III - VIII Semester scheme & Syllabus (2020-21)
Department
of
Aeronautical Engineering

SCHEME AND SYLLABUS

Department of Aeronautical Engineering

GLOBAL ACADEMY OF TECHNOLOGY
(Autonomous institution affiliated to VTU, Belagavi.
Accredited by NAAC with 'A' grade, NBA Accredited CS, E&C, E&E, MECH and IS branches)
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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 – An Overview

(Autonomous Institution under Visvesvaraya Technological University, Belagavi)

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 the Department:

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 skills.

3 Salient Featuresof Autonomy

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

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

Autonomy gives the privilege to:

- **Run courses relevant to 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:

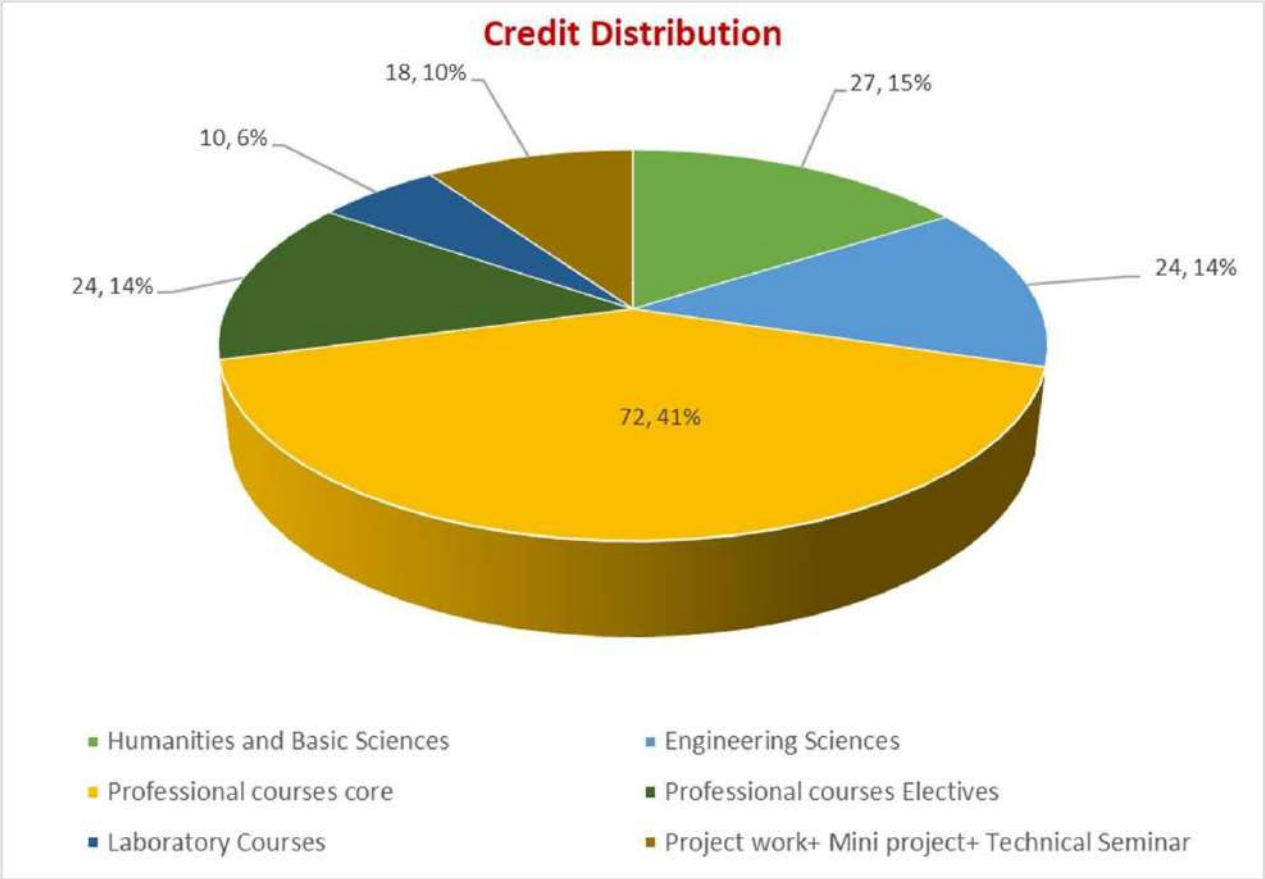
I. Theory course conducted for 1 hour/week/ semester;
II. Laboratory course or Tutorial conducted for 2 hours/week/semester. The following additional factors may also be noted in this connection:
III. The above figures shall be multiplied by a factor of 2 in the case of the Supplementary Semester,
IV. 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	27	**15**
2	Engineering Sciences	24	**14**
3	Professional courses core	72	**41**
4	Professional courses Electives	24	**14**
5	Laboratory Courses	10	**06**
6	Project work+ Mini project+ Technical Seminar	18	**10**
	Total	**175**	**100**


Credit Distribution
18, 10%
27, 15%
10, 6%
24, 14%
24, 14%
72, 41%
Humanities and Basic Sciences
Engineering Sciences
Professional courses core
Professional courses Electives
Laboratory Courses
Project work+ Mini project+ Technical Seminar

Department of Aeronautical Engineering

III - VIII Semester

SCHEME AND SYLLABUS

Applicable from 2020-21

Global Academy of Technology
(Autonomous Institution Affiliated to VTU)
Draft Scheme of Teaching and Examination 2020-21
Department of Aeronautical Engineering

III SEMESTER -UG

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical / Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	BSC	20MAT31C	Complex Variables and Probability	Mathematics	3	2	--	03	50	50	100	4
2	PC	20ANE32	Solid Mechanics	AE/ME	3	2	--	03	50	50	100	4
3	PC	20ANE33	Thermodynamics	AE/ME	3	2	--	03	50	50	100	4
4	PC	20ANE34	Fluid Mechanics	AE/ME	3	2	--	03	50	50	100	4
5	PC	20ANE35	Basics of Aeronautical Engineering	AE	3	-	--	03	50	50	100	3
6	PC	20ANE36/ 20MATDIP36	Materials and Manufacturing Process/Dip. Mathematics	AE/ME	3	-	--	03	50	50	100	3
7	PC	20ANEL37	Material Testing Laboratory	AE/ME	--	-	2	03	50	50	100	1
8	PC	20ANEL38	Foundry, Forging and Welding Lab	AE/ME	--	-	2	03	50	50	100	1
9	NCMC	NCMC3	Non Credit Mandatory Course 3	**Personality Development & Communication Skills (PD &C)**								
10	HSM	20KVK39/49	Vyavaharika Kannada (Kannada for communication)/	HSMC	--	2	--	--	100	--	100	0
		20KAK39/49	Aadalitha Kannada (Kannada for Administration)									
		OR			OR							0
		20CPH39	Constitution of India, Professional Ethics and Cyber Law		-	2	--	-	100	-	100	
				TOTAL	**18**	**10**	**04**	**24**	**500**	**400**	**900**	**24**

Note: BSC: Basic Science, PC: Professional Core, PE- Professional Elective, HSM: Humanity and Social Sciences, NCMC: Non-credit mandatory course.

20KVK39: Vyavaharika Kannada (Kannada for communication) is for non-kannada students and 20KAK39 Aadalitha Kannada (Kannada for Administration) is for students who speak, read and write kannada.

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs

(a) Diploma Mathematics 20MATDIP36 is prescribed for lateral entry Diploma holders admitted to III semester BE. The students shall attend the classes during this semester to complete all the formalities of the course and appear for the examination. In case, any student fails to register for the said course/ fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured F grade. In such a case, the students must fulfil the requirements during subsequent semester/s to appear for SEE. This course shall be considered for vertical progression.

(b) The regular students shall study the core subject 20XXX36. The selection of the core subject 20XXX36 should be such that the lateral entry diploma holders would have already studied its contents during the Diploma course and in its place the diploma students shall be studying 20DIPMAT36.

Courses prescribed to lateral entry B. Sc degree holders admitted to III semester of Engineering programs

Lateral entrant students from B.Sc. Stream, shall clear the non-credit courses **Computer Aided Engineering Drawing and Engineering Mechanics of the First Year Engineering Program**. These courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

NCMC3: Student can participate in any **Personality Development & Communication Skills Program** (minimum 5 days duration) conducted by Training and Placement cell of GAT/any other training organization. Students should be exposed to soft skills. Student should submit participation and successful completion certificate of PD&C for clearing this mandatory course.

***Mathematics Course for Different Programs:**

Sl. No.	Course Code	Course Title	Offered to Program/s
1	**20MAT31A**	Discrete Mathematics and Transform Calculus	Common to CS/IS/AI&DS/AI &ML
2	**20MAT31B**	Complex Variables, Probability and Sampling Techniques	Civil
3	**20MAT31C**	Complex Variables and Probability	Mechanical/Aeronautical
4	**20MAT31D**	Transforms, Numerical Methods and Advanced Linear Algebra	Electrical & Electronics
5	**20MAT31E**	Transforms, Complex Variables and Special Functions	Electronics and Communication

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IV SEMESTER -UG

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical / Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	BSC	20MAT41C	Transforms, Calculus of Variation and Numerical Techniques	Mathematics	3	2	--	03	50	50	100	4
2	PC8	20ANE42	Aerodynamics – I	ANE	3	2	--	03	50	50	100	4
3	PC9	20ANE43	Aero Propulsion – I	ANE	3	2	--	03	50	50	100	4
4	PC10	20ANE44	Aircraft structural mechanics	ANE	3	2	--	03	50	50	100	4
5	PC11	20ANE45	Measurements and Metrology	ANE/MED	3	-	--	03	50	50	100	3
6	PC12	20ANE46	Computer Aided Aircraft Drawing	ANE/MED	3	-	--	03	50	50	100	3
7	PC13	20ANEL47	Metrology and Measurements Lab	ANE/MED	-	-	2	03	50	50	100	1
8	PC14	20ANEL48	Fluid Mechanics Laboratory	ANE/MED	-	-	2	03	50	50	100	1
9	NCMC	NCMC4	Non Credit Mandatory Course 4	**Universal Human Values**								
10	HSM	20KVK39/49	Vyavaharika Kannada (Kannada for communication)/	HSMC	--	2	--	--	100	--	100	-
		20KAK39/49	Aadalitha Kannada (Kannada for Administration)									
		OR										
		20CPH39/49	Constitution of India, Professional Ethics and Cyber Law		-	2	--	-	100	-		
				TOTAL	**18**	**10**	**04**	**24**	**500**	**400**	**900**	**24**

Note: BSC: Basic Science, PC: Professional Core, PE- Professional Elective, HSM: Humanity and Social Science, NCMC: Non-credit mandatory course.

20KVK39/49 Vyavaharika Kannada (Kannada for communication) is for non-kannada students and 20KAK39/49 Aadalitha Kannada (Kannada for Administration) is for students who speak, read and write kannada.

NCMC4 Universal Human Values:
This course has been introduced to create high-quality practices and environment backed with human values and professional ethics in institutions of higher education.

Mathematics Course for Different Programs:

Sl. No.	Course Code	Course Title	Offered to Program/s
1	**20MAT41A**	Graph Theory, Probability and Sampling Techniques	Common to CS/IS/AI&DS
2	**20MAT41B**	Transform Calculus and Numerical Techniques	Civil
3	**20MAT41C**	Transforms, Calculus of Variation and Numerical Techniques	Common to Mechanical/Aeronautical
4	**20MAT41D**	Complex Variables, Probability and Variational Calculus	Electrical & Electronics
5	**20MAT41E**	Advanced Linear Algebra and Probability	Electronics and Communication

Global Academy of Technology
(Autonomous Institution Affiliated to VTU)
Scheme of Teaching and Examination 2020- 21
Department of Aeronautical Engineering

V SEMESTER -UG

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory	Tutorial	Practical	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	HSMC	20ANE51	Management and Entrepreneurship*	Aero	3	0	0	03	50	50	100	3
2	PC	20ANE52	Aerodynamics – II	Aero	3	2	0	03	50	50	100	4
3	PC	20ANE53	Aero Propulsion - II	Aero	3	2	0	03	50	50	100	4
4	PC	20ANE54	Aircraft Structural Analysis	Aero	3	2	0	03	50	50	100	4
5	PC	20ANE55	Composite Materials and Structures	Aero	3	0	0	03	50	50	100	3
6	PE1	20ANE56X	Professional Elective 1	Aero	3	0	0	03	50	50	100	3
7	PC	20ANEL57	Aircraft Structures Lab	Aero	0	0	2	03	50	50	100	1
8	PC	20ANEL58	Modelling And Analysis Lab	Aero	0	0	2	03	50	50	100	1
9	HSM	20CIV59	Environmental Science	Civil	2	0	0	-	50	0	50	0
10	NCMC	NCMC5	Non-Credit Mandatory Course 5	**Social Awareness Programs & Physical Activities such as Sports /Yoga**								
				TOTAL	**18**	**06**	**04**	**24**	**400**	**400**	**800**	**23**

Note: BSC: Basic Science, PC: Professional Core, PE: Professional Elective, HSM: Humanity and Social Science, NCMC: Non-credit mandatory course.

NCMC 5: Student can participate in any of the physical activities such as Sports, Marathon, Yoga conducted by college or any organization. Student should produce participation certificate for clearing this mandatory course from the Physical Director/ the competent authorities of the organization in which the student has undergone training. Physically challenged students can produce participation certificate of any technical/cultural events conducted by college/department clubs.
Student can participate in social awareness programs like:

- Dissemination of information on Govt. Schemes to village folk
- Guidance to village school children
- Organizing awareness programs on health issues, cleanliness, sanitization and hygiene.
- Participation in NSS activities like Swatch Bharat, Youth Red Cross, and Environmental Awareness programs etc.
- Certificate of participation from a competent authority like Headmaster of the school, Village Panchayat president, Village Panchayat member, NSS/ Youth Red Cross Coordinator is required for clearing this mandatory course. **This should be completed by the student before entering 7th Sem.**

***Entrepreneurship and IPR:** The syllabus for this course can be suitably set to cater to the requirements of individual program.

Professional Elective 1

Sl. No.	Course Code	Course Title
1	20ANE561	Unmanned Aerial Vehicle
2	20ANE562	Rocket and Missiles
3	20ANE563	Theory of Elasticity
4	20ANE564	Airworthiness and certification

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Department of Aeronautical Engineering

VI SEMESTER -UG

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory	Tutorial	Practical	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PC	20ANE61	Finite Element Methods	Aero	3	2	0	03	50	50	100	4
2	PC	20ANE62	Theory of Vibration	Aero	3	0	0	03	50	50	100	3
3	PC	20ANE63	Aircraft Performance	Aero	3	2	0	03	50	50	100	4
4	PE2	20ANE64X	Professional Elective 2	Aero	3	0	0	03	50	50	100	3
5	PE3	20ANE65X	Professional Elective 3	Aero	3	0	0	03	50	50	100	3
6	OE1	20ANE66X	Open Elective 1	Aero	3	0	0	03	50	50	100	3
7	PC	20ANEL67	Aerodynamics Lab	Aero	0	0	2	03	50	50	100	1
8	PC	20ANEL68	Aircraft Propulsion Lab	Aero	0	0	2	03	50	50	100	1
9	PC	20CVP69	Mini project	Aero	0	0	4	03	50	50	100	2
10	NCMC	NCMC6	Non-Credit Mandatory Course 6	**Career oriented training/Value added training/software training.**								
				TOTAL	**18**	**04**	**08**	**24**	**450**	**450**	**900**	**24**

Note: PC: Professional Core, PE- Professional Elective, OE- Open Elective, HSM: Humanity and Social Science, NCMC -Non-credit mandatory course.

Open Elective-1:

- Students can select any one of the open electives offered by **other Department**. Selection of an open elective is not allowed provided if:
- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of Departmental core courses or professional electives.

A similar course, under any category, is prescribed in the higher semesters of the programme. Registration to electives shall be documented under the guidance of faculty

NCMC6:

Student can opt any of the following Training programs:

1. **Career oriented training programs** (of minimum 30 hours) conducted by GAT –Website development, Animation, CNC technology, Hydraulics and Pneumatics, interior design and Architecture, PLC design, etc.
2. **Value added programs** (of minimum 30 hours) conducted by industries- training on LAB view, Embedded systems, HVAC, IoT, mobile app development etc.
3. **Software Training programs** (minimum one week) conducted by GAT, any other Institution, or industries – like CFD, Solid works, Mastercam, MATLAB, SCADA, Piping design, Ansys, STAAD-Pro, Electrical software packages, Microsoft, CISCO, SAP, IBM etc.

The student should submit training program clearance certificate. Students can also take up interdisciplinary training programs conducted by the industries. The certificate should clearly indicate that the student has successfully completed the training program.

Professional Elective 2

Sl. No.	Course Code	Course Title
1	20ANE641	Micro Processor and Control Engineering
2	20ANE642	Heat and Mass Transfer
3	20ANE643	Experimental Stress Analysis
4	20ANE644	Fuels and Combustion

Open Elective 1

Teaching Dept.	Sl. No.	Course Code	Course Title
AERONAUTICAL ENGINEERING	1	20ANE661	Introduction to Aerospace Engineering
	2	20ANE662	Aircraft Systems and Instrumentation

Professional Elective 3

Sl. No.	Course Code	Course Title
1	20ANE651	Space Mechanics
2	20ANE652	Experimental Aerodynamics
3	20ANE653	Aircraft Maintenance, Repair & Overhaul
4	20ANE654	Wind Tunnel Techniques

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VII SEMESTER -UG

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PC	20ANE71	Aircraft Stability and control	Aero	3	2	0	03	50	50	100	4
2	PC	20ANE72	Avionics	Aero	3	0	0	03	50	50	100	3
3	PE4	20ANE73X	Professional Elective 4	Aero	3	0	0	03	50	50	100	3
4	PE5	20ANE74X	Professional Elective 5	Aero	3	0	0	03	50	50	100	3
5	OE2	20ANE75X	Open Elective 2		3	0	0	03	50	50	100	3
6	PC	20ANEL76	Flight Simulation Lab	Aero	0	0	2	03	50	50	100	1
7	PC	20ANEL77	Avionics Lab	Aero	0	0	2	03	50	50	100	1
8	PC	20ANEP78	Project work Phase I	Aero	0	0	4	-	50	-	50	2
9	NCMC	NCMC7	Non-Credit Mandatory Course 7	MOOC/NPTEL/Industry Certified course/Competitive examinations/Online Courses approved by the department Board of Studies								
10	Internship			(If not completed during the vacation of VI and VII semesters , it shall be carried out during the vacation of VII and VIII semesters)								
				TOTAL	15	02	08	21	400	350	750	20

Note: PC: Professional Core, PE- Professional Elective, OE- Open Elective, HSM: Humanity and Social Science, NCMC -Non-credit mandatory course.

Open Elective-2: Students can select any one of the open electives offered by **other Department**. Selection of an open elective is **not allowed** provided:

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of faculty advisor.

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. SEE 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 SEE examination after satisfying the internship requirements.

Project Work Phase-1: Students can form a group with minimum of two and maximum of four. Under the allotted guide, student group should choose the Project title. For the chosen project title, the student group should carry out detailed Literature Survey, Problem Formulation, and Planning and design. CIE evaluation will be through a committee constituted with Guide as one of the members. Committee shall be constituted by HOD and UG project coordinator. CIE evaluation shall be as per the rubrics set by the department. Rubrics design will be done by HOD, UG project coordinator, one Professor, and one Associate Professor. Project Guide should direct and guide the student group to carry out project work.

NCMC7: Student can take up any competitive exams like TOFEL, GRE etc., or MOOC course. For clearing this Non-Credit course:

i. For Competitive exam, the student should submit the passing score card. ii. For MOOC course, student should submit certificate (or screen shot) from the registered online platforms (i.e., NPTEL, Coursera, edX, Udacity etc.). The certificate or the screenshot should indicate that student has cleared the online course.

The student can take industry (IT/core) certified courses (in campus or off campus) offered by industries and submit course clearance certificate. Students can also take up interdisciplinary certification courses conducted by the industries. The course duration shall be a minimum of 30 hours. The certificate should clearly indicate that the student has cleared the course. The student should complete this course before entering VIII semester.

The student can also take online courses approved by the Board of Studies of the program concerned. The course duration shall be a minimum of 30 hours.

Professional Elective 4

Sl. No.	Course Code	Course Title
1	20ANE731	Satellite Technology
2	20ANE732	Fatigue and Fracture Mechanics
3	20ANE733	Helicopter Engineering
4	20ANE734	Flight Scheduling and operations

Professional Elective 5

Sl. No.	Course Code	Course Title
1	20ANE741	Research Methodology
2	20ANE742	NDT in Aerospace Engineering
3	20ANE743	Computational Fluid Dynamics
4	20ANE744	Civil Aviation Requirement

Open Elective

Teaching Dept.	Sl. No.	Course Code	Course Title
AERONAUTICAL ENGINEERING	1	20ANE751	Introduction to UAV
	2	20ANE752	Airport Planning and Management
	3	20ANE753	Aircraft Materials and Production

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VIII SEMESTER -UG

Course and Course Code		Course Title	Teaching Department	Teaching Hours/Week			Examination				Credits
				Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P					
PC	20ANE81	Flight Vehicle Design	Aero	3	-	--	03	50	50	100	3
PE6	20ANE82X	Professional Elective 6	Aero	3	-	--	03	50	50	100	3
PC	20ANEP83	Project work Phase-II		-	-	20	03	50	50	100	10
PC	20ANES84	Technical Seminar		-	-	2	03	50	50	100	1
PC	20ANEI85	Internship		Completed during the vacation/s of VI and VII semesters and /or VII and VIII semesters.)			03	50	50	100	3
			TOTAL	**06**	**-**	**22**	**15**	**250**	**250**	**500**	**20**

Note: PC: Professional Core, PE- Professional Elective, OE- Open Elective, HSM: Humanity and Social Science.

CIE procedure for Project Work Phase - 2:

(i) 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. CIE evaluation shall be as per the rubrics set by the department. Rubrics design will be done by HOD, UG project coordinator, One professor, One Associate professor and One Assistant Professor. Project Guide should direct and guide the student group to carry out project work.

(ii) 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.

SEE for Project Work Phase - 2:

(i) 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.

(ii) 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 belongs to.

Internship: Those, who have not pursued /completed the internship, shall be declared as fail and have to complete during subsequent University examination after satisfying the internship requirements.

CIE evaluation shall be as per the rubrics set by the department. Rubrics design will be done by HOD and two senior professors. CIE evaluation will be through a committee constituted by HOD consisting of HOD, guide and two senior faculties.

Technical Seminar: Technical Seminar consists of:

i. Research paper presentation based on review of Research Publications or Patent.

ii. Research papers chosen should be at least from an IEEE conference, Springer Journal, Elsevier Journal

iii. Research paper should be related to the specific domain of engineering to which the student belongs.

CIE evaluation shall be as per the rubrics set by the department. Rubrics design will be done by HOD and two senior professors. CIE evaluation will be through a committee constituted by HOD consisting of HOD, guide and two senior faculty members.

Professional Elective 6

Sl. No.	Course Code	Course Title
1	20ANE821	Total Quality Management
2	20ANE822	Smart Materials and Nano technology
3	20ANE823	Flight Testing
4	20ANE824	Industrial Aerodynamics

SEMESTER – III

COURSE CURRICULUM(UG PROGRAMME)

SEMESTER – III

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

Course Code	**20MAT31C**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:2:0**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

Pre-requisite: Engineering Mathematics I, II

Course Objectives: To enable students to apply the knowledge of Mathematics in variousfields 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 Review of a function of a complex variable, limits, continuity, differentiability. Analytic functions, Cauchy-Riemann equations, construction of analytic functions using Milne Thomson method, Properties of analytic functions.	**10 Hours/ L2, L3**
Module 2 Conformal mapping, Bilinear transformations. Complex line integrals, Cauchy's theorem, Cauchy's integral formula, Taylor's series, Laurent's series, Singularities, poles, residues, Cauchy's residue theorem.	**10 Hours/ L2, L3**
Module 3 Probability, Axioms of probability, Conditional probability, Bayes theorem, Discrete and continuous random variables, Moments, Moment generating functions, Binomial, Uniform, exponential, Poisson, Normal distributions.	**10 Hours/ L2, L3**
Module 4 Joint distributions, Marginal and conditional distributions, Covariance, Correlation and linear regression, Transformation of random variables, Central limit theorem (for independent and identically distributed random variables) and law of large numbers.	**10 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, F-test.	**10 Hours/ L2, L3**

COURSE OUTCOMES:

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

CO1	Apply Cauchy Riemann equations to study different properties of analytic functions
CO2	Evaluate complex line integrals
CO3	Solve problems associated with random variables using probability distributions
CO4	Solve problems related to testing of hypothesis

Textbooks:

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

Reference books:

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

Two Tests are to be conducted for 50 marks each. Marks scored in each test is reduced to 20 and added to test component. CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests. **Some possible AATs:** seminar/assignments/ mini-projects/ concept videos/ partial reproduction of research work/ group activity/ any other.Typical Evaluation pattern is shown in Table 1.

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

Component		Marks	Total Marks
CIE	CIE Test-1	**20**	**50**
	CIE Test-2	**20**	
	Quiz 1/AAT	**05**	
	Quiz 2/AAT	**05**	
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	3	2	1									3				
CO2	3	2	1									3				
CO3	3	2	1									3				
CO4	3	2	1									3				
Average	3	2	1									3				

Low-1: Medium-2: High-3

III SEMESTER

COURSE: SOLID MECHANICS

Course Code	**20ANE32**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:2:0**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

Pre-requisites

- **Engineering Mathematics I, II**
- **Engineering Mechanics**

Course Objectives: To enable students to apply the knowledge of mechanics in broad domainof aeronautical engineering by making them to learn:

CLO1	Concepts of Basic and Axial Loading as applied to structural members
CLO2	Concepts and methods to construct Mohr's circle for determination of Principal stresses.
CLO3	Construction of Shear Force and Bending Moment diagrams.
CLO4	Methods to analyze the deflection in beams
CLO5	Concepts of torsion in shafts and types of springs

Content	**No. of Hours/ RBT levels**
Module 1 **CONCEPT OF STRESS & STRAIN**: state of stress & Strain at a point, Equilibrium equations, The state of plane stress and plane strain, Hooke's Law, Stress-strain curves for brittle and ductile materials, Allowable stress, Material selection for structural performance. Simple Stresses: Extension / Shortening of a bar, bars with cross sections varying in steps, bars with continuously varying cross sections. Elongation due to self-weight.	**10 Hours/ L3**
Module 2 **VOLUMETRIC STRAIN:** expression for volumetric strain, elastic constants, simple shear stress, shear strain, temperature stresses. **INTRODUCTION TO PLANE STRESS:** stresses on inclined sections, principal stresses & strains, Analytical & graphical method (Mohr's Circle) to find principal stresses & strains.	**10 Hours/ L3**

Module 3 **BENDING MOMENT AND SHEAR FORCE IN BEAMS**: Introduction, Types of beams, loads and reactions, shear forces and bending moments, rate of loading, sign conventions, relationship between shear force and bending moments. Shear force and bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load, (UDL) uniformly varying load (UVL) and couple for different types of beams.	**10 Hours/ L3**
Module 4 **THIN AND THICK CYLINDERS:** Thin cylinders: Thin cylindrical vessels subjected to internal pressure, stresses in thin cylindrical shells, maximum shear stress, Change in dimensions of thin cylinders : length, diameter and volume, Numerical Thick cylinders: LAME's theory, Stresses in a thick cylindrical stress, stress distribution, Numerical	**10 Hours/ L3**
Module 5 **TORSION OF CIRCULAR SHAFTS**: Introduction. Pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts. Power transmitted by solid and hollow circular shafts	**10 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Understand the types of stresses, strains developed in a member subjected to axial and thermal loads.
CO2	Solve Problems on principal stresses and strains and construction of Mohr's circle for determination of principal stress and strains.
CO3	Apply the method of shear force and bending moment diagrams for varied loads.
CO4	Solve the equations governing deflection of beams.
CO5	Apply the concepts of torsion in shafts.

Textbooks:

1. **W.A Nash and M. Potter**, "Strength of Materials", Schaum's Outline Series, McGraw Hill International Edition, Sixth Edition, 2013.B.V. Ramana, Higher Engineering Mathematics, TataMcGraw-Hill, 2006.
2. **R. K. Bansal,** "A Text Book of Strength of Materials", Sixth Edition, Lakshmi Publications Pvt.
   Limited, New Delhi, 2012.
3. **R. K. Rajput**, "Strength of Materials", Seventh Edition, S. Chand Limited, 2018.

Reference books:

1. S. Timoshenko and D.H. Young "Elements of Strength Materials Vol. I and Vol. II", T. Van
   Nostrand Co-Inc Princeton-N.J. 1990.
2. Parviz Ghavami, "Mechanics of Materials: An Introduction to Engineering Technology", First
   Edition, Springer International Publishing, 2015.

E-Books / Web References

1. http://www.springer.com/in/book/9783319061870
2. http://www.springer.com/in/book/9780278000520

MOOCs

1. https://onlinecourses.nptel.ac.in/noc19_me70/preview2.
2. https://nptel.ac.in/courses/112/106/112106138/

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 **onefull question from each module.**

Continuous Internal Evaluation (CIE):

Two Tests are to be conducted for 50 marks each. Marks scored in each test is reduced to 20 and addedto test component.

CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests. Two quizzes are to be conducted and each quiz is evaluated for 5 marks adding up to 10 marks.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	**20**	**50**
	CIE Test-2	**20**	
	Quiz 1/AAT	**05**	
	Quiz 2/AAT	**05**	
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
CO1			2												
CO2				3	3					3			2		
CO3	3			3	3					3					
CO4				2			2			3					
CO5		3					2					2		2	

Low-1: Medium-2: High-3

SEMESTER – III

COURSE: THERMODYNAMICS

Course Code	**20ANE33**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:2:0**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

Pre-requisites

- **Engineering Mathematics I, II**
- **Engineering Physics**

Course Objectives: To enable students to apply the knowledge of thermal engineering inbroad domain of aeronautical engineering by making them to learn:

CLO1	Basics of thermodynamics and use the first law of thermodynamics
CLO2	Concepts of the second law of thermodynamics using fundamental laws.
CLO3	Air standard cycles on different types of engines with special emphasis on mean effective pressure and P-V diagrams.
CLO4	Calculation of power developed from steam as the working medium
CLO5	Calculate the cooling load for human comfort in an air conditioning system

Content	**No. of Hours/ RBT levels**
Module 1 **FUNDAMENTAL CONCEPT AND FIRST LAW** Continuum, Macroscopic approach, Thermodynamic Systems – open, closed and isolated systems. Property, State, Path and Process, Quasi-static process, Work, internal energy, enthalpy, specific heat capacities and heat transfer, zeroth law of thermodynamics, First Law, Relation between pressure, volume and temperature for various processes.	**10 Hours/ L3**
Module 2 **SECOND LAW AND ENTROPY** Second Law – Kelvin Planck and Clausius statement, Reversibility and Irreversibility, Thermal Reservoir, Carnot Theorem, Carnot cycle, Reversed Carnot cycle, efficiency, COP, Thermodynamic temperature scale – Clausius inequality, Entropy, Change of entropy for various processes.	**10 Hours/ L3**
Module 3 **AIR STANDARD CYCLES** Otto, Diesel, Dual and Brayton cycles – air standard efficiency, Mean effective pressure. Actual and theoretical diagrams for I C Engines.	**10 Hours/ L3**

Module 4 **GAS CYCLES** Classification of a gas turbine. Applications, Simple open cycle gas turbine, Ideal and actual cycle for gas turbine, polytropic or small stage efficiency, cycle air rate, cycle work ratio, Optimum pressure ratio for maximum specific output in an actual gas turbine, optimum pressure ratio for maximum cycle thermal efficiency.	**10 Hours/ L3**
Module 5 **REFRIGERATION SYSTEM** Fundamentals of refrigeration, COP, Reversed Carnot cycle, Vapour compression refrigeration system, T-S, P-H diagrams, Vapour Absorption systems, Refrigerants – Types and properties.	**10 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Understand the basics of thermodynamics and use the first law of thermodynamics
CO2	Apply the concepts of the second law of thermodynamics using fundamental laws.
CO3	Able to imply on the air standard cycles on different types of engines with special emphasison mean effective pressure and P-V diagrams.
CO4	Able to calculate the power developed from steam as the working medium
CO5	Understand and be able to calculate the cooling load for human comfort.

Textbooks:

1. Yunus A. Cengal, "Thermodynamics an Engineering Approach", Tata McGraw - Hill Co. Ltd., 8th Edition, 2015.
2. P. K. Nag, "Engineering Thermodynamics", Tata McGraw-Hills Co., Ltd., 5th Edition, 2013.
3. Rajput, "Introduction to Thermodynamics", Lakshmi Publications, Mumbai, 2009.

Reference books:

4. E. Radhakrishnan, "Fundamentals of Engineering Thermodynamics", Prentice, Hall, India, 2006
5. Arora C. P, "Themodynamics", Tata McGraw-Hill, New Delhi, 2003
6. Holman J.P., "Thermodynamics", 3rd Edition, McGraw – Hill, 2007.

E-Books / Web References

1. https://docs.google.com/file/d/0B7OQo6ncgyFjZTdUWEItdHRGbHc/edit
2. https://books.google.co.in/books?id=GiLYEwSDLqsC&printsec=frontcover#v=onepage&q&f=f alse

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):

Two Tests are to be conducted for 50 marks each. Marks scored in each test is reduced to 20 and addedto test component.

CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests. Two quizzes are to be conducted and each quiz is evaluated for 5 marks adding

up to 10 marks.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	**20**	**50**
	CIE Test-2	**20**	
	Quiz 1/AAT	**05**	
	Quiz 2/AAT	**05**	
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
CO1	3		2												
CO2		3		3	3					3					
CO3				3	3					3					2
CO4				2			2			3				3	
CO5		3					2					2			

Low-1: Medium-2: High-3

SEMESTER – III

COURSE: FLUID MECHANICS

Course Code	**20ANE34**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:2:0**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

Pre-requisites

- **Engineering Mathematics I, II**
- **Engineering Physics**

Course Objectives: To enable students to apply the knowledge of fluids in broad domain ofaeronautical engineering by making them to learn:

CLO1	Basics of fluid properties and measurement of pressure
CLO2	Fluid kinematics and equations governing the same.
CLO3	Fluid Dynamics and applications of the Euler's equation
CLO4	Concepts of dimensional analysis
CLO5	Basics of turbines.

Content	**No. of Hours/ RBT levels**
Module 1 **FLUID PROPERTIES:** Definition and Units, Viscosity, Types of Fluids, Types of Flows. Hydrostatics: Buoyancy, Forces on submerged bodies, Manometers, Pressure Gauges.	**10 Hours/ L3**
Module 2 **FLUID KINEMATICS**: Continuity Equation (One and Three Dimensional), Flowvisualization, Velocity and Acceleration, Stream Function, Velocity Potential Function, Flow Net.	**10 Hours/ L3**
Module 3 **FLUID DYNAMICS**: Euler's equation of Fluid Motion, Bernoulli's Equation, Flow Measurements – Applications of Bernoulli's equation: Venturimeter, Pitot-Static tube and Orifice Plate. No derivations, Simple Problems	**10 Hours/ L3**
Module 4 **DIMENSIONAL ANALYSIS AND FLUID FLOW:** Rayleigh and Buckingham's π Theorem- Applications, Geometric, Dynamic and Kinematic Similarity, Fluid Flow: Pipe Flow, Friction Factor and Losses of head in pipes, Boundary Layer Flow, Boundary Layer Thickness and Boundary Layer Separation.	**10 Hours/ L3**

MODULE 5	
TURBOMACHINES: Classification, Working of a Turbomachine. CentrifugalPumps – Working, Head and Efficiency, Minimum Starting Speed. Reciprocating Pump: Working, Discharge and Work done by a Centrifugal Pump, Slip of a Reciprocating Pump.	**10 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Understand the properties, behavior of fluids.
CO2	Apply scientific method strategies to fluid mechanics: analyze qualitatively and quantitatively the problem situation, propose hypotheses and solutions
CO3	Analyze problems related to calculation of forces in fluid structure interaction
CO4	Apply the principles of dimensionless numbers, analyze the concepts of boundary layer and losses in fluid flow
CO5	Apply Euler's equation on working Principles of Turbomachines.

Textbooks:

1. Kumar K L, "Engineering Fluid Mechanics", Eighth Edition, S Chand, New Delhi, 2008
2. Munson, Bruce R, Young, Donald F, Wade W, "Fundamentals of Fluid Mechanics", 7th Edition, John Wiley and Sons, 2016
3. Modi and Seth, "Fluid Mechanics, Hydraulics and Hydraulic Machines", Stanford Publications, New Delhi 2002.

Reference books:

1. Streeter V L and Wylie, "Fluid Mechanics", Mc Graw Hill 1983.
2. Yunus A Cengel and John Cimbala, "Fluid Mechanics and Applications", Mc Graw Hill Education, 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 **onefull question from each module.**

Continuous Internal Evaluation (CIE):

Two Tests are to be conducted for 50 marks each. Marks scored in each test is reduced to 20 and addedto test component.

CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests.

Two quizzes are to be conducted and each quiz is evaluated for 5 marks adding up to 10 marks.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	**20**	**50**
	CIE Test-2	**20**	
	Quiz 1/AAT	**05**	
	Quiz 2/AAT	**05**	
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
CO1	3	3		3			2								
CO2				3	3					3					
CO3	3				3					3					
CO4							2			3					
CO5		3					2					2		2	

Low-1: Medium-2: High-3

SEMESTER – III

COURSE: BASICS OF AERONAUTICAL ENGINEERING

Course Code	**20ANE35**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:1:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Pre-requisites

- **Engineering Mathematics I, II**
- **Engineering Physics**

Course Objectives: To enable students to apply the knowledge of mechanics in broad domainof aeronautical engineering by making them to learn:

CLO1	Concepts of aircraft structures
CLO2	Basic Principles of flight.
CLO3	Concepts of Aero propulsion
CLO4	Concepts of aircraft stability
CLO5	Basics of Navigation systems

Content	No. of Hours/ RBT levels
Module 1 **BASICS AND INTRODUCTION TO AIRCRAFT STRUCTURES**: Classification of aircrafts, basic components of an aircraft, structural members, aircraft axis system, control surfaces and high lift devices. Helicopters – Their components andfunctions. Aircraft Structures: Classifications of structures – Monocoque, semi Monocoque and geodesic structures, typical wing and fuselage structure.	**8 Hours/ L3**
BASIC PRINCIPLES OF FLIGHT: Speed of sound – Significance. Bernoulli's theorem and its general application for generation of lift and measurement of air speed. Forces over wing section, aero foil nomenclature, pressure distribution over a wing section. Lift and drag components, generation of lift and drag, factors affecting lift and drag.	**8 Hours/ L3**
Module 3 **AERO PROPULSION**: Aircraft power plants Classification based on power plant and location and principle of operation. Turboprop, turbojet and turbofanengines, ram jets and scram jets – performance characteristics. Use of propellants and jets for production of thrust.	**8 Hours/ L3**

Module 4 **AIRCRAFT STABILITY**: Forces on an aircraft in flight, Static and dynamic stability, lateral, longitudinal and roll stability. Aircraft control systems, effect of flaps and stats on lift, control tabs, stalling, gliding, landing, turning. Aircraft maneuverers: Stalling, gliding and turning. Performance of aircrafts: Power curves, maximum and minimum speed for horizontal flight at a given altitude, effect of changes in engine power and altitude on performance	**8 Hours/ L3**
Module 5 **AIRCRAFT SYSTEMS**: Mechanical – Hydraulic, Pneumatic systems and their applications, environment control system, fuel and oxygen system. Electrical – Cockpit instrumentation and displays, Communication systems, navigation systems, power generation systems – engine driven alternators, auxiliary power module, power conversion, distribution and management.	**8 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Understand the different types of aircraft structures, helicopter components and fuselage.
CO2	Understand the concepts of speed of sound, applications of Bernoulli's theorem.
CO3	Apply the concepts of aero propulsion and the principle involved in aircraft structure.
CO4	Estimate the different forces in the aircraft, stability parameters and performance studies of aircrafts.
CO5	Understand the need and working of mechanical and electrical aircraft systems.

Textbooks:

1. John D Anderson, "Introduction to Flight", Mc Graw Hill Education, 2011.
2. Lalit Gupta and O P Sharma, "Fundamentals of flight Vol I to Vol IV", 2006.

Reference books:

1. A C Kermode, "Flight without formulae", Pearson Education, India, 1999.
2. Nelson R C, "Flight Stability and automatic control", Mc Graw Hill Education, 2011.

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 **onefull question from each module.**

Continuous Internal Evaluation (CIE):

Two Tests are to be conducted for 50 marks each. Marks scored in each test is reduced to 20 and addedto test component.

CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests. Two quizzes are to be conducted and each quiz is evaluated for 5 marks adding up to 10 marks.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	**20**	**50**
	CIE Test-2	**20**	
	Quiz 1/AAT	**05**	
	Quiz 2/AAT	**05**	
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
CO1		3					2								
CO2				3	3					3			3		
CO3	3			3	3					3					
CO4				2			2			3					
CO5		3					2					2		2	

Low-1: Medium-2: High-3

SEMESTER – III

COURSE: AIRCRAFT MATERIALS AND PRODUCTION

Course Code	**20ANE36**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Pre-requisites

- **Engineering Mathematics I, II**
- **Engineering Physics**

Course Objectives: To enable students to apply the knowledge of materials in broad domainof aeronautical engineering by making them to learn:

CLO1	Materials used in aircrafts
CLO2	Concepts of mechanical behavior of materials
CLO3	Various manufacturing techniques
CLO4	Principles of metal forming and its different types.
CLO5	Principles and types of non-conventional manufacturing process

Content	**No. of Hours/ RBT levels**
Module 1 **REQUIREMENTS OF AIRCRAFT MATERIALS, SELECTION OF MATERIAL FOR USE IN AIRCRAFTS:** Aluminum alloys, Magnesium alloys, Titanium alloys, Plain carbon and Low carbon steels, Copper alloys, Surface treatments aspect for each of the mentioned materials. Super Alloys: Introduction, Nickel based super alloys, cobalt based super alloys and iron based super alloys – Manufacturing processes associated with super alloys. Introduction to composite materials.	**8 Hours/ L3**
Module 2 **MECHANICAL BEHAVIOR OF MATERIALS**: Dislocation, Recrystallization and GrainGrowth, Iron carbon diagram, TTT diagram	**8 Hours/ L3**
Module 3 **INTRODUCTION TO MANUFACTURING**: Selection. Metal Joining techniques:Welding, Types – Arc Welding, Tungsten Inert Gas Welding, Metal Inert Gas Welding, Plasma Arc Welding, Resistance Welding.	**8 Hours/ L3**
Module 4 **METAL FORMING:** Principles of Forging, Rolling, Extrusion, Tube drawing, Sheet metal operations, Metal Spinning and Magnetic pulse forming	**8 Hours/ L3**
Module 5 **NON- CONVENTIONAL MACHINING PROCESS:** Abrasive jet Machining, Electric Discharge Machining, Electro- Chemical Machining, Ultrasonic Machining, Laser Beam Machining, Plasma Beam Machining.	**8 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Understand the types of materials used in aircrafts with special reference to super alloys.
CO2	Enumerate the Behavior of materials with an emphasized understanding of composition and temperature (Iron carbon and TTT diagram)
CO3	Understand and analyze the types of manufacturing process – metal joining
CO4	Understand the types of metal forming operations and its correlation to aircraft production.
CO5	Understand the latest in terms of machining technologies

Textbooks:

1. Titterton G F, "Aircraft Material and Processes", English Book store, 1998.
2. Serope Kalpakajian, "Manufacturing Engineering and Technology", Addison Wesley Publication, 3rd Edition, USA.
3. Hajra Chowdhary, "Elements of workshop technology", Vol 1 and 2, Media Promoters and Publishers, Mumbai 2005.

Reference books:

1. Hill E T, "The Materials of Aircraft Construction", Pitman London.

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 **onefull question from each module.**

Continuous Internal Evaluation (CIE):

Two Tests are to be conducted for 50 marks each. Marks scored in each test is reduced to 20 and addedto test component.

CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests. Two quizzes are to be conducted and each quiz is evaluated for 5 marks adding up to 10 marks.

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	**20**	**50**
	CIE Test-2	**20**	
	Quiz 1/AAT	**05**	
	Quiz 2/AAT	**05**	
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
CO1	3	3		3			2								
CO2				3	3										
CO3	3				3										
CO4							2								
CO5		3					2								

Low-1: Medium-2: High-3

SEMESTER – III

Course: ADDITIONAL MATHEMATICS

Course Code	**20MATDIP36**	**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 Mathematics in various fields ofengineering by making them to learn

CLO1	Derivatives, Polar curves and Radius of curvature
CLO2	Partial Derivatives and Jacobians
CLO3	Multiple integrals, beta & gamma functions
CLO4	Ordinary differential equations of first and second order

Content	No. of Hours/RBT levels
Module 1 Successive differentiation - simple problems. Polar Curves - angle between radius vector and tangent, angle between two curves, Pedal equation. Curvature and Radius of Curvature – Cartesian and Polar forms (without proof) –problems. Taylor's and Maclaurin's theorems for function of one variable (statement only)-problems.	**08 Hours / L2, L3**
Module 2 Evaluation of Indeterminate forms. Partial derivatives, Euler's theorem on homogeneous functions. Differentiation of implicit and composite functions. Jacobians. Taylor's theorem for functions of two variables. Maxima and Minima of functions of two variables.	**08 Hours / L2, L3**
Module 3 Multiple Integrals-Double integrals-introduction, direct evaluation, change oforder of integration, change of variables. Triple integrals-introduction and directevaluation. Beta and Gamma functions, relation between beta and gamma function, problems.	**08 Hours / L2, L3**
Module 4 Solution of first order and first degree differential equations – Variable Separable,Exact, reducible to exact and Bernoulli's differential equations. Applications: Orthogonal trajectories, Newton's law of Cooling and Electric Circuits.	**08 Hours / L2, L3**

Module 5	08 Hours /L2, L3
Second order linear ODE's with constant Coefficients-Inverse differential operators, method of variation of parameters, Cauchy's and Legendre's Linear differential equations.	

COURSE OUTCOMES:

Upon completion of this course, student will be able to

CO1	Apply the knowledge of differential calculus to solve problems related to curvature, maxima & minima of a function and Jacobians
CO2	Find area and volume of solids using multiple integrals
CO3	Evaluate definite integrals using beta and gamma functions
CO4	Solve linear differential equations of first and second order with constant/variable coefficients

Textbooks:

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

Reference books:

1. E. Kreyszig , Advanced Engineering Mathematics, John Wiley & Sons 10th Edition, 2016
2. N.P.Bali and Manish Goyal, A Textbook of Engineering Mathematics, Laxmi Publications 6thEdition, 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): Two Tests are to be conducted for 50 marks each. Marks scored in each test is reduced to 20 and added to test component. CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests.

Some possible AATs: seminar/assignments/ mini-projects/ concept videos/ partial reproduction ofresearch work/ group activity/ any other. Typical Evaluation pattern is shown in Table 1. **Table 1: Distribution of weightage for CIE & SEE of Regular courses**

Component		Marks	Total Marks
CIE	CIE Test-1	**20**	**50**
	CIE Test-2	**20**	
	Quiz 1/AAT	**05**	
	Quiz 2/AAT	**05**	
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
CO1	3	2	1									2			
CO2	3	2	1									2			
CO3	3	2	1									2			
CO4	3	2	1									2			
Average	3	2	1									2			

Low - 1: Medium - 2: High - 3

SEMESTER – III

COURSE: MATERIAL TESTING LABORATORY

Subject Code	**20ANEL37**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**0: 0: 2**	**SEE Marks**	**50**
Credits	**01**	**Examination Hours**	**03**

Course Objectives:

CLO1	To understand mechanical behaviour of various engineering materials by conducting standard tests.
CLO2	To learn material failure modes and the different loads causing failure.
CLO3	To learn the concepts of improving the mechanical properties of materials by differentmethods like heat treatment.
CLO4	To learn the concept of the preparation of samples to perform characterization such asmicrostructure and grain size.

Sl. No.	Experiments	No. of Hours/ RBT levels
	Part- A	
1	Brinell, Rockwell and Vicker's hardness test on various specimens.	**03 Hours / L1, L2, L3**
2	Izod and Charpy test on various specimens using impact-testing machine.	**03 Hours / L1, L2, L3**
3	Preparation of specimen for metallographic examination of different engineering materials. Study of microstructures of plain carbon steel, tool steel, gray CI, SG iron, brass, bronze & composite.	**03 Hours / L1, L2, L3**
4	To study the defects of cast and welded components using non-destructive tests: a) Ultrasonic flaw detection b) Magnetic crack detection c) Dye penetration testing.	**03 Hours / L1, L2, L3**
	Part - B	
1	Tensile, Shear, Bending and Compression tests of metallic and non-metallic specimen using Universal Testing Machine.	**08 Hours / L1, L2, L3**
2	Torsion test on metallic specimen using torsion testing machine.	**02 Hours / L1, L2, L3**
3	To study the wear characteristics of metals and non-metal materialsunder different parameters.	**02 Hours / L1, L2, L3**
4	Fatigue Test (demonstration only)	**02 Hours / L1, L2**

Course Outcomes:

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

CO1	Evaluate mechanical properties of engineering materials using universal testing machine.
CO2	Assess the impact strength of engineering materials using impact testing machine.
CO3	Examine the microstructure of the metals, alloys and composites using the optical microscope.
CO4	Evaluate torsional behaviour of shaft material.
CO5	Evaluate the hardness of the ferrous and non-ferrous materials.
CO6	Identify the defects in the material and in-service components using non-destructive testing methods.
CO7	Assess wear characteristics of metals and non-metals under different parameters

Textbooks:

1. Callister, W.D. Materials science and engineering: an introduction. John Wiley 6th Ed.
2. F. P. Beer & E. R. Johnston Mechanics of Material, 5th Edition, Tata McGraw Hill, New Delhi.

References:

1. Rajput, R K, Strength of materials in SI Units. Publisher N. S. Chand 7th edition.
2. Khurmi R S, Strength of materials: Mechanics of solids, Publisher N. S. Chand 24th edition.
3. Smith, W F, Hashemi J, Ravi Prakash, Materials science and engineering in S.I. Units.,McGraw Hill Education (India), 5th edition.
4. Shesha Prakash, M N, Suresh, Textbook of mechanics of materials, G.S. PHI Learning, 2011.
5. G E Dieter, Mechanical Metallurgy, SI Metric Edition, McGraw Hill.

Scheme of Examination:

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

	Component	Marks	Total Marks
SEE	PART- A	**15**	**50**
	PART- B	**25**	
	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	PSO3
CO1	3	1	1				1			1		1	2		
CO2	3	1	1				1			1		1	2		
CO3	3	1	1				1			1		1	2		
CO4	3	1	1				1			1		1	2		
CO5	3	1	1				1			1		1	2		
CO6	3	1	1				1			1		1	2		
CO7	3	1	1				1			1		1	2		

Low - 1: Medium - 2: High - 3

SEMESTER – III

COURSE: FOUNDRY, FORGING & WELDING LABORATORY

Subject Code	20ANEL38	CIE Marks	50
Hours/Week (L: T: P)	0:0:2	SEE Marks	50
Credits	01	Examination Hours	03

Course Objectives:

CLO1	Prepare sand specimens and conduct compression, shear, Grain fineness, Clay content andpermeability test.
CLO2	Create green sand mold using patterns.
CLO3	Prepare forged molds through various forging operations.
CLO4	Prepare welded joints using metal arc welding technique.

Sl. No.	Experiments	No. of Hours/RBT levels
PART- A : TESTING OF MOULDING SAND		
1	Compression and shear tests on universal sand testing machine.	02 Hours / L2, L3
2	Permeability test	01 Hours / L2, L3
3	Core hardness & mould hardness tests	01 Hours / L2, L3
4	Grain fineness number test (Sieve Analysis test)	02 Hours / L2, L3
5	Clay content tests and Moisture content tests.	02 Hours / L2, L3
PART - B : PREPARATION OF GREEN SAND MOULDS		
1	Single piece pattern	02 Hours / L2, L3
2	Split piece pattern.	02 Hours / L2, L3
PART - C: DEVELOPMENT OF CAST PRODUCT USING INDUCTION FURNACE		02 Hours / L2, L3
PART - D: PREPARATION OF FORGED MODELS		04 Hours / L2, L3
PART - E: PREPARATION OF WELDED JOINTS		02 Hours / L2, L3

DESIGN FOR CASTING (E-FOUNDRY VIRTUAL LAB) Determination of: Part Properties, Shape Complexity, Core Print, Buoyancy, Mold stress due to core, Mold Cavity layout, Solidification time, side feeder design, Insulated feeder design, Feeder neck design, Velocity and turbulence, casting fill time, gating choke design, gating sprue design, runner and gate design, casting yield, Tooling material cost, tooling manufacturing cost, Energy cost.	**02 Hours /L2, L3**

Course Outcomes:

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

CO1	Evaluate the properties of moulding sand by conducting compression, shear, and permeability test.
CO2	Develop green sand molds using single piece and split piece patterns.
CO3	Create forged components using different forging operations.
CO4	Demonstrate the different welded joints used in Arc welding technique.

Textbooks:

1. **P. N. Rao,** Manufacturing Technology Foundry, Forming & Welding, Volume-I, McGraw HillEducation India. 2019
2. **Dr. P.C. Sharma,** A Textbook of Production Technology, S.Chand & Company PVT.LTD, 4thEdition, 2014.

References:

1. **O.P. Khanna,** Foundry Technology, Dhanpat Rai Publications, 2017.
2. **Kalpakjian S., Schmid S.R**, Manufacturing Engineering & Technology, Pearson Edu Asia,4thEdition.
3. **Amitabha Ghosh, Ashok Kumar Malik,** Manufacturing Science, Affiliated East-West Press Ltd,1st Edition, 2015.
4. **Hajra Choudhary,** Workshop Technology, Media Promoters & Publishers, 13th Edition.

Scheme of Examination:

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

	Component	Marks	Total Marks
SEE	PART- A OR E	**10**	**50**
	PART- B OR D	**30**	
	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
CO1	3	2	1						2			1		
CO2	3	2	1						2			1		
CO3	3	2	1						2			1		
CO4	3	2	1						2			1		
Average	3	2	1						2			1		

Low - 1: Medium - 2: High - 3

SEMESTER – III

COURSE: Balake Kannada (for Non-Kannadiga Students)

Subject Code	20KVK39	CIE Marks	100
Hours/Week (L: T: P)	0:2:0	SEE Marks	-
Credits	0	Examination Hours	-

Course Learning Objectives:

The course will enable the students to understand Kannada and communicate (converse) in Kannada language.

Table of Contents

- Abbreviations
- Key to Transcription
- Easy learning of a Kannada Language: A few tips
- Necessity of learning a local langauge:
- Tips to learn the language with easy methods.
- Hints for correct and polite conservation
- About Kannada Language (Kannada Bhashe)
- Eight Kannada authors who have won 'Jnanpith Award'
- Information about Karnataka State

Part : I

Instructions to Teachers

1. How to Teach the BaLake Kannada Book
2. Methods to be followed in Teaching of all the chapters/ concepts

Chapter – 1 Listening and Speaking - KelisikoLLuvudu mattu Maatanaduvudu

1. Pronouns – SarvanaamagaLu
2. Adjectives – Naama VisheshaNagaLu
3. Verbs – KriyapadagaLu
4. Adverbs – KriyavisheshaNagaLu

Necessity of learning a local langauge:

The learning of local language,

- Encourages the respect for other people: it fosters an understanding of the interrelation of language and human nature.
- Expands one's view of the world, liberalizes one's experiences, and makes one more flexible and tolerant.
- Limits the barriers between people: barriers cause distrust and fear.
- Opens the door to art, music, dance, fashion, cuisine, film, philosophy, science...etc.
- Leads to an appreciation of cultural diversity.
- Helps fluent communication.

Language learning helps to develop strong cognitive skills, such as a better concept formation, mental flexibility, multitasking, listening skills and problem-solving, in addition to improve social interaction and also encourages the connection between peers.

Use of local language help to mingle with the local society and ensures security, pleasant welcoming from auto/cab drivers, shop owners, employees of local government etc., and make the living easier and more comfortable.

Tips to learn the language with easy methods.

Apart from the conventional method of learning from teachers, the learning of language can be accelerated by adopting the following methods.

1. Love the learning without boredom.
2. Talk to classmates and others in Kannada without hesitation and with no concern to grammatical mistakes during the initial stages of learning the language.
3. Use English words to continue the conversation when you find difficulty in finding suitable Kannada word/s. Vocabulary improves with the use of language.
4. While reading, read aloud (not silently or in a whisper manner, but audibly so that others are not being disturbed or others can hear what is being read). Reading aloud not only helps proper/ correct pronunciation of words with variation in pitch, pace, volume, pauses etc., but also produces a fluent and enjoyable delivery during conversation/debate/presentation.
5. Listen to Kannada news and watch Kannada movies.
6. Listen to Kannada FM radios for news, live conversations and songs.
7. Use online applications (apps) for fast learning.

Easy learning of a Kannada Language: A few tips

1. Watching Kannada movies (preferably with subtitles), can be of great help. This is an important and entertaining way to improve your language skills.
2. Do not hesitate. Speak the language at every possible opportunity.
3. Never mind if you are using less Kannada and more English words. Kanglish is anyway popular in Bangalore. However constantly try to improve your Kannada vocabulary.
4. Watch Kannada news. This is not only helpful in learning the language, but will help you to know your city better.
5. If you are a user of public transport, carefully listen to co-passengers' conversations.
6. Enjoy the local tang of the language by listening to Kannada FM stations.
7. Do not completely rely on 'Learn Kannada in 30 days' type of books. Many Bangaloreans will fail to comprehend your textbook language and you are sure to face some embarrassment, if you go strictly by books.

Hints for correct and polite conservation

1. Be vigilant about the verbs, the pronouns, the genders and tense required for day to day Conversation.
2. Pronounce the words properly.
3. Use plural form to address others.
4. Use simple sentences for conversation.

About Kannada Language (Kannada Bhashe)

- Kannada is one of the classical (Shastreeya) languages of India since November 01, 2008, and is the official language of the Karnataka state.
- This language is not just confined within the borders of Karnataka, for you will find it spoken by people in parts of the neighboring states of Andhra Pradesh, Tamil Nadu and Maharashtra. Kannada is spoken in its various dialects by Six to Seven million people across the globe. It is one among the top 40 most spoken languages of the world.
- Spoken Kannada is in use since 2500 years, and has its own script since 1900 years. Spoken Kannada varies according to the regions of Karnataka, while the written form of Kannada remains almost the same. Kannada is the third oldest language of India (after Sanskrit and Tamil).
- The written form of Kannada is phonetic and it is written as it is spoken.
- The first Kannada-English Dictionary (ShabdaKosha) was compiled in 1894 by a German priest, Rev. Ferdinand Kittel. He also wrote a book on Kannada Grammar entitled, "A Grammar of the Kannada Language: Comprising the Three Dialects of the Language".
- Several noted centuries old literary works of Kannada have been translated into Sanskrit, and other languages.
- November 1st of every year is celebrated as Kannada Rajyotsava Day throughout Karnataka state and is declared as a state holiday. This was the day that the name Karnataka was given to the Mysore state in the year 1973.

SEMESTER – III

COURSE: Samskruthika Kannada

Subject Code	20KAK39	CIE Marks	100
Hours/Week (L: T: P)	0:2:0	SEE Marks	-
Credits	0	Examination Hours	-

ಸಾಂಸ್ಕೃತಿಕ ಕನ್ನಡ ಕಲಿಕೆಯ ಉದ್ದೇಶಗಳು:

- ಪದವಿ ವಿದ್ಯಾರ್ಥಿಗಳಾಗಿರುವುದರಿಂದ ಸಾಂಸ್ಕೃತಿಕ ಕನ್ನಡ ಜೊತೆಗೆ ಕ್ರಿಯಾತ್ಮಕ ಕನ್ನಡವನ್ನು, ಕನ್ನಡ ಸಾಹಿತ್ಯ, ಸಂಸ್ಕೃತಿ ಮತ್ತು ನಾಡು ನುಡಿಯ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.
- ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಕನ್ನಡ ಭಾಷೆಯ ವ್ಯಾಕರಣದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು ಮತ್ತು ಕನ್ನಡ ಭಾಷಾ ರಚನೆಯಲ್ಲಿನ ನಿಯಮಗಳನ್ನು ಪರಿಚಯಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾ ಬರಹದಲ್ಲಿ ಕಂಡುಬರುವ ದೋಷಗಳು ಹಾಗೂ ಅವುಗಳ ನಿವಾರಣೆ.
- ಸಾಮಾನ್ಯ ಅರ್ಜಿಗಳು, ಸರ್ಕಾರಿ ಮತ್ತು ಅರೆ ಸರ್ಕಾರಿ ಪತ್ರವ್ಯವಹಾರದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು.
- ಭಾಷಾಂತರ ಮತ್ತು ಪ್ರಬಂಧ ರಚನೆ ಬಗ್ಗೆ ಆಸಕ್ತಿ ಮೂಡಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾಭ್ಯಾಸ, ಸಾಮಾನ್ಯ ಕನ್ನಡ ಹಾಗೂ ಆಡಳಿತ ಕನ್ನಡದ ಪದಗಳ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.

ಸಾಂಸ್ಕೃತಿಕ ಕನ್ನಡ ಪಠ್ಯಪುಸ್ತಕ

ಪರಿವಿಡಿ

ಭಾಗ – ಒಂದು ಲೇಖನಗಳು (ಕನ್ನಡ ನಾಡು, ನುಡಿ ಮತ್ತು ಸಂಸ್ಕೃತಿಗೆ ಸಂಬಂಧಿಸಿದ ಲೇಖನಗಳು)

೧. ಕರ್ನಾಟಕ ಸಂಸ್ಕೃತಿಗೆ : ಪಂಪ ನಾಗರಾಜಯ್ಯ

೨. ಕರ್ನಾಟಕದ ಏಕೀಕರಣ : ಒಂದು ಅಪೂರ್ವ ಚರಿತ್ರೆ – ಜಿ. ವೆಂಕಟಸುಬ್ಬಯ್ಯ

೩. ಆಡಳಿತ ಭಾಷೆಯಾಗಿ ಕನ್ನಡ – ವಿಶಾವಿಯ ಆಡಳಿತ ಕನ್ನಡ ಪುಸ್ತಕದಿಂದ ಆಯ್ದ ಲೇಖನ•

ಭಾಗ – ಎರಡು ಕಾವ್ಯ ಭಾಗ (ಆಧುನಿಕ ಪೂರ್ವ)

೪. ವಚನಗಳು : ಬಸವಣ್ಣ, ಅಕ್ಕಮಹಾದೇವಿ, ಅಲ್ಲಮಪ್ರಭು, ಆಯ್ದಕ್ಕಿ ಮಾರಯ್ಯ, ಜೇಡರ ದಾಸಿಮಯ್ಯ, ಆಯ್ದಕ್ಕಿ ಲಕ್ಕಮ್ಮ

೫. ಕೀರ್ತನೆಗಳು : ಅದರಿಂದೇನು ಫಲ ಇದರಿಂದೇನು ಫಲ – ಪುರಂದರದಾಸ

ತಲ್ಲಣಿಸದಿರು ಕಂಡ್ಯಾಕಾಳು ಮನವೆ – ಕನಕದಾಸ

೬. ತತ್ವಪದಗಳು : ಸಾವಿರ ಕೊಡಗಳ ಸುಟ್ಟು – ಶಿಶುನಾಳ ಷರೀಫ

ಶಿವಯೋಗಿ – ಬಾಲಲೀಲಾ ಮಹಾಂತ ಶಿವಯೋಗಿ

೭. ಜನಪದ ಗೀತೆ : ಬೀಸುವ ಪದ, ಬಡವರಿಗೆ ಸಾವ ಕೊಡಬೇಡ

ಭಾಗ – ಮೂರು ಕಾವ್ಯ ಭಾಗ (ಆಧುನಿಕ)

೮. ಮಂಕುತಿಮ್ಮನ ಕಗ್ಗ : ಡಿ.ವಿ.ಜಿ.

೯. ಕುರುಡು ಕಾಂಚಾಣ : ದ.ರಾ. ಬೇಂದ್ರೆ

೧೦. ಹೊಸಬಾಳಿನ ಗೀತೆ : ಕುವೆಂಪು

೧೧. ಹೆಂಡತಿಯ ಕಾಗದ : ಕೆ.ಎಸ್. ನರಸಿಂಹಸ್ವಾಮಿ

೧೨. ಮಬ್ಬಿನಿಂದ ಮಬ್ಬಿಗೆ : ಜಿ.ಎಸ್. ಶಿವರುದ್ರಪ್ಪ

೧೩. ಆ ಮರ ಈ ಮರ : ಚಂದ್ರಶೇಖರ ಕಂಬಾರ

೧೪. ಚೋಮನ ಮಕ್ಕಳ ಹಾಡು : ಸಿದ್ಧಲಿಂಗಯ್ಯ

ಭಾಗ – ನಾಲ್ಕು ತಾಂತ್ರಿಕ ವ್ಯಕ್ತಿ ಪರಿಚಯ, ಕಥೆ ಮತ್ತು ಪ್ರವಾಸ ಕಥನ

೧೫. ಡಾ. ಸರ್ ಎಂ. ವಿಶ್ವೇಶ್ವರಯ್ಯ – ವ್ಯಕ್ತಿ ಮತ್ತು ಐತಿಹ್ಯ : ಎ ಎನ್ ಮೂರ್ತಿರಾವ್

೧೬. ಯುಗಾದಿ : ವಸುಧೇಂದ್ರ

೧೭. ಮೆಗಾನೆ ಎಂಬ ಗಿರಿಜನ ಪರ್ವತ : ಪಿ.ಟಿ.ಪೋರಲಿಂಗಯ್ಯ

ಭಾಗ – ಐದು ವಿಜ್ಞಾನ ಮತ್ತು ತಂತ್ರಜ್ಞಾನ

೧೮. ಕರಕುಶಲ ಕಲೆಗಳು ಮತ್ತು ಪರಂಪರೆಯ ವಿಜ್ಞಾನ : ಕರಿಗೌಡ ದೀಚನಪಳ್ಳಿ

೧೯. 'ಕ' ಮತ್ತು 'ಬ' ಬರಹ ಶಂತ್ರಾಂಶಗಳು ಮತ್ತು ಕನ್ನಡದ ಟೈಪಿಂಗ್'

೨೦. ಕನ್ನಡ – ಕಂಪ್ಯೂಟರ್ ಶಬ್ದಕೋಶ'

೨೧. ತಾಂತ್ರಿಕ ಪದಕೋಶ : ತಾಂತ್ರಿಕ ಹಾಗೂ ಪಾರಿಭಾಷಿಕ ಕನ್ನಡ ಪದಗಳು'

'(ವಿಶಾವಿ ಯ ಆಡಳಿತ ಕನ್ನಡ ಪುಸ್ತಕದಿಂದ ಆಯ್ದ ಲೇಖನಗಳು – ಡಾ. ಎಲ್. ತಿಮ್ಮೇಶ ಮತ್ತು ಪ್ರೋ.ವಿ.ಕೇಶವಮೂರ್ತಿ)

SEMESTER – III

COURSE: CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND CYBER LAW

Course Code	20CPH39	CIE Marks	100
Hours/Week (L: T: P)	1 : 0 : 0	SEE Marks	-
No. of Credits	0	Examination Hours	-

Course Objectives:

CLO1	Know the fundamental political codes, structure, procedures, powers, and duties of Indiangovernment institutions, fundamental rights, directive principles, and the duties of citizens.
CLO2	Understand engineering ethics and their responsibilities; identify their individual roles and ethical responsibilities towards society.
CLO3	Know about the cybercrimes and cyber laws for cyber safety measures.

Content	No. of Hours
Module 1 **INTRODUCTION TO INDIAN CONSTITUTION:** The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian constitution, TheMaking of the Constitution, The Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India. Fundamental Rights and its Restriction and limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and significance in Nation building.	**03 Hours**
Module 2 **UNION EXECUTIVE AND STATE EXECUTIVE:** Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament- LS and RS, Parliamentary Committees, Important Parliamentary Terminologies.Supreme Court of India, Judicial Reviews and Judicial Activism. State Executives –Governor, Chief Minister, State Cabinet, State Legislature, High Court and SubordinateCourts, Special Provisions (Articles 370.371,371J) for some States.	**03 Hours**
Module 3 **ELECTIONS, AMENDMENTS AND EMERGENCY PROVISIONS:** Elections, Electoral Process, and Election Commission of India, Election Laws. Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments – 7, 9, 10, 12, 42, 44, 61, 73, 74, 75, 86 and 91, 94, 95, 100, 101, 118 and some important Case Studies. Emergency Provisions, types of Emergencies and its consequences. Constitutional special provisions: Special Provisions for SC and ST, OBC, Women, Children and Backward Classes.	**03 Hours**

Module 4 **PROFESSIONAL / ENGINEERING ETHICS:** Scope & Aims of Engineering & Professional Ethics - Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institution of Engineers (India): Profession, Professionalism, and Professional Responsibility. Clash of Ethics, Conflicts of Interest. Responsibilities in Engineering Responsibilities in Engineering and Engineering Standards, the impediments to Responsibility. Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering.	**03 Hours**
Module 5 **INTERNET LAWS, CYBER CRIMES AND CYBER LAWS:** Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of CyberCrimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship. Cybercrimes and enforcement agencies.	**03 Hours**

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

CO1	Have constitutional knowledge and legal literacy.
CO2	Understand Engineering and Professional ethics and responsibilities of Engineers.
CO3	Understand the cybercrimes and cyber laws for cyber safety measures.

Textbooks:

1. Constitution of India, Professional Ethics and Human, O Shubham Singles, Charles E. Haries,and et. al., Cengage Learning India, 2018.
2. Cyber Security and Cyber Laws, Alfred Basta and et. al., Cengage Learning India, 2018.

Reference Books:

1. Introduction to the Constitution of India, Durga Das Basu, Prentice –Hall, 2008.
2. Engineering Ethics, M. Govindarajan, S. Natarajan, V. S. Senthilkumar, Prentice – Hall, 2004.

Scheme of Examination:

There is no Semester End Examination for this course. The assessment is based on Continuous InternalEvaluation only.

Continuous Internal Evaluation (CIE):

CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests. Two quizzesare to be conducted and each quiz is evaluated for 5 marks adding up to 10 marks.

All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzeseffectively. Typical Evaluation pattern for this course is shown in Table 2.

Table 2: Distribution of weightage for CIE

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**100**
	CIE Test-2	**40**	
	Quiz 1/AAT	**10**	
	Quiz 2/AAT	**10**	
Grand Total			**100**

SEMESTER - IV

COURSE CURRICULUM(UG PROGRAMME) (CORE COURSES)

Applicable from 2021 – 2022

SEMESTER – IV

COURSE: TRANSFORMS, CALCULUS OF VARIATION AND NUMERICAL TECHNIQUES

Course Code	**20MAT41C**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:2: 0**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

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

CLO1	Laplace and Fourier Transforms
CLO2	Fourier series of periodic functions
CLO3	Heat and Wave equations
CLO4	Numerical solutions of differential equations
CLO5	Variational calculus

Content	**No. of Hours/ RBT levels**
Module 1 Laplace transforms of elementary functions, Laplace transforms of Periodic functions, unit-step function and Dirac delta function. Inverse Laplace Transform,Convolution theorem (without Proof), Solution of second order linear differential equations using Laplace transforms.	**10 Hours / L2, L3**
Module 2 Fourier series of periodic functions, half range Fourier sine and cosine series.Practical harmonic analysis. Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms and problems.	**10 Hours / L2, L3**
Module 3 Applications of partial differential equations: Vibrations of a stretched string- wave equation, one-dimensional heat flow. Two-dimensional heat flow, Solution of Laplace's equation, Laplace's equation in polar coordinates. Two dimensional wave equation.	**10 Hours / L2, L3**
Module 4 Numerical solution of ordinary differential equations of first order and first degreeusing 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 using Runge-Kutta method and Milne's method.	**10 Hours / L2, L3**
Module 5 Numerical solution of heat equation by Smith and Crank-Nicolson method. Numerical solution of wave equations explicit method. Variation of function and functional, variational problems, Euler's equation, Geodesics, Isoperimetric problems.	**10 Hours / L2, L3**

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

CO1	Determine Laplace and inverse Laplace transforms of given functions leading to the solution of linear differential equations.
CO2	Apply Fourier series to transform periodic signals into fundamental frequencies.
CO3	Apply Fourier Transforms to transform continuous time signals from time domain to frequency domain and vice versa.
CO4	Solve problems related to heat and wave equations.
CO5	Solve ordinary differential equations of first and second order using single step and multistep numerical methods.
CO6	Determine the extremal of functional using calculus of variations.

Textbooks:

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

Reference books:

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

Scheme of Examination:

Semester End Examination (SEE): SEE Question paper is to be set for 100 marks and the marks scoredwill be proportionately reduced to 50. There will be two full questions (with a maximum of three subquestions) 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 50 marks each. Marks scoredin each test is reduced to 20 and added to test component. CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests.
Some possible AATs: seminar/assignments/ mini-projects/ concept videos/ partial reproduction of research work/ group activity/ any other. Typical Evaluation pattern is shown in Table 2.

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

	Component	Marks	Total Marks
CIE	CIE Test-1	**20**	**50**
	CIE Test-2	**20**	
	Quiz 1/AAT	**05**	
	Quiz 2/AAT	**05**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

CO/PO Mapping															
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	3	2	1									3			
CO2	3	2	1									3			
CO3	3	2	1									3			
CO4	3	2	1									3			
CO5	3	2	1									3			
CO6	3	2	1									3			
Average	3	2	1									3			

Low - 1: Medium - 2: High - 3

SEMESTER IV

COURSE: AERODYNAMICS – I

Course Code	**20ANE42**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:2:0**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

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

CLO1	Basics of two dimensional flows
CLO2	Concepts of conformational transformation and its application to fluid flow problems
CLO3	Basics of airfoil and wing theory
CLO4	Principles of metal forming and its different types.
CLO5	Principles of boundary layer and displacement thickness

Content	No. of Hours/ RBT levels
Module 1 **REVIEW OF BASIC FLUID MECHANICS**: Euler equation, incompressible Bernoulli's equation - Continuity, momentum and energy equations in integral and differential form in Cartesian co-ordinate system.	**10 Hours/ L3**
Module 2 **TWO DIMENSIONAL FLOWS:** Basic flows – Source, Sink, Free and Forced vortex, uniform parallel flow. Their combinations, Pressure and velocity distributions onbodies with and without circulation in ideal and real fluid flows. Kutta Joukowski's theorem. D' Alembert Paradox, Magnus effects.	**10 Hours/ L3**
Module 3 **CONFORMAL TRANSFORMATION:** Complex potential, methodology of conformal transformation-Joukowski transformation and its application to fluid flow problems, Kutta condition, Blasius theorem.	**10 Hours/ L3**
Module 4 **AIRFOIL AND WING THEORY:** Airfoils Nomenclature and NACA series, Airfoil Characteristics, Vortex sheet, Kelvin Circulation theorem. Thin aerofoil theory and its applications. Introduction to Finite wing, Downwash and Induced Drag, Biot -Savart law and Helmhotz's theorems, Horse shoe vortex ,Prandtl's Classical Lifting line theory and its limitations.	**10 Hours/ L3**
Module 5 **VISCOUS FLOW**: Boundary layer and boundary layer thickness, displacement thickness, momentum thickness, energy thickness, boundary layerequations for a steady, two-dimensional incompressible flow, boundary layer growth over a flat plate, critical Reynolds number, Blasius solution	**10 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Apply the concept of Basic Fluid mechanics into aerodynamics to predict the suitable governing equations.
CO2	Obtain mathematical model of different types of flows and its combinations. Also find the pressure and velocity distribution for the simple objects
CO3	Apply mathematical modelling using conformal transformation for the airfoil
CO4	Develop a mathematical model using conformal transformation for the airfoil.
CO5	Apply the real time viscous flow and Boundary Layer behavior to airfoils

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 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):

Two Tests are to be conducted for 50 marks each. Marks scored in each test is reduced to 20 andadded to test component.

CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests. Two quizzes are to be conducted and each quiz is evaluated for 5 marks adding up to 10 marks.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	**20**	**50**
	CIE Test-2	**20**	
	Quiz 1/AAT	**05**	
	Quiz 2/AAT	**05**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

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

Low-1: Medium-2: High-3

SEMESTER IV

COURSE: AERO PROPULSION – I

Course Code	**20ANE43**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:2:0**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

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

CLO1	Fundamentals of gas turbine engines
CLO2	Nozzles and Aircraft inlets
CLO3	Aircraft compressors
CLO4	Concepts of combustion chambers
CLO5	Aircraft turbines

Content	No. of Hours/ RBT levels
Module 1 **FUNDAMENTAL OF GAS TURBINE ENGINES:** Review of thermodynamic cycles, Various method to improve efficiency and work output of gas turbine, Fundamentals of gas turbine engine use as aircraft power plant, Fundamental thrust equation, Factors affecting the thrust, Effect of pressure temperature and velocity on thrust, Different types of aircraft power plant - Performance characteristics - comparison	**10 Hours/ L3**
Module 2 **AIRCRAFT INLETS AND NOZZLE**: Basic of one dimensional Inlet flow - Subsonic Inlet - Supersonic Inlet - Internal, External and Mixed compression inlet - Mass flow characteristics - starting problem on supersonic inlets -. Applications to Nozzles and Exhaust velocity of nozzle - Area-Mach relation and types of nozzle- - nozzle efficiency - losses in nozzles - over expanded and under - expanded nozzles.	**10 Hours/ L3**
Module 3 **AIRCRAFT COMPRESSORS:** Centrifugal compressor: Principle of operation,Velocity Triangle, Work done and Pressure rise - Inlet Duct; Impeller; Slip factor - Centrifugal Compressor Characteristics: Surging and Choking. AxialFlow Compressor: Elementary theory, Velocity triangle, and Stage pressure rise - Factors affecting stage pressure ratio - Degree of reaction -free vortex design - Axial Compressor Characteristics.	**10 Hours/ L3**
Module 4 **COMBUSTION CHAMBER:** Types of combustion chambers in aircraft engines- Gas Turbine Combustion Mechanism: Flame stabilization and Flame Tube cooling - Important Combustion parameters: equivalence ratio, Percentage of Theoretical air and Excess air, Pressure losses, Combustion efficiency, Combustion intensity - Combustion Stability limits and Instability - Fuel injection systems – Gas turbine Emissions.	**10 Hours/ L3**

Module 5	
AIRCRAFT TURBINES: Impulse and reaction blading of gas turbines - Velocity triangles and power output - Elementary theory - Vortex theory - Choice of blade profile, pitch and chord - Estimation of stage performance - Limiting factors in gas turbine design- Overall turbine performance - Methods of blade cooling - Matching of turbine and compressor.	**10 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Analyze the different modes of fluid mechanics and heat transfer.
CO2	Analyze the fluid operating parameters and energy transfer parameters.
CO3	Analyze the incompressible and compressible flow propulsion.
CO4	Apply the various propulsion techniques.
CO5	Analyze the turbine performance.

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", StandardPublishers & Distributors, Delhi, 2010.

Reference books:

1. Jack D. Mattingly, "Element of Propulsion- Gas turbine and rockets", AIAA EducationSeries, New York, 2016.
2. H. Cohen, G. F. C. Rogers and H. I. H. Saravanamuttoo, "Gas Turbine Theory",Pearson Education, 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 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):

Two Tests are to be conducted for 50 marks each. Marks scored in each test is reduced to 20 andadded to test component.

CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests. Two quizzes are to be conducted and each quiz is evaluated for 5 marks adding

up to 10 marks.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	**20**	**50**
	CIE Test-2	**20**	
	Quiz 1/AAT	**05**	
	Quiz 2/AAT	**05**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

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

Low-1: Medium-2: High-3

SEMESTER IV

COURSE: AIRCRAFT STRUCTURAL MECHANICS

Course Code	**20ANE44**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:2:0**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

Course Objectives: To enable students to apply the knowledge of mechanics in broad domainof aeronautical engineering by making them to learn:

CLO1	Statically Determinate structures
CLO2	Statically Indeterminate Structures
CLO3	Unsymmetrical Bending
CLO4	Buckling of columns
CLO5	Crippling of Panels

Content	No. of Hours/ RBT levels
Module 1 **STATICALLY DETERMINATE STRUCTURES**: Statically determinate and indeterminatesystems, analysis of plane truss; method of joints, method of sections, analysis of space truss and plane frames, Principle of virtual work, Deflection of truss, frame and rings using unit load method	**10 Hours/ L3**
Module 2 **StATICALLY INDETERMINATE STRUCTURES:** Shear force and bending moment of fixed- fixed beam, Propped cantilever beam, Continuous beam, Clapeyron's Three Moment Equation, Moment Distribution Method. Deflection of indeterminate beams using energy method and unit load method	**10 Hours/ L3**
Module 3 **UNSYMMETRICAL BENDING**: Bending stresses in beams of unsymmetrical sections, Bending of symmetric sections with Skew loads, Principal axis method, Neutral axis method, Generalized K method	**10 Hours/ L3**
Module 4 **BUCKLING OF COLUMNS**: Columns with various end conditions, Euler's Columncurve, inelastic buckling, Rankine's formula, Column with initial curvature, Eccentric loading, South well plot, Beam column	**10 Hours/ L3**
Module 5 **BUCKLING AND CRIPPLING OF PANELS:** Bending of thin plates, Rectangular sheets under compression, Local buckling stress of thin walled sections, Crippling stresses by Needham's and Gerard's methods. Thin-walled column strength. Sheet stiffener panels. Effective sheet width, inter rivet and sheet wrinkling failures	**10 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Analyze the truss structure and find forces acting in the individual members deflections of the truss with the nature using different methods.
CO2	Analyze the reaction forces for indeterminate beams, draw shear force and bending moment diagrams for indeterminate beams using different methods.
CO3	Evaluate the bending stresses in unsymmetrical sections using different methods
CO4	Calculate crippling load of columns and beam columns with various end conditions using Euler's method and Rankine's formula.
CO5	Analyze the buckling and crippling characteristics of rectangular shear panels.

Textbooks:

1. T.M.G. Megson, "Aircraft Structures for Engineering Students", Fifth edition,
   ButterworthHeinemann, 2012.
2. D.J. Peery, "Aircraft Structures", Dover Publications Inc., 2011.

Reference books:

1. B.K. Donaldson, "Analysis of Aircraft Structures - An Introduction", Second edition,Cambridge University Press, 2012.
2. Howard D Curtis, 'Fundamentals of Aircraft Structural Analysis', WCB- McGraw Hill,
   1997.

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):

Two Tests are to be conducted for 50 marks each. Marks scored in each test is reduced to 20 andadded to test component.

CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests.

Two quizzes are to be conducted and each quiz is evaluated for 5 marks adding up to 10 marks.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	**20**	**50**
	CIE Test-2	**20**	
	Quiz 1/AAT	**05**	
	Quiz 2/AAT	**05**	
SEE	Semester End Examination	**50**	**50**
Grand Total			**100**

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

Low-1: Medium-2: High-3

SEMESTER IV

COURSE: MEASUREMENTS AND METROLOGY

Course Code	**20ANE45**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0: 0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Prerequisites: Engineering Physics

Course Objectives: To enable students to apply the knowledge of materials and alloys by making themlearn

CLO1	Standards of measurement, errors in measurement, limits and fits as applied to industrial specific standards
CLO2	Gauges, Basics of Geometrical Dimensioning and Tolerances
CLO3	Types of comparators, principles and devices used for angular measurement.
CLO4	Static characteristics of measurement, types and principle of working of transducers
CLO5	Principles of strain, temperature and pressure measurement

Content	**No. of Hours/RBT levels**
Module 1 **STANDARDS OF MEASUREMENT:** Definition and Objectives of metrology, line and endstandard, Transformation from line standard to end standard, calibration of end standards, Characteristics/Numericals. Definitions and concept of accuracy, precision. Errors in measurement, classification of errors. **Tolerances:** Definition of tolerance, specification in assembly, principle of interchange ability and selective assembly. Concept of limits, size and tolerances, compound tolerances, accumulation of tolerances.	**8 Hours / L2**
Module 2 **SYSTEM OF LIMITS, FITS, TOLERANCE AND GAUGES:** Limits, Fits and Tolerances, Principle of interchangeability and selective assembly, Hole base system & shaft basesystem, Limit gauging, classification of gauges, Taylor's principle, Numerical on limit gauge design. **GEOMETRICAL DIMENSIONING AND TOLERANCES :** Types of GD&T, Datum, Machine tool tests to check for Straightness, Flatness, Parallelism, Squareness, Roundness, Cylindricity, Runout Coordinate Measuring Machines: Structure, Probes, Operation, Applications of CMM.	**8 Hours / L3**
Module 3 **COMPARATORS:** Introduction to Comparators, characteristics, and classification of comparators. Measurements using Autocollimator, NPL	**8 Hours / L3**

flatness interferometer, Laser interferometer. Angular measurements, Bevel Protractor, Sine Principle and use of Sine bars, Sine centre, use of angle gauges, (numerical on building of angles) Clinometers.	
Module 4 **MEASUREMENT SYSTEMS AND METHODS :** Definition, Significance of measurement, Generalized measurement system, Static characteristics- Accuracy, Precision, Calibration, Threshold, Sensitivity, Hysteresis, Repeatability, Linearity, Loadingeffect, Dynamic characteristics- System response, Time delay. Errors in measurement, Classification of errors. **TRANSDUCERS** Transfer efficiency, primary and secondary transducers, and classification of transducers with examples. Quality attributes of transducers, intermediate modifying devices. Measurement of Force and Torque: Basic principles, proving ring, torque measurement, Prony brake, hydraulic dynamometer.	**8 Hours / L3**
Module 5 **MEASUREMENT OF STRAIN, TEMPERATURE, AND PRESSURE STRAIN MEASUREMENT**: Theoryof strain gauges, Types, Electrical resistance strain gauge, Preparation and mounting of Strain gauges, Gauge factor, Methods of strain measurement. Temperature measurement: Resistance thermometers, Thermocouple, Law of thermocouple, materials used for construction. **PRESSURE MEASUREMENT**: Basic principles, use of elastic members, Bridgeman gauge, McLeod gauge.	**8 Hours / L3**

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

CO1	Interpret the concept of standards in measurement, tolerances, interchangeability in measurements.
CO2	Apply the concepts of limits, fits, tolerances, geometrical tolerances in assemblies and industry components.
CO3	Explore the process of linear and angular measurements as applied to a few machine made components.
CO4	Infer on the concept of error measurement, principles of transducers and their measurement of force and torque.
CO5	Demonstrate the measurement of pressure, temperature and strain measurement.

Textbooks:

1. **Beckwith Marangoni and Lienhard** Mechanical Measurements by, Pearson Education, 6thEd.,2006.
2. **B C Nakra, K K Chaudhry** Instrumentation, Measurement and Analysis, McGraw–Hill, 4thEdition.
3. **R.K. Jain Engineering** Metrology, Khanna Publishers, 2009.

Reference books:

1. **N.V.Raghavendra and L.Krishnamurthy**, Engineering Metrology and Measurements, OxfordUniversity Press.
2. **Ernest Deoblin**, Deoblin's Measurement system, Dhanesh manick, McGraw–Hill
3. **Bentley**, Engineering Metrology and Measurements, Pearson Education.

MOOCs

1. https://onlinecourses.nptel.ac.in/noc19_me70/preview
2. https://nptel.ac.in/courses/112/106/112106138/

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):

Two Tests are to be conducted for 50 marks each. Marks scored in each test is reduced to 20 andadded to test component.

CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests. Two quizzes are to be conducted and each quiz is evaluated for 5 marks adding

up to 10 marks.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	**20**	**50**
	CIE Test-2	**20**	
	Quiz 1/AAT	**05**	
	Quiz 2/AAT	**05**	
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
CO1			2												
CO2				3	3					3					
CO3				3	3					3					
CO4				2			2			3					
CO5							2					2			

Low - 1: Medium - 2: High - 3

SEMESTER IV

COURSE: COMPUTER AIDED AIRCRAFT DRAWING

Course Code	**20ANE46**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**2: 0: 2**	**SEE Marks**	**50**
No. of Credits	**3**	**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 Solid Edge software andproduce drawings using orthographic projections.
CLO2	Draw the 3D part Model from the 2D sketches using Solid edge.
CLO3	Develop Part Models and create assembly using Solid edge.
CLO4	Convert Assembly drawing into 2D drafting and generate Bill of materials for assembleddrawing.
CLO5	Create exploded views, rendering using Solid Edge.

Content	**No. of Hours/RBT levels**
Module 1 **SKETCHING:** **Introduction to Solid Edge Software** 1. 3D Sketching Overview 2. Drawing ordered sketches of parts 3. Drawing commands 4. Sketch geometric relationships 5. Dimensioning sketches 6. Sketches in Path Finder 7. Moving sketches 8. Projecting elements onto a sketch plane **ORTHOGRAPHIC PROJECTIONS:** Introduction to orthographic projection, drawing of simple machine elements in first angle projection. Principle of visualization of objects, sectional views, full and half-sectional views.	**08 Hours / L3**
Module 2 **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).	**08 Hours / L6**
Module 3 **ASSEMBLY DESIGN** 1. Solid Edge Assembly 2. More Assembly Relationships	**08 Hours / L6**

3. The Assemble command 4. Assembly features 5. Assembly patterning 6. Inspecting assemblies 7. Replacing parts in an assembly Limits, fits and tolerances, types of tolerances and fits, hole basis and shaft basisof fits, and geometric dimensioning and tolerance. **Introduction to assembly drawing:** Assembly of propeller and hub assembly,wing assembly, fuselage assembly, engine mounts, helicopter rotor blade assembly, landing gear assembly. (Detailed 2D part drawings will be given). Student to complete at least three of the assembly drawings.	
Module 4 **DRAFTING:** 1. Creating detailed drawings 2. Drawing creation 3. Dimensions, Annotations and Parts Lists 4. Detailing a drawing 5. Bill of Materials **Conversion of Assembled view to 2D drafting.**	**08 Hours / L2**
Module 5 **THE EXPLODE-RENDER APPLICATION:** 1. Exploding an assembly 2. Rendering - define textures, lighting, shadows, backgrounds and otherproperties to create presentation style images. **Assign material properties and textures to parts and subassemblies.**	**08 Hours / L2**

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, 6th Edition, 2019.
2. Sidheshwar, Machine Drawing, Tata McGraw-Hill Education, 33 reprint 2006.
3. R. K. Dhawan, Machine Drawing, S Chand Publishing reprint, 2006.

E-Books / Web References

1. Solid Edge 2021 Part Design Tutorial for Beginner [COMPLETE].
2. https://www.youtube.com/watch?v=pgSHJmObd00
3. Solid Edge fundamentals https://support.industrysoftware.automation.siemens.com/training/se/en/ST4/pdf/mt0141 3-s-1040_en.pdf.
4. Assembly : https://support.industrysoftware.automation.siemens.com/training/se/en/ST4/pdf/spse016 60-s-1040_en.pdf
5. Explode — Render — Animate application : https://d2t1xqejof9utc.cloudfront.net/files/17325/SolidEdge_ERA_2.pdf?1357790407
6. Computer Mouse (Solid Edge Tutorial): https://www.youtube.com/watch?v=0SuN3pVSE_8

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 three full questions. First two module carrying 20 marks each and one full questionfrom the remaining three modules for 60 marks. Students are required to answer any **three full questions** choosing at least **one full question from each module.**

Continuous Internal Evaluation (CIE):

Two Tests are to be conducted for 50 marks each. Marks scored in each test is reduced to 20 and added to test component.

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	**20**	**50**
	CIE Test-2	**20**	
	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	PO1	PO1	PO1	PSO	PSO
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

SEMESTER IV

COURSE: MEASUREMENTS & METROLOGY LABORATORY

Subject Code	20ANEL47	CIE Marks	50
Hours/Week (L: T: P)	0:0:2	SEE Marks	50
Credits	01	Examination Hours	03

Course Objectives:

CLO1	Understand the principles of measuring instruments and gauges and their uses.
CLO2	Inspect spur gear and thread elements.
CLO3	Understand the process of evaluation and inspection of surface roughness.
CLO4	To understand calibration techniques of various measuring devices.

Sl. No.	Experiments	No. of Hours/RBT levels
	Part- A	
1	Calibration of Pressure Gauge using Bourdon tube measurement.	**02 Hours / L3**
2	Calibration of Thermocouple.	**02 Hours / L3**
3	Calibration of LVDT using micrometer.	**02 Hours / L3**
4	Calibration of Load cell using standard weights.	**02 Hours / L3**
5	Calibration of Micrometer using slip gauges.	**02 Hours / L3**
6	Determination of modulus of elasticity of a mild steel specimen using strain gauges.	**02 Hours / L3**
	Part - B	
1	Measurements using Optical Projector.	**02 Hours / L3**
2	Measurement of angle using Sine Centre / Sine bar / Bevel protractor.	**02 Hours / L3**
3	Measurement of alignment using Autocollimator.	**02 Hours / L3**
4	Measurements of Screw thread parameters using two wire or three-wire methods.	**02 Hours / L3**
5	Measurements of surface roughness using Tally Surf/Mechanical Comparator.	**02 Hours / L3**
6	Measurement of gear tooth profile using gear tooth Vernier/Gear tooth micrometer	**02 Hours / L3**

Demonstration:		
1	Measurement using Optical Flats.	**01 Hours / L2**
2	Measurement using Tool makers Microscope.	**01 Hours / L2**

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

CO1	Demonstrate the procedure of measurements and calibration of various measuring devices and systems.
CO2	Illustrate the methods for form measurements.
CO3	Demonstrate the use of Mechanical and optical comparators to measure the manufactured parts.
CO4	Evaluate the surface quality of a machined component using Surface roughness tester.

Textbooks:

1. B C Nakra, K K Chaudhry, Instrumentation, Measurement and Analysis, McGraw–Hill, 4th Edition.
2. Beckwith Marangoni and Lienhard, Mechanical Measurements, Pearson Education, 6th Edition, 2006.
3. R.K. Jain, Engineering Metrology, Khanna Publishers, 2009.

References:

1. Ernest Deoblin, Dhanesh manick, Deoblin's Measurement system, McGraw–Hill.
2. Bentley, Engineering Metrology and Measurements, Pearson Education Engineering.
3. N. V. Raghavendra and L. Krishnamurthy, Metrology and Measurements, Oxford University.

Scheme of Examination:

Semester End Examination (SEE):

	Component	Marks	Total Marks
SEE	PART- A	**15**	**50**
	PART- B	**25**	
	VIVA-VOCE	**10**	
SEE Total			**50**

Continuous Internal Evaluation (CIE):

	Component	Marks	Total Marks
CIE	MANUAL / RECORD	**20**	**50**
	CIE Test	**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
CO1	3	1		2					1			1		3
CO2	3	1		2					1			1		3
CO3	3	1		2					1			1		3
CO4	3	1		2					1			1		3
Average	3	1		2					1			1		3

Low - 1: Medium - 2: High - 3

SEMESTER IV

COURSE: FLUID MECHANICS LABORATORY

Subject Code	**20ANEL48**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**0:0:2**	**SEE Marks**	**50**
Credits	**01**	**Examination Hours**	**03**

Course Objectives:

CLO1	This course will provide a basic understanding of flow measurements using various types of flow measuring devices, calibration and losses associated with these devices.
CLO2	Energy conversion principles, analysis and understanding of hydraulic turbines and pumps.Performance analysis will be carried out using characteristic curves.
CLO3	Performance analysis of turbines and pumps will be carried out using characteristic curves

Sl. No.	**Experiments**	**No. of Hours/ RBT levels**
	Part- A	
1	Lab layout, calibration of instruments and standards to be discussed	**02 Hours / L2**
	Part - B	
1	Application of momentum equation for determination of coefficient ofimpact of jets on flat and curved blades	**02 Hours / L2**
2	Calibration of Orifice Meter	**02 Hours / L2**
3	Calibration of Orifice Meter Venturimeter	**02 Hours / L2**
4	Calibration of Orifice Meter V-Notch	**02 Hours / L2**
5	Performance Characteristics of Pelton Wheel	**02 Hours / L2**
6	Performance Characteristics of Kaplan Turbine	**02 Hours / L2**
7	Performance Characteristics of Francis Turbine	**02 Hours / L2**
8	Performance Testing of Single stage centrifugal pumps	**02 Hours / L2**
9	Performance Testing of Multi stage centrifugal pumps	**02 Hours / L2**
10	Performance Testing of Reciprocating pump	**02 Hours / L2**

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

CO1	Apply momentum equation for determination of coefficient of friction for impact of jets
CO2	Perform experiments to determine the coefficient of discharge of flow measuring devices
CO3	Conduct experiments on hydraulic turbines to draw characteristic curves.
CO4	Conduct experiments on pumps to draw characteristic curves.
CO5	Exhibit competency towards preventive maintenance of hydraulic machines

Textbooks:

1. Kumar K L, "**Engineering Fluid Mechanics**", Eighth Edition, S Chand, New Delhi, 2008
2. Modi and Seth, "**Fluid Mechanics, Hydraulics and Hydraulic Machines**", Stanford Publications, New Delhi 2002.

Scheme of Examination:

Semester End Examination (SEE):

Two experiments to be performed	2*40 = 80
Viva Voce	**20 Marks**

Note: SEE will be conducted for 100 Marks and reduced to 50

Continuous Internal Evaluation (CIE):

Weekly performance - Lab participation + Report	**30 Marks**
One Internal Assessment at the end of semester	**20 Marks**

CO/PO Mapping

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

Low - 1: Medium - 2: High - 3

SEMESTER – IV

COURSE: Balake Kannada (for Non-Kannadiga Students)

Subject Code	20KVK49	CIE Marks	100
Hours/Week (L: T: P)	0:2:0	SEE Marks	-
Credits	0	Examination Hours	-

Course Learning Objectives:

The course will enable the students to understand Kannada and communicate (converse) in Kannada language.

Table of Contents

- Abbreviations
- Key to Transcription
- Easy learning of a Kannada Language: A few tips
- Necessity of learning a local langauge:
- Tips to learn the language with easy methods.
- Hints for correct and polite conservation
- About Kannada Language (Kannada Bhashe)
- Eight Kannada authors who have won 'Jnanpith Award'
- Information about Karnataka State

Part : I

Instructions to Teachers

1. How to Teach the BaLake Kannada Book
2. Methods to be followed in Teaching of all the chapters/ concepts

Chapter – 1 Listening and Speaking - KelisikoLLuvudu mattu Maatanaduvudu

1. Pronouns – SarvanaamagaLu
2. Adjectives – Naama VisheshaNagaLu
3. Verbs – KriyapadagaLu
4. Adverbs – KriyavisheshaNagaLu

Necessity of learning a local langauge:

The learning of local language,

- Encourages the respect for other people: it fosters an understanding of the interrelation of language and human nature.
- Expands one's view of the world, liberalizes one's experiences, and makes one more flexible and tolerant.
- Limits the barriers between people: barriers cause distrust and fear.
- Opens the door to art, music, dance, fashion, cuisine, film, philosophy, science...etc.
- Leads to an appreciation of cultural diversity.
- Helps fluent communication.

Language learning helps to develop strong cognitive skills, such as a better concept formation, mental flexibility, multitasking, listening skills and problem-solving, in addition to improve social interaction and also encourages the connection between peers.

Use of local language help to mingle with the local society and ensures security, pleasant welcoming from auto/cab drivers, shop owners, employees of local government etc., and make the living easier and more comfortable.

Tips to learn the language with easy methods.

Apart from the conventional method of learning from teachers, the learning of language can be accelerated by adopting the following methods.

1. Love the learning without boredom.
2. Talk to classmates and others in Kannada without hesitation and with no concern to grammatical mistakes during the initial stages of learning the language.
3. Use English words to continue the conversation when you find difficulty in finding suitable Kannada word/s. Vocabulary improves with the use of language.
4. While reading, read aloud (not silently or in a whisper manner, but audibly so that others are not being disturbed or others can hear what is being read). Reading aloud not only helps proper/ correct pronunciation of words with variation in pitch, pace, volume, pauses etc., but also produces a fluent and enjoyable delivery during conversation/debate/presentation.
5. Listen to Kannada news and watch Kannada movies.
6. Listen to Kannada FM radios for news, live conversations and songs.
7. Use online applications (apps) for fast learning.

Easy learning of a Kannada Language: A few tips

1. Watching Kannada movies (preferably with subtitles), can be of great help. This is an important and entertaining way to improve your language skills.
2. Do not hesitate. Speak the language at every possible opportunity.
3. Never mind if you are using less Kannada and more English words. Kanglish is anyway popular in Bangalore. However constantly try to improve your Kannada vocabulary.
4. Watch Kannada news. This is not only helpful in learning the language, but will help you to know your city better.
5. If you are a user of public transport, carefully listen to co-passengers' conversations.
6. Enjoy the local tang of the language by listening to Kannada FM stations.
7. Do not completely rely on 'Learn Kannada in 30 days' type of books. Many Bangaloreans will fail to comprehend your textbook language and you are sure to face some embarrassment, if you go strictly by books.

Hints for correct and polite conservation

1. Be vigilant about the verbs, the pronouns, the genders and tense required for day to day Conversation.
2. Pronounce the words properly.
3. Use plural form to address others.
4. Use simple sentences for conversation.

About Kannada Language (Kannada Bhashe)

- Kannada is one of the classical (Shastreeya) languages of India since November 01, 2008, and is the official language of the Karnataka state.
- This language is not just confined within the borders of Karnataka, for you will find it spoken by people in parts of the neighboring states of Andhra Pradesh, Tamil Nadu and Maharashtra. Kannada is spoken in its various dialects by Six to Seven million people across the globe. It is one among the top 40 most spoken languages of the world.
- Spoken Kannada is in use since 2500 years, and has its own script since 1900 years. Spoken Kannada varies according to the regions of Karnataka, while the written form of Kannada remains almost the same. Kannada is the third oldest language of India (after Sanskrit and Tamil).
- The written form of Kannada is phonetic and it is written as it is spoken.
- The first Kannada-English Dictionary (ShabdaKosha) was compiled in 1894 by a German priest, Rev. Ferdinand Kittel. He also wrote a book on Kannada Grammar entitled, "A Grammar of the Kannada Language: Comprising the Three Dialects of the Language".
- Several noted centuries old literary works of Kannada have been translated into Sanskrit, and other languages.
- November 1st of every year is celebrated as Kannada Rajyotsava Day throughout Karnataka state and is declared as a state holiday. This was the day that the name Karnataka was given to the Mysore state in the year 1973.

SEMESTER – IV

COURSE: Samskruthika Kannada

Subject Code	20KAK49	CIE Marks	100
Hours/Week (L: T: P)	0:2:0	SEE Marks	-
Credits	0	Examination Hours	-

ಸಾಂಸ್ಕೃತಿಕ ಕನ್ನಡ ಕಲಿಕೆಯ ಉದ್ದೇಶಗಳು:

- ಪದವಿ ವಿದ್ಯಾರ್ಥಿಗಳಾಗಿರುವುದರಿಂದ ಸಾಂಸ್ಕೃತಿಕ ಕನ್ನಡ ಜೊತೆಗೆ ಕ್ರಿಯಾತ್ಮಕ ಕನ್ನಡವನ್ನು, ಕನ್ನಡ ಸಾಹಿತ್ಯ, ಸಂಸ್ಕೃತಿ ಮತ್ತು ನಾಡು ನುಡಿಯ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.
- ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಕನ್ನಡ ಭಾಷೆಯ ವ್ಯಾಕರಣದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು ಮತ್ತು ಕನ್ನಡ ಭಾಷಾ ರಚನೆಯಲ್ಲಿನ ನಿಯಮಗಳನ್ನು ಪರಿಚಯಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾ ಬರಹದಲ್ಲಿ ಕಂಡುಬರುವ ದೋಷಗಳು ಹಾಗೂ ಅವುಗಳ ನಿವಾರಣೆ.
- ಸಾಮಾನ್ಯ ಅರ್ಜಿಗಳು, ಸರ್ಕಾರಿ ಮತ್ತು ಅರೆ ಸರ್ಕಾರಿ ಪತ್ರವ್ಯವಹಾರದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು.
- ಭಾಷಾಂತರ ಮತ್ತು ಪ್ರಬಂಧ ರಚನೆ ಬಗ್ಗೆ ಆಸಕ್ತಿ ಮೂಡಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾಧ್ಯಾಸ, ಸಾಮಾನ್ಯ ಕನ್ನಡ ಹಾಗೂ ಆಡಳಿತ ಕನ್ನಡದ ಪದಗಳ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.

ಸಾಂಸ್ಕೃತಿಕ ಕನ್ನಡ ಪಠ್ಯಪುಸ್ತಕ

ಪರಿವಿಡಿ

ಭಾಗ – ಒಂದು ಲೇಖನಗಳು (ಕನ್ನಡ ನಾಡು, ನುಡಿ ಮತ್ತು ಸಂಸ್ಕೃತಿಗೆ ಸಂಬಂಧಿಸಿದ ಲೇಖನಗಳು)

೧. ಕರ್ನಾಟಕ ಸಂಸ್ಕೃತಿಗೆ : ಹಂಪ ನಾಗರಾಜಯ್ಯ

೨. ಕರ್ನಾಟಕದ ಏಕೀಕರಣ : ಒಂದು ಅಪೂರ್ವ ಚರಿತ್ರೆ – ಜಿ. ವೆಂಕಟಸುಬ್ಬಯ್ಯ

೩. ಆಡಳಿತ ಭಾಷೆಯಾಗಿ ಕನ್ನಡ – ವಿಶಾವಿಯ ಆಡಳಿತ ಕನ್ನಡ ಪುಸ್ತಕದಿಂದ ಆಯ್ದ ಲೇಖನ•

ಭಾಗ – ಎರಡು ಕಾವ್ಯ ಭಾಗ (ಆಧುನಿಕ ಪೂರ್ವ)

೪. ವಚನಗಳು : ಬಸವಣ್ಣ, ಅಕ್ಕಮಹಾದೇವಿ, ಅಲ್ಲಮಪ್ರಭು, ಆಯ್ದಕ್ಕಿ ಮಾರಯ್ಯ, ಜೇಡರ ದಾಸಿಮಯ್ಯ, ಆಯ್ದಕ್ಕಿ ಲಕ್ಕಮ್ಮ

೫. ಕೀರ್ತನೆಗಳು : ಅದರಿಂದೇನು ಫಲ ಇದರಿಂದೇನು ಫಲ – ಪುರಂದರದಾಸ

ತಲ್ಲಣಿಸದಿರು ಕಂಡ್ಯಾಳು ಮನವೆ – ಕನಕದಾಸ

೬. ತತ್ವಪದಗಳು : ಸಾವಿರ ಕೊಡಗಳ ಸುಟ್ಟು – ಶಿಶುನಾಳ ಷರೀಫ

ಶಿವಯೋಗಿ – ಬಾಲಲೀಲಾ ಮಹಾಂತ ಶಿವಯೋಗಿ

೭. ಜನಪದ ಗೀತೆ : ಬೀಸುವ ಪದ, ಬಡವರಿಗೆ ಸಾವ ಕೊಡಬೇಡ

ಭಾಗ – ಮೂರು ಕಾವ್ಯ ಭಾಗ (ಆಧುನಿಕ)

೮. ಮಂಕುತಿಮ್ಮನ ಕಗ್ಗ : ಡಿ.ವಿ.ಜಿ.

೯. ಕುರುಡು ಕಾಂಚಾಣ : ದ.ರಾ. ಬೇಂದ್ರೆ

೧೦. ಹೊಸಬಾಳಿನ ಗೀತೆ : ಕುವೆಂಪು

೧೧. ಹೆಂಡತಿಯ ಕಾಗದ : ಕೆ.ಎಸ್. ನರಸಿಂಹಸ್ವಾಮಿ

೧೨. ಮಬ್ಬಿನಿಂದ ಮಬ್ಬಿಗೆ : ಜಿ.ಎಸ್. ಶಿವರುದ್ರಪ್ಪ

೧೩. ಆ ಮರ ಈ ಮರ : ಚಂದ್ರಶೇಖರ ಕಂಬಾರ

೧೪. ಚೋಮನ ಮಕ್ಕಳ ಹಾಡು : ಸಿದ್ಧಲಿಂಗಯ್ಯ

ಭಾಗ – ನಾಲ್ಕು ತಾಂತ್ರಿಕ ವ್ಯಕ್ತಿ ಪರಿಚಯ, ಕಥೆ ಮತ್ತು ಪ್ರವಾಸ ಕಥನ

೧೫. ಡಾ. ಸರ್ ಎಂ. ವಿಶ್ವೇಶ್ವರಯ್ಯ – ವ್ಯಕ್ತಿ ಮತ್ತು ಐತಿಹ್ಯ : ಎ ಎನ್ ಮೂರ್ತಿರಾವ್

೧೬. ಯುಗಾದಿ : ವಸುಧೇಂದ್ರ

೧೭. ಮೆಗಾನೆ ಎಂಬ ಗಿರಿಜನ ಪರ್ವತ : ಪಿ.ಚಿ.ಬೋರಲಿಂಗಯ್ಯ

ಭಾಗ – ಐದು ವಿಜ್ಞಾನ ಮತ್ತು ತಂತ್ರಜ್ಞಾನ

೧೮. ಕರಕುಶಲ ಕಲೆಗಳು ಮತ್ತು ಪರಂಪರೆಯ ವಿಜ್ಞಾನ : ಕರೀಗೌಡ ದೀಚನಪಳ್ಳಿ

೧೯. 'ಕ' ಮತ್ತು 'ಬ' ಬರಹ ಶಂತ್ರಾಂಶಗಳು ಮತ್ತು ಕನ್ನಡದ ಟೈಪಿಂಗ್'

೨೦. ಕನ್ನಡ – ಕಂಪ್ಯೂಟರ್ ಶಬ್ದಕೋಶ'

೨೧. ತಾಂತ್ರಿಕ ಪದಕೋಶ : ತಾಂತ್ರಿಕ ಹಾಗೂ ಪಾರಿಭಾಷಿಕ ಕನ್ನಡ ಪದಗಳು'

'(ವಿಶಾವಿ ಯ ಅಡಳಿತ ಕನ್ನಡ ಪುಸ್ತಕದಿಂದ ಆಯ್ದ ಲೇಖನಗಳು – ಡಾ. ಎಲ್. ತಿಮ್ಮೇಶ ಮತ್ತು ಪ್ರೋ.ವಿ.ಕೇಶವಮೂರ್ತಿ)

SEMESTER – IV

COURSE: CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND CYBER LAW

Course Code	**20CPH49**	**CIE Marks**	**100**
Hours/Week (L: T: P)	**1 : 0 : 0**	**SEE Marks**	**-**
No. of Credits	**0**	**Examination Hours**	**-**

Course Objectives:

CLO1	Know the fundamental political codes, structure, procedures, powers, and duties of Indiangovernment institutions, fundamental rights, directive principles, and the duties of citizens.
CLO2	Understand engineering ethics and their responsibilities; identify their individual roles and ethical responsibilities towards society.
CLO3	Know about the cybercrimes and cyber laws for cyber safety measures.

Content	No. of Hours
Module 1 **INTRODUCTION TO INDIAN CONSTITUTION:** The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian constitution, TheMaking of the Constitution, The Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India. Fundamental Rights and its Restriction and limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and significance in Nation building.	**03 Hours**
Module 2 **UNION EXECUTIVE AND STATE EXECUTIVE:** Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament- LS and RS, Parliamentary Committees, Important Parliamentary Terminologies.Supreme Court of India, Judicial Reviews and Judicial Activism. State Executives –Governor, Chief Minister, State Cabinet, State Legislature, High Court and SubordinateCourts, Special Provisions (Articles 370.371,371J) for some States.	**03 Hours**
Module 3 **ELECTIONS, AMENDMENTS AND EMERGENCY PROVISIONS:** Elections, Electoral Process, and Election Commission of India, Election Laws. Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments – 7, 9, 10, 12, 42, 44, 61, 73, 74, 75, 86 and 91, 94, 95, 100, 101, 118 and some important Case Studies. Emergency Provisions, types of Emergencies and its consequences. Constitutional special provisions: Special Provisions for SC and ST, OBC, Women, Children and Backward Classes.	**03 Hours**

Module 4 **PROFESSIONAL / ENGINEERING ETHICS:** Scope & Aims of Engineering & Professional Ethics - Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institution of Engineers (India): Profession, Professionalism, and Professional Responsibility. Clash of Ethics, Conflicts of Interest. Responsibilities in Engineering Responsibilities in Engineering and Engineering Standards, the impediments to Responsibility. Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering.	**03 Hours**
Module 5 **INTERNET LAWS, CYBER CRIMES AND CYBER LAWS:** Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of CyberCrimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship. Cybercrimes and enforcement agencies.	**03 Hours**

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

CO1	Have constitutional knowledge and legal literacy.
CO2	Understand Engineering and Professional ethics and responsibilities of Engineers.
CO3	Understand the cybercrimes and cyber laws for cyber safety measures.

Textbooks:

3. Constitution of India, Professional Ethics and Human, O Shubham Singles, Charles E. Haries,and et. al., Cengage Learning India, 2018.
4. Cyber Security and Cyber Laws, Alfred Basta and et. al., Cengage Learning India, 2018.

Reference Books:

3. Introduction to the Constitution of India, Durga Das Basu, Prentice –Hall, 2008.
4. Engineering Ethics, M. Govindarajan, S. Natarajan, V. S. Senthilkumar, Prentice – Hall, 2004.

Scheme of Examination:

There is no Semester End Examination for this course. The assessment is based on Continuous InternalEvaluation only.

Continuous Internal Evaluation (CIE):

CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests. Two quizzesare to be conducted and each quiz is evaluated for 5 marks adding up to 10 marks.All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzeseffectively. Typical Evaluation pattern for this course is shown in Table 2.

Table 2: Distribution of weightage for CIE

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**100**
	CIE Test-2	**40**	
	Quiz 1/AAT	**10**	
	Quiz 2/AAT	**10**	
Grand Total			**100**

SEMESTER –IV

COURSE: UNIVERSAL HUMAN VALUES AND ETHICS

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

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, e, Guidance, Reverence, Glory, Gratitude and Love. • Comprehensive Human Goal: The Five Dimensions of Human Endeavour. • Harmony in Nature: The Four Orders in Nature. • The Holistic Perception of Harmony in Existence.	**05 Hours**

Module 4	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 ManagementModels.	

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 in 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 strategy to actualize a harmonious environment wherever they work.

Textbooks:

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

Reference Books:

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

Scheme of Examination:

There is no Semester End Examination for this course. The assessment is based on ContinuousInternal Evaluation only.

Continuous Internal Evaluation (CIE):

CIE is executed by way of two quizzes / Alternate Assessment Tools (AATs), and two tests.

Two quizzes are to be conducted and each quiz is evaluated for 5 marks adding up to 10 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. Typical Evaluation pattern for this course is shown in Table 1.

Table 1: Distribution of weightage for CIE

	Component	Marks	Total Marks
CIE	CIE Test-1	**40**	**100**
	CIE Test-2	**40**	
	Quiz 1/AAT	**10**	
	Quiz 2/AAT	**10**	
Grand Total			**100**

Dean Academic
Global Academy of Technology,
Rajarajeshwarinagar, Bengaluru-98

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

SEMESTER – V

COURSE

CURRICULUM

(UG PROGRAMME)

Dean Academic
Global Academy of Technology,
Rajarajeshwarinagar, Bengaluru-98

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

SEMESTER V

COURSE: Management & Entrepreneurship

Course Code	20ANE51	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 management and entrepreneurship in broad domain of Aeronautical Engineering by making them to learn:

CLO1	Outline the fundamentals management functions of manager and development of management.
CLO2	Explain the planning, decision making, organizational structure and staffing.
CLO3	Summarize the preparation of project report, need significance of report.
CLO4	Understand Entrepreneurships and entrepreneurship development process.
CL05	Outline the IP rights and procedure for granting patents.

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 or profession – Management and administration – Roles of management, Levels of management, skills and competence for effective Managing.	**08 Hours / L2**
Module 2 **PLANNING, ORGANIZING AND STAFFING:** **PLANNING:** Nature, purpose of planning process– objectives - Types of plans (Meaning only) - Decision making –– steps in planning & planning premises – Hierarchy of plans. **ORGANIZING:** Nature and purpose of organization, principles of Organizations – Types of organization – Documentation, Committees - Centralization vs. Decentralization of authority and responsibility, span of Control. **STAFFING:** Nature and importance of Staffing – process of selection and recruitment (in brief).	**08 Hours / L2**
Module 3 **PREPARATION OF PROJECT:** Meaning of Project, Project Identification, Project Selection, Project Report - Need and significance of project, Contents, formulation, Guidelines by Planning Commission for Project Report, Errors of Project Report, and Project Appraisal. Identification of Business Opportunities. Market Feasibility Study: Technical Feasibility Study, Financial Feasibility Study & Social Feasibility Study.	**08 Hours / L3**
Module 4 **ENTREPRENEUR:** Meaning of Entrepreneur, Evolution of the Concept, Functions of an Entrepreneur, Types of Entrepreneur, development of Entrepreneurship, steps in entrepreneurial process, Role of entrepreneurs in Economic Development: Entrepreneurship in India;	**08 Hours / L3**

Barriers of Entrepreneurship. Stages in entrepreneurial process, challenges of new venture start-ups; Analyzing why new ventures fail. Business Plan. **Creativity and Innovation:** Self-discovery, Creativity, Innovation Process, Sources of new ideas, methods of generating ideas, Creative problem solving. Feasibility analysis; Value- Proposition Canvas, Introduction to Design Thinking;	
Module 5 **INTELLECTUAL PROPERTY RIGHTS (IPR):** Principles of IPR, Kinds of IPR, Patent- Concepts, Novelty, Utility Inventiveness/Non-obviousness, Procedure for granting and obtaining patents; Copyright- conditions for grant of copyright, Copyright in Literary, Dramatic and Musical ,Works, Sound Recording, Cinematograph Films, Copyright in Computer Programme, Author Special Rights, Right of Broadcasting and performers, Trademark Law and Practices - Procedure of registration of trademark; Emerging Issues and Challenges; Few Future Aspects of Intellectual Property Rights;	**08 Hours / L3**

COURSE OUTCOMES:

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

CO1	Understand the managerial skills and role it plays at different levels in an organization.
CO2	Select the process and role of effective planning, organizing and staffing for the development of an organization.
CO3	Outline the guide lines to be followed for writing the project report, and to survey the market feasibility.
CO4	Illustrate the concept of entrepreneurship, process and barriers in entrepreneurship.
CO5	Appraise of IP rights like patents, industrial design, trademark, copyrights for effective protection and utilization of their innovations.

Textbooks:

1. Principles of Management – P.C. Tripathi, P.N. Reddy; Tata McGraw Hill, 5th Edition 2012.
2. Management and Entrepreneurship – N.V.R. Naidu & T. Krishna Rao, I.K. International, New Delhi – 2008

Reference books:

1. Management Fundamentals - Concepts, Application, Skill Development– 6th Edition.
2. Robert Lusier –Thomson Entrepreneurship Development – S S Khanka – S Chand & Co.
3. Management – Stephen Robbins – Pearson Education, PHI -17th Edition.
4. Dynamics of Entrepreneurial Development & Management – Vasant Desai–Himalaya Publishing.
5. Entrepreneurship Development– Small Business Enterprises – Poornima M Charantimath – Pearson Education –2006, 2nd Edition.

Scheme of Examination:

Semester End Examination (SEE):

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

Continuous Internal Evaluation (CIE):

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

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

	Component	Marks	Total Marks
CIE	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
CO1	2	1	-	-	-	-	2	-	2	1	-	1	-	-
CO2	2	1	-	-	-	-	2	-	2	1	-	1	-	-
CO3	2	1	-	-	-	-	2	-	2	1	2	1	-	-
CO4	2	1	-	-	-	-	2	-	2	1	-	1	-	-
CO5	2	2	-	-	-	3	2	-	2	2	-	2	-	-
Average	2	1	-	-	-	3	2	-	2	1	2	1	-	-

Low-1: Medium-2: High-3

SEMESTER V

COURSE: AERODYNAMICS – II

Course Code	**20ANE52**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:2:0**	**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 fans in Supersonic flows.
CLO3	To introduce the methodology of measurements in Supersonic flows.

Content	No. of Hours/ RBT levels
Module 1 **ONEDIMENSIONALCOMPRESSIBLE 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, 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.	**12 Hours/ L3**
Module 4 **LINEARIZED FLOW:** Velocity potential equation, Small Perturbation Potential Theory & linearized subsonic & 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**

COURSE OUTCOMES:

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

CO1	Calculate the Thermodynamic state variables in Compressible Flow.
CO2	Estimate the Properties across Normal and Oblique Shock Waves.
CO3	Understand the linearization of the Governing equations in Compressible flow.
CO4	Predict the 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 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
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO2	3	3	-	1	-	-	-	-	-	-	-	-	3	-
CO3	3	3	-	1	-	-	-	-	-	-	-	-	3	-
CO4	3	3	-	1	-	-	-	-	-	-	-	-	3	-
Average	3	3		1									3	

Low-1: Medium-2: High-3

SEMESTER – V

COURSE: AERO PROPULSION-II

Course Code	**20ANE53**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:2:0**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

Pre requisite: Aero Propulsion -1

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

CLO1	To introduce the basic concepts of jet propulsion.
CLO2	To make students learn the operating and performance characteristics of ramjet engines.
CLO3	To impart knowledge on the needs, various challenges in scramjet combustion and the applications of scramjet to hypersonic vehicle operations
CLO4	To give exposure to the students on the various kinds of propellants and internal ballistics of solid rocket motor.
CLO5	To make the students familiarize with the various subsystems of liquid, hybrid rockets and importance aspects of advanced propulsion systems

Content	**No. of Hours/RBT levels**
Module 1 **RAMJET PROPULSION:** Operating principle of ramjet engine – various components of ramjet engines and their efficiencies – modes of inlet operation - Combustion in ramjet engine –- performance characteristics – sample ramjet design calculations – flame stability problems in ramjet combustors –integral ram rockets.	**10 Hours/ L3**
Module 2 **SCRAMJET PROPULSION:** Introduction to hypersonic air breathing propulsion, hypersonic vehicles and supersonic combustion- need for supersonic combustion for hypersonic propulsion – salient features of scramjet engine and its applications for hypersonic vehicles – problems associated with supersonic combustion – engine/airframe integration aspects of hypersonic vehicles – various types scramjet combustors – fuel injection schemes in scramjet combustors – one dimensional models for supersonic combustion using method of influence coefficients.	**12 Hours/ L3**
Module 3 **SOLID ROCKET MOTOR:** Type of rockets – specific impulse of a rocket– rocket performance – Real and ideal nozzle - solid propellants– selection criteria of solid propellants – – internal ballistics – burning rate - propellant grain design Considerations – erosive burning in solid rockets – Igniters – types of igniters.	**10 Hours/ L3**

Module 4 **LIQUID AND HYBRID ROCKET ENGINES:** liquid propellant rockets – selection of liquid propellants – various feed systems for liquid rockets -thrust control in liquid rockets – cooling in liquid rockets and the associated heat transfer problems – advantages of liquid rockets over solid rockets - introduction to hybrid propulsion – advantages and limitations of hybrid propulsion - static testing of rockets and safety considerations	**10 Hours /L3**
Module 5 **ADVANCED PROPULSION TECHNIQUES:** Introduction to nozzle less propulsion and basic concepts - Electric rocket propulsion – Ion propulsion – Nuclear rocket – comparison of performance of these propulsion systems with chemical rocket propulsion systems - Solar sail.	**10 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Understand the operating and performance characteristics of ramjet engines.
CO2	Evaluate the needs, various challenges in scramjet combustion and the applications of scramjet to hypersonic vehicle operations.
CO3	Test the various kinds of propellants and internal ballistics of solid rocket motor.
CO4	Familiarize with the various subsystems of liquid, hybrid rockets
CO5	Interpret the importance aspects of advanced propulsion systems.

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**", John Wiley & Sons Inc., New York, 1993.
3. P. P Walsh and P. Pletcher**,** "**Gas Turbine Performance** ", Blackwell Science, 1998.

Reference books:

1. A S Rangawala, "**Turbomachinery Dynamics-Design and operations**", McGraw–Hill 2005.
2. Mathur, M., and Sharma, R.P., "**Gas Turbines and Jet and Rocket Propulsion**", Standard Publishers, New Delhi 1998.
3. H S Mukunda, "**Aerospace Chemical Propulsion**", I. K. International Pvt 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.

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
CO1	2	2	-	-	-	-	-	-	-	-	-	-	3	-
CO2	2	1	-	-	-	-	-	-	-	-	-	-	3	-
CO3	3	2	-	-	-	-	-	-	-	-	-	-	3	-
CO4	3	1	-	-	-	-	-	-	-	-	-	-	3	-
CO5	2	2	-	-	-	-	-	-	-	-	-	-	3	-
Average	2	2	-	-	-	-	-	-	-	-	-	-	3	-

Low-1: Medium-2: High-3

SEMESTER – V

COURSE: AIRCRAFT STRUCTURAL ANALYSIS

Course Code	**20ANE54**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:2:0**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

Pre requisite: Aircraft structural mechanics

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

CLO1	Loads on aircraft
CLO2	Shear Flow in open and closed beams
CLO3	Joints and fittings
CLO4	Structural Idealization
CLO5	Stress Analysis in wings and fuselage

Content	No. of Hours/RBT levels
Module 1 **LOADS ON AIRCRAFT:** Structural nomenclature – Types of loads – load factor – Aerodynamics loads – Symmetric maneuver loads – Velocity diagram – Function of structural components. **MATERIALS FOR AIRCRAFT STRUCTURES:** Metallic and non-metallic materials, Use of Aluminum alloy, titanium, stainless steel and composite materials. Desirable properties for aircraft application.	**10 Hours/ 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.	**10 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.	**10 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.	**10 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, torsion and shear, 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.	**12 Hours / L3**

COURSE OUTCOMES:

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

CO1	Outline the types of loads experienced by aircraft structure and materials used for aircraft structures.
CO2	Analyze the shear flow in open and closed sections.
CO3	Evaluate the loads on riveted joints and welded joints
CO4	Applying idealization concepts to simplify complex structural sections to understand how they behave, under given loading conditions.
CO5	Comprehend he stress analysis on wings and fuselage.

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
CO1	3	3	-	-	-	-	-	-	-	-	-	3	3	-
CO2	3	3	-	-	-	-	-	-	-	-	-	3	3	-
CO3	3	3	-	-	-	-	-	-	-	-	-	3	3	-
CO4	3	3	-	-	-	-	-	-	-	-	-	3	3	-
CO5	3	3	-	-	-	-	-	-	-	-	-	3	3	-
Average	3	3	-	-	-	-	-	-	-	-	-	3	3	-

Low-1: Medium-2: High-3

SEMESTER – V

COURSE: COMPOSITE MATERIALS AND STRUCTURES

Course Code	20ANE55	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Pre requisite: Materials and Manufacturing Process

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

CLO1	Introduction to Composite Materials.
CLO2	Processing of Polymer Matrix Composites.
CLO3	Micromechanics.
CLO4	Macro mechanics.
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 **MACROMECHANICS:** 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 **APPLICATIONS OF COMPOSITES MATERIALS:** 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:

CO1	Understanding the mechanics of composite materials.
CO2	Understand the processing methods in composite materials.
CO3	Apply the characterization methods for various engineering materials.
CO4	Comprehend and apply theories of structures for engineering problems.
CO5	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. 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
CO1	3	2	-	-	-	-	-	-	2	3	-	-	3	-
CO2	3	2	-	-	-	-	-	-	2	3	-	-	3	-
CO3	3	2	-	-	-	-	-	-	2	3	-	-	3	-
CO4	3	2	-	-	-	-	-	-	2	3	-	-	3	-
Average	3	2							2	3			3	

Low-1: Medium-2: High-3

SEMESTER: V

COURSE: AIRCRAFT STRUCTURES LAB

Course Code	**20ANEL57**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**0:0:2**	**SEE Marks**	**50**
No. of Credits	**1**	**Examination Hours**	**03**

Course Objectives:

- To understand the behavior of beams under different loading conditions
- To understand about different loads buckling and shear load
- To understand about fundamental frequency under vibrational load

LIST OF EXPERIMENTS	RBT levels
1. Deflection of a Simply Supported, Cantilever, Fixed and Continuous Beam	**L3**
2. Verification of Maxwell's Reciprocal Theorem.	**L3**
3. Determination of Young's Modulus and Poisson's Ratio	**L3**
4. Verification of Superposition Theorem	**L3**
5. Buckling load of slender Eccentric Columns and Construction of South well Plot	**L3**
6. Shear Failure of Bolted and Riveted Joints	**L3**
7. Determination of forces in the Truss structure	**L3**
8. Unsymmetrical Bending determination	**L3**
9. Determination of fundamental frequency of a cantilever beam and harmonics and Frequency spectrum analysis for a cantilever beam.	**L3**
10. Shear Centre for open section and Closed section	**L3**
11. Composite hand layup process	**L3**
12. Photo elastic apparatus	**L3**
13. Constant Beam Strength	**L3**

COURSE OUTCOMES:

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

CO1	Calculate the deflections of simply supported beams and cantilever beams.
CO2	Apply Maxwell reciprocal theorem and superposition theorem for simply supported beam and cantilever beam respectively.
CO3	Find the buckling load of the column for fixed and hinged conditions by applying South Well's theorem.
CO4	Analyze shear failure of bolts and riveted joints.
CO5	Examine frequency spectrum analysis of cantilever beam.

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
CO1	3	3	3	2	-	-	-	-	3	2	-	-	3	-
CO2	3	3	3	2	-	-	-	-	3	2	-	-	3	-
CO3	3	3	3	2	-	-	-	-	3	2	-	-	3	-
CO4	3	3	3	2	-	-	-	-	3	2	-	-	3	-
CO5	3	3	3	2	-	-	-	-	3	2	-	-	3	-
Average	3	3	3	2					3	2			3	

SEMESTER V

Course: MODELLING AND ANALYSIS LAB

Course Code	20ANEL58	CIE Marks	50
Hours/Week (L: T: P)	0:0:2	SEE Marks	50
No. of Credits	1	Examination Hours	03

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

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

Content	RBT levels
1. Geometric Modeling and Mesh Generation of symmetric Airfoil Geometry.	**L3**
2. Geometric Modeling and Mesh Generation of unsymmetrical Airfoil Geometry	**L3**
3. Computations and Analysis of 2-D Incompressible and Inviscid Flow over symmetric and unsymmetrical Airfoil.	**L3**
4. Geometric Modeling, Mesh Generation and flow analysis of 2-D Convergent-Divergent Nozzle.	**L3**
5. Generation of body fitting hexagonal mesh and flow analysis of serpentine inlet duct	**L3**
6. Structural Modeling of Sandwich Beam of Rectangular Cross-Section and Analyses for Stresses.	**L3**
7. Structural Modeling of a Three Dimensional Wing.	**L3**
8. Structural Modeling and Stress Analysis of a Fuselage Bulk Head.	**L3**
9. Structural Modeling and Stress Analysis of a Simply Supported Rectangular Plate Uniformly Compressed in one Direction.	**L3**
10. Structural Modeling and Stress Analysis of a Simply Supported Rectangular Plate Uniformly Compressed In one Direction with a Cut- Out in Center.	**L3**

COURSE OUTCOMES:

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

CO1	Model and analyze symmetric and unsymmetrical Aero foil Geometry.
CO2	Model and analyze 2D Convergent- Divergent Nozzle and 3Dserpentine inlet duct.
CO3	Analyze Sandwich Beam, 3D Wing and bulk head.
CO4	Perform Structural Modeling and Stress Analysis of a Simply Supported.
CO5	Model and analyze symmetric and unsymmetrical Aero foil Geometry.

Scheme of Examination:

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

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

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

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

CO/PO Mapping

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

SEMESTER V - PROFESSIONAL ELECTIVE 1

COURSE: UNMANNED AERIAL VEHICLE

Course Code	**20ANE561**	**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 unmanned aerial vehicle in broad domain of aeronautical engineering by making them to learn:

CLO1	History and overview of UAV systems
CLO2	Basic Aerodynamics
CLO3	Stability and Control
CLO4	Propulsion and load aspects
CLO5	Mission Planning and Control

Content	**No. of hr / RBT levels**
Module 1 **INTRODUCTION:** Aviation History and Overview of UAV systems, Classes and Missions of UAVs, Definitions and Terminology, UAV fundamentals, Examples of UAV systems-very small, small, Medium and Large UAV	**08 Hours / L3**
Module 2 **THE AIR VEHICLE BASIC AERODYNAMICS:** Basic Aerodynamics equations, Aircraft polar, the real wing and Airplane, Induced drag, the boundary layer, Flapping wings, Total Air-Vehicle Drag **PERFORMANCE:** Overview, climbing flight, Range and Endurance – for propeller driven aircraft, range- a jet-driven aircraft, Guiding Flight	**08 Hours/ L2**
Module 3 **STABILITY AND CONTROL:** Overview, Stability, longitudinal, lateral, dynamic stability, Aerodynamics control, pitch control, lateral control, Autopilots, sensor, controller, actuator, airframe control, inner and outer loops, Flight-Control Classification, Overall Modes of Operation, Sensors Supporting the Autopilot.	**10 Hours/ L3**
Module 4 **PROPULSION:** Overview, Thrust Generation, Powered Lift, Sources of Power, The Two-Cycle Engine, The Rotary Engine, The Gas Turbine, Electric Motors, Sources of Electrical power **LOADS AND STRUCTURES:** Loads, Dynamic Loads, Materials, Sandwich Construction, Skin or Reinforcing Materials, Resin Materials, Core Materials, Construction Techniques.	**08 Hours/ L3**
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	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Describe the basic functioning of UAV systems (L2)
CO2	Understand the basic aerodynamics, performance of UAV (L2)
CO3	Explain the stability and control of an UAV (L2)
CO4	Select the proper propulsion system and materials for UAV (L2)
CO5	Encompass how mission planning and control is carried out with proper payloads (L2)

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):

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
CO1	3	1	-	-	-	-	-	-	-	-	-	1	1	-
CO2	3	2	-	-	-	-	-	-	-	-	-	1	1	-
CO3	3	2	-	-	-	-	-	-	-	-	-	1	1	-
CO4	3	2	-	-	-	-	-	-	-	-	-	1	1	-
CO5	3	2	-	-	-	-	-	-	-	-	-	1	1	-
Average	3	2	-	-	-	-	-	-	-	-	-	1	1	-

Low-1: Medium-2: High-3

SEMESTER V - PROFESSIONAL ELECTIVE 1

COURSE: ROCKETS AND MISSILES

Course Code	**20ANE562**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Pre requisite: Aerodynamics and Aero Propulsion **Course Learning 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.

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 programme..	**08 Hours/** **L3**
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/** **L3**

COURSE OUTCOMES:

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

CO1	Understand the Current scenario of rockets and Missiles.
CO2	Analyze the Aerodynamic Characteristics of Rockets and Missiles.
CO3	Comprehend the knowledge about the Trajectory Motion of Rockets and Missiles.
CO4	Understand the Propulsion Systems and Materials used in 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**", John Wiley & Sons Inc., New York, 1993.

Reference books:

1. Mathur, M., and Sharma, R.P., "**Gas Turbines and Jet and Rocket Propulsion**", Standard Publishers, New Delhi 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 Mapping														
CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-	2	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-	2	-
Average	3	3											2	

SEMESTER V - PROFESSIONAL ELECTIVE 1

COURSE: THEORY OF ELASTICITY

Course Code	**20ANE563**	**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 Analysis

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.

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 Boussinesque problems – Rotating discs.	**10 Hours/ L3**
Module 4 **TORSION:** Navier's theory, St. 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:

CO1	Ability to use mathematical knowledge to solve problem related to structural elasticity.
CO2	Identify stress-strain relation in 3D, principal stress and principal strain.
CO3	Analyze a structure using Elasticity concepts.
CO4	Use analytical techniques to predict deformation, internal force and failure of simple solids and structural components.
CO5	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 of Materials", Prentice Hall, New Jersey, 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):

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
CO1	3	3	1	-	-	-	-	-	-	-	-	-	3	-
CO2	3	3	1	-	-	-	-	-	-	-	-	-	3	-
CO3	3	3	1	-	-	-	-	-	-	-	-	-	3	-
CO4	3	3	1	-	-	-	-	-	-	-	-	-	3	-
Average	3	3	1	-	-	-	-	-	-	-	-	-	3	-

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

SEMESTER V - PROFESSIONAL ELECTIVE 1

COURSE: AIRWORTHINESS AND CERTIFICATION

Course Code	**20ANE564**	**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 Airworthiness and Certification in broad domain of Aeronautical Engineering by making them to learn:

CLO1	To understand about the airworthiness and safety
CLO2	To know about the basics related to privileges and responsibilities of various categories
CLO3	Awareness about the procedure for developments and test flights and certification.
CLO4	Airworthiness directives, service bulletins, crew training.
CLO5	Accident investigation procedures.

CONTENT	**No. of Hours/RBT levels**
Module 1 **Introduction:** To aircraft rules as far as they relate to airworthiness and safety of aircraft. Airworthiness requirements for civil and military aircraft CAR, FAR, EASA and ICAO, regulations, Defense standards. Military standards and specifications.	**08 Hours/ L2**
Module 2 **Privileges and responsibilities of various categories of license:** Privileges and responsibilities of various categories of AME license and approved persons. Knowledge of mandatory documents like certificate of Registration, certificate of Airworthiness - conditions of issue and validity. Export certificate of Airworthiness. Knowledge of Log Book, Journey Log Book, Technical Log Book, etc.	**08 Hours/ L2**
Module 3 **Procedure for development and test flights and certification**: Certificate of Flight release, Certificate of Maintenance, Approved Certificates. Technical Publications, Aircraft Manual, Flight Manual, Aircraft Schedules. Registration, Procedure, Certification, Identification and Marking of Aircraft.	**08 Hours/ L2**
Module 4 **Airworthiness directives, service bulletins, crew training:** Modifications, concessions, airworthiness directives, service bulletins. Crew training and their licenses, approved inspection, and approved materials, identification of approved materials. Bonded and quarantine stores. Storage of various aeronautical products like rubber goods, various fluids.	**08 Hours/ L2**

Module 5	
Accident investigation procedures: Circumstances under which C of A is suspended. ICAO and IATA regulations, Chicago and Warsaw conventions. Familiarization of recent issues of Advisory Circulars. Civil Aviation Requirements Section 2 - Airworthiness.	**08 Hours/ L2**

COURSE OUTCOMES:

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

CO1	Understand the Airworthiness requirements for different categories of aircrafts.
CO2	Discuss the various certifications, technical log book.
CO3	Explain the procedure for development, test flight and certification.
CO4	Explain the procedure for training and their licenses, inspection, and approved materials.
CO5	Discuss the accident investigation procedures.

Textbooks:

1. The Indian Aircraft Act and the Rules.
2. Aircraft manual (India) volume – latest edition, the English book store, 17-l, Connaught circus, New Delhi.
3. Gran E L, Statistical Quality Control, McGraw Hill.

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.
2. Civil Aircraft Airworthiness Information and Procedures (CAP 562).

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
CO1	3	-	-	-	-	-	-	-	2	2	-	-	-	-
CO2	2	-	-	-	-	-	-	-	2	2	-	-	-	-
CO3	3	-	-	-	-	-	-	-	2	2	-	-	-	-
CO4	3	-	-	-	-	-	-	-	2	2	-	-	-	-
CO5	3	-	-	-	-	-	-	-	2	2	-	-	-	-
Average	3	-	-	-	-	-	-	-	2	2	-	-	-	-

Low-1: Medium-2: High-3

SEMESTER V

COURSE: ENVIRONMENTAL SCIENCE

Course Code	**20CIV59**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**1:0:0**	**SEE Marks**	**00**
No. of Credits	**0**	**Examination Hours**	**--**

Pre requisite: NIL

Course Learning Objectives: To enable students to apply the knowledge of Environmental science in daily life:

CLO1	The fundamentals of environmental science
CLO2	The types of natural resources
CLO3	Various global environmental concerns
CLO4	The types of wastes generated and their handling at a basic level
CLO5	The 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 environmental eco system: Structure and function of various types of eco systems. • Human activities- Food, Shelter, Economic and 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.	**08 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	**08 Hours/ L2**
Module 3 **Global Environmental Concerns:** (concepts, 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.	**08 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.	**08 Hours/ L2**
Module 5 **Latest development in Environmental Pollution Mitigation Tools (Concept of Applications):** Environmental impact assessment, Environmental Management systems, ISO14001; Environmental stewardship- NGOs.	**08 Hours/ L2**

COURSE OUTCOMES:

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

CO1	Understand holistically the key concepts of "Environment and Biodiversity"
CO2	Understand the types of Natural resources available and the effects of anthropogenic interventions.
CO3	Understand the gravity of various Global concerns
CO4	Understand the types of waste generated and their handling at a basic level.
CO5	Understand the importance of environmental law and policies.

Textbooks:

1. Benny Joseph, Environmental Science and Engineering", Tata McGraw-Hill, New Delhi, 2006
2. Gilbert M Masters, "Introduction to Environmental Engineering and Science", 2nd edition, Pearson Education, 2006.

Reference books:

1. Rajagopalan R, "Environmental Studies-From Crisis to Cure", Oxford University press, 2005.
2. G. Tyler Miller and Scott E. Spoolman, "Environmental Science", Cengage Learning India PVT LTD, Delhi, 2014.

Scheme of Examination:

Continuous Internal Evaluation (CIE):

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

Some possible AATs: Seminar/assignments/term paper/open ended experiments/mini projects/ concept videos/partial reproduction of research work/oral presentation of research work/group activity/developing a generic toolbox for problem solving/report based on participation in create –a-thon/make –a-thon/code –a-thon/ hack-a-thon conducted by reputed organizations/any other.

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

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

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

Low-1: Medium-2: High-3

SEMESTER – VI

COURSE

CURRICULUM

(UG PROGRAMME)

SEMESTER – VI

COURSE: FINITE ELEMENT METHODS

Course Code	**20ANE61**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:2:0**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

Pre requisite: Aircraft Structural Mechanics
Aircraft Structural Analysis

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:** Review of various approximate methods – Raleigh Ritz's, Galerkin and finite difference methods Governing equation and convergence criteria of finite element method.	**10 Hours/ L3**
Module 2 **DISCRETE ELEMENTS:** Bar elements, uniform sections, mechanical and thermal loading, varying section, truss analysis. Beam element with various loadings and boundary conditions - longitudinal and lateral vibration. Use of local and natural coordinates.	**12 Hours/ L3**
Module 3 **CONTINUUM ELEMENTS:** Plane stress, Plane strain and axisymmetric problems, constant and linear strain triangular elements, stiffness matrix, axisymmetric load vector.	**10 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.	**10 Hours/ L3**
Module 5 **FIELD PROBLEM**: Heat transfer problems, Steady state fin problems, Derivation of element matrices for two dimensional problems, Torsion problems.	**10 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Understand the approximate methods used for solving structural mechanics problems and formulation of governing equation for the finite element method, convergence criteria and advantage over other approximate method
CO2	Solve 1-D problems related to static analysis of structural members
CO3	Formulate the elemental matrices for 2-D problems.
CO4	Exposure to iso-parametric element formulations and importance of numerical integration.
CO5	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 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
CO1	3	3	1	-	-	-	-	-	-	-	-	-	3	-
CO2	3	3	1	-	-	-	-	-	-	-	-	-	3	-
CO3	3	3	1	-	-	-	-	-	-	-	-	-	3	-
CO4	3	3	1	-	-	-	-	-	-	-	-	-	3	-
Average	3	3	1										3	

Low-1: Medium-2: High-3

SEMESTER – VI

COURSE: THEORY OF VIBRATION

Course Code	**20ANE62**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:2:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Pre requisite: Aircraft Structural Mechanics
Aircraft Structural Analysis

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

CLO1	Basic concepts of vibrations, types of vibrations.
CLO2	Understand the working principle of vibration measuring instruments.
CLO3	Differentiate types of vibrations - according to dampness and particle motion.
CLO4	Acquire the knowledge of numerical methods for multi-degree freedom systems.
CLO5	To study the aero elastic effects of aircraft wing.

Content	No. of Hours/ RBT levels
Module 1 **INTRODUCTION:** Types of vibrations, S.H.M, principle of super position applied to Simple Harmonic Motions, Fourier theorem and simple problems.	**08 Hours/ L3**
Module 2 **UNDAMPED FREE VIBRATIONS:** Single degree of freedom systems. Undamped free vibration, natural frequency of free vibration, Spring and Mass elements, effect of mass of spring, Compound Pendulum. **DAMPED FREE VIBRATIONS:** Single degree of freedom systems, different types of damping, concept of critical damping and its importance, study of response of viscous damped systems for cases of under damping, critical and over damping, Logarithmic decrement.	**10 Hours/ L3**
Module 3 **FORCED VIBRATION:** Single degree of freedom systems, steady state solution with viscous damping due to harmonic force. Solution by Complex algebra, reciprocating and rotating unbalance, vibration isolation, transmissibility ratio due to harmonic excitation and support motion.	**08 Hours/ L3**
Module 4 **SYSTEMS WITH TWO DEGREES OF FREEDOM:** Introduction, principle modes and Normal modes of vibration, co-ordinate coupling, generalized and principal co-ordinates, Free vibration in terms of initial conditions. Applications: Vehicle suspension, Dynamic vibration absorber and Dynamics of reciprocating Engines. Continuous Systems: Introduction, vibration of string, longitudinal vibration of rods, Torsional vibration of rods.	**08 Hours/ L3**

Module 5	
MULTI DEGREES OF FREEDOM SYSTEMS: Introduction, Influence coefficients, Maxwell reciprocal theorem, Dunkerley's equation. Orthogonality of principal modes, Method of matrix Iteration-Method of determination of all the natural frequencies using sweeping matrix and Orthogonality principle. Holzer's method, Stodola method.	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Understand the basic concepts of vibrations.
CO2	Formulate the mathematical models for undamped and damped mechanical vibrations Systems.
CO3	Formulate the mathematical models for forced vibrations Systems
CO4	Predict the frequency response for mechanical vibration systems under loading conditions
CO5	Analyze the multi-degree freedom systems.

Textbooks:

1. Grover. G.K., "Mechanical Vibrations", 7th Edition, Nem Chand Brothers, Roorkee, India, 2003.
2. V.P. Singh., "Mechanical Vibrations", DhanpatRai & Company Pvt. Ltd, 2016.

Reference books:

1. Thomson W T, 'Theory of Vibration with Application' - CBS Publishers, 1990.
2. Bisplinghoff R.L., Ashely H and Hogman R.L., "Aeroelasticity", Dover Publication, New York, 1983.
3. Leonard Meirovitch, "Elements of Vibration Analysis". McGraw Hill International Edition, 2007.

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately 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
CO1	3	2	2	-	-	-	-	-	-	-	-	-	3	-
CO2	3	2	2	-	-	-	-	-	-	-	-	-	3	-
CO3	3	2	2	-	-	-	-	-	-	-	-	-	3	-
CO4	3	2	2	-	-	-	-	-	-	-	-	-	3	-
Average	3	2	2										3	

SEMESTER – VI

COURSE: AIRCRAFT PERFORMANCE

Course Code	**20ANE63**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:2:0**	**SEE Marks**	**50**
No. of Credits	**4**	**Examination Hours**	**03**

Pre requisite: Aerodynamics I
Aerodynamics II

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	Understand about drag forces, aerodynamic coefficients with variations in velocity and altitudes
CLO2	Steady performance
CLO3	Concept of range and endurance
CLO4	Take-off and Landing performance
CLO5	Maneuver Performance

Content	No. of Hours/ RBT levels
Module 1 **INTRODUCTION:** 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. **THE EQUATIONS OF MOTION STEADY UN-ACCELERATED FLIGHT:** Introduction, four forces of flight, General equation of motion, Power available and power required curves. Thrust available and thrust required curves. Conditions for power required and thrust required minimum. Altitude effects on power available and power required; thrust available and thrust required.	**10 Hours / L3**
MODULE 2 **STEADY PERFORMANCE:** Level Flight, Climb &Glide: Equation of motion for steady level flight, Performance of airplane in level flight. Maximum speed in level flight, Climb Performance: Equation of motion for Rate of climb- graphical and analytical approach - Absolute ceiling, Service ceiling, Time to climb – graphical and analytical approach, climb performance graph (hodograph diagram); **FUNDAMENTAL AIRPLANE PERFORMANCE PARAMETERS:** 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 Airplane: Physical consideration, Quantitative formulation, Breguet equation for Range and Endurance, Conditions for maximum range and endurance.	**12 Hours / L3**

JET AIRPLANE: Physical consideration, Quantitative formulation, Equation for Range and Endurance, Conditions for maximum range and endurance, Effect of head wind tail wind.	
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:

CO1	Understand the aircraft performance in steady un-accelerated and accelerated flight.
CO2	Understand the airplane performance parameters.
CO3	Determine the range and endurance of propeller and jet driven airplane.
CO4	Comprehend the aircraft take-off and landing performance.
CO5	Describe the different aircraft maneuvers.

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 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
CO1	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-	3	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-	3	-
Average	3	3											3	

Low-1: Medium-2: High-3

SEMESTER VI

COURSE: AERODYNAMICS LAB

Course Code	20ANEL67	CIE Marks	50
Hours/Week (L: T: P)	0:0:2	SEE Marks	50
No. of Credits	1	Examination Hours	03

Course Learning Objectives:

CLO1	Be acquainted with basic principles of aerodynamics using wind tunnel.
CLO2	Acquire the knowledge on flow visualization techniques.
CLO3	Understand the procedures used for calculating the lift and drag.

LIST OF EXPERIMENTS	RBT levels
1. Calibration of a subsonic Wind tunnel.	**L3**
2. Determination of lift for the given airfoil section.	**L3**
3. Pressure distribution over a smooth circular cylinder.	**L3**
4. Pressure distribution over a rough circular cylinder.	**L3**
5. Pressure distribution over a symmetric airfoil.	**L3**
6. Pressure distribution over a cambered airfoil.	**L3**
7. Force measurement using wind tunnel balancing set up.	**L3**
8. Flow over a flat plate at different angles of incidence.	**L3**
9. Flow visualization studies in low speed flows over cylinders.	**L3**
10. Flow visualization studies in low speed flows over airfoil with different angle of incidence.	**L3**
11. Calculation of total drag of a two-dimensional circular cylinder at low speeds using pitot-static probe wake survey.	**L3**
12. Calculation of total drag of a two-dimensional cambered airfoil at low speeds at incidence using pitot-static probe wake survey.	**L3**
13. Calculation of aerodynamic coefficients and forces acting on a model aircraft at various Angle of Attack and speeds using wind tunnel balance (With and Without Yaw).	**L3**
14. 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.	**L3**

COURSE OUTCOMES:

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

CO1	Describe the Fundamental Aerodynamic and geometrical properties related to External flows over Airfoils, Wings, and Bluff bodies.
CO2	Calculate the Aerodynamic Forces and moments experienced by Airfoils, Wings and Bluff bodies.
CO3	Use Wind Tunnel Instrumentation to measure flow Velocity and Lift and Drag.
CO4	Visualize the Flow and Pressure Distribution over 2D and 3D bodies by Smoke visualization Method.

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
CO1	3	3	-	2	2	-	-	-	-	-	-	-	-	2
CO2	3	3	2	2	3	-	-	-	-	-	-	-	-	2
CO3	3	3	2	2	3	-	-	-	-	-	-	-	-	2
CO4	3	3	2	2	2	-	-	-	-	-	-	-	-	2
Average	3	3	2	2	2									2

Low-1: Medium-2: High-3

SEMESTER VI

COURSE: AIRCRAFT PROPULSION LAB

Course Code	**20ANEL68**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**0:0:2**	**SEE Marks**	**50**
No. of Credits	**1**	**Examination Hours**	**03**

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

CLO1	To explore practically components of aircraft piston and gas turbine engines and their working principles.
CLO2	To impart practical knowledge of flow phenomenon of subsonic and supersonic jets.
CLO3	The Measure the burning velocity of any fuel-air mixture.
CLO4	The Estimate the performance of a propeller for given conditions.
CLO5	Study of cold/hot flow in a Ramjet duct

LIST OF EXPERIMENTS	**RBT levels**
1. Study of an aircraft piston engine. (includes the study of the assembly of subsystems, various components, their functions, and operating principles).	**L3**
2. Study of an aircraft jet engine (includes the study of the assembly of subsystems various components, their functions, and operating principles).	**L3**
3. Determination of Performance characteristics of a fixed/variable pitch propeller.	**L3**
4. Velocity profiles of free jet and wall jet.	**L3**
5. Wall pressure measurements in subsonic diffuser.	**L3**
6. Wall Pressure measurements in subsonic Ramjet.	**L3**
7. Wall pressure measurements in the supersonic Nozzle.	**L3**
8. Velocity and pressure measurements high speed jets.	**L3**
9. Flow visualization in a supersonic flow- Schlieren Technique.	**L3**
10. Flame Stabilization Studies using the conical flame holder.	**L3**
11. Performance estimation of Ram jet Engine.	**L3**
12. Study of forced convective heat transfer over a surface.	**L3**
13. Study of free convective heat transfer over a surface.	**L3**
14. Measurement of burning velocity of a premixed flame.	**L3**

COURSE OUTCOMES:

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

CO1	Identify components and information of piston and gas turbine engine.
CO2	Analyze behavior of flow through ducts and jet engine components.
CO3	Visualize flow phenomenon in supersonic flow.
CO4	Recognizes performance parameters of rocket propellants.
CO5	Distinguish subsonic and supersonic flow characteristics.

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
CO1	3	3	-	2	2	-	-	-	-	-	-	-	-	2
CO2	3	3	2	2	3	-	-	-	-	-	-	-	-	2
CO3	3	3	2	2	3	-	-	-	-	-	-	-	-	2
CO4	3	3	2	2	2	-	-	-	-	-	-	-	-	2
CO5	3	3	2	2	2	-	-	-	-	-	-	-	-	2
Average	3	3	2	2	2									2

SEMESTER VI

COURSE: MINI-PROJECT WORK

Course Code	**20ANEP69**	**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.

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**

SEMESTER VI - PROFESSIONAL ELECTIVE 2

COURSE: MICROPROCESSOR AND CONTROL ENGINEERING

Course Code	20ANE641	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 microprocessor and control engineering as an elective by making them to learn:

CLO1	Understand the basics about semiconductor devices.
CLO2	Know the basics about linear and digital IC's.
CLO3	Learn about architecture of Microprocessor and its application
CLO4	Concept of Open And Closed Loop Systems
CLO5	Characteristic Equation and Functions w.r.t system response

Content	No. of Hours/RBT levels
Module 1 **SEMICONDUCTOR DEVICES:** Transistors - FET and MOSFET - Silicon Controlled Rectifiers and Triacs - their Applications - Principles and Types of Transistor Amplifiers - RC Coupled, Transformer Coupled, Direct Coupled - Multistage, FET and Power Amplifiers.	**08 Hours/ L2**
Module 2 **LINEAR AND DIGITAL IC'S:** IC Technology - Elements of Fabrication of 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.	**10 Hours/ L2**
Module 3 **MICROPROCESSORS:** Architecture of Intel 8085- Instruction Formats - Addressing Modes - Simple Assembly Language Programs - Architecture and Functioning of Intel 8086 Processor - Instruction Formats - Addressing Modes. Microprocessor Applications in aerospace	**08 Hours/ L2**
Module 4 **OPEN AND CLOSED LOOP SYSTEMS:** Feedback control systems - Block diagram representation of control systems, Reduction of block diagrams, Output to input ratios, Signal flow graph.	**08 Hours/ L2**

Module 5	
CHARACTERISTIC EQUATION AND FUNCTIONS: Laplace transformation, Response of systems to different inputs viz., Step input, impulse, ramp, parabolic and sinusoidal inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit.	**08 Hours/ L2**

COURSE OUTCOMES:

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

CO1	Understand the concept of semiconductor devices
CO2	Understand about IC technology
CO3	Understand w.r.t Microprocessor and its application
CO4	Comprehend the open loop and closed loop systems
CO5	Understand the characteristics of system response to different inputs.

Textbooks:

1. Goankar. R.S., "Microprocessors, Programming to Architecture 8085", Penram International publishing PVT Ltd, New Delhi. 5th Edition 2002
2. OGATO, "Modern Control Engineering", Prentice - Hall of India Pvt. Ltd. New Delhi, 1991
3. GOPAL.M. "Control Systems, Principles and design" - Tata McGraw-Hill Publication, New Delhi, 2000.
4.

Reference books:

1. Naresh K. Sinha, "Control Systems", New Age International Publishers, New Delhi
2. Azzo, J.J.D. and C.H. Houpis, "Feed back control system analysis and synthesis", McGraw.
3. Ajit Pal., "Microprocessors", Tata McGraw-Hill, Revised Edition 1995.
4. Mathur A.P., "Introduction to Microprocessors", Tata McGraw-Hill, Revised Edition 1995

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
CO1	3	2	2	-	-	-	-	-	-	-	-	-	-	1
CO2	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO3	3	2	2	-	-	-	-	-	-	-	-	-	-	2
CO4	3	2	2	-	-	-	-	-	-	-	-	-	-	2
Average	3	2	2											2

Low-1: Medium-2: High-3

SEMESTER VI - PROFESSIONAL ELECTIVE 2

COURSE: HEAT AND MASS TRANSFER

Course Code	20ANE642	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	Fundamentals of different modes of heat transfer.
CLO2	About the conduction and thermal conductivity.
CLO3	Understand the free convection and forced convection.
CLO4	Radiation, heat exchangers and their effectiveness.
CLO5	Acquire the knowledge of heat transfer problems in combustion chambers.

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 AND MASS 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:

CO1	Review the fundamentals and modes of heat transfer.
CO2	Familiarize in the area of conduction and thermal conductivity
CO3	Understand the free convection and forced convection.
CO4	Comprehend Radiation, heat exchangers and their effectiveness.
CO5	Analyze the problems due to heat and mass transfer in several areas of aviation.

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
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO3	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO5	3	2	-	-	-	-	-	-	-	-	-	-	-	2
Average	3	2												2

Low-1: Medium-2: High-3

SEMESTER VI - PROFESSIONAL ELECTIVE 2

COURSE: EXPERIMENTAL STRESS ANALYSIS

Course Code	**20ANE643**	**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 Analysis

Course Learning Objectives: To study the various Experimental Techniques involved for Measuring Displacements, Stresses, Strains in Structural Components.

Content	No. of Hours/RBT levels
Module 1 **EXTENSOMETERS AND DISPLACEMENT SENSORS:** Principles of measurements, Accuracy, Sensitivity and range of measurements, Mechanical, Optical, Acoustical and Electrical extensometers and their uses, Advantages and disadvantages	**08 Hours/ L3**
Module 2 **ELECTRICAL RESISTANCE STRAIN GAUGES:** Principle of operation and requirements, Types and their uses, Materials for strain gauges, Calibration and temperature compensation, cross sensitivity, Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators, Rosette analysis.	**08 Hours/ L3**
Module 3 **PHOTOELASTICITY:** Two-dimensional photo elasticity, Photo elastic materials, Concept of light - photo elastic effects, Stress optic law, Plane and circular Polari scopes, Interpretation of fringe pattern, Calibration of photo elastic materials, Introduction to three-dimensional photo elasticity.	**10 Hours/ L3**
Module 4 **BRITTLE COATING AND MOIRE TECHNIQUES:** Relation between stresses in coating and specimen, use of failure theories in brittle coating, Moire method of strain analysis.	**08 Hours/ L3**
Module 5 **NON – DESTRUCTIVE TESTING:** Fundamentals of NDT- Radiography- Ultrasonic - Magnetic Particle Inspection - Fluorescent Penetrant Technique - Eddy Current Testing - Acoustic Emission Technique.	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Knowledge of stress and strain measurements in loaded components.
CO2	Acquiring information's, the usage of strain gauges and photo elastic techniques of measurement.
CO3	Formulate the general three-dimensional problems of stress-strain analysis especially fundamental problems of elasticity.
CO4	Analyze and detect the defects in solid and composite materials by using various Non-destructive Testing methods.

Textbooks:

1. Dally, J.W., and Riley, W.F., "**Experimental Stress Analysis**", McGraw Hill Inc., New York 1998.
2. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, k.,
"**Experimental Stress Analysis**", Tata McGraw Hill, New Delhi, 1984.
3. Sadhu Singh, "**Experimental Stress Analysis**", Khanna Publishers, New Delhi, 1996.

Reference books:

1. Durelli. A.J., "Applied Stress Analysis", Prentice Hall of India Pvt Ltd., New Delhi, 1970
2. Hetenyi, M., "Hand book of Experimental Stress Analysis", John Wiley and Sons Inc., New York, 1972.
3. Max Mark Frocht, "Photo Elasticity", John Wiley and Sons Inc., New York, 1968

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
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO2	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO3	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO4	3	3	-	-	-	-	-	-	-	-	-	-	-	2
Average	3	3												2

Low-1: Medium-2: High-3

SEMESTER VI - PROFESSIONAL ELECTIVE 2

COURSE: FUELS AND COMBUSTION

Course Code	**20ANE644**	**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 Fuels and Combustion in broaddomain 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 basic 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**: Introduction, 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. **ALTERNATIVE FUELS FOR AEROSPACE APPLICATIONS**: Hydrogen, Methane, Propane, Ammonia, Alcohols, Slurry fuels, Synthetic fuels, Fuels Produced by Fischer–Tropsch, Synthesis of Coal/Biomass, Biofuels, Alternative fuel Properties, Biodiesel Fuels.	**10 Hours/ L3**
Module 3 **BASIC CONSIDERATIONS**: Introduction, 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. **COMBUSTION FUNDAMENTALS:** Deflagration, Detonation, Classification of Flames, Physics of combustion Chemistry, Flammability Limits, Global Reaction-Rate Theory, Weak Mixtures, Rich Mixtures, Laminar Premixed Flames. Equivalence Ratio, Initial Temperature, Pressure, Turbulent Premixed Flames, Flame Propagation in Heterogeneous Mixtures of Fuel Drops.	**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. Definition of Stability Performance, Measurement of Stability Performance, Bluff-Body Flame holders, Stabilization, Mechanisms of Flame Stabilization, Flame Stabilization in Combustion Chambers. **COMBUSTION PERFORMANCE**: Combustion Efficiency, The Combustion Process, Reaction-Controlled Systems, Burning Velocity Model, Stirred Reactor Model, Mixing-Controlled Systems, Evaporation-Controlled Systems, Reaction- and Evaporation-Controlled Systems.	**08 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:

CO1	Distinguish fuels and their properties their treatment for aerospace applications.
CO2	Understand the basics of fuel treatment and alternative fuel for combustion
CO3	Comprehend the combustion fundamentals terms and definitions
CO4	Understand the combustion flame characterization, stabilization and combustion performance.
CO5	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
CO1	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO3	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	2
Average	3	2												2

Low-1: Medium-2: High-3

SEMESTER VI - PROFESSIONAL ELECTIVE 3

COURSE: SPACE MECHANICS

Course Code	**20ANE651**	**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 introduce concepts of satellite injection and satellite perturbations, trajectory, computation for interplanetary travel and flight of ballistic missiles based on the fundamental concepts of orbital mechanics.

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:** Kepler's laws of planetary motion and proof of the laws – Newton's universal law of gravitation - the many body problem - Lagrange-Jacobi identity – the circular restricted three body problem – liberation points – the general N-body problem – two body problem – relations between position and time.	**08 Hours/ L3**
Module 3 **SATELLITE INJECTION AND SATELLITE PERTURBATIONS:** General aspects of satellite injection – satellite orbit transfer – various cases – orbit deviations due to injection errors – special and general perturbations – method of variations of orbital elements – general perturbations approach.	**10 Hours/ L3**
Module 4 **INTERPLANETARY TRAJECTORIES:** Two-dimensional interplanetary trajectories – fast interplanetary trajectories – three dimensional interplanetary trajectories – launch of interplanetary spacecraft – trajectory estimation about the target planet – concept of sphere of influence – Lambert's theorem	**08 Hours/ L3**
Module 5 **BALLISTIC MISSILE TRAJECTORIES:** Introduction to ballistic missile trajectories – boost phase – the ballistic phase – trajectory geometry – optimal flights – time of flight – re-entry phase – the position of impact point – influence coefficients.	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Understand satellite injection, satellite perturbations and trajectory control.
CO2	Apply the knowledge of orbital mechanics to control ballistic missile.
CO3	Estimate the trajectory/orbit of a space vehicle or a satellite in a suitable coordinate system.
CO4	Understand orbit Perturbation Analysis for Satellite Orbits.

Textbooks:

1. Cornelisse, J.W., "**Rocket Propulsion and Space Dynamics**", J.W. Freeman & Co.,Ltd, London,1982
2. Parker, E.R., "**Materials for Missiles and Spacecraft**", Mc.Graw Hill Book Co. Inc., 1982.

Reference books:

1. Sutton, G.P., "**Rocket Propulsion Elements**", John Wiley & Sons Inc., New York, 5th Edition, 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 **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
CO1	3	2	-	2	-	-	-	-	-	-	-	-	-	2
CO2	3	2	-	2	-	-	-	-	-	-	-	-	-	2
CO3	3	2	-	2	-	-	-	-	-	-	-	-	-	2
CO4	3	2	-	2	-	-	-	-	-	-	-	-	-	2
Average	3	2		2										2

SEMESTER VI - PROFESSIONAL ELECTIVE 3

COURSE: EXPERIMENTAL AERODYNAMICS

Course Code	20ANE652	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Pre requisite: Aerodynamics-II

Course Learning Objectives: To provide extensive treatment of the operating principles and limitations of pressure and temperature measurements. To cover both operating and application procedures of hot wire anemometer. To describe flow visualization techniques and to highlight in depth discussion of analogue methods.

Content	No. of Hours/ RBT levels
Module 1 **BASIC MEASUREMENTS IN FLUID MECHANICS** Objective of experimental studies – Fluid mechanics measurements – Properties of fluids – Measuring instruments – Performance terms associated with measurement systems – Direct measurements - Analogue methods – Flow visualization.	**08 Hours/ L3**
Module 2 **WIND TUNNEL MEASUREMENTS:** Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels - Power losses in a wind tunnel – Instrumentation and calibration of wind tunnels – Wind tunnel balance – Wire balance – Strut-type – Platform-type – Yoke-type – Pyramid type – Strain gauge balance.	**10 Hours/ L3**
Module 3 **FLOW VISUALIZATION AND ANALOGUE METHODS:** Visualization techniques – Smoke tunnel – Hele-Shaw apparatus - Interferometer – Fringe - Displacement method – Schlieren system – Shadowgraph - Hydraulic analogy – Hydraulic jumps – Electrolytic tank.	**08 Hours/ L3**
Module 4 **PRESSURE, VELOCITY AND TEMPERATUREMEASUREMENTS:** Pitot - static tube characteristics - Velocity measurements - Hot-wire anemometry – Constant current and Constant Temperature Hot-Wire anemometer – Pressure measurement techniques - Pressure transducers – Temperature measurements.	**08 Hours/ L3**
Module 5 **SPECIAL FLOWS AND UNCERTAINTY ANALYSIS:** Measurements in boundary layers - Data acquisition and processing – Signal conditioning – Uncertainty analysis – Estimation of measurement errors – External estimate of the error – Internal estimate of the error – Uncertainty calculation - Uses of uncertainty analysis.	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Knowledge on Measurement Techniques in Aerodynamic flow.
CO2	Acquiring the basic knowledge of Wind Tunnel Measurement systems
CO3	Understand the use of specific instruments for Flow Parameter measurement like Pressure, Velocity.
CO4	Analyze the model measurements, Lift and Drag measurements through various techniques and testing of different models.

Textbooks:

1. Rathakrishnan, E., "**Instrumentation, Measurements, and Experiments in Fluids**," CRC Press – Taylor & Francis, 2007.
2. Robert B Northrop, "**Introduction to Instrumentation and Measurements**",Second Edition, CRC Press, Taylor & Francis, 2006.

Reference books:

1. Bradsaw "**Experimental Fluid Mechanics**", Elsevier, 2nd edition, 1970.
2. Pope, A., and Goin, L., "**High Speed Wind Tunnel Testing**", John Wiley, 1985.

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
CO1	3	3	-	2	2	-	-	-	-	-	-	-	-	2
CO2	3	3	-	2	2	-	-	-	-	-	-	-	-	2
CO3	3	3	-	2	2	-	-	-	-	-	-	-	-	2
CO4	3	3	-	2	2	-	-	-	-	-	-	-	-	2
Average	3	3		2	2									2

SEMESTER VI - PROFESSIONAL ELECTIVE 3

COURSE: AIRCRAFT MAINTENANCE, REPAIR & OVERHAUL

Course Code	**20ANE653**	**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 aircraft maintenance, repair & overhaul in broad domain of aeronautical engineering by making them to learn:

Content	No. of Hours/ RBT levels
Module 1 Fundamentals of Maintenance & Certification Types of maintenance, Redesign, Failure rate pattern, Other maintenance considerations. Aviation industry certification requirements, Type certificate (FAA form 8110.9), Airworthiness certificate (FAA form 8100-2), Aviation maintenance certifications, General, Airframe, Power plant, Avionics courses.	**8 Hours/ L3**
Module 2 Documentation for Maintenance Manufacturers documentation, Airplane maintenance manual, Fault insulation manual, Illustrated parts catalogue, structural repair manual, wiring diagram manual, Master minimum equipment, Federal Aviation regulation (FAR), Advisory circulars, Airworthiness direction ATA document standards, Technical policies and procedure manuals (TPPM).	**10 Hours / L3**
Module 3 Aircraft Management Maintenance Structure, Role of aviation management, Line supervisory management, Management areas of concern in an airlines, Manager of overhaul shops, Line maintenance control centre flight line (preflight & post flight), Aircraft Logbook, Maintenance crew skill requirements.	**08 Hours/ L3**
Module 4 Hanger Maintenance (on Aircraft) & Material Support Introduction, organization of hanger maintenance, Non- routine item, parts availability, cannibalization, Types of shops- sheet metal shop, Aircraft interior shop, Engine shop, Avionics shop, ground support equipment, outsourcing of shop maintenance work, operation of overhaul shops, Material support, Material management inventory control, Support functions of material, Parts ordering, Storage, Issue, control and handling, Parts receiving quality control, calibration program, stock level adjustments, shelf life, exchanges, warranty & modifications of parts.	**08 Hours / L3**
Module 5 Maintenance Safety & Trouble shooting Safety regulations, occupational safety and health standards maintenance safety program, Airlines safety management, General safety rules, Accident & injury reporting, Hazardous materials storage and handling aircraft furnishing practices trouble shooting, Knowledge of malfunctions.	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Understand the fundamentals of maintenance and certification
CO2	Acquire the knowledge of documentation for maintenance
CO3	Familiarize the role of aviation management and skill required by the maintenance crew
CO4	Comprehend hanger maintenance of aircrafts.
CO5	Understand the Aircraft Maintenance, safety and trouble shooting

Textbooks:

1. **Harry A Kinnison, Tariq Siddiqui**, " Aviation Maintenance Management ", Mc Graw Hill education (India) Private Ltd, 2013.
2. **Kroes, Watkins, Delp Larry Reithmaier,** "Aircraft Repair Manual", Mc Graw-Hill Education, 2013.

Reference books:

1. **Brimm. D J, Bogges, H E,** "Aircraft Maintenance", Pitman publishing corp, London, 1952

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
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO2	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO3	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO4	3	3	-	-	-	-	-	-	-	-	-	-	-	2
Average	3	3												2

Low-1: Medium-2: High-3

SEMESTER VI - PROFESSIONAL ELECTIVE 3

COURSE: WIND TUNNEL TECHNIQUES

Course Code	**20ANE654**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Pre requisite: Aerodynamics I

Course Learning Objectives: The Students are exposed to Various Types and Techniques of Aerodynamic data generation on Aerospace Vehicle Configurations in the Aerospace Industry.

Content	No. of Hours/ RBT levels
Module 1 **LOW SPEED WIND TUNNELS:** Classification –non-dimensional numbers-types of similarities - Layout of open circuit and closed circuit subsonic wind tunnels – design parameters-energy ratio - HP calculations – Calibration methods.	**08 Hours / L3**
Module 2 **HIGH SPEED WIND TUNNELS:** Blow down, in draft and induction tunnel layouts and their design features -Transonic, and supersonic tunnels-peculiar features of these tunnels and operational difficulties - sample design calculations and calibration methods.	**08 Hours/ L3**
Module 3 **SPECIAL WIND TUNNEL TECHNIQUES:** Types of Special Wind Tunnels – Hypersonic, Gun and Shock Tunnels – Design features and calibration methods- Intake tests – store carriage and separation tests - wind tunnel model design for these tests.	**08 Hours/ L3**
Module 4 **WIND TUNNEL INSTRUMENTATION:** Instrumentation and sensors required for both steady and unsteady measurements – Force measurements using three component and six component balances – calibration of measuring instruments – error estimation and uncertainty analysis.	**10 Hour/ L3**
Module 5 **FLOW VISUALIZATION and NON-INTRUSIVE FLOW DIAGNOSTICS:** Smoke and Tuft grid techniques – Dye injection special techniques – Oil flow visualization and PSP techniques - Optical methods of flow visualization – PIV and Laser Doppler techniques – Image processing and data deduction.	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Understand the working principle of Blow down, In draft tunnels and their specifications
CO2	Knowledge about horizontal buoyancy, flow angularities while carrying out calibration
CO3	Understand the working principle of component axis balance and internal balances
CO4	Ability to carry out the smoke and tuft flow visualization procedures in WT testing

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.

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.

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	PSO3
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
CO4	3	3	-	-	-	-	-	-	-	-	-	-	-	2	-
Average	3	3												2	

Low-1: Medium-2: High-3

SEMESTER VI - OPEN ELECTIVE 1

COURSE: INTRODUCTION TO AEROSPACE ENGINEERING

Course Code	20ANE661	CIE Marks	50
Hours/Week (L: T: P)	3:0:0	SEE Marks	50
No. of Credits	3	Examination Hours	03

Course Learning Objectives:

1. Course will prepare engineer about the basics of aircraft and aerospace engineering
2. Course will introduce the current progress in aerospace engineering.

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 INSTRUMENTS:** Flight instruments and navigation instruments – accelerometers, air speed indicators – Mach meters – altimeters – gyroscopic instruments. Principles and operation.	**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 STRUCTURES AND MATERIALS:** Properties of flight vehicle Materials; importance of strength to weight ratio, classification and characteristics of composite materials.	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Understand the History and introduction to Aviation and effect on environment.
CO2	Understand the basic concept of Aerodynamics and Aircraft systems
CO3	Understand the basics of Aerospace Engineering propulsion system and Power Plants
CO4	Understand the basic Structures and Materials of Aircrafts

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 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
CO1	2	2	-	-	-	-	-	-	-	-	-	-	-	1
CO2	2	2	-	-	-	-	-	-	-	-	-	-	-	2
CO3	2	2	-	-	-	-	-	-	-	-	-	-	-	2
CO4	2	2	-	-	-	-	-	-	-	-	-	-	-	2
Average	2	2												2

Low-1: Medium-2: High-3

SEMESTER VI - OPEN ELECTIVE 1

COURSE: AIRCRAFT SYSTEMS AND INSTRUMENTATION

Course Code	**20ANE662**	**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 systems and instrumentation in broaddomain of aeronautical engineering by making them to learn:

CLO1	About the aircraft control systems.
CLO2	About the aircraft systems
CLO3	Acquire the knowledge of aircraft engine systems
CLO4	About the auxiliary systems
CLO5	About 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 systems, 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:

CO1	Distinguish the conventional and modern control systems.
CO2	Classify the aircraft systems.
CO3	Categorize different types of aircraft instruments.
CO4	Comprehend the engine and fuel systems
CO5	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
CO 1	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO 2	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO 3	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO 4	3	2	-	-	-	-	-	-	-	-	-	-	2	-
CO 5	3	2	-	-	-	-	-	-	-	-	-	-	2	-
Average	3	2											2	

Low-1: Medium-2: High-3

SEMESTER VI - OPEN ELECTIVE 1

COURSE: AIRCRAFT MAINTENANCE, REPAIR & OVERHAUL

Course Code	**20ANE663**	**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 aircraft maintenance, repair & overhaul in broad domain of aeronautical engineering by making them to learn:

Content	No. of Hours/ RBT levels
Module 1 Fundamentals of Maintenance & Certification Types of maintenance, Redesign, Failure rate pattern, Other maintenance considerations. Aviation industry certification requirements, Type certificate (FAA form 8110.9), Airworthiness certificate (FAA form 8100-2), Aviation maintenance certifications, General, Airframe, Power plant, Avionics courses.	**08 Hours/ L3**
Module 2 Documentation for Maintenance Manufacturers documentation, Airplane maintenance manual, Fault insulation manual, Illustrated parts catalogue, structural repair manual, wiring diagram manual, Master minimum equipment, Federal Aviation regulation (FAR), Advisory circulars, Airworthiness direction ATA document standards, Technical policies and procedure manuals (TPPM).	**10 Hours/ L3**
Module 3 Aircraft Management Maintenance Structure, Role of aviation management, Line supervisory management, Management areas of concern in an airlines, Manager of overhaul shops, Line maintenance control centre flight line (preflight & post flight), Aircraft Logbook, Maintenance crew skill requirements.	**08 Hours/ L3**
Module 4 Hanger Maintenance (on Aircraft) & Material Support Introduction, organization of hanger maintenance, Non- routine item, parts availability, cannibalization, Types of shops- sheet metal shop, Aircraft interior shop, Engine shop, Avionics shop, ground support equipment, outsourcing of shop maintenance work, operation of overhaul shops, Material support, Material management inventory control, Support functions of material, Parts ordering, Storage, Issue, control and handling, Parts receiving quality control, calibration program, stock level adjustments, shelf life, exchanges, warranty & modifications of parts.	**08 Hours/ L3**
Module 5 Maintenance Safety & Trouble shooting Safety regulations, occupational safety and health standards maintenance safety program, Airlines safety management, General safety rules, Accident & injury reporting, Hazardous materials storage and handling aircraft furnishing practices trouble shooting, Knowledge of malfunctions.	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Understand the fundamentals of maintenance and certification
CO2	Acquire the knowledge of documentation for maintenance
CO3	Familiarize the role of aviation management and skill required by the maintenance crew
CO4	Comprehend hanger maintenance of aircrafts.
CO5	Understand the Aircraft Maintenance, safety and trouble shooting

Textbooks:

1. **Harry A Kinnison, Tariq Siddiqui**, " Aviation Maintenance Management ", Mc Graw Hill education (India) Private Ltd, 2013.

2. **Kroes, Watkins, Delp Larry Reithmaier,** "Aircraft Repair Manual", Mc Graw-Hill Education, 2013.

Reference books:

1. **Brimm. D J, Bogges, H E,** "Aircraft Maintenance", Pitman publishing corp, London, 1952

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
CO1	2	2	-	-	-	-	-	-	-	-	-	-	-	2
CO2	2	2	-	-	-	-	-	-	-	-	-	-	-	2
CO3	2	2	-	-	-	-	-	-	-	-	-	-	-	2
CO4	2	2	-	-	-	-	-	-	-	-	-	-	-	2
CO5	2	2												
Average	2	2												2

Low-1: Medium-2: High-3

Dean Academic
Global Academy of Technology,
Rajarajeshwarinagar, Bengaluru-98

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

SEMESTER – VII

COURSE

CURRICULUM

(UG PROGRAMME)

Dean Academic
Global Academy of Technology,
Rajarajeshwarinagar, Bengaluru-98

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	**20ANE71**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:1:0**	**SEE Marks**	**50**
No. of Credits	**4**	**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	**10 Hours/ L3**

estimation of aileron effectiveness, roll control by spoilers, aileron reversal, aileron reversal speed	
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:

CO1	Obtain static margin of airplane in stick fixed and free aspects.
CO2	Understand the design concept of rudder by considering the critical situations that demand the use of rudder.
CO3	Estimate total lateral stability of an airplane.
CO4	Determine the natural frequency and damping ratio of phugoid and short period motions.
CO5	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

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
CO1	3	3	2	2	-	-	-	-	-	-	-	3	1	-
CO2	3	3	2	2	-	-	-	-	-	-	-	3	1	-
CO3	3	3	2	2	-	-	-	-	-	-	-	3	1	-
CO4	3	3	2	2	-	-	-	-	-	-	-	3	1	-
Average	3	3	2	2	-	-	-	-	-	-	-	3	1	-

Low-1: Medium-2: High-3

SEMESTER – VII

COURSE: AVIONICS

Course Code	**20ANE72**	**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 AVIONICS:** Need for avionics in civil and military aircraft and space systems – integrated avionics and weapon systems – typical avionics subsystems, design, technologies – Introduction to digital computer and memories.	**08 Hours/L2**
Module 2 **DIGITAL AVIONICS ARCHITECTURE:** Avionics system architecture – data buses – MIL-STD-1553B – ARINC – 420 – ARINC – 629	**08 Hours/L2**
Module 3 **FLIGHT DECKS AND COCKPITS:** Control and display technologies: CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil and Military Cockpits: MFDS, HUD, MFK, HOTAS.	**08 Hours/L2**
Module 4 **INTRODUCTION TO NAVIGATION SYSTEMS:** Radio navigation – ADF, DME, VOR, LORAN, DECCA, OMEGA, ILS, MLS – Inertial Navigation Systems (INS) – Inertial sensors, INS block diagram – Satellite navigation systems – GPS.	**08 Hours/L2**
Module 5 **AIR DATA SYSTEMS AND AUTO PILOT:** Air data quantities – Altitude, Air speed, Vertical speed, Mach Number, Total air temperature, Mach warning, Altitude warning – Auto pilot – Basic principles, Longitudinal and lateral auto pilot.	**10 Hours/L2**

COURSE OUTCOMES:

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

CO1	Describe the need for avionics in civil and military aircraft.
CO2	Understand about modern Aviation and avionics architecture.
CO3	Familiarize about control and display technologies used
CO4	Describe about the different navigation systems
CO5	Identify and understand the use of air data systems and auto pilot

Textbooks:

1. Albert Helfrick.D., "Principles of Avionics", Avionics Communications Inc., 2004.
2. Collinson.R.P.G. "Introduction to Avionics", Chapman and Hall, 1996.

Reference books:

1. Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989.
2. Pallet.E.H.J., "Aircraft Instruments and Integrated Systems", Pearsons, Indian edition 2011.
3. Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J.,U.S.A. 1993.
4. Spitzer. C.R. "The Avionics Hand Book", CRC Press, 2000.
5. S Nagabhushana and N Prabhu, “Principles of Modern Avionics”, I. K. International Pvt Ltd, distributed by Wiley, Edition 2019.

Scheme of Examination:

Semester End Examination (SEE):

SEE Question paper is to be set for 100 marks and the marks scored will be proportionately 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
CO1	3	-	-	-	-	-	-	-	-	-	-	2	-	2
CO2	3	2	-	-	-	-	-	-	-	-	-	2	-	2
CO3	3	2	-	-	-	-	-	-	-	-	-	2	-	2
CO4	3	2	-	-	-	-	-	-	-	-	-	2	-	2
Average	3	2	-	-	-	-	-	-	-	-	-	2	-	2

Low-1: Medium-2: High-3

SEMESTER – VII

COURSE: FLIGHT SIMULATION LAB

Course Code	**20ANEL76**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**0:0:2**	**SEE Marks**	**50**
No. of Credits	**1**	**Examination Hours**	**03**

Course Learning Objectives:

CLO1	Be acquainted with basic principles of Matlab using different
CLO2	Acquire the knowledge on Simscape
CLO3	Understand the procedures for using Simulink

LIST OF EXPERIMENTS	**RBT LEVELS**
1. Plot root locus with variables in transfer function through MATLAB	**L3**
2. Draw Bode plot from a transfer function in MATLAB and explain the gain and phase margins	**L3**
3. Model mass-spring damper system in MATLAB	**L3**
4. Model mass-spring damper in Simulink and Simscape	**L3**
5. Simulate a DC motor in Simulink and Simscape	**L3**
6. Simulate a DC motor with PID controller and tune the PID	**L3**
7. Simulate a package drop from an aircraft	**L3**
8. Simulate and visualize aircraft takeoff	**L3**
9. Model an UAV package delivery	**L3**
10. Estimate G forces for flight data	**L3**
11. Simulate aircraft longitudinal motion and demonstrate the effect of static margin variation for a doublet input in pitch	**L3**
12. Simulate a rotor-flying manipulator	**L3**
13. Model Maneuver stabilization for a mini drone	**L3**

COURSE OUTCOMES:

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

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

Scheme of Examination:

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

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

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

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

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

SEMESTER: VII

COURSE: AVIONICS LAB

Course Code	**20ANEL77**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**0:0:2**	**SEE Marks**	**50**
No. of Credits	**1**	**Examination Hours**	**03**

Course Learning Objectives:

CLO1	Be acquainted with basic principles of working of different measuring devices used in aircraft.
CLO2	Acquire the knowledge on gyroscope and use of radio magnetic indicator.
CLO3	Study about MIL-STD , data bus
CLO4	Use of encoders / decoders, addition/Subtraction of binary numbers

Sl.No.	**LIST OF EXPERIMENTS**	**RBT LEVELS**
1	Calibration and measurement with Air Speed Indicator.	**L3**
2	Calibration and measurement with Altimeter	**L3**
3	Calibration and measurement with Rate of Climb Indicator and Attitude Indicator	**L3**
4	Calibration and measurement with - Turn and Slip Indicator	**L3**
5	Gyroscopic Instruments – Demonstration for vertical speed hold	**L3**
6	Gyroscopic Instruments – Demonstrate for rate feedback modeling	**L3**
7	Demonstration of use of Radio Magnetic Indicator (RMI)	**L3**
8	16 Channel Analog to Digital Converter & Generation of Ramp, Square, Triangular wave.	**L3**
9	Study of Pulse Amplitude Modulation (PAM) and Demodulation	**L3**
10	Study of MIL-STD-1553 B Data Bus	**L3**
11	Addition and Subtraction of 8-bit and 16-bit numbers using Microprocessor.	**L3**
12	Interface programming with 4-digit 7 segment display and switches and LED's.	**L3**
13	Encoder/Decoder Circuits, Multiplexer/DE multiplexer Circuits and Addition/Subtraction of binary numbers.	**L3**
14	Timer Circuits, Shift Registers, Binary Comparator Circuits	**L3**

COURSE OUTCOMES:

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

CO1	Demonstration of principles , for the working of different measuring devices used in aircraft.
CO2	Demonstration the use of gyroscopic Instruments for vertical speed and feedback modelling
CO3	Comprehend the use of Microprocessor for different operations
CO4	Construction of different circuits like timer , Shift Registers, Binary Comparator Circuits

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
CO1	3	2	-	2	2	-	-	-	-	-	-	-	-	2
CO2	3	2	2	2	3	-	-	-	-	-	-	-	-	2
CO3	3	2	2	2	3	-	-	-	-	-	-	-	-	2
CO4	3	2	2	2	2	-	-	-	-	-	-	-	-	2
Average	3	2	2	2	2									2

Low - 1: Medium - 2: High - 3

SEMESTER – VII – PROFESSIONAL ELECTIVE 4

COURSE: SATELLITE TECHNOLOGY

Course Code	**20ANE731**	**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 Introduction to Python Program 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 manoeuvres 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 manoeuvres 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)	**10 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 etc), 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:

CO1	Explain the concepts of Orbits and their mechanics.
CO2	Explain the concepts of structural design, analyzing techniques and various types of loads in satellite structural subsystem.
CO3	Acquire knowledge on the importance of thermal control subsystem and its design studies
CO4	Explain the concepts of satellite sensors and actuators that needed for Attitude control subsystem development.
CO5	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
CO1	3	3	3	-	2	2	-	-	-	-		2	3	-
CO2	3	3	3	-	2	3	-	-	-	-	2	2	3	-
CO3	3	2	3	-	2	-	-	-	-	3	-	2	2	-
CO4	2	3	3	-	3	2	-	-	3	3	-	2	3	-
CO5	3	3	3	-	2	-	-	-	2	-	3	3	2	-
Average	3	3	3	-	3	2	-	-	3	3	2	2	3	-

Low-1: Medium-2: High-3

SEMESTER – VII – PROFESSIONAL ELECTIVE 4

COURSE: FATIGUE AND FRACTURE MECHANICS

Course Code	**20ANE732**	**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 Analysis

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

CLO1	To impart knowledge in structural integrity in the context of fatigue failure.
CLO2	To gain knowledge in statistical aspects of fatigue behavior.
CLO3	To impart knowledge in physical aspects of fatigue.
CLO4	To familiarize the student with theoretical fracture mechanics and make him/her competent to carry out simple fracture analysis procedures
CLO5	To enable the student to appreciate the different aspects of fatigue testing methods

Content	No. of Hours/ RBT levels
Module 1 **FATIGUE OF STRUCTURES:** S.N. curves - Endurance limits - Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams - Notches and stress concentrations - Neuber's stress concentration factors - Plastic stress concentration factors - Notched S.N. curves – Fatigue of composite materials.	**08 Hours/ L3**
Module 2 **STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR:** Low cycle and high cycle fatigue - Coffin - Manson's relation - Transition life - cyclic strain hardening and softening - Analysis of load histories - Cycle counting techniques –Cumulative damage - Miner's theory - Other theories.	**08 Hours/ L3**
Module 3 **PHYSICAL ASPECTS OF FATIGUE:** Phase in fatigue life - Crack initiation - Crack growth - Final Fracture - Dislocations - fatigue fracture surfaces.	**08 Hours/ L3**
Module 4 **FRACTURE MECHANICS:** Strength of cracked bodies - Potential energy and surface energy - Griffith's theory - Irwin - Orwin extension of Griffith's theoryto ductile materials - stress analysis of cracked bodies	**10 Hours/ L3**
Module 5 **FATIGUE DESIGN AND TESTING:** Safe life and Fail-safe design philosophies -Importance of Fracture Mechanics in aerospace structures - Application to composite materials and structures.	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Apply mathematical knowledge to define fatigue behaviors.
CO2	Analyze the load histories and cumulative damage due to fatigue.
CO3	Ability to investigate the life of a structure under dynamic loading conditions.
CO4	Knowledge of fracture mechanics approach applicable to homogeneous and heterogeneous materials.
CO5	Knowledge of probalistic approach and development of mathematical models for life prediction of structures and knowledge of safe life and fail safe design.

Textbooks:

1. Barrois W, Ripley, E.L., "Fatigue of aircraft structure," Pergamon press. Oxford, 1983.
2. Prashant Kumar – Elements of fracture mechanics" Tata McGraw Hill Education Private Limited ,2009

Reference books:

1. Kare Hellan ,'Introduction to Fracture Mechanics', McGraw Hill, Singapore,1985.
2. Knott, J.F., "Fundamentals of Fracture Mechanics," - Buterworth& Co., Ltd., London, 1983.
3. Sih C.G., Sijthoff and W Noordhoff, "Mechanics of fracture Vol - I" International Publishing Co., Netherlands, 1989.

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
CO1	3	3	2	2	-	-	-	-	-	-	-	-	2	-
CO2	3	3	2	2	-	-	-	-	-	-	-	-	2	-
CO3	3	3	2	2	-	-	-	-	-	-	-	-	2	-
CO4	3	3	2	2	-	-	-	-	-	-	-	-	2	-
Average	3	3	2	2	-	-	-	-	-	-	-	-	2	-

Low-1: Medium-2: High-3

SEMESTER – VII – PROFESSIONAL ELECTIVE 4

COURSE: HELICOPTER ENGINEERING

Course Code	**20ANE733**	**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
Aerodynamics II

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.

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**
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:

CO1	Explain the Parts of Helicopters and their functionality
CO2	Apply the Momentum theory for Analysis of Helicopter Aerodynamics
CO3	Apply the Blade Element theory for Analysis of Helicopter Aerodynamics
CO4	Calculate the performance parameters in various flight Conditions
CO5	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.A.R.S. Bramwell, George Done and Davis Balmford, Bramwell's Helicopter Dynamics, 2nd Edition, Butterworth-Heinemann (Reed Educational & Professional Publishing Ltd.), 2001.
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
CO1	3	2	-	-	-	-	-	-	1	1	-	1	1	1
CO2	3	3	1	-	-	-	-	-	-	-	-	1	1	1
CO3	3	3	1	-	-	-	-	-	1	1	-	1	1	1
CO4	3	3	1	-	-	-	-	-	1	1	-	1	1	1
CO5	3	3	-	-	-	-	-	-	-	-	-	1	1	1
Average	3	3	1						1	1		1	1	1

Low-1: Medium-2: High-3

SEMESTER – VII – PROFESSIONAL ELECTIVE 4

COURSE: FLIGHT SCHEDULING AND OPERATIONS

Course Code	**20ANE734**	**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 Flight Scheduling and Operations in broad domain of Aeronautical Engineering by making them to learn:

CLO1	Understanding about network diagrams.
CLO2	Understand the process of fleet assignment.
CLO3	Flight Scheduling and its Significance
CLO4	Know about the aircraft routing- maintenance requirements.
CLO5	How the Gate Assignment and Aircraft Boarding Strategy is carried out.

Content	No. of Hours/RBT levels
Module 1 **NETWORK FLOWS AND INTEGER PROGRAMMING MODELS:** Complexity of airline planning, operations and dispatch- need for optimization- role of operations research and simulation. Networks- definitions, network flow models- shortest path problem, minimum cost flow problem, maximum flow problem, multi-commodity problem. mathematical formulation- decision variables, objective function, constraints, and methods of solution.	**10 Hours/ L3**
Module 2 **FLEET ASSIGNMENT:** Purpose of fleet assignment. Fleet types, fleet diversity, and fleet availability-performance measures, Formulation of the fleet assignment problem- decision variables, objective function, constraints, and solution. Scenario analysis, fleet assignment models.	**08 Hours/ L3**
Module 3 **FLIGHT SCHEDULING AND ITS SIGNIFICANCE:** The route system of the airlines- point- to-point flights, hub and spoke flights. Schedule construction-operational feasibility, economic viability. Route development and flight scheduling process- load factor and frequency- case study	**08 Hours/ L3**
Module 4 **AIRCRAFT ROUTING AND MANAGEMENT:** Goal of aircraft routing- maintenance requirements, other constraints. Routing cycles, route generators. Mathematical models of routing- decision variables, objective functions, alternatives, constraints- flight coverage and aircraft available.	**08 Hours/ L3**

Example problems and solutions.	
Module 5 **GATE ASSIGNMENT AND AIRCRAFT BOARDING STRATEGY:** Gate assignment- significance- the problem-levels of handling-passenger flow, distance matrix mathematical formulation, solution. Common strategies for aircraft boarding process, mathematical model, interferences, model description, aisle interferences.	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Understand and apply the concept of Network Flows and Integer Programming Models for solving numerical related different network models.
CO2	Discuss the Fleet Assignment.
CO3	Understand about airlines- point-to-point flights, hub and spoke flights and significance of flight scheduling.
CO4	Understand the Aircraft Routing and Management by using math model.
CO5	Discuss the Gate Assignment and Aircraft Boarding Strategy.

Textbooks:

1. Bazargan M, Airline Operations and Scheduling, Ash gate Publishing Ltd, 2nd Edition 2010.
2. Belobaba P, Odoni, A., Barnhart, C, The Global Airline Industry Wiley, N.Y., 2009.

Reference books:

1. Wensveen, J.G, Air Transportation: A Management Perspective, Ashgate Publishing Ltd, 6th Edition, 2007.
2. Ahuja, R., Network Flows-Theory, Algorithms and Applications, Prentice-Hall, 1993.

Scheme of Examination:

Semester End Examination (SEE):

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

Continuous Internal Evaluation (CIE):

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

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

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

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

Low-1: Medium-2: High-3

SEMESTER – VII - PROFESSIONAL ELECTIVE 5

COURSE: RESEARCH METHODOLOGY

Course Code	**20ANE741**	**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 Research Methodology in broad domain of aeronautical engineering by making them to learn:

CLO 1	To make the student understand the foundations of Research and problem solution
CLO 2	Knowledge in Research design, Qualitative and Quantitative Research
CLO 3	Knowledge to formulate and derive static and dynamic aero elastic equations of motion.

Content	**No. of Hours/ RBT levels**
Module 1 **RESEARCH METHODOLOGY:** Introduction, Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India. **DEFINING THE RESEARCH PROBLEM:** Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration	**10 Hours/ L3**
Module 2 **REVIEWING THE LITERATURE:** Place of the literature review in research, bringing clarity and focus to research problem, improving research methodology, broadening knowledge base in research area, enabling contextual findings, Review of the literature, searching the existing literature, reviewing the selected literature, developing a theoretical framework, developing a conceptual framework, writing about the literature reviewed. **RESEARCH DESIGN**: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs	**08 Hours/ L3**
Module 3 **DESIGN OF SAMPLE SURVEYS:** Design of Sampling: Introduction, Sample Design, Sampling and Non-Sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. **MEASUREMENT AND SCALING:** Qualitative and Quantitative Data.	**08 Hours/**

Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement, Techniques of Developing Measurement Tools, Scaling, Scale Classification Bases, Scaling Technics, Multidimensional Scaling, Deciding the Scale. **DATA COLLECTION:** Introduction, Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.	**L3**
Module 4 **TESTING OF HYPOTHESES:** Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis. **CHI-SQUARE TEST:** Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using Chi Square Tests	**08 Hours/ L3**
Module 5 **INTERPRETATION AND REPORT WRITING:** Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports. **INTELLECTUAL PROPERTY**: The Concept, Intellectual Property System in India, Different types of IPR	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Understand the research problem by literature review to solve problems
CO2	Develop skills in qualitative and quantitative data analysis and presentation.
CO3	Develop advanced critical thinking skills.
CO4	Understand to write the report writing and awareness about IPR

Textbooks:

1. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.

Reference books:

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
2. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.

3. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
4. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.

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
CO1	3	2	2	-	-	-	-	1	-	-	-	-	-	1
CO2	3	2	2	-	-	-	-	1	-	-	-	-	-	1
CO3	3	2	2	-	-	-	-	1	-	-	-	-	-	1
CO4	3	2	2	-	-	-	-	1	-	-	-	-	-	1
Average	3	2	2	-	-	-	-	1	-	-	-	-	-	1

Low-1: Medium-2: High-3

SEMESTER – VII - PROFESSIONAL ELECTIVE 5

Course: NDT IN AEROSPACE ENGINEERING

Course Code	**20ANE742**	**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.

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 characterisation. 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, Penetrameters, 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:

CO1	Explain the fundamental concepts of NDT
CO2	Discuss the different methods of NDT
CO3	Explain the concept of Thermography and Eddy current testing
CO4	Explain the concept of Ultrasonic Testing and Acoustic Emission
CO4	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
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO2	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO3	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO4	3	3	-	-	-	-	-	-	-	-	-	-	-	2
CO5	3	3	-	-	-	-	-	-	-	-	-	-	-	2
Average	3	3	-	-	-	-	-	-	-	-	-	-	-	2

Low-1: Medium-2: High-3

SEMESTER – VII- PROFESSIONAL ELECTIVE 5

COURSE: COMPUTATIONAL FLUID DYNAMICS

Course Code	**20ANE743**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Pre requisite: Aerodynamics -II

Course Objectives: To enable students to apply the knowledge of Computational Fluid Dynamics in broad domain of aeronautical engineering by making them to learn:

CLO1	To introduce Governing Equations of viscous fluid flows
CLO2	To introduce numerical modelling and its role in the field of fluid flow and heat transfer
CLO3	To enable the students to understand the various discretization methods, solution Procedures and turbulence modelling.
CLO4	To create confidence to solve complex problems in the field of fluid flow and heat transfer by using high speed computers.

Content	**No. of Hours/ RBT levels**
Module 1 **GOVERNING EQUATIONS AND BOUNDARY CONDITIONS:** Basics of computational fluid dynamics – Models of flows, governing equations of fluid dynamics – substantial derivatives physical meaning of divergence of velocity, Continuity, Momentum and Energy equations – Physical boundary conditions, Elliptic, Parabolic and Hyperbolic equations.	**08 Hours/ L3**
Module 2 **FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION:** Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three -dimensional diffusion problems – Parabolic equations – Explicit and Implicit schemes, Use of Finite Difference and Finite Volume methods.	**08 Hours/ L3**
Module 3 **FINITE VOLUME METHOD FOR CONVECTION DIFFUSION:** Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law.	**08 Hours/ L3**
Module 4 **FLOW FIELD ANALYSIS:** Finite volume methods -Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants- PISO Algorithms.	**10 Hours/ L3**

Module 5	
TURBULENCE MODELS AND MESH GENERATION: Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation – Mesh refinement – Adaptive mesh – Software tools.	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Derive the governing equations and boundary conditions for Fluid dynamics
CO2	Analyse Finite difference and Finite volume method for Diffusion
CO3	Analyse Finite volume method for Convective diffusion
CO4	Analyse Flow field problems
CO5	Explain the Turbulence models and Mesh generation techniques

Textbooks:

1. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill Publishing Company Ltd., 2017.
2. Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Fluid Dynamics: The finite volume Method", Pearson Education Ltd, Second Edition,2007

Reference books:

1. Anil W. Date "Introduction to Computational Fluid Dynamics" Cambridge University Press, 2005.
2. Chung, T.J. "Computational Fluid Dynamics", Cambridge University, 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 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
CO1	3	3	-	-	2	-	-	-	-	2	-	-	-	2
CO2	3	3	-	-	2	-	-	-	-	2	-	-	-	2
CO3	3	3	-	-	2	-	-	-	-	2	-	-	-	2
CO4	3	3	-	-	2	-	-	-	-	2	-	-	-	2
CO5	3	3	-	-	2	-	-	-	-	2	-	-	-	2
Average	3	3	-	-	2	-	-	-	-	2	-	-	-	2

Low-1: Medium-2: High-3

SEMESTER – VII – PROFESSIONAL ELECTIVE 5

COURSE: CIVIL AVIATION REQUIREMENT

Course Code	**20ANE744**	**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 AI and ML in broad domain of Aeronautical Engineering by making them to learn:

CLO1	Fundamental concepts of Artificial Intelligence (AI).
CLO2	Application of AI in aircraft industry
CLO3	AI in the real time application

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 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.	**10 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Should be able to have the knowledge of Indian Aircraft Rules 1937 and related publication
CO2	Should be able to have the knowledge CAR series B and C (MEL, cockpit and emergency check list and Defects rectification and analysis)
CO3	Should be able to have the knowledge CAR series E for approval of organizations: in various categories and CAR series M.
CO4	Should be able to have the knowledge CAR145, CAR -21 Type certificate and Noise certificate
CO5	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
CO1	2	2	-	-	-	-	-	-	2	2	-	-		
CO2	3	3	-	-	-	-	-	-	2	2	-	-		
CO3	3	3	-	-	-	-	-	-	2	2	-	-		
CO4	3	3	-	-	-	-	-	-	2	2	-	-		
Average	2	2	-	-	-	-	-	-	2	2	-	-		

Low-1: Medium-2: High-3

SEMESTER – VII- OPEN ELECTIVE 2

COURSE: INTRODUCTION TO UAV

Course Code	**20ANE751**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

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

CLO1	History and overview of UAV systems
CLO2	Basic Aerodynamics
CLO3	Loads on UAV
CLO4	Navigation and Mission planning and control
CLO5	Launch and recovery system

Content	No. of Hours/RBT levels
Module 1 **INTRODUCTION:** Aviation History and Overview of UAV systems, Classes and Missions of UAVs, Definitions and Terminology, UAV fundamentals, Examples of UAV systems-very small, small, Medium and Large UAV	**08 Hours/ L2**
Module 2 **THE AIR VEHICLE BASIC AERODYNAMICS:** Basic Aerodynamics equations, Aircraft polar, the real wing and Airplane, Induced drag, the boundary layer, Total Air-Vehicle Drag.	**08 Hours/ L2**
Module 3 **LOADS ON AIR VEHICLE:** Loads and Structures Loads, Dynamic Loads, Materials, Sandwich Construction, Skin or Reinforcing Materials, Resin Materials, Core Materials, Construction Techniques.	**10 Hours/ L2**
Module 4 **NAVIGATION, MISSION PLANNING AND CONTROL:** Overview of NAVSTAR Global Positioning System (GPS), TACAN, LORAN C, Inertial Navigation, Radio Tracking, Way-point Navigation, Air Vehicle and Payload Control, Reconnaissance/Surveillance Payloads, Weapon Payloads, Other Payloads, Data-Link Functions and Attributes, Data-Link Margin, Data-Rate Reduction.	**08 Hours/ L2**
Module 5 **UAV LAUNCH AND RECOVERY:** Types of Launch Systems, Types of Recovery Systems, Launch and Recovery Tradeoffs.	**08 Hours/ L2**

COURSE OUTCOMES:

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

CO1	Comprehend the basic aviation history and UAV systems
CO2	Understand the basic aerodynamics
CO3	Acquire knowledge about structures Loads, Dynamic Loads and types of material used
CO4	Understand Navigation, Mission Planning and Control
CO5	Understand the basics of launch and recovery systems

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 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.**

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
CO1	3	1	-	-	-	-	-	-	-	-	-	-	2	-
CO2	3	1	-	-	-	-	-	-	-	-	-	-	2	-
CO3	3	1	-	-	-	-	-	-	-	-	-	-	2	-
CO4	3	1	-	-	-	-	-	-	-	-	-	-	2	-
Average	3	1	-	-	-	-	-	-	-	-	-	-	2	-

Low-1: Medium-2: High-3

SEMESTER – VII - OPEN ELECTIVE 2

COURSE: AIRPORT PLANNING & MANAGEMENT

Course Code	**20ANE752**	**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.

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:

CO1	Explain the typical operations of airports from a management perspective
CO2	Identify the economic, political and social role of airports
CO3	Discuss the airport financial management
CO4	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
CO1	3	3	-	-	-	-	-	-	-	-	-	-	-	1
CO2	3	3	-	-	-	-	-	-	-	-	-	-	-	1
CO3	3	3	-	-	-	-	-	-	-	-	-	-	-	1
CO4	3	3	-	-	-	-	-	-	-	-	-	-	-	1
Average	3	3	-	-	-	-	-	-	-	-	-	-	-	1

Low-1: Medium-2: High-3

SEMESTER – VII - OPEN ELECTIVE 2

COURSE: AIRCRAFT MATERIALS AND PRODUCTION

Course Code	**20ANE753**	**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 engineering materials and phase diagram
CLO2	Know about casting and welding process
CLO3	Familiarize with the sheet metal and riveting process
CLO4	To study about conventional and modern manufacturing processes
CLO5	Use of composite materials in aircraft industries

Content	No. of Hours/RBT levels
Module 1 **AIRCRAFT ENGINEERING MATERIALS:** Engineering materials Steels, Solid solutions, Binary phase diagrams, study of iron, iron carbon phase diagram, heat treatment, annealing, normalizing, hardening and tempering of Aluminum and steel, Non-Ferrous metals and Alloys: Structure and properties of copper and its alloys, Aluminum and its alloys, Titanium and its alloys.	**08 Hours/ L2**
Module 2 **CASTING, WELDING AND INSPECTION TECHNIQUES:** General principles of various casting processes Sand casting, die-casting, centrifugal casting, investment casting, Shell molding types; Principles and equipment used in arc welding, gas welding, resistance welding, solid, laser welding, and electron beam welding, soldering and brazing techniques.	**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 **CONVENTIONAL AND MODERN MANUFACTURING PROCESSES:** General working principles, applications and operations of lathe, shaper, milling machines, grinding, drilling machine, computer numeric control machining. Working principles and applications of abrasive jet machining, ultrasonic machining, Electric discharge machining and electro chemical machining, laser beam, electron beam, plasma arc machining. Rapid prototyping, Additive manufacturing process.	**10 Hours/ L2**

Module 5	
AIRCRAFT COMPOSITES: Introduction to fiber reinforced plastics, glass and carbon composites; Fibers and resins; Characteristics and applications, Classification of aircraft materials; Materials used for aircraft components, Application of composite materials, Super alloys, emerging trends in aerospace materials.	**08Hours/ L2**

COURSE OUTCOMES:

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

CO1	Understand about the basics of phase diagrams, equilibrium diagrams.
CO2	Describe the basics of manufacturing processes, patterns, properties of molding sands.
CO3	Explain about the importance of various materials for aircraft industry
CO4	Comprehend the various conventional and modern manufacturing processes
CO5	Understand the need of composite materials for aircraft industries

Textbooks:

1. S. Kalpakjian, Steven R. Schmid, "Manufacturing Engineering and Technology", Addison Wesley, 5th Edition, 1991.
2. S. C. Keshu, K. K Ganapathy, "Aircraft production technology and management", Interline Publishing House, Bangalore, 3rd Edition, 1993.
3. Douglas F. Horne – "Aircraft production technology" – Cambridge University Press, 1st Edition,1986.

Reference books:

1. R. K. Jain, "Production technology", McGraw Hill, 1st Edition, 2002.
2. O. P. Khanna, M. Lal, "Production technology", Dhanpat Rai Publications, 5th Edition, 1997

Scheme of Examination:

Semester End Examination (SEE):

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

Continuous Internal Evaluation (CIE):

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

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

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

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

Low-1: Medium-2: High-3

SEMESTER – VII

COURSE: PROJECT WORK PHASE 1

Course Code	20ANEP78	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**

SEMESTER – VIII

COURSE

CURRICULUM

(UG PROGRAMME)

SEMESTER – VIII

COURSE: FLIGHT VEHICLE DESIGN

Course Code	**20ANE81**	**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 Analysis

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	Design geometry, thrust to weight ratio and wing loading of an aircraft.
CLO3	Initial sizing and configuration layout.
CLO4	Application of aerodynamics, propulsion and aircraft structures in 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 SELECTION:** 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:** 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 RATIO & WING LOADING:** Thrust to weight definitions, Power loading, Statistical estimate of T/W. Thrust matching, Wing Loading and its effect on Stall speed, Take-off Distance, Catapult take-off, and Landing Distance. 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:** Rubber engine sizing, Fixed engine sizing, Geometry sizing – Fuselage, Wing, Tail volume coefficient, and Control surface sizing, **CONFIGURATION LAYOUT & LOFT:** Conic lofting, Conic fuselage development, Conic shape parameter, Wing-tail layout & Loft. aerofoil linear interpolation. Aerofoil flat- wrap interpolation. Wing aerofoil layout-flap wrap. Wetted area	**08 Hours/ L3**

determination. Special considerations in configuration layout: Aerodynamic, Structural, Detectability. Crew station, Passenger, and Payload arrangements.	
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. **STRUCTURAL LOADS:** Structures fundamentals, Loads categories, Air loads – maneuver loads, gust loads, air loads on lifting surface, air loads due to control deflection, Inertial loads, Power-plant loads, Landing gear loads.	**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:

CO1	Overview of conceptual design process of an aircraft, airfoil and wing geometry.
CO2	Estimate the design geometry, thrust to weight ratio and wing loading of an aircraft.
CO3	Discuss initial sizing and configuration layout.
CO4	Explain the application of aerodynamics, propulsion and aircraft structures in design.
CO5	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
CO1	3	3	-	-	-	-	-	-	2	-	-	2	2	1
CO2	3	3	-	-	-	-	-	-	2	-	-	2	2	1
CO3	3	3	-	-	-	-	-	-	2	-	-	2	2	1
CO4	3	3	-	-	-	-	-	-	2	-	-	2	2	1
CO5	3	3	-	-	-	-	-	-	2	-	-	2	2	1
Average	3	3	-	-	-	-	-	-	2	-	-	2	2	1

Low-1: Medium-2: High-3

SEMESTER – VIII - PROFESSIONAL ELECTIVE 6

COURSE: TOTAL QUALITY MANAGEMENT

Course Code	**20ANE821**	**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:** Need for quality – Evolution of quality – Definition of quality – Dimensions of 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:

CO1	Familiarize basic concepts of quality gurus.
CO2	Gain and apply the knowledge of TQM principles.
CO3	Identify the appropriate the statistical tool to achieve the quality control.
CO4	Employ the principles of continuous process improvement tools.
CO5	Gain and 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 / 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
CO1	3	3	1	-	-	2	-	2	-	-	-	3	-	-
CO2	3	3	1	-	-	2	-	2	-	-	-	3	-	-
CO3	3	3	1	-	-	2	-	2	-	-	-	3	-	-
CO4	3	3	1	-	-	2	-	2	-	-	-	3	-	-
Average	3	3	1	-	-	2	-	2	-	-	-	3	-	-

Low-1: Medium-2: High-3

SEMESTER – VIII - PROFESSIONAL ELECTIVE 6

COURSE: SMART MATERIALS & NANO TECHNOLOGY

Course Code	**20ANE822**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Pre requisite: Materials and Manufacturing Process

Course Objectives: To enable students to apply the knowledge of Smart Materials & Nano Technology in broad domain of Aeronautical Engineering by making them to learn:

CLO1	Learn about different materials and characteristics .
CLO2	Knowledge on optics and electromagnetic
CLO3	Principles of Vibration
CLO4	Basics of Nanotechnology and Quantum Mechanics

Content	No. of Hours/RBT levels
Module 1 **INTRODUCTION:** Characteristics of composites and ceramics materials, Electro- magnetic materials and shape memory alloys-processing and characteristics Sensing and Actuation Principles of electromagnetic, acoustics, chemical and mechanical sensing and actuation, Types of sensors and their applications.	**08 Hours/ L2**
Module 2 **OPTICS AND ELECTROMAGNETIC:** Principles of optical fiber technology, characteristics of active and adaptive optical system and components Design and manufacturing principles. **STRUCTURES:** Principles of drag and turbulence control through smart skins, applications in environment such as aerospace and transportation vehicles, manufacturing, repair and maintainability aspects.	**08 Hours/ L2**
Module 3 **PRINCIPLES OF VIBRATION AND MODAL ANALYSIS:** PZT Actuators, MEMS, Magnetic shape Memory Alloys, Characteristics and Applications. Principles of structural acoustic control.	**08 Hours/ L2**
Module 4 **INTRODUCTION TO NANOTECHNOLOGY:** Importance of Nanotechnology-History of Nanotechnology-Opportunity at the nano scale length and time scale in structures-energy Landscapes-Inter dynamic aspects of intermolecular forces -classification based on the dimensionality- nano particles nanoclusters-nanotubes-nanowires and nano dots- Semiconductor nanocrystals carbon nanotubes- Influence of Nano structuring on Mechanical, optical, electronic, magnetic and chemical properties.	**08 Hours / L2**

Module 5	
BASICS OF QUANTUM MECHANICS: Introduction to Quantum Mechanics - Schrodinger equation time dependent and time independent equations Operators and observables - Commutation relations - Hermitian operators.	**08 Hours/ L2**

COURSE OUTCOMES:

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

CO1	Identify the characteristics of various smart materials.
CO2	To make student familiarize with the principles the Optics and Electromagnetic principles
CO3	Apply principles of vibrations and perform modal analysis
CO4	Understand the importance of nanotechnology and quantum mechanics.

Textbooks:

1. A. V. Srinivasan, 'Analysis and Design' - 'Smart Structures –Cambridge University Press, New York, 2001
2. M V Gandhi and B S Thompson Chapmen & Hall, 'Smart Materials and Structures' London, 1992.

Reference books:

1. Banks HT, R C Smith, Y Wang, Massow S A 'Smart Materials and Structures', Paris 1996
2. Pradeep.T, 'A textbook of Nanoscience and Nanotechnology', Tata McGraw Hill education private ltd, 2012.

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
CO1	3	2	-	-	-	-	-	-	-	-	-	-	3	-
CO2	3	2	-	-	-	-	-	-	-	-	-	1	3	-
CO3	3	2	-	-	-	-	-	-	-	-	-	1	3	-
CO4	3	2	-	-	-	-	-	-	-	-	-	1	3	-
Average	3	2	-	-	-	-	-	-	-	-	-	1	3	-

Low-1: Medium-2: High-3

SEMESTER – VIII - PROFESSIONAL ELECTIVE 6

COURSE: FLIGHT TESTING

Course Code	**20ANE823**	**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:** 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. **PERFORMANCE FLIGHT TESTING -TAKE-OFF, LANDING, TURNING FLIGHT:** Turning performance limitations. Drag estimation. Take-off and landing - methods, procedures and data reduction.	**08 Hours/ L3**

Module 4 **STABILITY AND CONTROL - LONGITUDINAL AND MANOEUVRING:** Flight test Methods: Static longitudinal stability; Dynamic longitudinal stability. Data reduction. Maneuvering stability methods & data reduction. **STABILITY AND CONTROL - LATERAL & DIRECTIONAL:** Flight Test methods: - Lateral and directional static stability: Lateral and directional dynamic stability. Regulations and data reduction.	**10 Hours/ L3**
Module 5 **FLYING QUALITIES:** MIL and FAR regulations. Cooper-Harper scale. Pilot rating. Flight test procedures. **HAZARDOUS FLIGHT TESTING:** Stall and spin- regulations, test and recovery techniques. Dive testing for flutter, vibration and buffeting.	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Review the scope of flight testing, its types and reducing uncertainty.
CO2	Identify the purpose, scope and working of various instruments employed for flight-testing.
CO3	Examine the performance of flight at different operating conditions.
CO4	Illustrate the stability and control aspects at various flight condition.
CO5	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
CO1	3	-	-	-	-	-	-	-	-	-	-	-	-	2
CO2	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO3	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO4	3	2	-	-	-	-	-	-	-	-	-	-	-	2
CO5	3	2	-	-	-	-	-	-	-	-	-	-	-	2
Average	3	2	-	-	-	-	-	-	- -	-	-	-	-	2

Low-1: Medium-2: High-3

SEMESTER – VIII - PROFESSIONAL ELECTIVE 6

COURSE: INDUSTRIAL AERODYNAMICS

Course Code	**20ANE824**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**3:0:0**	**SEE Marks**	**50**
No. of Credits	**3**	**Examination Hours**	**03**

Course Objectives: To familiarize the learner with non-aeronautical uses of aerodynamics such as road vehicle, building aerodynamics and problems of flow induced vibrations.

Content	No. of Hours/ RBT levels
Module 1 **ATMOSPHERE:** Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows.	**08 Hours/ L3**
Module 2 **WIND ENERGY COLLECTORS:** Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory.	**08 hours/ L3**
Module 3 **VEHICLE AERODYNAMICS:** Power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of trains and Hovercraft.	**08 Hours/ L3**
Module 4 **BUILDING AERODYNAMICS:** Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, building codes, Building ventilation and architectural aerodynamics.	**10 Hours/ L3**
Module 5 **FLOW INDUCED VIBRATIONS:** Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter.	**08 Hours/ L3**

COURSE OUTCOMES:

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

CO1	Understand the use of aerodynamics for non- aerodynamic shapes such as vehicle, building.
CO2	Identify the Atmospheric boundary layer and applications of wind energy collectors.
CO3	Analyze the aerodynamics of road vehicles, buildings and problems of flow induced vibrations.
CO4	Solve the problems and able to analyze vibrations during flow.

Textbooks:

1. M. Sovran (Ed), "Aerodynamics and drag mechanisms of bluff bodies and Road vehicles", Plenum press, New York, 1978.
2. Sachs. P., "Winds forces in Engineering", Pergamon Press, 1978.

Reference books:

1. Blevins. R.D., "Flow Induced Vibrations", Van Nostrand, 1990.
2. Calvent. N.G., "Wind Power Principles", Charles Griffin & Co., London, 1979.

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
CO1	3	3	-	2	-	-	-	-	-	-	-	-	-	2
CO2	3	3	-	2	-	-	-	-	-	-	-	-	-	2
CO3	3	3	-	2	-	-	-	-	-	-	-	-	-	2
CO4	3	3	-	2	-	-	-	-	-	-	-	-	-	2
Average	3	3	-	2	-	-	-	-	-	-	-	-	-	2

Low-1: Medium-2: High-3

SEMESTER – VIII

COURSE: PROJECT WORK PHASE II

Course Code	20ANEP83	CIE Marks	50
Hours/Week (L: T: P)	0:0:20	SEE Marks	50
No. of Credits	10	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.	

SEMESTER – VIII

COURSE: TECHNICAL SEMINAR

Course Code	**20ANES84**	**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**

SEMESTER – VIII

COURSE: INTERNSHIP

Course Code	**20ANEI85**	**CIE Marks**	**50**
Hours/Week (L: T: P)	**0:0:4**	**SEE Marks**	**50**
No. of Credits	**3**	**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.

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**

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