Course Learning Objectives:

CLO1	The fundamentals of environmental science.
CLO2	The types of natural resources
CLO3	The various global environmental concerns.
CLO4	The types of wastes generated and their handling at a basic level
CLO5	The area of environmental law and policies with a few important acts in the field

CONTENT	**No. of Hours/RBT levels**
Module 1 **Environment:** • Definition, scope & importance • Components of Environment Ecosystem: Structure and function of various types of ecosystems • Human Activities – Food, Shelter, and Economic & Social Security. • Population - Growth, variation among nations – population explosion and impact on environment Biodiversity: Types, Value, Hot spots, Threats and Conservation of biodiversity Forest Wealth, and Deforestation.	**04 Hours / L2**
Module 2 **Natural Resources**: Forest, Water, Mineral, Food, Energy, Land Environmental Pollution - Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards.	**04 Hours / L2**
Module 3 **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.	**04 Hours / L2**
Module 4 **Sources:** Sources of Solid waste, Types of solid waste, Physical and Chemical composition of municipal solid waste. Solid Waste Management Rules in India, Sources and management of E – Waste, Biomedical Waste, Hazardous waste, and construction waste at individual and community level. Socio-economic aspect of waste management Environmental Toxicology.	**04 Hours / L2**

Module 5	04 Hours / L2
Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications): Environment Impact Assessment, Environmental Management Systems, ISO14001; Environmental Stewardship, NGOs.	

COURSE OUTCOMES:

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

CO57.1	Understand holistically the key concepts "Environment", and "Biodiversity".
CO57.2	Classify the types of natural resources available and the effects of anthropogenic interventions.
CO57.3	Express the gravity of various global environmental concerns.
CO57.4	Categorize the types of wastes generated and their handling at a basic level.
CO57.5	Understand the importance of environmental law and policies.

Textbooks:

1. Environmental studies, Benny Joseph, Tata Mcgraw-Hill 2nd edition 2012
2. Environmental studies, S M Prakash, pristine publishing house, Mangalore 3rd edition-2018
3. Gilbert M.Masters, Introduction to Environmental Engineering and Science, 2nd edition, Pearson Education, 2004

Reference books:

1. Benny Joseph, Environmental studies, Tata Mcgraw-Hill 2nd edition 2009
2. M.Ayi Reddy Textbook of Environmental Science and Technology, BS publications 2007
3. Dr. B.S Chauhan, Environmental Studies, University of science press 1st edition

Web References:

https://www.hzu.edu.in/bed/E%20V%20S.pdf
https://onlinecourses.nptel.ac.in/noc23_hs155/preview
https://onlinecourses.swayam2.ac.in/cec19_bt03/preview

Scheme of Examination:

Semester End Examination (SEE): SEE Question paper is to be set for 50 marks with multiple choice questions of 1 mark each covering all aspects of the syllabus.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 50 marks each. The average of the three tests are taken for computation of CIE. Question paper for each of the CIE is to be of the multiple-choice type with 50 question each.
Typical Evaluation pattern for regular courses is shown in Table.

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

	Component	Marks	Total Marks
CIE	CIE Test-1	**50**	50
	CIE Test-2	**50**	
	CIE Test-3	**50**	
SEE	Semester End Examination	**50**	**50**
		Grand Tot	**100**

	CO/PO Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO57.1	2	-	-	-	-	-	3	-	-	-	-	-	1	-	-
CO57.2	2	1	-	-	-	-	3	-	-	-	-	1	1	-	1
CO57.3	2	-	2	-	-	2	3	1	-	-	-	1	1	-	1
CO57.4	2	2	-	-	-	2	3	-	-	-	-	-	-	-	1
CO57.5	2	-	-	-	-	2	3	-	-	-	-	-	-		1
Average	**2**	**1.5**	**2**			**2**	**3**	**1**	**-**	**-**	**-**	**1**	**1**		**1**

Low-1: Medium-2: High-3

SEMESTER -V

COURSE: UNIVERSAL HUMAN VALUES

Course Code	**22UHV57**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**1:0:0**	**SEE Marks**	**50**
No. of Credits	**1**	**Examination Hours**	**01**

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 **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 **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 **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, 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	05 Hours
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.	
Module 5	**05 Hours**
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.	

COURSE OUTCOMES:

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

CO1	Understand the significance of value inputs in a classroom and start applying them i their life and profession
CO2	Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.
CO3	Understand the role of a human being in ensuring harmony in society and nature.
CO4	Distinguish between ethical and unethical practices and start working out the strateg 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:

Semester End Examination (SEE): SEE Question paper is to be set for 50 marks with multiple choice questions of 1 mark each covering all aspects of the syllabus.

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 50 marks each. The average of the three tests are taken for computation of CIE. Question paper for each of the CIE is to be of the multiple-choice type with 50 question each.

Typical Evaluation pattern for regular courses is shown in Table.

Table 1: Distribution of weightage for CIE & SEE for 1 credit course

	Component	Marks	Total Marks
CIE	CIE Test-1	**50**	**50**
	CIE Test-2	**50**	
	CIE Test-3	**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	PSO3	PSO4
CO1	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
CO2	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
CO3	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
CO4	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
Average	-	-	-	-	-	-	-	**2**	-	-	-	**1**	-		-	-

Low-1: Medium-2: High-3

SEMESTER -V
PROGRAM ELECTIVE 1

COURSE: COMPOSITE MATERIALS AND STRUCTURES

Course Code	**22ANE551**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**2:2:0**	**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 its 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 **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. **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 **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. **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 **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 **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. **Failure Theory:** Tsai-Hill, Tsai-Wu, Max Stress and Max Strain	**10 Hours / L3**
Module 5 **Inspection & Quality Control:** Destructive & Non-Destructive Testing, Tensile, Compression, Flexural, Shear, Hardness; ultrasonic testing – A-B-C scan **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:

CO551.1	Understanding the mechanics of composite materials.
CO551.2	Understand the processing methods in composite materials.
CO551.3	Apply the characterization methods for various engineering materials.
CO551.4	Comprehend and apply theories of structures for engineering problems.
CO551.5	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
CO551.1	3	3	-	-	-	-	-	-		-	-	-	3	-
CO551.2	3	3	-	-	-	-	-	-		-	-	-	3	-
CO551.3	3	3	-	-	-	-	-	-		-	-	-	3	-
CO551.4	3	3	-	-	-	-	-	-		-	-	-	3	-
CO551.5	3	3	-	-	-	-	-	-		-	-	-	3	-
Average	3	3	-	-						-			3	

Low-1: Medium-2: High-3

SEMESTER – V
Program Elective -I

COURSE: AIR NAVIGATION

Course Code	**22ANE552**	**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 air navigation in broad domain of aeronautical engineering by making them to learn:

CLO1	Study the basic principle of operation of Air Traffic Control Communication.
CLO2	Learn the concept to Navigate correctly to the destination
CLO3	Apply the knowledge of celestial navigation system to fix the location of object.

Content	No. of Hours/ RBT levels
Module 1 **Basics of Navigation:** The solar system, The earth, Time and time conversions-apparent time, UTC, LMT, standard times, international dateline, Directions, terrestrial magnetism: declination, deviation and compass variations, magnetic poles, isogonals, relationship between true and magnetic Distance	**08 Hours/ L2**
Module 2 **Magnetism and Compasses:** General principles, terrestrial magnetism, resolution of the earth's total magnetic force into vertical and horizontal components, the effects of change of latitude on these components, Aircraft magnetism, Change of deviation with change of latitude and with change in aircraft's heading, turning and acceleration errors, compasses, serviceability tests, advantages and disadvantages of the remote indicating compasses, adjustment and compensation of direct reading magnetic compass	**08 Hours/ L2**
Module 3 **Charts:** General properties of the miscellaneous type of projections, Mercator, Lambert conformal conic, Polar stereographic, Transverse Mercator, Oblique Mercator, the representation of meridians, parallels, great circles, and rhumb lines, direct Mercator, Lambert conformal conic, Polar Stereographic, the use of current aeronautical charts, plotting positions, methods of indicating scale and relief, conventional signs, measuring tracks and distances, plotting bearings	**08 Hours/ L2**
Module 4 **Dead Reckoning Navigation (DR):** Basics of dead reckoning, Use of the navigational computer, The triangle of velocities, methods of solution for the determination of heading, ground speed, wind velocity, track and drift	**08 Hours/ L2**

angle, track error, time and distance problems, Determination of DR position, Measurement of DR elements, Resolution of current DR problems, Measurement of maximum range, radius of action, point-of-safe-return and point-of-equal-time, Miscellaneous DR uncertainties and practical means of correction	
Module 5 **In-flight Navigation:** Use of visual observations and application to in-flight navigation, Navigation in climb descent, average airspeed, average wind velocity, ground speed/distance covered during climb or descent, Navigation in cruising flight, use of fixes to revise navigation data as ground speed revision, off-track corrections, calculation of wind speed and direction, ETA revisions, Flight log (including navigation records)	**08 Hours/ L2**

COURSE OUTCOMES:

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

CO552.1	Understand the basic concepts of navigation system.
CO552.2	Outline the Principles of Magnetism and Compasses
CO552.3	Formulate a comparative study of Charts used in Navigation Systems
CO552.4	Analyze the chart reading and problem occurring on dead reckoning applying ir natural means to navigate accurately to the destination
CO552.5	Apply the concept to Navigate correctly to in-flight Navigation

Textbooks:

1. C.W. Martin, Air Navigation.
2. D.C.T. Benett, The Complete Air Navigation.

Reference books:

1. T.C. Lyon, Practical Air Navigation.
2. RAT Manual of Air Navigation, A.P. 1234Vols. A, B, D &E.

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
CO552.1	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO552.2	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO552.3	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO552.4	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO552.5	3	3	-	-	-	-	-	-	-	-	-	-	3	-
Average	3	3	-	-	-	-	-	-	-	-	-	-	3	-

Low-1: Medium-2: High-3

SEMESTER – V
Program Elective -I

COURSE: AIRCRAFT SYSTEMS AND INSTRUMENTATION

Course Code	**22ANE553**	**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 aircraft systems and instrumentation in broad domain of aeronautical engineering by making them to learn:

CLO1	To provide the knowledge on the aircraft control systems.
CLO2	learn about the aircraft systems
CLO3	Acquire the knowledge of aircraft engine systems
CLO4	To provide the basic knowledge of Aircraft auxiliary systems
CLO5	Acquire the knowledge on aircraft and air data instruments.

Content	No. of Hours/ RBT levels
Module 1 **AIRCRAFT CONTROL SYSTEMS:** Conventional Systems, fully powered flight controls, Power actuated systems, Modern control systems, Digital fly by wire systems, Auto pilot system active control Technology.	**08 Hours/ L2**
Module 2 **AIRCRAFT SYSTEMS:** Hydraulic systems, Study of typical workable system, components, Pneumatic systems, **Advantages**, working principles, Typical Air pressure system, Brake system, Typical Pneumatic power system, Components, Landing Gear systems, Classification.	**08 Hours/ L2**
Module 3 **ENGINE SYSTEMS:** Fuel systems for Piston and jet engines, Components of multi engines. lubricating **systems** for piston and jet engines - Starting and Ignition systems - Typical examples for piston and jet engines.	**08 Hours/ L2**
Module 4 **AUXILIARY SYSTEM**: **Basic** Air cycle systems, Vapour Cycle system Evaporative vapor cycle systems, Evaporative air cycle systems, Fire protection systems, Deicing and anti-icing systems.	**08 Hours/ L2**
Module 5 **AIRCRAFT INSTRUMENTS**: Flight Instruments and Navigation Instruments, Gyroscope, Accelerometers, Air speed **Indicators**, TAS, EAS, Mach Meters, Altimeters, Principles and operation, Study of various types of engine instruments, Tachometers, Temperature gauges, Pressure gauges, Operation and Principles.	**08 Hours/ L2**

COURSE OUTCOMES:

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

CO553.1	Distinguish the conventional and modern control systems.
CO553.2	Classify the aircraft systems.
CO553.3	Categorize different types of aircraft instruments.
CO553.4	Comprehend the engine and fuel systems
CO553.5	Understand the basic flight and air data instrumentation

Textbooks:

1. Ian Moir and Allan Seabridge, " Aircraft Systems: Mechanical, Electrical and Avionics-Subsystem Integration ", Wiley India Pvt Ltd, 3rd edition, 2012.
2. Pallet, E.H.J**,** "Aircraft Instruments and Integrated Systems ", Longman Scientific and Technical Institute, 1996.

Reference books:

1. Lalit Gupta and OP. Sharma, "Aircraft Systems (Fundamentals of Flight Vol. IV) Himalayan Books 2006.
2. R.W. Sloley and W.H. Coulthard, "The aircraft Engineers Handbook, No4, Instruments", 6th Edition, 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 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
CO553.1	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO553.2	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO553.3	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO553.4	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO553.5	3	3	-	-	-	-	-	-	-	-	-	-	3	-
Average	3	3	-	-	-	-	-	-	-	-	-	-	3	-

Low-1: Medium-2: High-3

SEMESTER – V
Program Elective -I

COURSE: GAS TURBINE TECHNOLOGY

Course Code	**22ANE554**	**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 Gas Turbine Technology in broad domain of aeronautical engineering by making them to learn:

CLO1	Revise various engine types and understand engine materials and manufacturing
CLO2	Study about engine fuel systems and engine starting systems with FADEC Interface
CLO3	Evaluate engine parts and their performance
CLO4	Analyse engine design performance and health monitoring
CLO5	Understand engine testing, measurements and instrumentation

Content	No. of Hours/ RBT levels
Module 1 **Gas Turbine Engines, materials and manufacturing:** Types of engines showing arrangement of parts. Operating parameters. Energy distribution of turbojet, turboprop and turbofan engines. Criteria for selection of materials. Heat ranges of metals, high temperature strength. Surface finishing. Powder metallurgy. Use of composites and Ceramics. Super alloys for Turbines.	**08 Hours/ L2**
Module 2 **Engine Systems:** Fuel systems and components. Sensors and Controls. FADEC interface with engine. Oil system components. Typical oil system. Starting systems. Typical starting characteristics. Various gas turbine starters.	**08 Hours/ L3**
Module 3 **Engine parts & their performance Estimation:** Compressor MAP. Surge margin, Testing and Performance Evaluation. Combustor MAP, Pressure loss. Testing and Performance Evaluation. Turbine MAP. Turbine Testing and Performance Evaluation. Ram pressure recovery of inlet duct. Propelling nozzles, after burner, maximum mass flow conditions. Testing and Performance Evaluation	**08 Hours/ L3**
Module 4 **Engine Design Performance and Health monitoring:** Design & off-design Performance. Surge margin requirements, surge margin stack up. Transient performance. Qualitative characteristics quantities. Transient working lines. Starting process & Wind milling of Engines. Thrust engine start envelope. Calculations for design and off-design performance from given test data– (case study for a single shaft Jet Engine). Engine health monitoring.	**08 Hours/ L3**

Module 5	
Engine Testing, Measurements and Instrumentation: Proof of Concepts: Design Evaluation tests. Structural Integrity. Environmental Ingestion Capability. Preliminary Flight Rating Test, Qualification Test, Acceptance Test. Reliability figure of merit. Durability and Life Assessment Tests, Test Beds and its types, Ram Air Testing, Altitude Testing, Ground Testing, Flight testing. Data Acquisition system, Jet thrust measurements in flight, Measurement of Shaft speed, Torque, Thrust, Pressure, Temperature, Vibration, Stress, Temperature of turbine blading etc. Engine performance trends: Mass and CUSUM plots. Accuracy and Uncertainty in Measurements. Uncertainty analysis. Performance Reduction Methodology.	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO554.1	Revise various engine types and understand engine materials and manufacturing
CO554.2	Identify engine fuel systems and engine starting systems with FADEC Interface
CO554.3	Evaluate engine parts and their performance
CO554.4	Analyse engine design performance and health monitoring
CO554.5	List engine testing, measurements and instrumentation

Textbooks:

1. Irwin E. Treager, Gas Turbine Engine Technology, McGraw Hill Education, 3rd edition,2013
2. P. P Walshand P. Peletcher , Gas Turbine Performance, Blackwell Science Science 1998
2. A. W. Morley Jean Fabri Pergamon, Advanced Aero-Engine Testing, 1959

Reference books:

1. JP Holman, Experimental methods for Engineers, Tata Mc Graw Hill 7th edition,2007
2. Michael J. Kores, and Thomas W. Wild, Aircraft Power Plant Tata Mc Graw Hill Publishing Co. Ltd7thEdition,2002

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
CO552.1	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO552.2	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO552.3	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO552.4	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO552.5	3	3	-	-	-	-	-	-	-	-	-	-	3	-
Average	3	3	-	-	-	-	-	-	-	-	-	-	3	-

Low-1: Medium-2: High-3

VI SEMESTER SYLLABUS

Head of the Department
Dept. of Aeronautical Engineering
Global Academy of Technology
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SEMESTER – VI

COURSE: AIRCRAFT PERFORMANCE

Course Code	**22ANE61**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**2:2:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Pre requisite: Low Speed Aerodynamics

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

CLO1	learn how airplanes fly and perform in steady, un-accelerated flight
CLO2	understand key aspects of airplane performance such as maximum speed, climb capabilities
CLO3	calculate the range and endurance of airplanes, considering different propulsion types and wind conditions.
CLO4	Analyze take-off, landing, and maneuvering performance and learn how airplanes perform in steady, un-accelerated flight

Content	No. of Hours/ RBT levels
Module 1: THE EQUATIONS OF MOTION STEADY UN-ACCELERATED FLIGHT The evolution of the airplane and the performance, a short history. Variation of lift, drag and moment coefficient with angle of attack and Mach number, 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. Altitude effects on power available and power required; thrust available and thrust required.	**10 Hours / L3**
MODULE 2: FUNDAMENTAL AIRPLANE PERFORMANCE Level Flight, Climb &Glide: Equation of motion for steady level flight, Performance of airplane in level flight. Maximum speed in level flight, Climb. 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). Thrust – to –weight ratio, Wing loading, Drag polar, and lift-to – drag ratio. Minimum velocity: Stall and High lift devices.	**10 Hours / L3**
Module 3: RANGE AND ENDURANCE Propeller driven and Jet Airplane: Physical consideration, Quantitative formulation, Breguet equation for Range and Endurance, Conditions for maximum range and endurance. Effect of head wind and tail wind for jet airplane.	**12 Hours / L3**
Module 4: AIRCRAFT PERFORMANCE IN ACCELERATED FLIGHT Take-off Performance: Calculation of Ground roll, Calculation of distance while airborne to clear obstacle, Balanced field length. LANDING PERFORMANCE AND ACCELERATED CLIMB: Calculation of approach distance, Calculation of flare distance, Calculation of ground roll, ground effects. Acceleration in climb.	**10 Hours / L3**

Module 5: MANEUVER PERFORMANCE 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.	**10 Hours / L3**

COURSE OUTCOMES:

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

CO61.1	Understand the variation of aerodynamic coefficients with varying flow parameters
CO61.2	Apply the concepts of steady performance to analyze level flight, climb, and glide performance.
CO61.3	Determine the range and endurance of propeller and Jet driven airplane.
CO61.4	Comprehend the aircraft take-off and landing performance.
CO61.5	Identify and explain the key factors affecting maneuver performance

Textbooks:

1. John D. Anderson, Jr., "Aircraft Performance and Design", McGraw-Hill International, 1999.
2. John D. Anderson, Jr., "Introduction to flight", McGraw-Hill International, 2000.

Reference books:

1. Perkins, C.D., and Hage, R.E, "Airplane Performance stability and Control", John Wiley Son Inc, New York, company, 1988.
2. Barnes W. McCormick, "Aerodynamics, Aeronautics, and Flight Mechanics", John Wiley & Sons, 2nd Edition, 1994.

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
CO61.1	3	3	2	1	1	-	-	-	-	-	-	1	3	-
CO61.2	3	3	2	1	1	-	-	-	-	-	-	1	3	-
CO61.3	3	3	2	1	1	-	-	-	-	-	-	1	3	-
CO61.4	3	3	2	1	1	-	-	-	-	-	-	1	3	-
CO61.5	3	3	2	1	1	-	-	-	-	-	-	1	3	-
Average	**3**	**3**	**2**	1	1							**1**	**3**	

Low-1: Medium-2: High-3

SEMESTER -V

COURSE: AIRCRAFT STRUCTURS-II

Course Code	**22ANE62**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**SEE Marks**	**50**
No. of Credits	**3**	**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 **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, deflection due to bending, calculation of section properties, approximation for thin-walled sections.	**08Hours/ L3**
Module 2 **SHEAR FLOW IN OPEN SECTIONS** Thin walled beams, Concept of shear flow, shear centre, Elastic axis. With one axis of symmetry, with wall effective and ineffective in bending, unsymmetrical beam sections. **SHEAR FLOW IN CLOSED SECTIONS** Bredt – Batho formula, Single and multi – cell structures, approximate methods. Shear flow in single and multi-cell under bending -with walls effective and ineffective.	**08 Hours/ L3**
Module 3 **JOINTS AND FITTINGS** Bolted or riveted joints, accuracy of fitting analysis, eccentrically loaded connections, welded joints, and concept of effective width.	**08 Hours/ L3**
Module 4 **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 **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. **STRESS ANALYSIS IN FUSELAGE FRAMES:** Bending, shear, torsion, cut-outs in fuselages, principles of stiffeners construction, fuselage frames, shear flow distribution.	**08 Hours / L3**

COURSE OUTCOMES:

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

CO53.1	Evaluate the direct bending stresses exhibited in both open and closed sections, employing advanced analytical techniques to comprehend their structural implications.
CO53.2	Examine and assess the intricate patterns of shear flow within both open and closed sections employing advanced analytical methodologies to grasp their structural ramifications.
CO53.3	Determine loads on riveted and welded joints for optimized structural performance.
CO53.4	Applying idealization concepts to simplify complex structural sections to understand how they behave, under given loading conditions.
CO53.5	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
CO53.1	3	3	2	-	-	-	-	-	-	-	-	1	3	-
CO53.2	3	3	2	-	-	-	-	-	-	-	-	1	3	-
CO53.3	3	3	2	-	-	-	-	-	-	-	-	1	3	-
CO53.4	3	3	2	-	-	-	-	-	-	-	-	1	3	-
CO53.5	3	3	2	-	-	-	-	-	-	-	-	1	3	-
Average	3	3	2	-	-	-	-	-	-	-	-	1	3	-

Low-1: Medium-2: High-3

SEMESTER -VI

COURSE: CONTROL ENGINEERING AND MICROPROCESSORS

Course Code	**22ANE63**	**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 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: 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.	**10 Hours/L3**
Module 2: 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/L3**
Module 3: 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/ L4**
Module 4: 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/L4**
Module 5: MICROPROCESSORS Architecture of Intel 8085- Instruction Formats - Addressing Modes - Simple Assembly Language Programs - Architecture andFunctioning of Intel 8086 Processor - Instruction Formats – Addressing Modes. Microprocessor Applications in aerospace	**08 Hours/L4**

COURSE OUTCOMES:

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

CO63.1	Comprehend the open loop & closed loop systems and Mathematical Models.
CO63.2	Solve the complex physical systems using Block diagrams and Signal Flow Graphs and obtain Transfer function
CO63.3	Apply the feedback control systems for stability and Controllers
CO63.4	Summarize the basic knowledge on Linear and Digital ICs.
CO63.5	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. 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	**40**	**50**
	CIE Test-2		
	CIE Test-3		
	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
CO63.1	3	3	2	2	1	-	-	-	1	1	1	-	1	1
CO63.2	3	3	2	2	1	-	-	-	1	1	1	-	1	1
CO63.3	3	3	2	2	1	-	-	-	1	1	1	-	1	1
CO63.4	3	3	2	2	1	-	-	-	1	1	1	-	1	1
CO63.5	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

SEMESTER VI
PROFESSIONAL ELECTIVE 2

COURSE: ROCKET AND MISSILES

Course Code	**22ANE641**	**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: 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**
Module 2: 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 3: 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 4: STAGING AND CONTROL OF ROCKETS AND MISSILES: Multi staging of rockets and ballistic missiles – Multistage Vehicle Optimization – Stage Separation Dynamics – Stage Separation Techniques in atmosphere and in space, Introduction to aerodynamic and jet control methods – various types of aerodynamic control methods for tactical and short-range missiles.	**10 Hours/ L3**

Module 5: 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:

CO641.1	Classify rockets and missiles based on various methods and explain the basic aerodynamic characteristics of different types.
CO641.2	Analyze the Motion of Rocket and Missiles in free space and gravitational field
CO641.3	Analyze the Aerodynamic Forces and Moments of Rockets and Missiles.
CO641.4	Describe the Stage separation of Multi staging rocket and various aerodynamic & jet control methods
CO641.5	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 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

SEMESTER VI
PROGRAM ELECTIVE -2

COURSE: THEORY OF ELASTICITY

Course Code	**22ANE642**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**2:2:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Pre requisite: Aircraft Structures-I

Course Leaning Objectives: To enable students to apply the knowledge of Theory of Elasticity in broad domain of aeronautical engineering by making them to learn:

CLO1	To make the student understand the elastic behavior of different structural components under various loadings and boundary conditions.
CLO2	Describe the Plane stress and Plane strain Problems
CLO3	Knowledge to formulate and derive static and dynamic aero elastic equations of motion.
CLO4	To understand the theories of torsion, including Navier's theory, Saint-Venant's theory, and Prandtl's theory, and apply them to analyze torsional behavior
CLO5	To introduce classical plate theory, its assumptions, governing equations, and boundary conditions

Content	No. of Hours/RBT levels
Module 1: BASIC EQUATIONS OF ELASTICITY Definition of Stress and Strain: Stress - Strain relationships - Equations of Equilibrium, Compatibility equations, Boundary Conditions, Saint Venant's principle - Principal Stresses, Stress Ellipsoid – Stress invariant	**08 Hours/ L3**
Module 2: PLANE STRESS AND PLANE STRAIN PROBLEMS Airy's stress function, Bi- harmonic equations, Polynomial solutions, Simple two-dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams.	**08 Hours/ L3**
Module 3: POLAR COORDINATES Equations of equilibrium, Strain - displacement relations, Stress – strain relations, Airy's stress function, Axi – symmetric problems, Introduction to Dunder's table, curved beam analysis, Lame's, Kirsch, Michell's and Boussinesq problems – Rotating discs.	**10 Hours/ L3**
Module 4: TORSION Navier's theory, Saint. Venant's theory, Prandtl's theory on torsion, semi- inverse method, and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections. Membrane Analogy.	**08 Hours/ L3**
Module 5: INTRODUCTION TO THEORY OF PLATES AND SHELLS Classical plate theory – Assumptions – Governing equations – Boundary conditions – Navier's method of solution for simply supported rectangular plates – Levy's method of solution for rectangular plates under different boundary conditions.	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO642.1	Ability to use mathematical knowledge to solve problem related to structura elasticity.
CO642.2	Identify stress-strain relation in 3D, principal stress and principal strain.
CO642.3	Analyze a structure using Elasticity concepts.
CO642.4	Use analytical techniques to predict deformation, internal force and failure of simple solids and structural components.
CO642.5	Solve aerospace-relevant problems in plane strain and plane stress in Cartesian and polar coordinates.

Textbooks:

1. Ansel C Ugural and Saul K Fenster, "Advanced Strength and Applied Elasticity", 4th Edition, Prentice Hall, New Jersey, 2003. 100
2. Bhaskar, K., and Varadan, T. K., "Theory of Isotropic/Orthotropic Elasticity", CRC Press USA, 2009.
3. Timoshenko, S., and Goodier, T.N.,"Theory of Elasticity", McGraw– Hill Ltd., Tokyo, 1990.

Reference books:

1. Barber, J. R., "Elasticity", Kluwer Academic Publishers, 2004
2. Sokolnikoff, I. S.,"Mathematical Theory of Elasticity", McGraw– Hill, New York, 1978.
3. Volterra& J.H. Caines,"Advanced Strength ofMaterials", Prentice Hall, NewJersey,1991
4. Wang, C. T., "Applied Elasticity", McGraw – Hill Co., New York, 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):

ThreeTestsaretobeconductedfor40markseach.CIEisexecutedbywayofquizzes/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
CO642.1	3	3	1	-	1	-	-	-	-	-	-	-	2	-
CO642.2	3	3	1	-	1	-	-	-	-	-	-	-	2	-
CO642.3	3	3	1	-	1	-	-	-	-	-	-	-	2	-
CO642.4	3	3	1	-	1	-	-	-	-	-	-	-	2	-
Average	3	3	1	-	1	-	-	-	-	-	-	-	2	-

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

SEMESTER VI
PROGRAM ELECTIVE -2

COURSE: AIRCRAFT MAINTENANCE, OVERHAUL AND REPAIRS

Course Code	**22ANE643**	**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: AIRCRAFT GROUND HANDLING AND SUPPORT EQUIPMENT Mooring, jacking, leveling and towing operations - Preparation - Equipment - precautions - Engine starting procedures - Piston engine, turboprops and turbojets - Engine fire extinguishing - Ground power units.	**08 Hours/ L2**
Module 2: GROUND SERVICING OF VARIOUS SUB SYSTEMS AND SAFETY MAINTENANCE Air conditioning and pressurization - Oxygen and oil systems - Ground units and their maintenance. Shop safety - Environmental cleanliness - Precautions	**08 Hours/ L2**
Module 3: INSPECTION Process - Purpose - Types - Inspection intervals - Techniques - Checklist - Special inspection - Publications, bulletins, various manuals - FAR Air worthiness directives - Type certificate Data Sheets - ATA specifications	**08 Hours/ L2**
Module 4: 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 - Classification - Repair or replacement - Sheet metal inspection - N.D.T. Testing - Riveted repair design, Damage investigation - reverse technology. Reliable quality.	**08 Hours/ L2**
Module 5: AIRCRAFT HARDWARE, MATERIALS, SYSTEMS PROCESSES Hand tools - Precision instruments - Special tools and equipment in an airplane maintenance shop - Identification terminology - Specification and correct use of various aircraft hardware (i.e. nuts, bolts, rivets, screws etc.) - identification of all types of fluid 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:

CO643.1	understand ground handling procedures and precautions, engine starting procedures
CO643.2	understand about the ground servicing of sub systems in Aircraft and safety precautions
CO643.3	To know about the FAA airworthiness regulations and the checklist involved in each inspection of aircraft
CO643.4	Describe welding process sheet metal repair used I aircraft maintenance
CO643.5	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 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
CO643.1	3	2	-	-	-	-	-	-	-	-	-	1	2	-
CO643.2	3	2	-	-	-	-	-	-	-	-	-	1	2	-
CO643.3	3	2	-	-	-	-	-	-	-	-	-	1	2	-
CO643.4	3	2	-	-	-	-	-	-	-	-	-	1	2	-
CO643.5	3	2	-	-	-	-	-	-	-	-	-	1	2	-
Average	3	2										1	2	

Low-1: Medium-2: High-3

SEMESTER VI
PROGRAM ELECTIVE 2

COURSE: FUELS AND COMBUSTION

Course Code	**22ANE644**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Pre-requisite: Aircraft Propulsion

Course Learning Objectives: To enable students to apply the knowledge of Fuels and Combustion in broad domain of aeronautical engineering by making them to learn:

CLO1	About the fuel properties
CLO2	Fuel treatment and Alternative fuels for Aerospace applications
CLO3	Combustion chemistry and fundamentals
CLO4	Flame characterization, stabilization, and combustion performance
CLO5	Fuels of aircraft and rocket fuel and their properties.

Content	No. of Hours/ RBT levels
Module 1: FUEL PROPERTIES Fuel Properties, Combustion Properties of Fuels, Calorific Value, Enthalpy, Spontaneous-Ignition temperature, Limits of Flammability, Smoke Point, Luminometer Number, Smoke Volatility Index, Pressure and Temperature Effects, Sub atmospheric Pressure, Low Temperature, High Temperature.	**08 Hours/ L3**
Module 2: FUEL TREATMENT AND ALTERNATIVE FUELS Types of Hydrocarbons. Production of Liquid Fuels. Removal of Sulfur Compounds, Contaminants. Additives, Gum Prevention, Corrosion Inhibition/Lubricity Improvers, Anti-Icing, Antistatic– Static Dissipaters, Metal Deactivators and Antismoke. Biofuels, Synthesis of biofuels, Alternative fuel and their Properties, Biodiesel Fuels.	**08 Hours/ L3**
Module 3: COMBUSTION CONSIDERATIONS Basic Design Features, Combustor Requirements, Fuel Preparation, Atomizers, liner wall-cooling Techniques, combustor stability limits, combustor exit temperature traverse quality (pattern factors), Combustors for Low Emissions. Deflagration, Detonation, Classification of Flames, Flammability Limits, Global Reaction-Rate Theory, Weak Mixtures, Rich Mixtures.	**08 Hours/ L3**

Module 4: COMBUSTION FLAME CHARACTERIZATION AND STABILIZATION: Droplet and Spray Evaporation, Heat-Up Period, Evaporation Constant, Convective Effects, Ignition Theory, Gaseous Mixtures, Heterogeneous Mixtures, Spontaneous Ignition, Adiabatic Flame Temperature, Factors Influencing the Adiabatic Flame Temperature. Combustion Efficiency, The Combustion Process, Reaction and Evaporation Controlled Systems.	**10 Hours/L3**
Module 5: FUEL CLASSIFICATION AND ROCKET FUELS Classification of Liquid Fuels, Aircraft Gas Turbine Fuels. Classification of Gaseous Fuels. Classification of rocket fuels, rocket fuel specifications and fuels properties.	**08 Hours/L3**

COURSE OUTCOMES:

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

CO644.1	Identify fuels and their properties their treatment for aerospace applications.
CO644.2	Interpret various fuel treatments and alternative fuel for combustion
CO644.3	Explain the combustion fundamentals terms and definitions
CO644.4	Categorize combustion flame, stabilization, and combustion performance.
CO644.5	Classify fuels of aircraft and rocket fuel and their properties.

Textbooks:

1. Arthur H. Lefebvre & Dilip R. Ballal, "Gas Turbine Combustion, Alternative fuels and Emissions ", CRC Press, 3rd Edition, 2010.
2. Minkoff, G.J., and C.F.H. Tipper, "Chemistry of Combustion Reaction ", Butterworths, London, 1962.
3. Samir Sarkar, “Fuels & Combustion”, Orient Long man, 1996.

Reference books:

1. C George Segeler**,** "Gas Engineers Handbook ", Industrial Press, New York, 1966.
2. Williams, D.A., and G. James, "Liquid Fuels ", London Pergamon, London, 1963.
3. Wilson, P.J. and J.H. Wells, “Coal, Coke and Coal Chemicals”, McGraw-Hill, New York, 1960

Scheme of Examination: Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be reduced proportionately 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 **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
CO644.1	3	2	-	-	-	-	1	-	1	-	-	-	3	-
CO644.2	3	2	-	-	-	-	1	-	1	-	-	-	3	-
CO644.3	3	2	-	-	-	-	1	-	1	-	-	-	3	-
CO644.4	3	2	-	-	-	-	1	-	1	-	-	-	3	-
Average	3	2					1		1				3	

Low-1: Medium-2: High-3

SEMESTER VI

OPEN ELECTIVE-I

COURSE: INTRODUCTION TO AEROSPACE ENGINEERING

Course Code	**22ANE651**	**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: 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: 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: AIRCRAFT STRUCTURES AND MATERIALS Properties of flight vehicle Materials; importance of strength to weight ratio, classification and characteristics of composite materials.	**08 Hours / L3**
Module 4: 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: 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:

CO651.1	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
CO651.2	Capable of applying Bernoulli's Principle to understand lift and drag, describe airfoil nomenclature, and analyze forces
CO651.3	Assess the properties of materials used in aviation, recognize the significance
CO651.4	Categorizing and describing different types of aircraft engines, explaining their operational principles
CO651.5	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-Hill 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):

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
CO651.1	3	2	-	-	-	-	-	-	-	-	-	1	1	-
CO651.2	3	2	-	-	-	-	-	-	-	-	-	1	2	-
CO651.3	3	2	-	-	-	-	-	-	-	-	-	1	2	-
CO651.4	3	2	-	-	-	-	-	-	-	-	-	1	2	-
CO651.5	3	2										1	2	

Low-1: Medium-2: High-3

SEMESTER VI

OPEN ELECTIVE-I

COURSE: THE HISTORY OF AVIATION

Course Code	**22ANE652**	**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
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: 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: 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: 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. The growth of commercial aviation and the birth of major airlines.	**08 Hours / L3**
Module 4: 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.	**10 Hours / L3**

Module 5: 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:

CO652.1	Gain an understanding of the contributions of historical figures and the evolution of ideas leading to the development of aviation
CO652.2	Appreciate the significance of the Wright brothers' historic flight and their pioneering contributions to aviation
CO652.3	Recognize the achievements of aviation pioneers like Charles Lindbergh and the growth of commercial aviation
CO652.4	Understand the critical role of aviation in global conflicts and the transition into the Cold War era.
CO652.5	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														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO652.1	2	2	-	-	-	-	-	-	-	-	-	-	1	-
CO652.2	2	2	-	-	-	-	-	-	-	-	-	-	2	-
CO652.3	2	2	-	-	-	-	-	-	-	-	-	-	2	-
CO652.4	2	2	-	-	-	-	-	-	-	-	-	-	2	-
Average	2	2											2	

Low-1: Medium-2: High-3

SEMESTER- VI
OPEN ELECTIVE 1

COURSE: AIRPORT PLANNING & MANAGEMENT

Course Code	**22ANE653**	**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

Content	No. of Hours/ RBT levels
Module 1: 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/ L2**
Module 2: 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/ L2**
Module 3: 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/ L2**

Module 4: 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/L2**
Module 5: 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/ L2**

COURSE OUTCOMES:

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

CO653.1	Explain the typical operations of airports from a management perspective
CO653.2	Identify the economic, political and social role of airports
CO653.3	Describe the airport operations
CO653.4	Discuss the airport financial management
CO653.5	Explain and defining capacity, factors affecting capacity and delay

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**

CO/PO Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO653.1	3	3	-	-	-	-	-	-	-	-	-	-	-	1
CO653.2	3	3	-	-	-	-	-	-	-	-	-	-	-	1
CO653.3	3	3	-	-	-	-	-	-	-	-	-	-	-	1
CO653.4	3	3	-	-	-	-	-	-	-	-	-	-	-	1
Average	3	3	-	-	-	-	-	-	-	-	-	-	-	1

Low-1: Medium-2: High-3

SEMESTER VI
OPEN ELECTIVE-I

COURSE: AIRLINE INDUSTRY

Course Code	**22ANE654**	**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 airline industry in broad domain of Aeronautical Engineering by making them to learn:

CLO1	Understand the history, stakeholders, and contemporary challenges of the airline industry
CLO2	Analyze various airline business models and strategies, including pricing, revenue management, and alliances.
CLO3	Explore aircraft fleet management, flight operations, airport procedures, and safety protocols.
CLO4	Examine airline cost structures, financial metrics, revenue sources, and profitability strategies.
CLO5	Understand airline industry regulation, international agreements, environmental considerations, and emerging trends

Content	**No. of Hours/ RBT levels**
Module 1: INTRODUCTION TO THE AIRLINE INDUSTRY Overview of the airline industry, including its historical development. Key players in the industry, such as airlines, airports, and regulatory bodies. Trends and challenges in the airline industry, including globalization and deregulation	**08 Hours/ L3**
Module 2: AIRLINE BUSINESS MODELS AND STRATEGIES Different types of airline business models (full-service carriers, low-cost carriers, regional airlines). Airline pricing strategies, revenue management, and fare structures. Marketing and branding in the airline industry. Strategic alliances and partnerships among airlines.	**08 Hours/ L3**
Module 3: AIRLINE OPERATIONS AND MANAGEMENT Aircraft fleet planning and management. Flight operations, including scheduling and route planning. Airport operations and ground handling. Maintenance, repair, and overhaul (MRO) of aircraft. Safety and security considerations in airline operations.	**08 Hours / L3**
Module 4: AIRLINE ECONOMICS AND FINANCE Cost structures in the airline industry, including fixed and variable costs. Financial performance metrics (load factor, yield, revenue per available seat mile). Sources of revenue (passenger revenue, ancillary revenue). Financial challenges and strategies for profitability.	**10 Hours / L3**

Module 5: REGULATION AND INTERNATIONAL AVIATION Airline regulation and government oversight. International agreements and organizations governing air travel (IATA, ICAO). Environmental and sustainability issues in aviation. Emerging trends in the airline industry, such as the impact of new technologies and changing passenger preferences.	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO654.1	Develop a comprehensive understanding of the evolution, key players, and current trends in the airline industry.
CO654.2	Compare different airline business models, assess pricing strategies, and recognize the importance of alliances in the airline industry
CO654.3	Gain insight into fleet planning, flight scheduling, airport operations, and safety measures in airline operations.
CO654.4	Analyze cost components, financial metrics, revenue streams, and propose financial strategies for airlines
CO654.5	Explain regulatory frameworks, international agreements' impact, sustainability issues, and anticipate future industry trends.

Textbooks:

1. Paul Stephen Dempsey, Laurence E. Gesell, Airline management : strategies for the 21st century, Coast Aire Publications, Chandler, Ariz., 1997
2. John Wensveen, Air Transportation-A Global Management Perspective, Routledge, 9th Edition, 2023
3. Nawal K. Taneja, Airline Industry-Poised for Disruptive Innovation?, Taylor and Francis, 2016.

Reference books:

1. Stephen Shaw, Airline Marketing and Management, Routledge, 7th Edition, 2011
2. Peter S. Morrell, Airline Finance, Routledge, 5th Edition, 2021
3. Charles E. Harris and Robert W. Kaps, International Aviation
4. T. R. Lakshmanan and Vijay Kumar, Sustainable Aviation

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
CO654.1	2	2	-	-	-	-	-	-	-	-	-	-	1	-
CO654.2	2	2	-	-	-	-	-	-	-	-	-	-	2	-
CO654.3	2	2	-	-	-	-	-	-	-	-	-	-	2	-
CO654.4	2	2	-	-	-	-	-	-	-	-	-	-	2	-
Average	2	2											2	

Low-1: Medium-2: High-3

SEMESTER-VI

COURSE: ENVIRONMENTAL SCIENCE

Course Code	**22CIV66**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**1:0:0**	**SEE Marks**	**50**
No. of Credits	**1**	**Examination Hours**	**01**

Course Learning Objectives:

CLO1	The fundamentals of environmental science.
CLO2	The types of natural resources
CLO3	The various global environmental concerns.
CLO4	The types of wastes generated and their handling at a basic level
CLO5	The area of environmental law and policies with a few important acts in the field

CONTENT	**No. of Hours/RBT levels**
Module 1 **Environment:** • Definition, scope & importance • Components of Environment Ecosystem: Structure and function of various types of ecosystems • Human Activities – Food, Shelter, and Economic & Social Security. • Population - Growth, variation among nations – population explosion and impact on environment Biodiversity: Types, Value, Hot spots, Threats and Conservation of biodiversity, Fore Wealth, and Deforestation.	**04 Hours / L2**
Module 2 **Natural Resources**: Forest, Water, Mineral, Food, Energy, Land Environmental Pollution - Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards.	**04 Hours / L2**
Module 3 **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.	**04 Hours / L2**
Module 4 **Sources:** Sources of Solid waste, Types of solid waste, Physical and Chemical composition of municipal solid waste. Solid Waste Management Rules in India, Sources and management of E – Waste, Biomedical Waste, Hazardous waste, and construction waste at individual and community level. Socio-economic aspect of waste management Environmental Toxicology.	**04 Hours / L2**
Module 5 **Latest Developments in Environmental Pollution Mitigation Tools** (Concept and Applications): Environment Impact Assessment, Environmental Management Systems, ISO14001; Environmental Stewardship, NGOs.	**04 Hours / L2**

COURSE OUTCOMES:

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

CO57.1	Understand holistically the key concepts "Environment", and "Biodiversity".
CO57.2	Classify the types of natural resources available and the effects of anthropogenic intervention
CO57.3	Express the gravity of various global environmental concerns.
CO57.4	Categorize the types of wastes generated and their handling at a basic level.
CO57.5	Understand the importance of environmental law and policies.

Textbooks:

4. Environmental studies, Benny Joseph, Tata Mcgraw-Hill 2nd edition 2012
5. Environmental studies, S M Prakash, pristine publishing house, Mangalore 3rd edition-2018
6. Gilbert M.Masters, Introduction to Environmental Engineering and Science, 2nd edition, Pearson Education, 2004

Reference books:

4. Benny Joseph, Environmental studies, Tata Mcgraw-Hill 2nd edition 2009
5. M.Ayi Reddy Textbook of Environmental Science and Technology, BS publications 2007
6. Dr. B.S Chauhan, Environmental Studies, University of science press 1st edition

Web References:

https://www.hzu.edu.in/bed/E%20V%20S.pdf
https://onlinecourses.nptel.ac.in/noc23_hs155/preview
https://onlinecourses.swayam2.ac.in/cec19_bt03/preview

Scheme of Examination:

Semester End Examination (SEE): SEE Question paper is to be set for 50 marks with multiple choice questions of 1 mark each covering all aspects of the syllabus.

Continuous Internal Evaluation (CIE): Three Tests are to be conducted for 50 marks each. The average of the three tests are taken for computation of CIE. Question paper for each of the CIE is to be of the multiple-choice type with 50 question each.

Typical Evaluation pattern for regular courses is shown in Table.

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

	Component	Marks	Total Marks
CIE	CIE Test-1	**50**	50
	CIE Test-2	**50**	
	CIE Test-3	**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	PSO3
CO57.1	2	-	-	-	-	-	3	-	-	-	-	-	1	-	-
CO57.2	2	1	-	-	-	-	3	-	-	-	-	1	1	-	1
CO57.3	2	-	2	-	-	2	3	1	-	-	-	1	1	-	1
CO57.4	2	2	-	-	-	2	3	-	-	-	-	-	-	-	1
CO57.5	2	-	-	-	-	2	3	-	-	-	-	-	-		1
Average	**2**	**1.5**	**2**			**2**	**3**	**1**	**-**	**-**	**-**	**1**	**1**		**1**

Low-1: Medium-2: High-3

SEMESTER –VI

COURSE: UNIVERSAL HUMAN VALUES

Course Code	**22UHV66**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**1:0:0**	**SEE Marks**	**50**
No. of Credits	**1**	**Examination Hours**	**01**

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 **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 **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 **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, 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	05 Hours
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.	
Module 5	**05 Hours**
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.	

COURSE OUTCOMES:

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

CO1	Understand the significance of value inputs in a classroom and start applying them i their life and profession
CO2	Distinguish between values and skills, happiness and accumulation of physical facilities, the Self and the Body, Intention and Competence of an individual, etc.
CO3	Understand the role of a human being in ensuring harmony in society and nature.
CO4	Distinguish between ethical and unethical practices and start working out the strateg to actualize a harmonious environment wherever they work.

Textbooks:

4. A.N Tripathy, New Age International Publishers, 2003.
5. Bajpai. B. L, New Royal Book Co, Lucknow, Reprinted, 2004
6. Bertrand Russell Human Society in Ethics & Politics

Reference Books:

6. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
7. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
8. Corliss Lamont, Philosophy of Humanism Gaur. R.R. , Sangal. R, Bagari G.P, A Foundation Course in Value Education, Excel Books, 2009.
9. Gaur. R.R. , Sangal R , Bagaria G.P, Teachers Manual, Excel Books, 2009.
10. I.C. Sharma, Ethical Philosophy of India, Nagin & co, Julundhar William Lilly- Introduction to Ethics -Allied Publisher

Scheme of Examination:

Semester End Examination (SEE): SEE Question paper is to be set for 50 marks with multiple choice questions of 1 mark each covering all aspects of the syllabus.

Continuous Internal Evaluation (CIE):

Three Tests are to be conducted for 50 marks each. The average of the three tests are taken for computation of CIE. Question paper for each of the CIE is to be of the multiple-choice type with 50 question each.

Typical Evaluation pattern for regular courses is shown in Table.

Table 1: Distribution of weightage for CIE & SEE for 1 credit course

	Component	Marks	Total Marks
CIE	CIE Test-1	**50**	**50**
	CIE Test-2	**50**	
	CIE Test-3	**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	PSO3	PSO4
CO1	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
CO2	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
CO3	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
CO4	-	-	-	-	-	-	-	2	-	-	-	1	-	-	-	-
Average	-	-	-	-	-	-	-	**2**	-	-	-	**1**	-		-	-

Low-1: Medium-2: High-3

SEMESTER – VII

COURSE: FLIGHT SIMULATION LAB

Course Code	**22ANEL67**	**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	Plot the root locus and bode plot
CLO2	Calculate the dynamic response of aircraft
CLO3	Use computational tools to model aircraft trajectory.

S.No	**LIST OF EXPERIMENTS**	**RBT LEVELS**
1	Draw Pole-Zero map of dynamic system model with plot customization option	**L3**
2	Plot root locus with variables in transfer function through MATLAB	**L3**
3	Plot root locus for a dynamic system though MATLAB	**L3**
4	Draw Bode plot from a transfer function in MATLAB and explain the gain and phase margins	**L3**
5	Simulate a spring- mass- damper system with and without a forcing function though SIMULINK	**L3**
6	Simulate a bomb drop from an aircraft on a moving tank in pure pursuit motion	**L3**
7	Develop a straight and level flight simulation program using MATLAB	**L3**
8	Simulate aircraft Take-off and Landing with trajectory tracing	**L3**
9	Simulate stall of aircraft and show the effect of variation in static margin on stalling characteristics	**L3**
10	Simulate aircraft longitudinal motion and demonstrate the effect of static margin variation for a pulse input in pitch that is intended to bleed the airspeed.	**L3**
11	Simulate aircraft longitudinal motion and demonstrate the effect of static margin variation for a doublet input in pitch.	**L3**
12	Given a Quartic characteristic equation, determine two quadratics that shall result in poles of short period oscillations and poles of Phugoid. Vary the coefficients of polynomial to study the movement of poles.	**L3**
13	Given a Quartic characteristics equitation, determine Poles and Time constants for Roll mode, Spiral motion, and Dutch roll. Vary the coefficients of polynomial to study the movement of poles	**L3**

COURSE OUTCOMES:

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

CO77.1	Plot the root locus and bode plot
CO77.2	Calculate the dynamic response of aircraft
CO77.3	Use computational tools to model aircraft trajectory.

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**

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO77.1	3	2	2	-	3	-	-	-	-	-	-	-	-	2
CO77.2	3	2	2	-	3	-	-	-	-	-	-	-	-	2
CO77.3	3	2	2	-	3	-	-	-	-	-	-	-	-	2
Average	3	2	2	-	3	-	-	-	-	-	-	-	-	2

Low-1: Medium-2: High-3

SEMESTER VI

COURSE: MINI-PROJECT

Course Code	**22ANEM68**	**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:

CO68.1	Able to make comprehensive use of the technical knowledge gained from previous courses
CO68.2	Able to understand technologies concerned with the project
CO68.3	Able to apply project management skills (scheduling work, procuring parts and documenting expenditures and working within the confines of a deadline).
CO68.4	Able to analyze, develop and demonstrate the proposed work
CO68.5	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.

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 Mini-Project 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
CO68.1	3	3	3	3	3	2	3	3	3	3	3	2	2	2
CO68.2	3	3	3	3	3	2	3	3	3	3	3	2	2	2
CO68.3	3	3	3	3	3	2	3	3	3	3	3	2	2	2
CO68.4	3	3	3	3	3	2	3	3	3	3	3	2	2	2
CO68.5	3	3	3	3	3	2	3	3	3	3	3	2	2	2

Low-1: Medium-2: High-3

VII Semester Syllabus

Head of the Department
Dept. of Aeronautical Engineering
Global Academy of Technology
R.R. Nagar, Bengaluru - 560 098.

SEMESTER – VII

COURSE: AIRCRAFT STABILITY AND CONTROL

Course Code	**22ANE71**	**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

Course Objectives: To enable students to apply the knowledge of Aircraft Stability and Control in broad

domain of aeronautical engineering by making them to learn:

CLO1	To impart knowledge on the criteria for longitudinally stable configuration.
CLO2	To provide the aspects of weathercock stability and requirements of rudder.
CLO3	To impart knowledge on dihedral effect and aileron control power.
CLO4	To provide the methodology to obtain the characteristic modes of an airplane in longitudinal motion.
CLO5	To impart knowledge on autorotation and spin and Dutch roll motions of airplanes.

Content	**No. of Hours/RBT levels**
Module 1: STATIC LONGITUDINAL STABILITY AND CONTROL General concepts-Degrees of freedom of a rigid body, Static and dynamic stability, Need for stability in an airplane, inherently and marginally stable airplanes, Stability and Controllability, Requirements of control surfaces, criteria for longitudinal static stability, contribution to stability by wing, tail, fuselage, wing fuselage combination, Total longitudinal stability, Neutral point-Stick fixed and Stick free aspects, Free elevator factor, static margin, Hinge moment, Power effects on stability-propeller and jet aircrafts, longitudinal control, Movement of centre of gravity, elevator control effectiveness, elevator control power, elevator angle to trim, elevator angle per g, maneuver point, Stick force gradient and stick force per g, Aerodynamic balancing.	**10 Hours/ L3**
Module 2: STATIC DIRECTIONAL STABILITY AND CONTROL Directional stability-yaw and sideslip, Criterion of directional stability, contribution to static directional stability by wing, fuselage, tail, Power effects on directional stability-propeller and jet aircrafts, Rudder fixed and rudder free aspects, Rudder lock and Dorsal fin, Directional control, rudder control effectiveness, rudder requirements, adverse yaw, asymmetric power condition, spin recovery.	**10 Hours/ L3**
Module 3: STATIC LATERAL STABILTY AND CONTROL Lateral Stability-Dihedral effect, criterion for lateral stability, evaluation of lateral stability contribution of fuselage, wing, wing fuselage, tail, total static lateral stability, lateral control, aileron control power, aileron effectiveness, strip theory estimation of aileron effectiveness, roll control by spoilers, aileron reversal, aileron reversal speed	**10 Hours/ L3**

Module 4: DYNAMIC LONGITUDINAL STABILITY Aircraft Equations of motion, small disturbance theory, Estimation of longitudinal stability derivatives stability derivatives, Routh's discriminant, solving the stability quadratic, Phugoid motion, Factors affecting the period and damping.	**10 Hours/ L3**
Module 5: DYNAMIC LATERAL AND DIRECTIONAL STABILITY Dutch roll and spiral instability, Auto rotation and spin, Stability derivatives for lateral and directional dynamics.	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO71.1	Obtain static margin of airplane in stick fixed and free aspects.
CO71.2	Understand the design concept of rudder by considering the critical situations that demand the use of rudder.
CO71.3	Estimate total lateral stability of an airplane.
CO71.4	Determine the natural frequency and damping ratio of Phugoid and short period motions.
CO71.5	Explain the recovery procedure of an airplane from dangerous situations like autorotation and spin.

Textbooks:

1. Nelson, R.C. Flight Stability & Automatic Control, McGraw Hill, 1998.
2. Perkins C.D. & Hage R.E. Airplane performance, stability and control, John Wiley & Sons 1967.

Reference books:

1. Babister, A.W. Aircraft Stability and response, Pergamon Press, 1980.
2. Etkin, B., Dynamics of Flight Stability and Control, Wiley, third edition 1995.
3. McCormick, B.W. Aerodynamics, Aeronautics & Flight Mechanics John Wiley, 1995.
4. Pamadi, B.N. Performance, Stability, Dynamics, and Control of Airplanes, AIAA Education Series, 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 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

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

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO71.1	3	3	2	-	-	-	-	-	-	-	-	1	2	-
CO71.2	3	3	2	-	-	-	-	-	-	-	-	1	2	-
CO71.3	3	3	2	-	-	-	-	-	-	-	-	1	2	-
CO71.4	3	3	2	-	-	-	-	-	-	-	-	1	2	-
CO71.5	3	3	2	-	-	-	-	-	-	-	-	1	2	
Average	3	3	2	-	-	-	-	-	-	-	-	1	2	-

Low-1: Medium-2: High-3

SEMESTER – VII

COURSE: AVIONICS

Course Code	**22ANE72**	**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 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: INTRODUCTION TO DIGITAL ELECTRONICS Logic Gates, Boolean Algebra, Encoders, Decoders, Multiplexer and Demultiplexer, Microprocessor-Introduction to VLSI.Antenna-types, radiation pattern, voltage and current distribution, polarization. Introduction to digital computer and memories.	**08 Hours/L2**
MODULE 2: INTRODUCTION TO AVIONICS Need for avionics, Typical avionics subsystems, design, technologies –Avionics Bus Architecture-Digital Data Buses, Fiber Optic Buses, integrated avionics and weapon systems.	**08 Hours/L2**
MODULE 3: 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 4: COMMUNICATION AND AUTOMATIC FLIGHT CONTROL HF, U/VHF, Satellite Communication, Selcal, Air Traffic Control (ATC) Transponder, Traffic Collision & Avoidance System (TCAS), Identification of Friend & Foe (IFF). Emergency locator transmitters Longitudinal, Lateral & Direction Autopilot.	**08 Hours/L2**

MODULE 5: 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), Astronavigation.	**10 Hours/L2**

COURSE OUTCOMES:

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

CO72.1	Describe the need for avionics in civil and military aircraft.
CO72.2	Understand about modern Aviation and avionics architecture.
CO72.3	Familiarize about control and display technologies used
CO72.4	Describe about the different navigation systems
CO72.5	Identify and understand the use of air data systems and auto pilot

Textbooks:

1. Civil Avionics Systems: Ian Moir, Allan Seabridge, AIAA Education Series.
2. Aircraft System: Ian Moir & Allan Seabridge, John Wiley.
3. Aircraft Electricity & Electronics: T.K. Eismin, Macmillan.
4. Geroge Kannedy: Electronic Communication System, McGraw Hill.
5. Myron Kayton and Walter R fried, Avionics Navigation Systems, John Wiley and Sons.
6. J. Powell: Aircraft Radio Systems, Himalayan Books, 1990.
7. L Tetley and D Calcutt, Electronic Aids to Navigation, Edward Arnold Publishers 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 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
CO72.1	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO72.2	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO72.3	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO72.4	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO72.5	3	3	-	-	-	-	-	-	-	-	-	-	-	
Average	3	3	-	-	-	-	-	-	-	-	-	-	-	2

Low-1: Medium-2: High-3

SEMESTER – VII

COURSE: COMPUTATIONAL FLUID DYNAMICS

Course Code	**22ANE73**	**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

CONTENT	**No. of Hrs /RBT Levels**
MODULE-1: 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 L1, L2**
MODULE-2: MATHEMATICAL BEHAVIOUR OF PARTIA DIFFERENTIAL EQUATIONS: Classification of partial differentia equations – Cramer Rule, Eigenvalue method. Hyperbolic, parabolic, an elliptic form of equations. Impact of classification on physical an computational fluid dynamics. Case studies-steady inviscid supersonic flow unsteady inviscid flow, steady boundary layer flow, unsteady therma conduction, and steady subsonic inviscid flow.	**10 Hours L2,L3**
MODULE-3: 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 L2,L3, L4**
MODULE-4: GRID GENERATION AND ADAPTIVE GRI METHODS Need for grid generation and Body-fitted coordinate system. Structured Grids-essential features. Structured Grid generation techniques- algebraic	**8 Hours L2,L3**

and numerical methods. Unstructured Grids-essential features. Unstructured Grid generation techniques- Delaunay-Voronoi diagram, Advancing Front Method (AFM). multi-block grid generation, Surface grid generation, multi-block grid generation, and meshless methods. Grid quality, adaptive grids and Adaptive Structured Grid Generation, Unstructured adaptive grid Methods.	
MODULE-5: FINITE VOLUME TECHNIQUES AND APPLICATION Spatial discretization- cell centered and cell vertex techniques (overlapping control volume, duel control volume). Temporal discretization- Explicit time stepping, and implicit time stepping. Time step calculation. Applications: Aspects of numerical dissipation & dispersion. Approximate factorization, Flux Vector splitting. Diffusion problem	**8 Hours L2,L3**

LIST OF EXPERIMENTS

S.N	List of Experiments	RBT Levels
1	Grid Generation over a 2D airfoil geometry	L4
2	Flow analysis through Parallel Plates	L4
3	Viscous Flow analysis over a Circular cylinder at low Reynolds Number (2D)	L4
4	Flow analysis over a 3D Finite wing Structure	L4
5	To simulate the characteristics of swept wings	L4
6	To simulate and analyse the flow through nozzles	L4
7	To simulate and analyse the flow through diffusers	L4
8	To simulate and analyse convergent-divergent passages	L4
9	To simulate normal shock waves oblique shock waves, and expansion waves for Internal flows	L4
10	To simulate bow shock, oblique shock waves, and expansion waves for External flows	L4

COURSE OUTCOMES:

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

CO73.1	Comprehend the fundamental concepts of CFD and derive basic Governing Equations.
CO73.2	Assimilate Mathematical behavior of PDEs vis a vis nature of flow
CO73.3	Analyze FDM techniques for Time/Space marching and numerical schemes.
CO73.4	Describe Grid generation and utilization techniques.
CO73.5	Apply Spatial/Temporal discretization in FVM applications.

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, VijayaShankar,"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/.

Practical knowledge references

1. https://ocw.mit.edu/courses/2-29-numerical-fluid-mechanics-spring-2015/pages/lecture-notes-and-references/
2. https://confluence.cornell.edu/display/SIMULATION/FLUENT+Learning+Modules

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. 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

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

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**30**
	CIE Test-2		
	CIE Test-3		
	Laboratory	**20**	**20**
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
CO73.1	3	3	2	2	1	-	-	-	1	1	1	-	1	1
CO73.2	3	3	2	2	1	-	-	-	1	1	1	-	1	1
CO73.3	3	3	2	2	1	-	-	-	1	1	1	-	1	1
CO73.4	3	3	2	2	1	-	-	-	1	1	1	-	1	1
CO73.5	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

SEMESTER VII
PROFESSIONAL ELECTIVE 3

COURSE: HEAT TRANSFER

Course Code	**22ANE741**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Pre requisite: Thermodynamics

Course Learning Objectives: To enable students to apply the knowledge of Heat and Mass Transfer in broad domain of aeronautical engineering by making them to learn:

CLO1	Develop a comprehensive understanding of the various modes of heat and mass transfer
CLO2	Derive and analyze the three-dimensional heat conduction equation in different coordinate systems
CLO3	Gain expertise in solving convection problems
CLO4	Acquire knowledge of radiation heat transfer mechanisms
CLO5	Apply heat transfer principles to aerospace-related scenarios

Content	**No. of Hours/RBT levels**
Module 1: FUNDAMENTALS OF HEAT AND MASS TRANSFER Different modes of heat transfer and mass and momentum transfer, elements of mass diffusion and boundary layer theory. Mass transfer definition and terms used in mass transfer analysis, Fick's First law of diffusion.	**08 Hours /L3**
Module 2: CONDUCTION Derivation of general three-dimensional conduction equation in Cartesian coordinate, discussion on 3-D conduction in cylindrical and spherical coordinate systems. Effect of variation of thermal conductivity on heat transfer in solids - Heat transfer problems in infinite and semi- infinite solids. Significance of Biot and Fourier Numbers, Chart solutions of transient conduction systems.	**08 Hours /L3**
Module 3: CONVECTION Concepts of Continuity, Momentum and Energy Equations. Dimensional Analysis-Buckingham's Pi Theorem - Application for developing non-dimensional correlation for convective heat transfer. **FREE CONVECTION:** Development of Hydrodynamic and thermal boundary layer along a vertical plate, Use of empirical relations for Vertical plates and pipes. **FORCED CONVECTION:** External Flows, Concepts of hydrodynamic and thermal boundary layer and use of empirical correlations for Flat plates and Cylinders. Internal Flows, Concepts about Hydrodynamic and Thermal Entry Lengths, use of empirical correlations for Horizontal Pipe Flow and annulus flow.	**10 Hours /L3**

Module 4: RADIATION & HEAT EXCHANGERS DESIGN Radiation: Introduction to physical mechanism - Radiation properties - Radiation shape factors - Heat exchange between non-black bodies - Radiation shields. Heat transfer coefficient, fouling and fouling factor; LMTD, Effectiveness-NTU methods of analysis of heat exchangers. Numerical problems.	**08 Hours /L3**
Module 5: HEAT TRANSFER PROBLEMS IN AEROSPACE ENGINEERING Heat transfer problems in gas turbine combustion chambers - Rocket thrust chambers - Aerodynamic heating -Ablative heat transfer. Heat transfer problems in turbine and nozzle blades.	**08 Hours /L3**

COURSE OUTCOMES:

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

CO741.1	Describe the fundamentals of heat and mass transfer
CO741.2	Apply conduction heat transfer concept to all solids, extended surfaces
CO741.3	Calculate free and forced convective heat transfers on various geometries
CO741.4	Explain various radiation properties and Illustrate different types of heat exchangers
CO741.5	Apply and analyse the concepts to various aerospace applications

Textbooks:

1. Ozisik, "Heat transfer-A basic approach", Tata McGraw Hill, 2002
2. Holman, J.P**,** "Heat Transfer", McGraw Hill Book Co., Inc., New York, 8th edition,1996.

Reference books:

1. Sachdeva, S.C, "Fundamentals of Engineering Heat and Mass Transfer", Wiley Eastern Ltd., New Delhi, 1981.
2. Yunus A-Cengel, "Heat transfer, a practical approach", Tata McGraw Hill 3rd edition, 2007.
3. P.K. Nag, “Heat transfer”, Tata McGraw Hill, 2002.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO741.1	3	3	3	1	-	-	-	-	3	-	-	1	1	-
CO741.2	3	3	3	1	-	-	-	-	3	-	-	1	1	-
CO741.3	3	3	3	1	-	1	1	-	3	-	-	1	1	-
CO741.4	3	3	3	1	-	-	-	-	3	-	-	1	1	-
CO741.5	3	3	3	1	-	-	-	-	3	-	-	1	1	-
Average	3	3	3	1		1	1		3			1	1	-

Low-1: Medium-2: High-3

SEMESTER VII
PROGRAM ELECTIVE 3

COURSE: SPACE MECHANICS

Course Code	**22ANE742**	**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	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: 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: 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: 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**
Module 4: 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: 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:

CO742.1	Understand the basic Concepts in Orbital Mechanics and Attitude Dynamics.
CO742.2	Analyze the Orbital motion of a satellite relative to their gravitational body.
CO742.3	Understand the Orbital elements to define the shape, size and orientation of an orbit for satellite injection.
CO742.4	Estimate the trajectory/orbit of a space vehicle or a satellite in a suitable coordinate system.
CO742.5	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.

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
CO742.1	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO742.2	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO742.3	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO742.4	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO742.5	3	3	-	-	-	-	-	-	-	-	-	-	3	-
Average	3	3	-	-	-	-	-	-	-	-	-	-	3	

Low-1: Medium-2: High-3

SEMESTER VII
PROGRAM ELECTIVE-3

COURSE: EXPERIMENTAL AERODYNAMICS

Course Code	**22ANE743**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Pre-requisite: Aerodynamics, Aerodynamics Lab

Course Learning Objectives:

CLO1	Types and techniques of Aerodynamic data generation
CLO2	Theoretical foundation behind experimentation in the various speed ranges corresponding to subsonic, supersonic and hypersonic Mach numbers
CLO3	Classical and state of the art measurement devices and techniques for measurement parameters such as pressure, temperature and velocity.
CLO4	Flow visualization techniques meant for incompressible and compressible flows

Content	**No. of Hours/ RBT levels**
Module 1: **LOW SPEED WIND TUNNELS:** Introduction, Wind tunnel- Classification, Applications, Model making, non-dimensional parameters, Low speed wind tunnel-Irregularities of flow in low speed tunnels, Reduction of turbulence, Effect of screens on turbulence, Honey combs, Wind tunnel contractions, The diffuser, Losses in wind tunnel circuit Power requirements – power economy	**08 Hours/ L3**
Module 2 **HIGH SPEED WIND TUNNELS:** Introduction, Types of high-speed tunnels, Supersonic wind tunnels - Test section flow parameters, Components of supersonic wind tunnels, Power required for the operation of supersonic wind tunnels, Closed circuit supersonic wind tunnel, Actual flow in the supersonic wind tunnel	**10 Hours/ L3**
Module 3 **SHOCK TUBES:** Introduction to shock tube, Shock tube equations, Comparison between shock heating and isentropic heating, Particle velocity behind moving shock, Dependence of shock strength on diaphragm pressure ratio, Reflected shocks, Viscous effects and the shock tube boundary layer, Observation time in shock tube, Interaction of reflected shock and the contact surface, Shock tube diaphragm and bursting techniques Measurement of shock speed	**08 Hours/ L3**

Module 4 **WIND TUNNEL INSTRUMENTATION:** **Measurement of Pressure**: Introduction, Manometers, Pressure transducers, Measurement of high pressures, Ranges of different manometers, Measurement of vacuum, Measurement of pressure in flows, Measurement of stagnation or total pressure, Lag in manometric systems **Measurement of Temperature**: Introduction, Expansion thermometer or liquid in glass thermometer (LIG), Change of state thermometers, Electrical resistance thermometry, Thermoelectric thermometry, Temperature measurement problems in flows, Sensors/probes for measuring stagnation temperature **Measurement of Velocity**: Pneumometric methods, Measurement in compressible flows, Measurement of supersonic velocity /Mach number, Hot wire anemometer (HWA)	**08 Hours/ L3**
Module 5 **FLOW VISUALIZATION and NON-INTRUSIVE FLOW DIAGNOSTICS:** Introduction, Flow visualization by direct injection (Tracer methods) , Smoke and Tuft grid techniques – Dye injection special techniques – Oil flow visualization, Index of refraction methods, Theoretical background, Deflection of light ray in a medium of constant density gradient ,The schlieren method, Color schlieren, Shadowgraph method ,Interferometer method ,Glow discharge visualization for low density flows	**08 Hours/L3**

COURSE OUTCOMES:

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

CO743.1	Summarize the classifications, working principle, design features and power considerations of low speed wind tunnel configurations.
CO743.2	Comprehend/Apply the operational requirements, design features and power considerations of supersonic wind tunnel configurations.
CO743.3	Analyze the principles governing shock tube equations, reflected shocks, shock tube boundary layer and the measurement of shock speed.
CO743.4	Identify different conventional and state of the art instruments for measuring pressure, temperature and velocity
CO743.5	Infer the flow pattern effectively using various flow visualization techniques

Textbooks:

1. Rae, W.H. and Pope, A., "Low Speed Wind Tunnel Testing", John Wiley Publication, 3rd edition, 2010
2. Rae, W.H. and Pope, A. ‘’High Speed Wind Tunnel Testing’’ John Wiley Publication, 1984.
3. Gaydon,A.G. and Hurle, J.R. “Shock Tubes in high temperature chemical physics”
4. Slezinger. “Wind Tunnels and their Instrumentation”

Reference books:

1. Rathakrishnan, E., “Instrumentation, Measurements, and Experiments in Fluids,” CRC Press – Taylor & Francis, 2007.

2. Lecture course on Advanced Flow diagnostic techniques 17-19 September 2008 NAL, Bangalore.
3. Doeblin. "Measurement Systems:Application & Design"

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

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

	omponent	larks	Total Marks
CIE	IE Test-1	**40**	**50**
	IE Test-2		
	IE Test-3		
	uizzes /Assignment	**10**	
SEE	emester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping														
CO/PO	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO743.1	3	3	2	2	1	-	-	-	1	1	1	1	1	1
CO743.2	3	3	2	2	1	-	-	-	1	1	1	1	1	1
CO743.3	3	3	2	2	1	-	-	-	1	1	1	1	1	1
CO743.4	3	3	2	2	1	-	-	-	1	1	1	1	1	1
CO743.5	3	3	2	2	1	-	-	-	1	1	1	1	1	1
Average	3	3	2	2	1	-	-	-	1	1	1	1	1	1

Low-1: Medium-2: High

SEMESTER – VII
PROGRAM ELECTIVE-3

COURSE: HELICOPTER ENGINEERING

Course Code	**22ANE744**	**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 principles 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 analyze helicopter aerodynamics
CLO3	Understand the basics of blade element theory and its application in designing th blade profiles
CLO4	Evaluate the helicopters performance.
CLO5	Explore the dynamics and vibration aspects of helicopters

Content	No. of Hours/ RBT levels
Module 1: 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: 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: 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: 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. Hover performance, Hover in ground Effect, Hover out of ground effect, hover ceiling, forward flight performance and power required	**08 Hours/ L2**
Module 5: 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:

CO744.1	Explain the Parts of Helicopters and their functionality
CO744.2	Apply the Momentum theory for Analysis of Helicopter Aerodynamics
CO744.3	Apply the Blade Element theory for Analysis of Helicopter Aerodynamics
CO744.4	Calculate the performance parameters in various flight Conditions
CO744.5	Understand the complexity of rotor dynamics and helicopter vibrations

Textbooks:

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
CO744.1	3	2	-	-	-	-	-	-	1	1	-	1	1	1
CO744.2	3	3	1	-	-	-	-	-	-	-	-	1	1	1
CO744.3	3	3	1	-	-	-	-	-	1	1	-	1	1	1
CO744.4	3	3	1	-	-	-	-	-	1	1	-	1	1	1
CO744.5	3	3	-	-	-	-	-	-	-	-	-	1	1	1
Average	3	3	1						1	1		1	1	1

Low-1: Medium-2: High

SEMESTER – VII
OPEN ELECTIVE 2

COURSE: DRONE TECHNOLOGY

Course Code	**22ANE751**	**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 drone and its functioning.

CLO1	To Identify & select different types of drones, drone rules and regulations
CLO2	Understand aerodynamics, BLDC motors and different type of batteries
CLO3	Understand different sensors and Flight Control System
CLO4	To understand the mission plans and its control systems

Content	No. of Hours/ RBT levels
Module 1: Introduction to drones Different types of Drones, Nomenclatures, History of aerial drones, reputation, airframe, Configurations, basic components, current/future uses of drones. DGCA regulations	**10 Hours L1, L2**
Module 2: Air vehicle and Propulsion system Basics of aerodynamics**,** 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.	**10 Hours L1, L2**
Module 3: Battery System for drones 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.	**10 Hours L1, L2**
Module 4: Sensors for drones Introduction of different sensors used in drone like accelerometers, inertial measurement units, tilt and lidar sensor, gyro sensor. Principle of operation, their roles and characteristics. Selection of appropriate sensor as per requirement. Introduction to Flight controller system	**10 Hours L1, L2**

Module 5: Mission Planning and Control Air Vehicle and Payload Control, Reconnaissance/Surveillance Payloads, Weapon Payloads, Other Payloads, Data-Link Functions and Attributes, Data-Link Margin, Data-Rate Reduction, Launch Systems, Recovery Systems, Launch and Recovery Tradeoffs	**10 Hours** **L1, L2**

COURSE OUTCOMES:

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

CO751.1	Identify different types of drones and drone rules and regulations
CO751.2	Explain the Drone Aerodynamics and propulsion system
CO751.3	Illustrate the different battery systems
CO751.4	Identify different sensors and Flight Control System
CO751.5	Encompass how mission planning and control is carried out with proper payloads (L2)

Textbooks:

1. The Drone Rules, 2021. The Gazette of India: Extraordinary [Part II—Sec. 3(i)].
2. John Baichtal "Building Your Own Drones" A Beginner's Guide to Drones, UAVs, and ROVs Que Publishing, ISBN - 9780789755988
3. Julio Alberto Mendoza "Drones to Go" A Crash Course for Scientists and Makers, Apress ISBN-978-1-4842-6787-5
4. "Aerodynamics for Naval Aviators" by H. H. Hurt Jr. Reprint edition, 1979, U.S. Navy
5. "Introduction to Flight" by John D. Anderson Jr. 8th edition, 2018, McGraw-Hill Education
6. "Radio Control for Model Aircraft" by David Boddington (3rd edition, 2014, Special Interest Model Books
7. "Drone Maintenance and Repair" by Col. Patrick Sherman (1st edition, 2017, CreateSpace Independent Publishing Platform
8. "Quadcopters and Drones: A Beginner's Guide to Successfully Flying and Choosing the Right Drone" by Mark D. Thompson, 1st edition, 2015, CreateSpace Independent Publishing Platform
9. "FPV Drone Racing Guide" by Christian Mollica, 1st edition, 2016, CreateSpace Independent Publishing Platform.

Reference books:

1. Paul Gerin Fahlstrom, Thomas James Gleason, Introduction to UAV Systems, Wiley Publication John Wiley & Sons, Ltd, 4th Edition 2012.
2. Landen Rosen, Unmanned Aerial Vehicle, Alpha Editions, N.Y., 2012
3. Valavanis, Kimon P, Unmanned Aerial Vehicles, Springer, 2011.
4. 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
CO751.1	3	2	1	-	1	-	1	1	1	1	-	1	1	1
CO751.2	3	2	1	-	1	-	-	-	1	1	-	1	1	1
CO751.3	3	2	1	-	1	-	1	-	1	1	-	1	1	1
CO751.4	3	2	1	-	1	-	1	-	1	1	-	1	1	1
CO751.5	3	2	1	-	1	-	1	-	1	1	-	1	1	1
Average	**3**	**1**	**1**		**1**		**1**	**1**	**1**	**1**		**1**	**1**	**1**

Low-1: Medium-2: High-3

SEMESTER – VII
OPEN ELECTIVE 2

COURSE: AIR TRAFFIC CONTROL

Course Code	**22ANE752**	**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 Air traffic controls and its functioning.

CLO1	To trace the historical evolution of air traffic control, define the roles and responsibilities of air traffic controllers
CLO2	To educate about the different types of airspace (Class A, B, C, D, E, and G), explore air traffic flow management, familiarize them with ATC procedures
CLO3	To study radiotelephony communication procedures, introduce the ICAO phonetic alphabet and phraseology
CLO4	To familiarize with navigation aids and equipment (e.g., VOR, GPS, ILS), introduce radar systems and surveillance techniques
CLO5	To understand safety management systems in air traffic control, emphasize collision avoidance and traffic separation strategies

Content	**No. of Hours/ RBT levels**
Module 1: Introduction to Air Traffic Control Overview of the aviation industry, Historical development of air traffic control, Role and responsibilities of air traffic controllers, ATC facilities and their functions.	**10 Hours L1, L2**
Module 2: Airspace and Air Traffic Management Types of airspace (Class A, B, C, D, E, and G)., Air traffic flow management, Air traffic control procedures and coordination, Airspace regulations and restrictions.	**10 Hours L1, L2**
Module 3: Air Traffic Communication Radiotelephony communication procedures, ICAO phonetic alphabet and phraseology, Use of ATC communication equipment, Emergency communication procedures	**10 Hours L1, L2**
Module 4: Navigation and Surveillance Navigation aids and equipment (e.g., VOR, GPS, ILS), Radar systems and surveillance techniques, Navigation charts and flight planning, Aircraft tracking and position reporting	**10 Hours L1, L2**
Module 5: Safety and Emergency Procedures Safety management systems in ATC, Collision avoidance and traffic separation.	**10 Hours L1, L2**

Emergency procedures for aircraft and ATC, Human factors in air traffic control	

COURSE OUTCOMES:

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

CO752.1	Understand the aviation industry's foundations, appreciate the historical context of air traffic control, describe the duties of air traffic controllers
CO752.2	Categorize various airspace classes, explain air traffic flow management concepts, understand ATC coordination procedures, and interpret airspace regulations.
CO752.3	Skillful in radiotelephony communication, effectively utilize the ICAO phonetic alphabet and phraseology, operate ATC communication equipment
CO752.4	Utilize various navigation aids, understand radar systems, surveillance methods, and plan flights using navigation charts
CO752.5	Familiar in safety management systems, capable of implementing collision avoidance and traffic separation measures, proficient in handling emergency situations

Textbooks:

1. Michael S. Nolan, "Fundamentals of air traffic control", Cengage brain, ISBN-13: 978-1-4354-8272-2, Fourth edition, 2011.
2. Seth B. Young, Ph.D.Alexander T. Wells, Ed.D., "Airport Planning and Management", McGraw-Hill Education, Sixth Edition, 2011.

Reference books:

1. Air safety procedures manual, air safety directorate office of the director general of civil aviation, Technical centre, New Delhi
2. Airplane flying handbook, U.S. Department of transportation federal aviation administration, Flight standards service**.**

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**
CO752.1	1	-	-	-	-	-	1	1	-	-	-	1	1	-
CO752.2	1	-	-	-	-	-	-	-	-	-	-	1	1	-
CO752.3	1	-	-	-	-	-	1	-	-	-	-	1	1	-
CO752.4	1	-	-	-	-	-	1	-	-	-	-	1	1	-
Average	**1**						**1**	**1**				**1**	**1**	

Low-1: Medium-2: High-3

SEMESTER – VII
OPEN ELECTIVE 2

COURSE: INNOVATIONS IN SPACE TECHNOLOGIES

Course Code	**22ANE753**	**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 manoeuvres
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: 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: 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**
Module 3: 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: 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: 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:

CO753.1	Comprehend various types of space missions, make informed decisions regarding launch vehicle selection, understand the basics of rocket propulsion
CO753.2	Explain the principles and methods of various atmospheric re-entry techniques, and understand their applications in space missions
CO753.3	Have a strong grasp of orbital mechanics, be capable of calculating and planning various orbital maneuvers
CO753.4	Analyze and control the attitude of satellites in different scenarios, understand the dynamics of various satellite configurations
CO753.5	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
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**

CO/PO Mapping

CO/PO Mapping														
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO753.1	3	3	-	-	-	-	-	-	-	-	-	1	2	-
CO753.2	3	3	-	-	-	-	-	-	-	-	-	1	2	-
CO753.3	3	3	-	-	-	-	-	-	-	-	-	1	2	-
CO753.4	3	3	-	-	-	-	-	-	-	-	-	1	2	-
CO753.5	3	3	-	-	-	-	-	-	-	-	-	1	2	-
Average	**3**	**3**	-	-	-	-	-	-	-	-	-	**1**	**1**	**-**

Low-1: Medium-2: High-3

SEMESTER VII
Open Elective
COURSE: URBAN AIR MOBILITY

Course Code	**22ANE754**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**1:0:0**	**SEE Marks**	**50**
No. of Credits	**1**	**Examination Hours**	**03**

Course Objectives: To enable students to apply the knowledge of Urban air mobility in broad domain of aeronautical engineering by making them to learn:

CLO1	Understand UAM and its ecosystem in India
CLO2	Acquire knowledge on the classification and operations of UAM
CLO3	comprehend the ecosystem and infrastructure developments for UAM
CLO4	appreciate the UAM and DRONE rules and regulation
CLO5	Describe the type certification for UAM

Content	No. of h r / RBT levels
Module 1: INTRODUCTION TO UAM UAM, the evolving landscape of urban air mobility in india, UAM around the globe and its progress, enabling ecosystem for UAM in India, policy support.	**03 Hours / L3**
Module 2: The Unmanned Aircraft System Rules, 2021 Category - The unmanned aircraft are classified based on the maximum all up weight including its pay load, DGCA Guidelines for UAS, Operations of UAS, Drone Port	**03 Hours/ L2**
Module 3: VEHICLE TYPES Main Use Cases and Infrastructure, UDAN-RCS Scheme of Government of India	**03 Hours/ L3**
Module 4: UNMANNED AIRCRAFT SYSTEM(UAS) Drone Rules 2021, Amendment Rules 2022	**03 Hours/ L3**
Module 5: Digital sky platform Type certificate, RPCS details, list of RPTOS, UIN details	**03 Hours/ L3**

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

CO754.1	Understand UAM and its ecosystem in India
CO754.2	Acquire knowledge on the classification and operations of UAM
CO754.3	comprehend the ecosystem and infrastructure developments for UAM
CO754.4	appreciate the UAM and DRONE rules and regulation
CO754.5	Describe the type certification for UAM

Textbooks:

1. Paul Gerin Fahlstrom, "Thomas James Gleason, Introduction to UAV Systems", Wiley Publication John Wiley & Sons, Ltd, 4th Edition 2012.
2. Landen Rosen, "Unmanned Aerial Vehicle, Alpha Editions", N.Y., 2012

Reference books:

1. Valavanis, Kimon P, "Unmanned Aerial Vehicles", Springer, 2011.
2. 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):

ThreeTestsaretobeconductedfor40markseach.CIEisexecutedbywayofquizzes/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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO754.1	3	2	-	-	-	-	1	2	-	-	-	1	1	-
CO754.2	3	2	-	-	-	-	1	2	-	-	-	1	1	-
CO754.3	3	2	-	-	-	-	1	2	-	-	-	1	1	-
CO754.4	3	2	-	-	-	-	1	2	-	-	-	1	1	-
CO754.5	3	2	-	-	-	-	1	2	-	-	-	1	1	-
Average	3	2	-	-	-	-	1	2	-	-	-	1	1	-

Low-1: Medium-2: High-3

SEMESTER – VII

COURSE: PROJECT PHASE 1

Course Code	**22ANEP76**	**CIE Marks**	**50**
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: 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. CIE procedure for Project Work Phase - 1: **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 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 batch mates. **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. 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.	**04 Hours**

Individual student performance are evaluated based on the following COs :

CO76.1	Able to make comprehensive use of the technical knowledge gained from previous courses
CO76.2	Able to understand technologies concerned with the project
CO76.3	Able to apply project management skills (scheduling work, procuring parts and documenting expenditures and working within the confines of a deadline).
CO76.4	Able to analyze, develop and demonstrate the proposed work
CO76.5	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	--	--
Grand Total			**100**

CO/PO Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO76.1	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO76.2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO76.3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO76.4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO76.5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Low-1: Medium-2: High-3

SEMESTER – VII

COURSE: AVIONICS LAB

Course Code	**22ANEL77**	**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	understand data acquisition from various sensors
CLO2	Study the concepts of actuation and alerting system.
CLO3	Perform the analog and digital system communication
CLO4	Working of wireless protocol and data transfer
CLO5	Principles of data transfer in MIL STD 1553B and AFDX data bus

S.N	**LIST OF EXPERIMENTS**	**RBT LEVELS**
1	Determination of velocity and range of the target using RADAR	**L3**
2	Estimation of RPM and time period of oscillation using RADAR	**L3**
3	Display the orientation of the control surface and change the orientation of the control surface to stabilize the aircraft.	**L3**
4	Sense the temperature and pressure of cabin and provide alarm during emergency	**L3**
5	Configuration and data transfer using MIL STD 1553	**L3**
6	Configuration and data transfer using ARINC 429	**L3**
7	Configuration and data transfer using AFDX	**L3**
8	Perform onboard communication using satellite communication	**L3**
9	Determination of aircraft attitude using inertial navigation system	**L3**
10	Demonstrate the application of GPS system	**L3**
11	Estimation of distance or altitude measurement of the aircraft	**L3**

COURSE OUTCOMES:

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

CO77.1	Carry out data acquisition from various sensors on board
CO77.2	Perform the operation of actuation and alerting system.
CO77.3	Execute data communication between analog and digital system
CO77.4	Experiment how wireless protocol and interrupts used in data transfer
CO77.5	Understand the data transfer on MIL STD 1553B and AFDX data bus

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**

CO/PO Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO77.1	3	2	2	-	3	-	-	-	-	-	-	-	-	2
CO77.2	3	2	2	-	3	-	-	-	-	-	-	-	-	2
CO77.3	3	2	2	-	3	-	-	-	-	-	-	-	-	2
Average	3	2	2	-	3	-	-	-	-	-	-	-	-	2

Low-1: Medium-2: High-3

VIII Semester Syllabus

Head of the Department
Dept. of Aeronautical Engineering
Global Academy of Technology
R.R. Nagar, Bengaluru - 560 098.

SEMESTER VIII

COURSE: AIRCRAFT DESIGN

Course Code	**22ANE81**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**4:0:0**	**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: 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.	**10 Hours/ L3**
Module 2: 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: 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**
Module 4: 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: 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**

COURSE OUTCOMES:

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

CO81.1	Comprehend aircraft design fundamentals, including introduction, requirements, phases conceptual design, weight calculations, trade studies, and airfoil principles.
CO81.2	Estimate the design geometry, thrust to weight ratio and wing loading of an aircraft.
CO81.3	Discuss initial sizing and configuration layout.
CO81.4	Acquire a thorough understanding of aerodynamic coefficients, propulsion systems, jet engine thrust, thrust-drag analysis, and piston and turboprop engine performance.
CO81.5	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.
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):

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO81.1	3	3	-	-	-	-	-	-	-	-	-	-	2	-
CO81.2	3	3	-	-	-	-	-	-	-	-	-	-	2	-
CO81.3	3	3	-	-	-	-	-	-	-	-	-	-	2	-
CO81.4	3	3	-	-	-	-	-	-	-	-	-	-	2	-
CO81.5	3	3	-	-	-	-	-	-	-	-	-	-	2	-
Average	3	3	-	-	-	-	-	-	-	-	-	-	2	-

Low-1: Medium-2: High-3

SEMESTER – VIII
PROGRAM ELECTIVE 4

COURSE: SATELLITE TECHNOLOGY

Course Code	**22ANE821**	**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 Satellite Technology in broad domain of Aeronautical Engineering by making them to learn:

CLO1	To introduce basic aspects of satellite subsystems and their functions peculiarities of space environment and types of satellite orbits to students.
CLO2	To impart knowledge to students on orbit determination and maneuvers and ground station network requirements.
CLO3	To make students familiarize with satellite mechanical and structural configurations and satellite thermal control systems.
CLO4	To acquaint students with satellite control requirements and type of control maneuvers and sensors needed for control.
CLO5	To impart knowledge to students on satellite power electronics telemetry and tele-command systems.

Content	**No. of Hours/RBT levels**
Module 1: INTRODUCTION TO SATELLITE SYSTEMS Common satellite applications and missions – Typical spacecraft orbits – Definitions of spin the three axis stabilization-Space environment – Launch vehicles – Satellite system and their functions (structure, thermal, mechanisms, power, propulsion, guidance and control, bus electronics)	**08 Hours/ L3**
Module 2: ORBITAL MECHANICS Fundamental of flight dynamics – Time and coordinate systems – Orbit determination and prediction – Orbital maneuvers – GPS systems and application for satellite/orbit determination –Ground station network requirements.	**08 Hours/ L3**
Module 3: SATELLITE STRUCTURES & THERMAL CONTROL Satellite mechanical and structural configuration: Satellite configuration choices, launch loads, separation induced loads, deployment requirements – Design and analysis of satellite structures – Structural materials and fabrication – The need of thermal control: externally induced thermal environment – Internally induced thermal environment - Heat transfer mechanism: internal to the spacecraft and external heat load variations – Thermal control systems: active and passive methods.	**08 Hours/ L3**

Module 4: SPACECRAFT CONTROL Control requirements: attitude control and station keeping functions, type of control maneuvers –Stabilization schemes: spin stabilization, gravity gradient methods, 3 axis stabilization – Commonly used control systems: mass expulsion systems, momentum exchange systems, gyro and magnetic torque - Sensors star and sun sensors, earth sensor, magnetometers and inertial sensors.	**08 Hours/ L3**
Module 5: POWER SYSTEM AND BUS ELECTRONICS Solar panels: Silicon and Ga-As cells, power generation capacity, efficiency – Space battery systems – battery types, characteristics and efficiency parameters – Power electronics. Telemetry and telecommand systems: Tm & TC functions, generally employed communication bands (UHF/VHF, S, L, Ku, Ka), their characteristics and applications. Coding Systems – Onboard computer- Ground checkout Systems	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO821.1	Explain the concepts of Orbits and their mechanics.
CO821.2	Explain the concepts of structural design, analyzing techniques and various types of loads in satellite structural subsystem.
CO821.3	Acquire knowledge on the importance of thermal control subsystem and its design studies
CO821.4	Explain the concepts of satellite sensors and actuators that needed for Attitude control subsystem development.
CO821.5	Acquire the knowledge of satellite attitude as well as orbital dynamics in order to design the satellite control subsystem

Textbooks:

1. E.F Bruhn, “Analysis and Design of Flight Vehicle Structures”, Tri-State off set company, USA, 1980.
2. Francis J. Hale , “Introduction Space Flight”, Prentice Hall, 1994.
3. Rilay, FF , “Space Systems Engineering”, McGraw Hill, 1982.
4. Michael D. Griffin and James R. French , “Space Vehicle Design”, , AIAA Education Series, 1991.
5. Vertregt.M, “Principles of Astronautics”., Elsevier Publishing Company, 1985.

Reference books:

1. Craft Lewis H. Abraham, “Structural Design of Missiles & Space”, McGraw Hill, 1992.
2. Hughes P.C. , “Spacecraft Altitude Dynamics”, Wilsey, 1986.
3. Richard.F, Filipowsky Eugen I Muehllorf , “Space Communications Systems”, Prentice Hall, 1995.
4. “Spacecraft Thermal Control”, Hand Book, Aerospace Press, 2002.

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
CO821.1	3	3	-	2	-	-	-	-	-	-	-	1	2	-
CO821.2	3	3	-	2	-	-	-	-	-	-	-	1	2	-
CO821.3	3	3	-	2	-	-	-	-	-	-	-	1	2	-
CO821.4	3	3	-	2	-	-	-	-	-	-	-	1	2	-
CO821.5	3	3	-	2	-	-	-	-	-	-	-	1	2	-
Average	3	3	-	2	-	-	-	-	-	-	-	1	2	-

Low-1: Medium-2: High-3

SEMESTER VIII
PROGRAM ELECTIVE 4

COURSE: CRYOGENIC PROPULSION

Course Code	**22ANE822**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Pre-requisite: Aero Propulsion-II

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

CLO1	The fundamental physics of cryogenic engineering and their fluid properties.
CLO2	The properties of cryogenic materials, explore various cryogenic refrigeration techniques, and study liquefaction of natural gas
CLO3	To introduce various cryogenic insulation methods.
CLO4	The design considerations for cryogenic storage vessels and instrumentation
CLO5	To explore various cryogenic equipments.

Content	**No.of Hours/ RBT levels**
Module 1: INTRODUCTION TO CRYOGENIC ENGINEERING Thermo physical and fluid dynamic properties of liquid and gas hydrogen, Thermo physical and fluid dynamic properties of liquid and gas helium, Liquefaction systems of hydrogen and helium gases, Liquefaction systems of hydrogen and helium gases, Refrigeration and liquefaction principals; Joule Thomson effect and inversion curve; Adiabatic and isenthalpic expansion with their comparison	**08 Hours/ L3**
Module 2: PROPERTIES OF CRYOGENIC MATERIALS Cryogenic fluids, Solids at cryogenic temperatures; Superconductivity, Recuperative - Linde - Hampson, Claude, Cascade, Heylandt, Kapitza, Collins, Simon; Regenerative - Stirling cycle and refrigerator, Slovay refrigerator, Gifford-McMahon refrigerator, Vuilleumier refrigerator, Pulse Tube refrigerator; Liquefaction of natural gas	**10 Hours/ L3**
Module 3: CRYOGENIC INSULATION Vacuum insulation, evacuated porous insulation, gas filled Powders and fibrous materials, Solid foams, Multilayer insulation, Liquid and vapour Shields, Composite insulations	**08 Hours/ L3**
Module 4: STORAGE AND INSTRUMENTATION OF CRYOGENIC LIQUIDS Design considerations of storage vessel; Dewar vessels; Industrial storage vessels; Storage of cryogenic fluids in space; Transfer systems and Lines for cryogenic liquids; Cryogenic valves in transfer lines; Two phase flow in Transfer	**08 Hours/ L4**

system; Cool-down of storage and transfer systems, Measurement of strain, pressure, flow, liquid level and Temperature in cryogenic environment; Cryostats	
Module 5: CRYOGENIC EQUIPMENT Cryogenic heat exchangers - recuperative and regenerative; Variables affecting heat exchanger and system performance; Cryogenic compressors, Pumps, expanders; Turbo alternators; Effect of component inefficiencies; System Optimization, Magneto-caloric refrigerator; 3He-4He Dilution refrigerator; Cryo-pumping; Cryogenic Engineering applications in energy, aeronautics, space industry, biology, preservation Application of Cryogenic Engineering in Transport	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO822.1	Illustrate the fundamental physics of cryogenic engineering and their fluid properties.
CO822.2	Interpret the properties of materials at cryogenic temperatures and refrigeration techniques.
CO822.3	Determine appropriate insulation techniques for cryogenic applications.
CO822.4	Categorize cryogenic storage systems, transfer systems, and instrumentation for measuring key parameters in cryogenic environments.
CO822.5	Apply cryogenic engineering principles to real-world applications

Textbooks:

1. T.M. Flynn, Marcel Dekker., Cryogenic Engineering, marcel dekker,2nd edition, 2005
2. Bose and P. Sengupta, "Cryogenics: Applications and Progress", Tata McGraw Hill.
3. J.G. Weisend II, Taylor and Francis, "Handbook of Cryogenic Engineering",

Reference books:

1. R.Barron,"Cryogenic Systems", Oxford University Press.
2. K.D.Timmerhaus and T.M. Flynn, "Cryogenic Process Engineering", Plenum Press.
3. G.G.Haselden,"CryogenicFundamentals", AcademicPress.
4. C.A.Bailey,"AdvancedCryogenics",PlenumPress.
5. R.W. Vance and W.M. Duke , "Applied Cryogenic Engineering", John Wiley & sons.

Scheme of Examination: Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be reduced proportionately 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
CO822.1	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO822.2	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO822.3	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO822.4	3	2	-	-	-	-	-	-	-	-	-	-	-	2
Average	3	2												2

Low-1: Medium-2: High-3

SEMESTER – VIII
PROGRAM ELECTIVE-4
COURSE: UAV ARTIFICIAL INTELLIGENCE SYSTEMS

Course Code	**22ANE823**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Pre requisite: Drone Technology

Course Learning Objectives: To enable students to apply the knowledge of Drones and Intelligent Systems in broad domain of Aeronautical Engineering by making them to learn:

CLO1	To Gain the Knowledge of UAS and Artificial intelligence systems
CLO2	To Inculcate the Knowledge of UAS in various applications
CLO3	To insight the communications of UAS
CLO4	To comprehend the DRONE usage in image processing applications
CLO5	To impart the Practice the UAV maintenance and operations regulations

Content	No. of Hours/RBT levels
Module 1: UNMANNED AERIAL SYSTEMS Drone Basics, Unmanned Aerial Systems (UAS), Drone Sensors, Micro Controllers, Internet of Thinks (IOT) Systems, IOT Controls, Different Types of UAV and its Applications, Recent Trends in Artificial Intelligence Systems	**8 Hours/ L3**
Module 2: UAV SENSORS UAV Sensor Systems, Different Sensor Modules, Monitoring Systems – Pollution, Air Quality, Weather, Medical, Traffic, Surveillance, Tracking, Agriculture, Space. Sensor Integrations, Sensor Programming.	**08 Hours/ L3**
Module 3: UAV COMMUNICATION SYSTEMS Autonomous - Waypoints Navigations, Ground Control Station (GCS), UAV Telemetry Systems - Various Flight Controllers, Radar Communication Systems, UAV Stealth Technology, Radar Absorbing Material, Drone Jamming Technology.	**08 Hours/ L3**
Module 4: IMAGE PROCESSING Drone Intelligent Modes, Drone Smart Modes, FPV & Image Processing System Image Processing, Multispectral Camera, Lidar, GIS Mapping.	08 Hours/ L3
Module 5: UAV MAINTENANCE Vehicle Test Controller Duties, UAV Checklist – Pre Flight Checklist, Post Flight Checklist, UAV Maintenance Process, UAV Overhauling, RC Simulators an Controls, DGCA-Drone Regulations, DGCA Drone Pilot Rule.	08 Hours/ L3

COURSE OUTCOMES:

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

CO823.1	Understand the UAS and Artificial intelligence systems
CO823.2	Comprehend the UAS in various applications
CO823.3	Describe communications of UAS
CO823.4	Summarize the DRONE usage in image processing applications
CO823.5	Practice the UAV maintenance and operations regulations

Textbooks:

1. Unmanned Aircraft Systems: UAVS Design, Development and Deployment, Reg Austin 2010 John Wiley & Sons, Ltd
2. Design of Unmanned Aerial Systems, Dr. Mohammad H. Sadraey, 2020 John Wiley & Sons Ltd.

Reference books:

1. Introduction to UAV Systems, Jean-Marc Moschetta and Kamesh Namuduri
2. UAV Networks and Communications, Edited by Kamesh Namuduri, University of North Texas, Serge Chaumette, Université de Bordeaux, Jae H. Kim, Boeing Research and Technology, James P. G. Sterbenz, University of Kansas Cambridge University Press, November 2017

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO823.1	3	3	-	-	-	-	-	-	2	-	-	2	2	1
CO823.2	3	3	-	-	-	-	-	-	2	-	-	2	2	1
CO823.3	3	3	-	-	-	-	-	-	2	-	-	2	2	1
CO823.4	3	3	-	-	-	-	-	-	2	-	-	2	2	1
CO823.5	3	3	-	-	-	-	-	-	2	-	-	2	2	1
Average	3	3	-	-	-	-	-	-	2	-	-	2	2	1

Low-1: Medium-2: High-3

SEMESTER – VIII
PROGRAM ELECTIVE-4

COURSE: GUIDANCE AND CONTROL

Course Code	**22ANE824**	**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: Introduction to Guidance and Controls Concepts of navigation, guidance, and control. Introduction to basic principles. Air data information. 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: Tracking with Radar and Guidance Systems Mono pulse tracking. Conical scan and sequential lobbing. Automatic tracking with surveillance radar (ADT). 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: Transfer Functions and Missile Control System Input-output Transfer function. Basic altitude reference. Concepts of Open loop and Close Loop. 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: Missile Guidance Proportional navigation guidance; command guidance. Comparison of guidance system performance. Bank to turn missile guidance	**08 Hours/ L3**
Module 5: Integrated Flight/Fire Control System Director fire control system. Tracking control laws. Longitudinal flight control system. Lateral flight control system. Rate of change of Euler angle, Auto Pilot.	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO824.1	Comprehend the basic concepts of navigation, guidance and control.
CO824.2	Acquire the knowledge of radar systems and other guidance systems
CO824.3	Understand the missile guidance and
CO824.4	summarize missile control system.
CO824.5	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**

CO/PO Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO824.1	3	3	-	-	-	-	-	-	2	-	-	2	2	1
CO824.2	3	3	-	-	-	-	-	-	2	-	-	2	2	1
CO824.3	3	3	-	-	-	-	-	-	2	-	-	2	2	1
CO824.4	3	3	-	-	-	-	-	-	2	-	-	2	2	1
CO824.5	3	3	-	-	-	-	-	-	2	-	-	2	2	1
Average	3	3	-	-	-	-	-	-	2	-	-	2	2	1

Low-1: Medium-2: High-3

SEMESTER – VIII
PROGRAM ELECTIVE-5

COURSE: CIVIL AVIATION REQUIREMENT

Course Code	**22ANE831**	**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 Civil 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: INDIAN AIRCRAFT RULES 1937 AND RELATED PUBLICATIONS 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: 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: 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: 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: 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 manufacture, registration and	**10 Hours/ L3**

airworthiness control of hot air balloons, Age of Aircraft to be imported for Scheduled / Non-Scheduled including Charter, General Aviation and other Operations, Issue/Renewal and Suspension of Special Certificate of Airworthiness.	

COURSE OUTCOMES:

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

CO831.1	Should be able to have the knowledge of Indian Aircraft Rules 1937 and related publication
CO831.2	Should be able to have the knowledge CAR series B and C (MEL, cockpit and emergency check list and Defects rectification and analysis)
CO831.3	Should be able to have the knowledge CAR series E for approval of organizations: in various categories and CAR series M.
CO831.4	Should be able to have the knowledge CAR145, CAR -21 Type certificate and Noise certificate
CO831.5	Should be able to have the knowledge C.A.R. series F airworthiness and continued airworthiness, Registration / deregistration of aircraft, Micro light and Hot air balloons, Issue/Renewal and Suspension of Special Certificate of Airworthiness

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.**

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
CO831.1	3	2	-	-	-	-	-	-	2	2	-	-		1
CO831.2	3	2	-	-	-	-	-	-	2	2	-	-		1
CO831.3	3	2	-	-	-	-	-	-	2	2	-	-		1
CO831.4	3	2	-	-	-	-	-	-	2	2	-	-		1
CO831.5	3	2							2	2				1
Average	3	2	-	-	-	-	-	-	2	2	-	-		1

Low-1: Medium-2: High-3

SEMESTER – VIII
PROGRAM ELECTIVE 5
COURSE: NDT IN AEROSPACE ENGINEERING

Course Code	**22ANE832**	**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

Course Objectives: To study and understand the various Non Destructive Evaluation and Testing methods, theory and their industrial applications.

CLO1	To introduce the concepts of Non-Destructive Testing (NDT) and differentiate it from mechanical testing, and to provide an overview of NDT methods
CLO2	To explore surface NDT methods, specifically Liquid Penetrant Testing and Magnetic Particle Testing.
CLO3	To introduce Thermography principles, including contact and non-contact inspection methods, and Eddy Current Testing
CLO4	To provide an understanding of Ultrasonic Testing principles, transducers, instrumentation, and data representation
CLO4	To explain Radiography principles, X-Ray interactions with matter, imaging techniques, film and filmless methods, filters, geometric factors, and characteristics of films

Content	**No. of Hours/ RBT levels**
Module 1: OVERVIEW OF NDT NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT. Visual inspection – Unaided and aided.	**08 Hours/ L3**
Module 2: SURFACE NON-DESTRUCTIVE EXAMINATION METHODS **Liquid Penetrant Testing:** Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. **Magnetic particle testing:** Theory of magnetism, inspection materials magnetisation methods, interpretation and evaluation of test indications, principles and methods of demagnetization, residual magnetism.	**08 Hours/ L3**
Module 3: THERMOGRAPHY AND EDDY CURRENT TESTING **Thermography** Principles, contact and non-contact inspection methods, Techniques for applying liquid crystals. Advantages and limitation, infrared radiation and infrared detectors, instrumentations and methods, applications. **Eddy Current Testing**- Generation of eddy currents, properties of eddy currents Eddy current sensing elements, probes, instrumentation, types of arrangement, applications, advantages, limitations, interpretation/evaluation.	**08 Hours/ L3**

Module 4: ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE) Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B- scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique –Principle, AE parameters, Applications	**10 Hours/ L3**
Module 5: RADIOGRAPHY (RT) Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films - graininess, density, speed, contrast, characteristic curves, Penetrometers, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO832.1	Explain the fundamental concepts of NDT
CO832.2	Discuss the different methods of NDT
CO832.3	Explain the concept of Thermography and Eddy current testing
CO832.4	Explain the concept of Ultrasonic Testing and Acoustic Emission
CO832.5	Explain the concept of Radiography

Textbooks:

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2014.
2. Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010

Reference books:

1. ASM Metals Handbook," Non-Destructive Evaluation and Quality Control", American Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. Charles, J. Hellier, "Handbook of Non-destructive evaluation", McGraw Hill, New York 2001.
3. Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 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														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO832.1	3	1	-	-	1	-	-	-	-	1	-	1	1	2
CO832.2	3	3	-	-	2	-	-	-	-	1	-	1	1	2
CO832.3	3	3	-	-	2	-	-	-	-	1	-	1	1	2
CO832.4	3	2	-	-	2	-	-	-	-	1	-	1	1	2
CO832.5	3	2	-	-	2	-	-	-	-	1	-	1	1	2
Average	3	3	-	-	2	-	-	-	-	1	-	1	1	2

Low-1: Medium-2: High-3

SEMESTER – VIII
PROGRAM ELECTIVE 5

COURSE: FLIGHT TESTING

Course Code	**22ANE833**	**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.

Content	**No. of Hours/RBT levels**
Module 1: 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/ L3**
Module 2: 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/ L3**
Module 3: 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/ L3**
Module 4: 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.	10 Hours/ L3

Module 5: FLYING QUALITIES: MIL and FAR regulations. Cooper-Harper scale. Pilot rating. Flight test procedures. stall and spin- regulations, test and recovery techniques. Dive testing for flutter, vibration and buffeting.	08 Hours/ L3

COURSE OUTCOMES:

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

CO833.1	Review the scope of flight testing, its types and reducing uncertainty.
CO833.2	Identify the purpose, scope and working of various instruments employed for flight-testing.
CO833.3	Examine the performance of flight at different operating conditions.
CO833.4	Illustrate the stability and control aspects at various flight condition.
CO833.5	Explain the various regulations and recovery techniques.

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
CO833.1	3	-	-	-	-	-	-	-	-	-	-	-	2	2
CO833.2	3	2	-	-	-	-	-	-	-	-	-	-	2	2
CO833.3	3	2	-	-	-	-	-	-	-	-	-	-	2	2
CO833.4	3	2	-	-	-	-	-	-	-	-	-	-	2	2
CO833.5	3	2	-	-	-	-	-	-	-	-	-	-	2	2
Average	3	2	-	-	-	-	-	-	-	-	-	-	2	2

Low-1: Medium-2: High-3

SEMESTER – VIII
PROGRAM ELECTIVE 5

COURSE: TOTAL QUALITY MANAGEMENT

Course Code	**22ANE834**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Pre requisite: Management of Entrepreneurship

Course Objectives: To enable students to apply the knowledge of Total Quality Management in broad domain of aeronautical engineering by making them to learn:

CLO1	To learn about the evolution and the basic concepts of quality.
CLO2	To understand the various principles, practices of TQM to achieve quality.
CLO3	To learn the various statistical approaches for Quality control.
CLO4	To understand the TQM tools for continuous process improvement.
CLO5	To learn the importance of ISO and Quality systems.

Content	**No. of Hours/RBT levels**
Module 1: INTRODUCTION TO TQM Need for quality – Evolution of quality – Definition of quality – Dimensions o product and service quality – Basic concepts of TQM – TQM Framework – Barriers to TQM Contributions of Quality Gurus — Deming's 14 point principles – Crosby's 14 point principles – Juran Triology.	**08 Hours/ L3**
Module 2: TQM PRINCIPLES Quality statements – Customer focus –Customer orientation, Customer satisfaction, Customer complaints, Customer retention – Continuous process improvement – PDCA cycle, 5s, Kaizen – Supplier partnership –Partnering, Supplier selection, Supplier Rating	**08 Hours/ L3**
Module 3: TOOLS & TECHNIQUES I The seven traditional tools of quality- Histogram – Pareto diagram – Cause and effect diagram – Flow charts –Check sheet – Scatter diagram – Quality control charts – The seven new tools of quality – Why-why analysis – Affinity diagram – Interrelationship digraph – Tree diagram –Prioritization matrix – Process decision program chart – Activity network diagram.	**10 Hours/ L3**
Module 4: TQM TOOLS AND TECHNIQUES II Quality Circles - Cost of Quality – Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.	**08 Hours/ L3**

Module 5: QUALITY MANAGEMENT SYSTEM Introduction—Benefits of ISO Registration— ISO 9000 Series of Standards–Sector-Specific Standards— AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements— Implementation— Documentation— Internal Audits–Registration--ENVIRONMENTAL MANAGEMENT SYSTEM: Introduction—ISO 14000 S	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO834.1	Illustrate basic concepts of quality gurus.
CO834.2	Apply the knowledge of TQM principles.
CO834.3	Choose the appropriate the statistical tool to achieve the quality control.
CO834.4	Identify principles of continuous process improvement tools.
CO834.5	Apply the knowledge of quality systems.

Textbooks:

1. Dale H. Besterfield, Carol Besterfield-Michna, Glen H. Besterfield, Mary BesterfiedSacre, Hemant Urdhwareshe, Rashmi Urdhwareshe, "Total Quality Management, Pearson Publications, 3rd Edition, 2003.
2. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, 3rd Edition, 2003.

Reference books:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 6th Edition, South-Western (Thomson Learning), 2005.
2. Janakiraman,B and Gopal, R.K, "Total Quality Management – Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
3. Chapman and Hall, "Total Quality Management", 2 nd Edition, 1995.
4. Mukherjee,P.N "Total Quality Management", Prentice- Hall iof India Private Limited, 2006.
5. Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.

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

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
CO834.1	3	2	1	-	-	2	-	-	-	-	-	2	-	2
CO834.2	3	2	1	-	-	2	-	-	-	-	-	2	-	2
CO834.3	3	2	1	-	-	2	-	-	-	-	-	2	-	2
CO834.4	3	2	1	-	-	2	-	-	-	-	-	2	-	2
CO834.5	3	2	1	-	-	2	-	-	-	-	-	2	-	2
Average	3	2	1	-	-	2	-	-	- -	-	-	2	-	2

Low-1: Medium-2: High-3

SEMESTER -VIII

Project Phase II

Course Code	**22ANE84**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**0:0:20**	**SEE Marks**	**50**
No. of Credits	**12**	**Examination Hours**	**03**

CONTENT	No. of Hours/ RBT levels
CIE procedure for Project Work Phase - II: **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 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. **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. 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. **SEE for Project Work Phase - II:** **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. **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.	

Individual student performance are evaluated based on the following COs :

CO84.1	Able to make comprehensive use of the technical knowledge gained from previous courses
CO84.2	Able to understand technologies concerned with the project
CO84.3	Able to apply project management skills (scheduling work, procuring parts and documenting expenditures and working within the confines of a deadline).
CO84.4	Able to analyze, develop and demonstrate the proposed work
CO84.5	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
CO84.1	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO84.2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO84.3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO84.4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO84.5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Low-1: Medium-2: High-3

SEMESTER -VIII

COURSE: TECHNICAL SEMINAR

Course Code	**22ANES85**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**0:0:2**	**SEE Marks**	**50**
No. of Credits	**1**	**Examination Hours**	**03**

Technical Seminar:

All the students admitted to IV year of BE/B. Tech shall have to do power point presentation on any topic related to Aeronautical Engineering during VIII Semester and make a report of the presented topic referring to journals in that area. The prescribed credit shall be included in VIII Semester and shall be considered for the award of bachelor's degree. Those who do not present the Technical Seminar shall be declared fail and shall have to complete during subsequent University examination after satisfying the Technical Seminar requirements.

CIE procedure for Seminar:

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 Seminar shall be based on the evaluation of Seminar report, presentation skill and question and answer session in the ratio 50:25:25.

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	**50**	**50**
SEE	Technical Seminar Presentation + Report	**50**	**50**
Grand Total			**100**

CO/PO Mapping

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO85.1	3	3	1	1	1	2	3	3	3	3	-	3	2	2
CO85.2	3	3	1	1	1	2	3	3	3	3	-	3	2	2
CO85.3	3	3	1	1	1	2	3	3	3	3	-	3	2	2
CO85.4	3	3	1	1	1	2	3	3	3	3	-	3	2	2
CO85.5	3	3	1	1	1	2	3	3	3	3	-	3	2	2

Low-1: Medium-2: High-3

SEMESTER -VIII

COURSE: INTERNSHIP

Course Code	**22INT86**	**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.

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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