ESTD. 1939

KARNATAK LAW SOCIETY'S
GOGTE INSTITUTE OF TECHNOLOGY
"JNANA GANGA" UDYAMBAG, BELAGAVI-590008,
KARNATAKA, INDIA.
Approved by AICTE & UGC
Permanently Affiliated and Autonomous Institution Under
Visvesvaraya Technological University, Belagavi
www.git.edu

ESTD. 1979

2018-19 Scheme

Department: Aeronautical Engineering

Programme: B.E. (Aeronautical Engineering)

3rd to 8th Semester Scheme of Teaching and Examination

3rd to 8th Semester Syllabus

INSTITUTION VISION

Gogte Institute of Technology shall stand out as an institution of excellence in technical education and in training individuals for outstanding caliber, character coupled with creativity and entrepreneurial skills.

MISSION

To train the students to become Quality Engineers with High Standards of Professionalism and Ethics who have Positive Attitude, a Perfect blend of Techno-Managerial Skills and Problem solving ability with an analytical and innovative mindset.

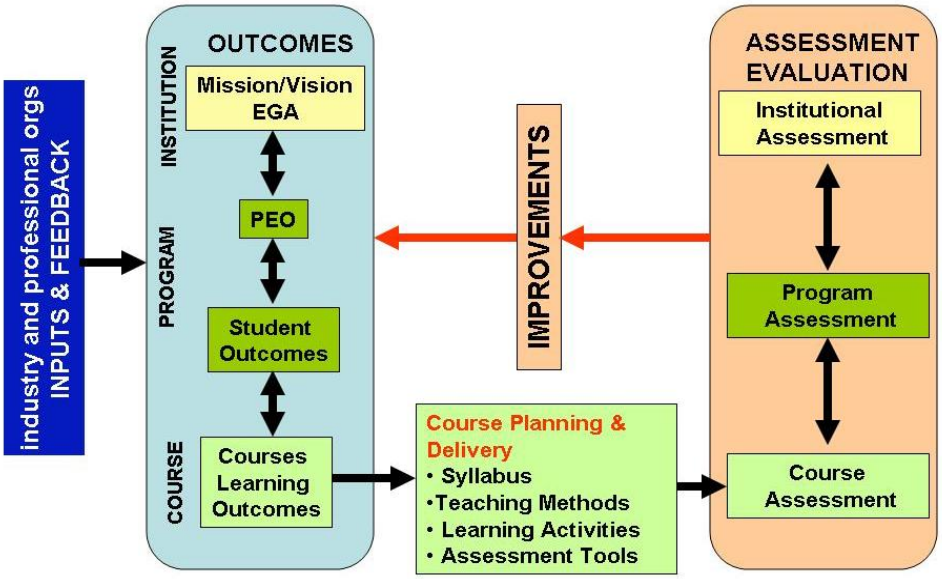
QUALITY POLICY

- Imparting value added technical education with state-of-the-art technology in a congenial, disciplined and a research oriented environment.
- Fostering cultural, ethical, moral and social values in the human resources of the institution.
- Reinforcing our bonds with the Parents, Industry, Alumni, and to seek their suggestions for innovating and excelling in every sphere of quality education.

DEPARTMENT VISION
The vision of the department of aeronautical engineering is to be recognized globally as a centre of excellence for education leading to well qualified professional engineers who are innovative, industry ready and also cater to the needs of the society.

MISSION
The mission of the department of aeronautical Engineering is to educate, inspire and mentor students to excel as professional with strong leadership skills and commitment to the society.

OUTCOME BASED EDUCATION (OBE)



PROGRAM OUTCOMES (POs):

National Board of Accreditation (NBA) has framed the Program Outcomes (PO) based on twelve Graduate Attributes (GA). These POs are generic to engineering education and applies to all branches of Engineering.

1.Engineering Knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

2.Problem Analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics,natural sciences and Engineering sciences.

3.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.

4.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.

5.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.

6.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.

7.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.

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

9.Individual and team work: Function effectively as an individual and as a member or leader in diverse teams, and in multidisciplinary settings.

10.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.

11. Project management and finance: Demonstrate knowledge and understanding of the engineering 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.

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

PROGRAM EDUCATIONAL OBJECTIVES (PEOs):

1. The graduates will acquire core competence in basic science and aeronautical engineering fundamentals necessary to formulate, analyze, and solve engineering problems and to pursue advanced study or research.

2. The graduates will engage in the activities that demonstrate desire for ongoing personal and professional growth and self-confidence to adapt to rapid and major changes.

3. The graduates will maintain high professionalism and ethical standards, effective oral and written communication skills, work as part of teams on multidisciplinary projects under diverse professional environments, and relate engineering issues to the society, global economy and to emerging technologies.

PROGRAM SPECIFIC OUTCOMES (PSOs):

1. An ability to identify, formulate and apply knowledge of mathematics, science to solve Aeronautical engineering problems keeping in mind economical, environmental and social context.

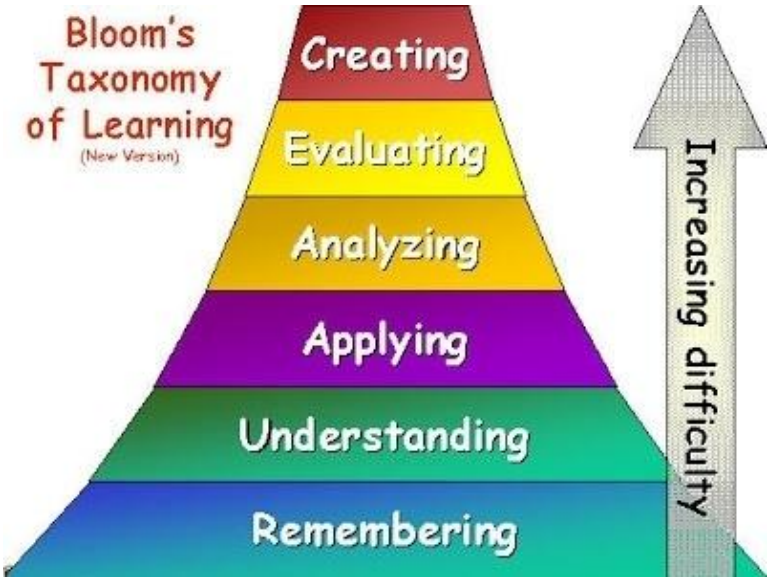
2. A Knowledge of contemporary issues and an ability to use the techniques, skills and modern engineering tools necessary to engage in lifelong learning in the field of Aerodynamics, propulsion, Avionics and structures streams.

3. An ability to work in multidisciplinary projects professionally and ethically.

BLOOM'S TAXONOMY OF LEARNING OBJECTIVES

Bloom's Taxonomy in its various forms represents the process of learning. It was developed in 1956 by Benjamin Bloom and modified during the 1990's by a new group of cognitive psychologists, led by Lorin Anderson (a former student of Bloom's) to make it relevant to the 21st century. The **revised taxonomy** given below emphasizes what a learner "Can Do".

Lower order thinking skills (LOTS)		
L1	Remembering	Retrieve relevant knowledge from memory.
L2	Understanding	Construct meaning from instructional material, including oral, written, and graphic communication.
L3	Applying	Carry out or use a procedure in a given situation – using learned knowledge.
Higher order thinking skills (HOTS)		
L4	Analyzing	Break down knowledge into its components and determine the relationships of the components to one another and then how they relate to an overall structure or task.
L5	Evaluating	Make judgments based on criteria and standards, using previously learned knowledge.
L6	Creating	Combining or reorganizing elements to form a coherent or functional whole or into a new pattern, structure or idea.



Scheme of Teaching and Examination- 3rd to 8th Semester B.E.

As per the guidelines of UGC CBCS the courses can be classified into:

(i) Core Courses (PC): This is the course which is to be compulsorily studied by a student as a core requirement to complete the requirements of a program in a said discipline of study. These courses will have 4 credits per course.

(ii) Foundation Courses: The Foundation Courses are of two kinds:

Compulsory Foundation: These courses are the courses based upon the content that leads to Knowledge enhancement. These courses provide opportunities to improve technological knowledge before entering industry as well as preparing students for higher degrees in technological subjects. They are mandatory for all disciplines. These courses will have 4 credits per course.

The courses are: **Basic Science Courses (BS), Engineering Science Courses (ES)**.

Foundation Electives: These are value based courses aimed at man making education. The course is related to **Humanities and Social Science Courses (HS).**

(iii) Elective Courses: This is course, which can be chosen from the pool of papers. It may be supportive to the discipline/ providing extended scope/enabling an exposure to some other discipline / domain / nurturing student proficiency skills.

An elective may be **Discipline Centric (PE)** or **Open Elective (OE).**

(iv) Mandatory Non-Credit Courses (MNC): These courses are mandatory for students joining B.E Program and students have to successfully complete these courses before the completion of degree.

Semester wise distribution of credits for B.E program

Total credits for B.E Program: 175 credits

		Regular batch		**Dip. Lateral entry**	
	Semester	**Credits per Sem**	**Total credits**	**Credits per Sem**	**Total credits**
1st year	1	20	40	----	----
	2	20		----	
2nd year	3	24	48	24	48
	4	24		24	
3rd year	5	24	48	24	48
	6	24		24	
4th year	7	23	39	23	39
	8	16		16	
	Total	**175**	**175**	**135**	**135**

Credit definition:

Lecture (L):One Hour /week – 1 credit
Tutorial (T): Two hour /week – 1 credit
Practicals (P): Two hours /week – 1 credit;

Third Semester (Regular)									
S.No.	**Course Code**	**Course Title**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T - P			**CIE**	**SEE**	**Total**
1.	18MATAE31	Statistical-Numerical – Fourier Techniques	BS	4 – 0 – 0	4	4	50	50	100
2.	18AE32	Elements of aeronautics	PC	4 – 0 – 0	4	4	50	50	100
3.	18AE33/ME33	Fluid mechanics	PC	4 – 0 – 0	4	4	50	50	100
4.	18AE34	Aircraft materials and process	PC	4 – 0 – 0	4	4	50	50	100
5.	18AE35/ME35	Mechanics of materials	PC	4 – 0 – 0	4	4	50	50	100
6.	18AEL36	Fluid mechanics Lab	PC	0 – 0 – 3	3	1.5	25	25	50
7.	18AEL37	Mechanics of materials lab/ MT lab	PC	0 – 0 – 2	2	1	25	25	50
8.	18AEL38	Machine shop Lab	PC	0 – 0 – 3	3	1.5	25	25	50
9.	18AE39	Kannada/ Environmental Studies	HS	MNC			50		
		Total			**28**	**24**	**375**	**325**	**650**

Third Semester (Diploma)									
S.No.	**Course Code**	**Course Title**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T - P			**CIE**	**SEE**	**Total**
1.	18DMATAE31	Engineering Mathematics –I	BS	4 – 0 – 0	4	4	50	50	100
2.	18AE32	Elements of aeronautics	PC	4 – 0 – 0	4	4	50	50	100
3.	18AE33/ME33	Fluid mechanics	PC	4 – 0 – 0	4	4	50	50	100
4.	18AE34	Aircraft materials and process	PC	4 – 0 – 0	4	4	50	50	100
5.	18AE35/ME35	Mechanics of materials	PC	4 – 0 – 0	4	4	50	50	100
6.	18AEL36	Fluid mechanics Lab	PC	0 – 0 – 3	3	1.5	25	25	50
7.	18AEL37	Mechanics of materials lab /MT lab	PC	0 – 0 – 2	2	1	25	25	50
8.	18AEL38	Machine shop Lab	PC	0 – 0 – 3	3	1.5	25	25	50
9.	18AE39	Kannada/ Environmental Studies	HS	MNC			50		
		Total			**28**	**24**	**375**	**325**	**650**

Fourth Semester (Regular)									
S.No.	**Course Code**	**Course Title**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T - P			**CIE**	**SEE**	**Total**
1.	18MATAE41	Partial Differential Equations Sampling Techniques Z transform	BS	4 – 0 – 0	4	4	50	50	100
2.	18AE42	Engineering thermodynamics	PC	4 – 0 – 0	4	4	50	50	100
3.	18AE43	Theory of machines	PC	4 – 0 – 0	4	4	50	50	100
4.	18AE44	Aircraft structures- I	PC	4 – 0 – 0	4	4	50	50	100
5.	18AE45	Low speed aerodynamics	PC	4 – 0 – 0	4	4	50	50	100
6.	18AEL46	Aerodynamics Lab-I	PC	0 – 0 – 3	3	1.5	25	25	50
7.	18AEL47	Theory of machines Lab	PC	0 – 0 – 3	3	1.5	25	25	50
8.	18AEL48	Aircraft structures Lab	PC	0 – 0 – 2	2	1	25	25	50
9.	18AE49	Kannada/ Environmental Studies	HS	MNC			50		
		Total			28	24	375	325	650

 # MNC: Mandatory Non-credit course. Pass in this course is mandatory for the award of degree.

Fourth Semester (Diploma)									
S.No.	**Course Code**	**Course Title**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T - P			**CIE**	**SEE**	**Total**
1.	18DMATAE41	Engineering Mathematics –II	BS	4 – 0 – 0	4	4	50	50	100
2.	18AE42	Engineering thermodynamics	PC	4 – 0 – 0	4	4	50	50	100
3.	18AE43	Theory of machines	PC	4 – 0 – 0	4	4	50	50	100
4.	18AE44	Aircraft structures- I	PC	4 – 0 – 0	4	4	50	50	100
5.	18AE45	Aerodynamics	PC	4 – 0 – 0	4	4	50	50	100
6.	18AEL46	Aerodynamics Lab-I	PC	0 – 0 – 3	3	1.5	25	25	50
7.	18AEL47	Theory of machines Lab	PC	0 – 0 – 3	3	1.5	25	25	50
8.	18AEL48	Aircraft structures Lab	PC	0 – 0 – 2	2	1	25	25	50
9.	18AE49	Kannada/ Environmental Studies	HS	MNC			50		
		Total			**28**	**24**	**375**	**325**	**650**

Fifth Semester (Regular)									
S.No.	**Course Code**	**Course Title**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T - P			**CIE**	**SEE**	**Total**
1.	18AE51	Computer aided aircraft components drawing	PC	2 – 0 – 4	6	4	50	100	100
2.	18AE52	Aircraft Performance	PC	4 – 0 – 0	4	4	50	100	100
3.	18AE53	Aircraft Propulsion	PC	4 – 0 – 0	4	4	50	100	100
4.	18AE54	Gas Dynamics	PC	3 – 0 – 0	3	3	50	100	100
5.	18AE551X	Professional Elective-I	PE	3 – 0 – 0	3	3	50	100	100
6.	18AE561X	**Open Elective – I (Parent and Other Branch)**	OE	3 – 0 – 0	3	3	50	100	100
7.	18AEL56	Aerodynamics Lab -II	PC	0 – 0 – 3	3	1.5	25	50	50
8.	18AEL57	Aircraft Propulsion Lab-I	PC	0 – 0 – 3	3	1.5	25	50	50
		Total			**29**	**24**	**350**	**350**	**700**

List of Professional Electives -I

S.No.	Course code	Course Title
1	18AE5511	Flight testing
2	18AE5512	Finite Element Analysis
3	18AE5513	Fracture mechanics
4	18AE5514	Turbo machines
5	18AE5515	Aircraft system and instrumentation

List of Open Electives -I

S.No.	Course code	Course Title
1	18AE5611	Wind Tunnel Techniques
2	18AE5612	Measurement and metrology
3	18AE5613	Composite materials

Fifth Semester (Diploma)									
S.No.	**Course Code**	**Course Title**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T - P			**CIE**	**SEE**	**Total**
1.	18DMATAE51	Mathematics –III**	BS	4 – 0 – 0	4	4	50	50	100
2.	18AE52	Aircraft Performance	PC	4 – 0 – 0	4	4	50	50	100
3.	18AE53	Aircraft Propulsion	PC	4 – 0 – 0	4	4	50	50	100
4.	18AE54	Gas Dynamics	PC	3 – 0 – 0	3	3	50	50	100
5.	18AE551X	Professional Elective-I	PE	3 – 0 – 0	3	3	50	50	100
6.	18AE561X	**Open Elective – I (Parent and Other Branch)**	OE	3 – 0 – 0	3	3	50	50	100
7.	18AEL57	Aerodynamics Lab -II	PC	0 – 0 – 3	3	1.5	25	25	50
8.	18AEL58	Aircraft Propulsion Lab-I	PC	0 – 0 – 3	3	1.5	25	25	50
9.	18AE59	Communicative English	HS	MNC		MNC	50		
		Total			**27**	**24**	**400**	**350**	**700**

**** One Course of 4 credits exempted in 5th sem for Diploma lateral entry students to maintain the same credits as regular.**

List of Professional Electives –I

S.No.	Course code	Course Title
1	18AE5511	Flight testing
2	18AE5512	Finite Element Analysis
3	18AE5513	Fracture mechanics
4	18AE5514	Turbo machines
5	18AE5515	Aircraft system and instrumentation

List of Open Electives –I

S.No.	Course code	Course Title
1	18AE5611	Wind Tunnel Techniques
2	18AE5612	Measurement and metrology
3	18AE5613	Composite materials

Sixth Semester									
S.No.	**Course Code**	**Course Title**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T - P			**CIE**	**SEE**	**Total**
1.	18AE61	Gas turbine technology	PC	4 – 0 – 0	4	4	50	50	100
2.	18AE62	Flight vehicle design	PC	4 – 0 – 0	4	4	50	50	100
3.	18AE63	Aircraft stability and control	PC	4 – 0 – 0	4	4	50	50	100
4.	18AE641X	Professional Elective-II	PE	3 – 0 – 0	3	3	50	50	100
5.	18AE651X	Professional Elective-III	PE	3 – 0 – 0	3	3	50	50	100
6.	18AE661X	**Open Elective – II (Other Branch only)**	OE	3 – 0 – 0	3	3	50	50	100
7.	18AEL67	Simulation Lab	PC	0 – 0 – 2	2	1	25	25	50
8.	18AEL68	Aircraft Propulsion Lab- II	PC	0 – 0 – 2	2	1	25	25	50
9.	18AE69	Constitution of India, PE and HV	HS	1 – 0 – 0	1	1	25	25	50
		Total			**26**	**24**	**375**	**375**	**750**

List of Professional Electives –II

S.No.	Course code	Course Title
1	18AE6411	Aircraft maintenance, repair and overhaul
2	18AE6412	Non destructive techniques
3	18AE6413	Control engineering
4	18AE6414	Heat and Mass Transfer
5	18AE6415	Theory of Combustion

List of Open Electives -II

S.No.	Course code	Course Title
1	18AE6611	Introduction to aerospace engineering
2	18AE6612	Unmanned Aerial Vehicles & applications
3	18AE6613	Air-breathing Engines

List of Professional Electives -III

S.No.	Course code	Course Title
1	18AE6511	Theory of vibrations
2	18AE6512	Rockets and missiles
3	18AE6513	Air traffic control
4	18AE6514	Satellite communication
5	18AE6515	Aircraft systems

Seventh Semester									
S.No.	**Code**	**Course Title**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T - P			**CIE**	**SEE**	**Total**
1	18AE71	Airport planning and management	HS	3 – 0 – 0	3	3	50	50	100
2.	18AE72	Avionics and Navigation Systems	PC	4 – 0 – 0	4	4	50	50	100
3.	18AE73	Aircraft structure –II	PC	4 – 0 – 0	4	4	50	50	100
4.	18AE741X	Professional Elective-IV	PE	3 – 0 – 0	3	3	50	50	100
5.	18AE751X	Professional Elective-V	PE	3 – 0 – 0	3	3	50	50	100
6.	18AE761X	**Open Elective – III (Other Branch only)**	OE	3 – 0 – 0	3	3	50	50	100
7.	18AEL77	Avionics, Instrumentation and Navigation Lab	PC	0 – 0 – 2	2	1	25	25	50
8.	18AEL78	Design, Modeling & Analysis Lab	PC	0 – 0 – 2	2	1	25	25	50
9.	18AE79	**Seminar on Project synopsis (Design Thinking Approach) Project Phase -1**	**PC**	0 – 0 – 2	2	1	25	-	25
		Total			**26**	**23**	**375**	**350**	**725**

Project Phase -1: CIE- 25 marks (Average of 25 marks –Internal guide and 25 marks- presentation)

List of Professional Electives –IV

S.No.	Course code	Course Title
1	18AE7411	Helicopter dynamics
2	18AE7412	Computational fluid dynamics
3	18AE7413	Aero elasticity
4	18AE7414	Computer integrated manufacturing
5	18AE7415	Airworthiness and Certification

List of Professional Electives -V

S.No.	Course code	Course Title
1	18AE7511	Experimental aerodynamics
2	18AE7512	Air transportation system
3	18AE7513	Flight dynamics
4	18AE7514	Hydraulics & Pneumatics
5	18AE7515	Additive manufacturing

List of Open Electives –III

S.No.	Course code	Course Title
1	18AE7611	Introduction to Rocket propulsion
2	18AE7612	Airport operations
3	18AE7613	Aircraft general maintenance

Eighth Semester									
S.No.	**Code**	**Course Title**		**Contact Hours**	**Total Contact Hours/week**	**Total credits**	**Marks**		
				L – T - P			**CIE**	**SEE**	**Total**
1.	18AE81	Internship	PC			2	50	--	50
2.	18AE82	Intellectual Property Rights	SS	Self Study		1	50		50
3.	18AE83	Professional Certification – 1 (English / any other foreign language)	HS			1	25	--	25
4.	18AE84	Professional Certification - 2	PC			1	25	--	25
5.	18AE85	Project Phase -2	PC			2	50(25+25)	--	50
6.	18AE86	Project Phase -3	PC			4	50(25+25)	--	50
7.	18AE87	Project Phase-4 (Final Viva Voce)	PC	Final		5	--	100	100
						16	**250**	**100**	**350**

Internship: 6 to 8 weeks duration

Project Phase -2 and 3: CIE- 50 marks (25 marks –Internal guide + 25 marks- presentation)

Syllabus of 3rd Semester

Statistical – Numerical – Fourier Techniques
(Common to all branches)

Course Code	18MATAE31	**Credits**	4
Course type	BS	**CIE Marks**	50 marks
Hours/week: L-T-P	4-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = Hrs; Tutorial = Hrs Total = 40 Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

1. Learn Numerical methods to solve Algebraic, Transcendental and Ordinary Differential Equations.
2. Understand the concept of Fourier series and apply when needed.
3. Get acquainted with Fourier Transforms and its properties.
4. Study the concept of Random variables and its applications.
5. Get acquainted with Joint Probability Distribution and Stochastic processes.

Pre-requisites : Basic Differentiation and Integration, Basic Probabilities, Basic Statistics

Unit – I **8 Hours**

Numerical solution of Algebraic and Transcendental equations:
Method of false position, Newton- Raphson method (with derivation), Fixed point iteration method (without derivation).
Numerical solution of Ordinary differential equations: Taylor's Series method, Euler and Modified Euler method, Fourth order Runge–Kutta method

Unit – II **8 Hours**

Fourier Series:. Periodic functions. Dirichlet's conditions, Fourier series, Half range Fourier sine and cosine series. Practical examples, Harmonic analysis.

Unit – III **8 Hours**

Fourier transforms: Infinite Fourier Transform and Properties. Fourier Sine and Cosine Transforms Properties and Problems.

Unit – IV **8 Hours**

Probability: Random Variables (RV), Discrete and Continuous Random variables, (DRV,CRV) Probability Distribution Functions (PDF) and Cumulative Distribution Functions(CDF), Expectations, Mean, Variance. Binomial, Poisson, Exponential and Normal Distributions. Practical examples.

Unit – V **8 Hours**

Joint PDF and Stochastic Processes: Discrete Joint PDF, Conditional Joint PDF, Expectations (Mean, Variance and Covariance).Definition and classification of stochastic processes. Discrete

state and discrete parameter stochastic process, Unique fixed probability vector, Regular Stochastic Matrix, Transition probability, Markov chain

Books	
	Text Books:
1.	B.S. Grewal – Higher Engineering Mathematics, Khanna Publishers, 42nd Edition, 2012. ISBN-13: 978-8193328491
2.	P.N.Wartikar & J.N.Wartikar– Applied Mathematics (Volume I and II) Pune Vidyarthi Griha Prakashan, 7th Edition 1994.
3.	B. V. Ramana- Higher Engineering Mathematics, Tata McGraw-Hill Education Private Limited,
	Reference Books:
1.	Erwin Kreyszig –Advanced Engineering Mathematics, John Wiley & Sons Inc., 9th Edition, 2006.
2.	Peter V. O' Neil – Advanced Engineering Mathematics, Thomson Brooks/Cole, 7th Edition, 2011.
3.	Glyn James – Advanced Modern Engineering Mathematics, Pearson Education, 4th Edition, 2010.

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Use** Numerical methods and **Solve** Algebraic, Transcendental and Ordinary differential equations.	**L3**
2.	**Develop** frequency bond series from time bond functions using Fourier series.	**L3**
3.	**Understand** Fourier Transforms and its properties.	**L2**
4.	**Understand** the concept of Random variables, PDF, CDF and its applications	**L2**
5.	**Extend** the basic probabilityconcept to Joint Probability Distribution, Stochastic processes.	**L2**
6.	**Apply** Joint Probability Distribution, Stochastic processes to solve relevant problems.	**L3**

	Program Outcome of this course (POs)	**PO No.**
1.	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2.	Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**
3.	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.	**PO12**

Course delivery methods	**Assessment methods**
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment / Case Study
3. **Scilab/Matlab/ R-Software/Geogebra**	3. Quiz
	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Elements of Aeronautics

Course Code	18AE32	**Credits**	4
Course type	PC	**CIE Marks**	50 marks
Hours/week: L-T-P	4-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 50 Hrs; Tutorial = 0 Hrs Total = 50 Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Students should

1. Understand the history, basic principle of aviation, trends in aerospace Industry.
2. Understand the basics of flight &aircraft propulsion.
3. Understand the various flight controls and dynamics of aircraft
4. Understand different systems of an aircraft

Unit – I 10 Hours

Introduction to Aircrafts

History of aviation; Atmosphere and its properties; Classification of aircraft and space vehicles, Basic components of an aircraft; structural members; aircraft axis system; aircraft motions; control surfaces & its systems. Helicopters, their parts and functions.

History of Indian Aviation Sector, Introduction to Military Aircraft, Transport Aircraft, Unmanned Aircraft, Types of aerospace Industry, Aerospace manufacturing, materials technology, global and Indian Aircraft scenario.

Self-learning topics: Drones (flapping wing, MAV, quad copters)

Unit – II 10 Hours

Basic principles of flight – significance of speed of sound; airspeed and groundspeed; standard atmosphere; Bernoulli's theorem and its application for generation of lift and measurement of airspeed; forces over wing section, aerofoil nomenclature, pressure distribution over a wing section. Lift and drag components – generation of lift and drag; aerodynamic center, Mach number and supersonic flight effects; simple problems on lift and drag.

Self-learning topics: Center of pressure, aspect ratio.

Unit – III 8 Hours

Aircraft Propulsion: Aircraft power plants, classification based on power plant and location and principle of operation. Aircraft power plants – basic principles of piston, & jet engines; Brayton cycle and its application to gas turbine engines; use of propellers and jets for production of thrust, Advance engines and simple problems.

Self-learning topics: Ramjet, Scramjet

Unit – IV 12 Hours

Aircraft Stability: Forces on an aircraft in flight; static and dynamic stability; longitudinal, lateral and roll stability; necessary conditions for longitudinal stability; basics of aircraft control systems. Effect of flaps and stats on lift, control tabs, stalling, gliding, landing, turning, aircraft manoeuvres; stalling, gliding, turning. Simple problems on these. Performance of aircraft – power curves, maximum and minimum speeds for horizontal flight at a given altitude; effect of changes in engine power and altitude on performance; correct and incorrect angles of bank;

aerobatics, inverted manoeuvres. Simple problems.

Unit – V **10 Hours**

Aircraft Systems: Mechanical systems and their components; hydraulic and pneumatic systems; oxygen System; environmental Control System; fuel system. Electrical systems, flight deck and cockpit systems; navigation system, communication system.
Aircraft systems (Mechanical) –Hydraulic and pneumatic systems and their applications, fuel system, Environment control system and oxygen system
Aircraft systems (Electrical) – flight control system, cockpit instrumentation and displays; communication systems; navigation systems; power generation systems – engine driven alternators, auxiliary power Module, power conversion, distribution and management.
Self-learning topics: ram air turbine.

Books	
	Text Books:
1.	John D. Anderson, "Introduction to Flight", McGraw-Hill Education, 2011. ISBN 9780071086059.
2.	Lalit Gupta and O P Sharma, "Fundamentals of Flight Vol-I to Vol-IV", Himalayan Books, 2006, ISBN-13: 978-8170020974
	Reference Books:
1.	Ian Moir, Allan Seabridge, "Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration", John Wiley & Sons, 2011. ISBN 978111965006.
2.	Nelson R.C., "Flight stability and automatic control", McGraw-Hill International Editions, 1998. ISBN 9780071158381.
3.	Sutton G.P., "Rocket Propulsion Elements", John Wiley, New York, 8th Ed., 2011; ISBN: 1118174208, 9781118174203.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. Rajkumar S. Pant, IIT Bombay (https://swayam.gov.in/nd1_noc19_ae05/preview)
2.	**NPTEL:** Online Resources: Lecture by: Prof. Debi Prasad Mishra, IIT Kanpur https://swayam.gov.in/nd1_noc19_ae08/preview
3.	**NPTEL:** Online Resources: Lecture by: Prof. Jacco M. Hoekstra, Jos Sinke and others https://www.coursebuffet.com/course/890/edx/introduction-to-aeronautical-engineering-delft

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Demonstrate** the aero vehicle behavior for various Atmosphere layers	**L3**
2.	**Distinguish** the types of Aircrafts & industries	**L3**
3.	**Solve** the basics of Aerodynamics & flight mechanics problems	**L3**
4.	**Interpret** the air-breathing engines & its components	**L3**
5.	**Illustrate** the basics of flight dynamics, aircraft performance and maneuverability.	**L3**
6.	**Demonstrate** the various systems of aircraft	**L3**

	Program Outcome of this course (POs)	PO No.
1.	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2.	Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**
3.	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	**PO9**
4.	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.	**PO12**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment / Case Study
	3. Quiz
	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Fluid Mechanics

Course Code	18AE 33/18 ME33B/43B	**Credits**	4
Course type	PC	**CIE Marks**	50 marks
Hours/week: L-T-P	4-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 50 Hrs; Tutorial = 0 Hrs Total = 50 Hrs	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives

1. To introduce and explain the fundamentals of fluid mechanics, which is used in the applications of Aerodynamics, Hydraulics, Marine Engineering, Gas dynamics etc.
2. To give fundamental knowledge of fluid, its properties and behavior under various conditions of internal and external flows
3. To understand hydrostatic law, principle of buoyancy and stability of a floating body.
4. To imbibe basic laws and equations used for analysis of static and dynamic fluids
5. To inculcate the importance of fluid flow measurement and its applications in Industries
6. To find the losses in a flow system, flow through circular pipes and flow past immersed bodies.

Pre-requisites: Knowledge of basic engineering mathematics and mechanics.

Unit – I 08 Hours

Basics: Introduction, Properties of fluids, Newton's law of viscosity, variation of viscosity with temperature, surface tension and capillarity. Newtonian and Non-Newtonian fluids. Numerical examples.

Unit - II 10 Hours

Fluid Statics: Pascal's law, Hydrostatic Law, levels of pressure. Units and Inter conversion. Pressure measurement by simple, differential manometers.

Total pressure force and center of pressure for inclined plane surface submerged in static fluid. Numerical examples.

Buoyancy: Buoyancy, center of buoyancy, meta center and meta centric height. Stability of floating bodies. Numerical examples

Self-learning: Inverted differential manometers.

Unit - III 14 Hours

Fluid Kinematics: Introduction, Eulerian and Lagrangian description of fluid motion, types of flows, velocity and acceleration of a fluid particle, concept of local and convective accelerations. Law of conservation of mass in 2D and 3D Cartesian coordinates, Discharge and mean velocity.

Fluid Dynamics: Introduction, Euler's equation of motion and subsequent derivation of

Bernoulli's equation, Bernoulli's equation for real fluids. Numerical examples.

Flow measurements: Application of Bernoulli's theorem such as venturimeter, pitot tube, orifices etc. Discharge over rectangular notch and triangular notch. Related numerical examples.

Self-learning: Concepts of Velocity potential function and stream function and their inter conversion

Unit - IV **10 Hours**

Losses in fluid flow: Energy consideration in pipe flow, Losses in pipe flow, Darcy Weisbach formula, major losses. Minor losses in pipe flow. Numerical on combined losses.

Dimensional analysis: Dimensions and units, Dimensional Homogeneity and dimensionless ratios, methods of dimensional analysis, Buckingham Pi theorem, Numerical, types of Similitude and non-dimensional parameters used in Fluid Mechanics.

Self-learning:. concepts of HGL and TEL

Unit – V **08 Hours**

Laminar flow and viscous effects: Entrance flow and Developed flow, Fully developed laminar flow in circular pipes, Hagen – Poiseuille equation, related numerical.

Flow past immersed bodies: Drag, Lift, expression for lift and drag (no derivation), pressure drag and friction drag, streamlined and bluff bodies. Numerical Examples

Introduction to compressible flow: Propagation of sound waves through compressible fluids, sonic velocity and Mach number. Numerical.

Books	
	Text Books:
1.	K.L. Kumar, "Engineering Fluid Mechanics", Multicolor revised edition, S. Chand and Co, Eurasia Publishing House, New Delhi, 2010 ISBN-13: 978-8121901000
2.	R.K. Bansal, "A text book of Fluid Mechanics", Laxmi Publications Pvt. Ltd., New Delhi.2018, ISBN-13: 978-8131808153
	Reference Books:
1.	Yunus A. Cenegal, and John M. Cimbala, "Fluid Mechanics", Second edition, McGraw Hill Education (India) Pvt. Ltd. 2017, ISBN-13: 978-9339204655
2.	Fox, Introduction to Fluid Mechanics, McDonald, John Wiley Publications, 6th edition onwards.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof Suman Chakraborty, IIT Kharagpur. (https://onlinecourses.nptel.ac.in/noc17_me04/preview)
2.	**NPTEL:** Online Resources: Lecture by: Prof S. Datta and Prof Niranjan Sahoo., IITG (Guwahati) (http://www.nptel.ac.in/courses/Webcourse-contents/IIT-%20Guwahati/fluid_mechanics/index.htm)
3.	**NPTEL**: Online Resources: Lecture by: Prof Viswanathan Shankar (IIT Kanpur) (http://nptel.ac.in/courses/103104044/)

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Explain the mechanics of fluids at rest by observing the fluid Phenomena.	**[L2]**
2.	Compute the pressure measurement and stability of submerged bodies.	**[L3]**
3.	Explain the mechanics of fluids in motion under ideal and real conditions.	**[L3]**
4.	Examine energy losses in pipe transitions. Apply Buckingham Pi theorem for various cases of fluid flow.	**[L3]**
5.	Evaluate pressure drop in pipe flow using Hagen-Poiseuille equation for laminar flow in a pipe. Distinguish types of flows	**[L3]**

Program Outcome of this course (POs)

		PO No.
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2.	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
3.	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	**PO8**
4.	**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.	**PO10**
5.	**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.	**PO12**

Course delivery methods		Assessment methods	
1.	Black Board Teaching	1.	Internal Assessment
2.	Power Point Presentation	2.	Assignment, Quiz
3.	Working Models	3.	Course Seminar
4.	Videos	4.	Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Aircraft Materials and Processes

Course Code	18AE34	**Credits**	4
Course type	PC	**CIE Marks**	50 marks
Hours/week: L-T-P	4-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 50 Hrs; Tutorial = 0 Hrs Total = 50 Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

1. Study the aircraft engineering materials with heat treatment techniques.
2. Understand the various manufacturing processes and selection of process for suitable applications.
3. Understand the working principles and applications of conventional and non-conventional machining along with their advantages and disadvantages.
4. Demonstrate the importance of composites & its applications in different streams of aerospace industry

Pre-requisites: Knowledge of basic engineering mathematics and mechanics.

Unit – I 10 Hours

Aircraft Engineering Materials & Heat treatment: Classification of aircraft materials - Materials used for aircraft components, Heat treatment of carbon steel, aluminium alloys, magnesium alloys and titanium alloys used in aircraft. Types of corrosions - Effect of corrosion on mechanical properties - Protection against corrosion - Corrosion resistant materials used in aircraft.

Unit – II 10 Hours

Casting, Welding and Inspection Techniques: General principles of various casting processes Sand
casting, die-casting, centrifugal casting, investment casting, Shell moulding types; Principles and equipment used in arc welding, gas welding, resistance welding, solid, laser welding, and electron
beam welding, soldering and brazing techniques. Need for NDT,
Self-learning topics: ultrasonic testing, Radiographic testing.

Unit – III 10 Hours

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, fasteners, Different stages of aircraft assembly.
Self-learning topics: Jigs and Fixtures

Unit – IV **10 Hours**

Conventional And Unconventional Machining 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,

Self-learning topics: electron beam, plasma arc machining.

Unit – V **10 Hours**

Aircraft Composites: Definition and comparison of composites with conventional monolithic materials, Reinforcing fibers and Matrix materials, Fabrication of composites and quality control aspects, Carbon-Carbon Composites production, properties and applications, inter metallic matrix composites, ablative composites based on polymers, ceramic matrix, metal matrix composites based on aluminum, magnesium.

Self-learning topics: titanium and nickel based composites for engines

Books	
	Text Books:
1.	S. Kalpakjian, Steven R. Schmid, ―Manufacturing Engineering and Technology, Pearson Education; Seventh edition (28 March 2018). ISBN-13: 978-9332587908
2.	S. C. Keshu, K. K Ganapathy, ―Aircraft production technology and management, Interline Publishing House, Bangalore, 3rd Edition, 1993.
	Reference Books:
1.	S. C. Keshu, K. K Ganapathy, ―Aircraft production techniques, Interline Publishing House, Bangalore, 3rd Edition, 1993.
2.	R. K. Jain, ―Production technology, Khanna Publishers; 17th edition edition (2004) ISBN-13: 978-8174090997
3.	Douglas F. Horne, ―Aircraft production technology, Cambridge University Press, 1st Edition, 1986.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. B S Murty, IIT Kharagpur https://nptel.ac.in/courses/113105057/
2.	**NPTEL:** Online Resources: Lecture by: Prof. Jayanta Das, IIT Kharagpur https://nptel.ac.in/courses/113105081/
3.	**NPTEL:** Online Resources: Lecture by: Prof. R. Velmurugan, IIT Madras https://nptel.ac.in/courses/101106038/
4.	**NPTEL:** Online Resources: Lecture by: Prof. P. M. Mohite, IIT Kanpur https://nptel.ac.in/courses/101104010/

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Choose** the various Aircraft Engineering Materials & heat treatment processes.	**L3**
2.	**Employ** the knowledge of different types of Casting, Welding and Inspection Techniques	**L3**
3.	**Demonstrate** the various Sheet Metal operations and its applications	**L3**
4.	**Differentiate** Conventional And Unconventional Machining processes	**L3**
5.	**Compare** the various Composites materials in aircraft.	**L3**

	Program Outcome of this course (POs)	PO No.
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2.	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
3.	**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.	**PO12**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment, Quiz
3. Working Models	3. Course Seminar
4. Videos	4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Mechanics of Materials

Course Code	18AE35/ME45	**Credits**	4
Course type	PC	**CIE Marks**	50 marks
Hours/week: L-T-P	4-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 50 Hrs; Tutorial = 0 Hrs Total = 50 Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

1. Understand the basic terms such as forces, stress and strain. Learn stress-strain diagram. Apply the principles of mechanics to analyze structural and machine elements.
2. Learn Mohr's circle diagram and its application. Calculate the stress and orientation of their planes subjected to tensile, compressive and shears forces.
3. Identify the different types of beams and the types of loading. Construct bending moment (BM) and shear force (SF) diagram for beams with different loadings. Derive expressions to determine the bending stress, defection and shear stress in beams subjected to various types of loading.
4. Establish relation between torque (twisting moment), shear stress and dimensions of shaft. Design the shaft required to transmit power based on strength and rigidity. Classify the different types of columns. Derive Euler's equation for columns. Design the columns based on Euler's equation and Rankine's equation.

Unit – I **10 Hours**

Simple Stress and Strain: Introduction, Stress, Strain, Mechanical properties of materials, Linear elasticity, Hooke's Law and Poisson's ratio, Stress-Strain behaviour of Mild steel. Extension / Shortening of a bar, bars with cross sections varying in steps, bars with continuously varying cross sections (circular and rectangular), Principle of super position.

Self-learning topics: Elongation due to self weight

Unit – II **10 Hours**

Compound Stresses: Stress in Composite Section, Volumetric strain, expression for volumetric strain, elastic constants, simple shear stress, shear strain, temperature stresses (including compound bars). Introduction, Plane stress, stresses on inclined plane, principal stresses and maximum shear stresses, and orientation of these planes Mohr's circle for plane stress.

Self-learning topics: Stress tensor.

Unit – III **10 Hours**

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. Numerical on Shear force and bending moment diagrams for cantilever and simply supported beam under point and uniformly distributed load only.

Self-learning topics: SFD and BMD for uniformly varying load (UVL) and moment for overhanging beams

12 Hours

Unit – IV

Bending and Shear Stresses in Beams: Introduction, Theory of simple bending, assumptions in simple bending. Bending stress equation. Shearing stresses in beams for various cross sections. (Composite / notched beams not included).

Deflection of Beams: Introduction, Differential equation for deflection. Double integration method for simply supported and cantilever beam subjected to point load only. Deflection by Macaulay's method.

Self-learning topics: Shearing stress in beams of other sections, Use of Castiglinios theorem for different conditions of beam

Unit – V **8 Hours**

Torsion of Circular Shafts and Elastic Stability of Columns:

Introduction, Pure torsion, assumptions, derivation of torsional equations, torsional rigidity/stiffness of shafts. Power transmitted by solid and hollow circular shafts.

Columns: Euler's theory for axially loaded elastic long columns. Derivation of Euler's load for hinged ends conditions only, Numerical on Euler's formula for different end conditions, limitations of Euler's theory. Derivation of Rankine's Equation.

Self-learning topics: Derivation of Euler's formula for different end conditions.

Books	
	Text Books:
1.	R. C. Hibbeler, "Mechanics of Materials", Prentice Hall. Pearson Edu. 9th edition, 2005 ISBN-13: 978-9332584037
2.	James M. Gere, "Mechanics of Materials", Thomson, Fifth edition 2004.
3.	Ferdinand Beer & Russell Johnston, "Mechanics of Materials", McGraw Hill Education India Private Limited; Seventh edition (1 July 2017) ISBN-13: 978-9339217624
	Reference Books:
1.	S. S. Rattan , "Strength of Materials", Tata McGraw Hill, 2009
2.	S.S.Bhavikatti , "Strength of Materials", Vikas publications House -1 Pvt. Ltd., 2nd Ed., 2006.
3.	K.V. Rao, G.C. Raju, "Mechanics of Materials", First Edition, 2007
4.	Egor.P. Popov , "Engineering Mechanics of Solids", Pearson Edu. India, 2nd, Edition, 1998
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	NPTEL course: Mechanics of Materials by Dr. U Saravanan, IIT Madras. https://nptel.ac.in/courses/105106172/
2.	NPTEL course: Advance solid Mechanics by Dr. U Saravanan, IIT Madras. https://nptel.ac.in/courses/105106049/
3.	NPTEL course: Applied Elasticity for Engineers by Dr. T.G. Sitaraman, IISc Bangalore and Dr.LGovindaraju Bangalore University. https://nptel.ac.in/courses/105108070/
4.	NPTEL course: Advanced strength of Materials by Prof. S.K.Maiti, IIT Bombay. https://nptel.ac.in/courses/112101095/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Apply** the concepts of stress, strain, failure and strain energy.	**L3**
2. **Analyze** the structures under biaxial and shear loading.	**L3**
3. **Analyze** the beams for bending and shear forces with different loading conditions.	**L4**
4. **Analyze** stresses and deflections of beam structures experiencing a combination of internal transverse shear and bending moment.	**L4**
5. **Analyze** the shaft for shear stresses under torsion and column under buckling.	**L3**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
3. **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.	**PO12**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment, Quiz
3. Working Models	3. Course Seminar
4. Videos	4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Fluid Mechanics Lab

Course Code	18AEL36	**Credits**	1.5
Course type	PC	**CIE Marks**	25 marks
Hours/week: L-T-P	0-0-3	**SEE Marks**	25 marks
Total Hours:	24	**SEE Duration**	3 Hours/2 Hours for 50 marks

Course learning objectives

1. To introduce the experimental methods of determining Energy Losses in a pipe flow.
2. To inculcate the importance of fluid flow measurement and its applications in Industries.
3. To determine the frictional losses in flow through pipes.
4. To present the use of equipments for measurement of flow in closed conduits
5. To present the use of equipments for measurement of flow in open channels
6. To classify the flow as laminar or turbulent based on Reynolds number
7. To present the experimental method of determination of Metacentric height

Pre-requisites : Concepts of Physics, Basics of Fluid Mechanics

List of experiments

1. An experiment on Venturimeter to determine the co efficient of discharge. Compare the experimental Cd value with that obtained graphically.
2. An experiment on Orifice meter to determine the co efficient of discharge. Compare the experimental Cd value with that obtained graphically.
3. To determine the coefficient of discharge of a triangular notch (V-notch).
4. To determine the coefficient of discharge of a rectangular notch (R-notch).
5. Conduct an experiment on frictional losses in pipe flow. Compare the theoretical and experimental values of friction loss and friction factor with Moody's chart.
6. Conduct an experiment for minor losses in pipe flow. Compare the theoretical and experimental minor losses (bend, elbow, expansion, contraction and gate valve).
7. An experiment on Reynolds apparatus and classify the flow as laminar and turbulent.
8. Conduct an experiment to determine the metacentric height of a floating body and evaluate its stability.
9. Demonstration on reciprocating pumps.
10. Demonstration on rotary pumps

Books	
1.	K.L. Kumar, "Engineering Fluid Mechanics", Multicolor revised edition, S. Chand and Co, Eurasia Publishing House, New Delhi
2.	R.K. Bansal, "A text book of Fluid Mechanics", Laxmi Publications Pvt. Ltd., New Delhi.

Course Outcome (COs)

	At the end of the course, the student will be able to	Bloom's Level
1.	**Assess** the reason for discrimination of the Cd values of venturimeter and Orifice meter for the same experimental setup	**L3**
2.	**Examine** the deviation between theoretical and experimental values of frictional losses in a pipe flow	**L3**
3.	**Analyze** the variation of co efficient of discharge of rectangular and triangular notches.	**L3**
4.	**Compute** the experimental friction factor for a given material of the pipe and Compare the same with value obtained from Moody chart.	**L4**
5.	**Interpre**t various minor losses in a pipe flow and means to minimize them.	**L3**
6.	**Evaluate** the stability of a floating body by determining its metacentric height	**L3**
7.	Flow **classification** as Laminar or turbulent by calculating the Reynolds Number	**L3**

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2.	**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.	**PO4**
3.	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	**PO8**
4.	**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.	**PO10**
5.	**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.	**PO12**

Assessment methods

1. Conduct of Experiment
2. Journal evaluation/assessment
3. Open ended experiments
4. Viva-voce

Scheme of Continuous Internal Evaluation (CIE):

Components	Attendance/conduct of lab	Journal	Lab project	Total Marks
Maximum marks :25	10	10	5	25
Submission and certification of journal is compulsory to qualify for SEE Minimum marks required to qualify for SEE : 10 out of 25 marks				

Semester End Examination (SEE):

<table>
<tr><td>1.</td><td colspan="3">It will be conducted for 50 marks having 3 hours/2 hours duration. It will be reduced to 25 marks for the calculation of SGPA and CGPA.</td></tr>
<tr><td>2.</td><td colspan="3">Only one experiment to be conducted. In case, there are two parts then one experiment from each part.</td></tr>
<tr><td rowspan="4">3.</td><td>Initial write up</td><td>10 marks</td><td rowspan="4">50 marks</td></tr>
<tr><td>Conduct of experiment(s), result and conclusion</td><td>20 marks</td></tr>
<tr><td>One marks question</td><td>10 marks</td></tr>
<tr><td>Viva-voce</td><td>10 marks</td></tr>
<tr><td>4.</td><td colspan="3">Viva voce is conducted for individual student and not in group</td></tr>
<tr><td>5.</td><td colspan="3">Minimum passing marks to be scored in SEE: 20 out of 50 marks</td></tr>
</table>

Mechanics of Materials Lab

Course Code	18AEL37	**Credits**	1
Course type	PC	**CIE Marks**	25 marks
Hours/week: L-T-P	0-0-2	**SEE Marks**	25 marks
Total Hours:	24	**SEE Duration**	3 Hours/2 Hours for 50 marks

Course learning objectives

1. Learn the behaviour of materials under different loading conditions.
2. Understand the concept of hardness, wear and impact tests.
3. Understand the new methods of crack detection in a specimen.

Pre-requisites : Knowledge of material science and mechanics of material

List of experiments

1. Conducting Tensile, Compression test on metallic and non-metallic specimens using Universal Testing Machine.
2. An experiment for Conducting Fatigue test on mild steel specimen.
3. To determine wear rate on wear test machine for Mild steel, Aluminum/Brass, Polymer specimens.
4. To determine Hardness of ferrous and nonferrous specimens by using Brinell, Rockwell & Vickers machine.
5. Conduct an experiment to determine impact strength of a Aluminum, Mild steel and Cast Iron specimen by Izod &Charpy test.
6. Conduct an experiment on mild steel specimen to determine torsional strength.
7. To conduct an experiment on Magnetic crack detector to detect crack.
8. To conduct an experiment on Ultrasonic flaw detector to check for flaws in a specimen
9. To conduct an experiment to detect defects in a specimen by the die penetration method.
10. Conduct an experiment to determine deflection of (a) Cantilever beam (b) Simply supported beam, and compare it with theoretically estimated value.

Books	
1.	Nicholas P. Cheremisinoff, Paul N. Cheremisinoff, Handbook of Advanced Materials Testing (Materials Engineering) 1st Edition, 2011 and onwards.
2.	Suryanarayana, A. V. K., Testing of Metals, BS Publication, 2nd edition, 2007 and onwards.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Analyze** the behaviour of materials under different loading conditions like Tensile, Compression, Bending, Shear, Impact, Torsion, Fatigue and Hardness and be able to apply the procedures and techniques in real time problems.	**L4**
2. **Use** different methods of crack detection.	**L3**
3. **Interpret** and know the procedure & importance testing at various loading conditions.	**L3**

	Program Outcome of this course (POs)	PO No.
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2.	**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.	**PO4**
3.	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	**PO8**
4.	**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.	**PO10**
5.	**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.	**PO12**

Assessment methods

1. Conduct of Experiment
2. Journal evaluation/assessment
3. Open ended experiments
4. Viva-voce

Scheme of Continuous Internal Evaluation (CIE):

Components	Attendance/conduct of lab	Journal	Lab project	Total Marks
Maximum marks :25	10	10	5	25
Submission and certification of journal is compulsory to qualify for SEE Minimum marks required to qualify for SEE : 10 out of 25 marks				

Semester End Examination (SEE):

1.	It will be conducted for 50 marks having 3 hours/2 hours duration. It will be reduced to 25 marks for the calculation of SGPA and CGPA.		
2.	Only one experiment to be conducted. In case, there are two parts then one experiment from each part.		
3.	Initial write up	10 marks	50 marks
	Conduct of experiment(s), result and conclusion	20 marks	
	One marks question	10 marks	
	Viva-voce	10 marks	
4.	Viva voce is conducted for individual student and not in group		
5.	Minimum passing marks to be scored in SEE: 20 out of 50 marks		

Machine shop Lab

Course Code	18AEL38	**Credits**	1.5
Course type	PC	**CIE Marks**	25 marks
Hours/week: L-T-P	0-0-3	**SEE Marks**	25 marks
Total Hours:	24	**SEE Duration**	3 Hours/2 Hours for 50 marks

Course learning objectives

1. Understand different types of machines, machine specifications and different controls available on machine tools.
2. Understand use of different cutting tools and accessories required for various machining operations.
3. Learn the usage of various tool and work holding devices used on lathe, shaper an milling machines.
4. Perform machining operations on lathe, milling and shaper to prepare the jobs.

Pre-requisites : Basics of Metal Cutting and Machine Tools

List of experiments

1. Preparation of model on lathe involving facing, plain turning, step turning
2. Preparation of model on lathe involving facing, taper turning, step turning, thread cutting, grooving, knurling.
3. Preparation of model on lathe involving drilling, boring, internal thread cutting
4. Cutting of V-Groove/dovetail/rectangular groove on a mild steel plate using a Shaper/Milling.
5. Cutting of gear teeth and slotting using milling machine.
6. Demonstration of machining/drilling on Vertical machining centre (VMC).
7. Gear cutting by different machines.
8. Assembly of components

Books	
1.	Heinrich Gerling, “All About Machine Tools” New Age International publisher
2.	S. K. Hajra Choudhury, Nirjhar Roy and A. K. Hajra Choudhury “Metal cutting-Vol. II”, Media Promoters & Publishers Pvt. Ltd.
3.	B. L. Juneja and G. S. Sekhon, “Fundamentals of Metal cutting and Machine tools”, New Age International Publishers.
	E-Recourses

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Use** the components of machine tools and their accessories.	**L3**
2. **Analyse** given production drawing.	**L4**
3. **Choose** the sequence of operations, Calculate machining time and indexing for given jobs.	**L3**
4. **Experiment** the working of VMC	**L4**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
3. **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.	**PO3**
4. **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.	**PO4**
5. 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.	**PO5**
6. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	**PO8**
7. **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.	**PO10**
8. **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.	**PO12**

Assessment methods

1. Conduct of Experiment
2. Journal evaluation/assessment
3. Open ended experiments
4. Viva-voce

Scheme of Continuous Internal Evaluation (CIE):

Components	Attendance/conduct of lab	Journal	Lab project	Total Marks
Maximum marks :25	10	10	5	25
Submission and certification of journal is compulsory to qualify for SEE Minimum marks required to qualify for SEE : 10 out of 25 marks				

Semester End Examination (SEE):

1.	It will be conducted for 50 marks having 3 hours/2 hours duration. It will be reduced to 25 marks for the calculation of SGPA and CGPA.		
2.	Only one experiment to be conducted. In case, there are two parts then one experiment from each part.		
3.	Initial write up	10 marks	50 marks
	Conduct of experiment(s), result and conclusion	20 marks	
	One marks question	10 marks	
	Viva-voce	10 marks	
4.	Viva voce is conducted for individual student and not in group		
5.	Minimum passing marks to be scored in SEE: 20 out of 50 marks		

Syllabus of 4th Semester

Engineering Mathematics –IV

Course Code	18MATAE41	**Credits**	4
Course type	BS	**CIE Marks**	50 marks
Hours/week: L-T-P	4-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs; Tutorial = 10 Hrs Total = 50 Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

1. Learn the concept of Interpolation and use appropriately.
2. Understand the concept of Partial Differential Equations.
3. Apply Partial Differential Equations to solve practical problems.
4. Get acquainted with Sampling Distribution and Testing of Hypothesis.
5. Study the concept of Calculus of Variations and its applications.

Pre-requisites : Partial Differentiation, Basic Probability, Probability Distribution, Basic Integration, Basic Statistics

Unit – I 8 Hours

Finite Differences and Interpolation:, Forward and Backward differences, Newton's Forward and Backward Interpolation Formulae, Divided Difference, Newton's Divided Difference Formula (without proof). Lagrange's Interpolation Formula. Illustrative examples. Numerical Integration: Newton- Cotes Quadrature formula, Trapezoidal rule, Simpsons $1/3^{rd}$ rule, Simpsons $3/8^{th}$ rule, Weddle's rule. Practical Examples

Unit – II 8 Hours

Partial Differential Equations: Formation of PDE by elimination of arbitrary Constants and Functions, Solution of non homogeneous PDE by direct integration, Solution of homogeneous PDE involving derivative with respect to one independent variable only.

Unit – III 8 Hours

Applications of Partial Differential Equations: Derivation of One dimensional Heat and Wave equations. Solutions of one dimensional Heat and Wave equations, Two dimensional Laplace equation by the method of separation of variables. Numerical solution of one dimensional Heat and Wave equations, Two dimensional Laplace equation by finite differences.

Unit – IV 8 Hours

Sampling distribution and Testing of Hypothesis: Sampling, Sampling distribution, Sampling distribution of means, Level of significance and confidence limits, Tests of significance for

small and large samples. ‘t’ and ‘chi square’ distributions. Practical examples.

Unit – V **8 Hours**

Calculus of Variations: Concept of a Functional, Extremal of a Functional, Euler’s equation and equivalents. Standard problems. **Applications**: Geodesics, Hanging chain, Minimal surface of revolution and Brachiostochrone problem.

Z -Transform: Definition, Standard Z transforms, Linearity, Damping rule, Shifting properties, Initial and Final value Theorems-Examples. Inverse Z transforms and Solution of Difference Equations by Z transforms.

Books	
	Text Books:
1.	B.S. Grewal – Higher Engineering Mathematics, Khanna Publishers, 42nd Edition, 2012. ISBN-13: 978-8193328491
2.	P.N.Wartikar & J.N.Wartikar– Applied Mathematics (Volume I and II) Pune Vidyarthi Griha Prakashan, 7th Edition 1994.
3.	B. V. Ramana- Higher Engineering Mathematics,Tata McGraw-Hill Publishing Company Ltd.
4.	Erwin Kreyszig –Advanced Engineering Mathematics, John Wiley & Sons Inc., 9th Edition, 2006
	Reference Books:
1.	Peter V. O’ Neil – Advanced Engineering Mathematics, Thomson Brooks/Cole, 7th Edition, 2011.
2.	Glyn James – Advanced Modern Engineering Mathematics, Pearson Education, 4th Edition, 2010.

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom’s Level
1.	**Use** Numerical methods and **Solve** Algebraic, Transcendental and Ordinary differential equations.	**L3**
2.	**Develop** frequency bond series from time bond functions using Fourier series.	**L3**
3.	**Understand** Fourier Transforms and its properties.	**L2**
4.	**Understand** the concept of Random variables, PDF, CDF and its applications	**L2**
5.	**Extend** the basic probability concept to Joint Probability Distribution, Stochastic processes.	**L2**
6.	**Apply** Joint Probability Distribution, Stochastic processes to solve relevant problems.	**L3**

	Program Outcome of this course (POs)	**PO No.**
1.	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2.	Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**

4.	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.	**PO12**

Course delivery methods	**Assessment methods**
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment / Case Study
3.	3. Quiz
4.	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Engineering Thermodynamics

Course Code	18AE42	**Credits**	4
Course type	PC	**CIE Marks**	50 marks
Hours/week: L-T-P	4-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 50 Hrs; Tutorial = 0 Hrs Total = 50 Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

1. To understand the basic concepts of thermodynamics like system, properties, equilibrium, pressure, specific volume, temperature, zeroth law of thermodynamics. to learn thermodynamic properties using tables of thermodynamic properties
2. To understand the first law of thermodynamics for closed and open systems undergoing different thermodynamic processes
3. To learn the equivalence of two statements of second law of thermodynamics
4. Evaluate the performance of gas power cycles
5. To acquire the knowledge of performance measurement and testing of IC engines.
6. Derive an expression for the efficiency of single acting and multi stage acting reciprocating compressor and derive an expression for volumetric efficiency of reciprocating compressor.
7. Analyze the vapor –compression refrigeration systems., vapor absorption refrigeration system

Unit – I 8 Hours

Fundamental Concepts & Definitions: Thermodynamics; definition and scope. Thermodynamic system and control volume. Macroscopic v/s Microscopic point of view. Properties and state of a substance. Intensive and extensive properties. Quasi-equilibrium process. Processes and cycles. Mechanical v/s thermodynamic cycle. Pressure. Equality of temperature. The zeroth law of thermodynamics. Temperature scales. Numerical problems on above concepts.

Pure Substance behavior & Ideal Gases : Pure substance – Definition, Vapour – Liquid – Solid phase equilibrium of a pure substance, T-v and P-T diagrams, Tables of thermodynamic properties

Unit – II 8 Hours

Work & Heat: Thermodynamic definition of work. Work done at the moving boundary of a simple compressible system in a quasi-equilibrium process. Expression for work in case of constant pressure, isothermal and polytrophic processes. Problems on work. Definition of heat. Comparison of heat and work.

First Law of Thermodynamics for closed systems: First law of thermodynamics for a system undergoing a cycle. First law of thermodynamics for a change in state of a system. Concept of energy. Internal Energy, kinetic energy and potential energy. Internal energy - a thermodynamic property. Simple problems on internal energy The thermodynamic property enthalpy.

Unit – III 10 Hours

First Law of Thermodynamics for open systems: First law as a rate equation. Conservation of mass. Conservation of mass and control volume. The first law of thermodynamics for a control volume. The steady state steady flow process. Illustrative problems. Nozzle, Turbine and throttling process. Illustrative problems

Second Law of Thermodynamics: Limitations of first law. Heat engines and refrigerator. Efficiency and C.O.P.. Kelvin Planck statement and Clausius statement of second law of thermodynamics. Equivalence of statements of second law. The reversible process. Factors that render processes irreversible. The Carnot cycle. Two propositions regarding efficiency of Carnot cycle. Illustrative Problems
Self-learning topics: Concept of entropy

Unit – IV **12 Hours**

Gas Power Cycles: Air standard cycles; Assumptions, Carnot, Otto and Diesel cycles, P-V and T-S diagrams, description, efficiencies. Comparison of Otto and Diesel cycles for same compression ratio. Comparison of Otto and Diesel cycles for same maximum pressure and temperatures, Numerical problems.
IC Engines: Definitions of various terms like brake power, Indicated power, Friction power, efficiencies, measurement of BP, IP, FP, Air and fuel consumption, speed etc. Load test on IC engines, Illustrative numerical.

Unit – V **10 Hours**

Reciprocating Compressors: - Operation of a single stage reciprocating compressors. Derivation of work per cycle for a compressor with and without clearance, volumetric efficiency. Saving in work, optimum intermediate pressure for perfect inter-cooling, minimum work for compression, Numerical problems.
Refrigeration: -Vapour compression refrigeration system; description, analysis, refrigerating effect, capacity, power required, units of refrigeration, COP. Numerical problems. Vapour absorption refrigeration system.
Self-learning topics: Refrigerants and their desirable properties.

Books	
	Text Books:
1.	Claus Borgnakke, Richard Sonntag, “Fundamentals of thermodynamics”, 7th edition, John Wiley & sons 2009. ISBN-13: 978-8126521524
2.	Yunus Cengel and Michael Boles, “Thermodynamics (SI Units)”, 6th Edition and onwards, Tata McGraw Hill, 2012.
	Reference Books:
1.	Michael J. Moran, Howard N. Shapiro, Daisie D. Boettner, Margaret B. Bailey, “Principles of engineering thermodynamics”, 7th Editionand onwards, Wiley India publishers, 2012.
2.	Dr. S.S. Banwait, Dr. S.C. Laroiya, “Properties Of Refrigerant & Psychrometric Tables & Charts In SI Units”, Birla Pub. Pvt. Ltd., New Delhi, 2008
3.	M. David Burghardt, “Engineering Thermodynamics with Applications”, 3rd edition and onwards, Harper and Row Publications, 1986.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1	NPTEL course: Mechanics of Materials by Dr. Jayanth Singh , IIT Kanpur https://nptel.ac.in/courses/101104067/
2	NPTEL course: Mechanics of Materials by Dr. D P Mishra , IIT Kanpur. https://nptel.ac.in/courses/101104063/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Use** the basic concepts of thermodynamics such as system, state, state postulate, equilibrium, properties, process and cycle.	**L3**
2. **State and Apply** the first law of thermodynamics for a closed and open systems	**L3**
3. **State & Apply** second law of thermodynamics	**L3**
4. **Derive** an expression for thermal efficiency of an air standard cycles used in IC Engines and compare them.	**L3**
5. To **acquire** the knowledge of performance measurement and testing of IC engines	**L3**
6. **Calculate** work and volumetric efficiencies of reciprocating compressors	**L3**
7. **Analyze** vapor compression refrigeration cycle and Vapour absorption refrigeration system.	**L4**

Program Outcome of this course (POs)	PO No.
1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**
3. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	**PO8**
4. 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.	**PO12**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment / Case Study
3.	3. Quiz
4.	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Theory of Machines

Course Code	18AE43	**Credits**	4
Course type	PC	**CIE Marks**	50 marks
Hours/week: L-T-P	4-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 50 Hrs; Tutorial = 0 Hrs Total = 50 Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives	
1.	Understand the various kinematic links, **pairs, mechanisms.**
2.	Understand the theoretical principles of static and dynamic force analysis of mechanisms.
3.	Study the balancing rotating in same and different planes.
4.	Understand the principles of governors, gyroscope.
5.	Understand mechanical vibrations and its types.

Pre-requisites: Basic knowledge of Mechanics of Materials.

Unit – I 10 Hours

Introduction : Definitions of Link or element, kinematic pairs, Degrees of freedom, Kinematic chain, Mechanism, Structure, Mobility of Mechanism, Inversion, and Machine. Kinematic Chains and Inversions: Inversions of Four bar chain, Single slider crank chain and Double slider crank chain and their applications, Numerical.

Unit – II 10 Hours

Static Force Analysis: Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque. **Static force analysis of four bar mechanism and slider-crank mechanism with and without friction.**

Balancing of Rotating Masses: Static and dynamic balancing. Balancing of single rotating mass by balancing masses in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes. Numerical

Unit – III 10 Hours

Governors: Types of governors, force analysis of Porter and Hartnell governors. Controlling force. Stability, sensitiveness. Isochronisms, effort and power.

Gyroscope: Introduction, Vectorial representation of angular motion. Gyroscopic couple. Effect of gyroscopic couple on ship, plane disc, aero plane. N**umerical.**

Unit – IV 10 Hours

Mechanical Vibration: Types of vibrations, definitions, Simple Harmonic Motion (S.H.M.).Work done by harmonic force. Principle of super position applied to SHM **Undamped (Single Degree of Freedom) Free Vibrations,** Natural frequencies of simple systems.

Damped free vibrations (1DOF): Types of damping, analysis with viscous damping - derivations for over, critical and under damped systems, logarithmic decrement and problems. Numerical**.**

Self-learning topics: Torsional and transverse vibrations

Unit – V **10 Hours**

Introduction to forced vibrations: forced vibrations, Vibration measuring Instruments, Critical Speed of shaft, and Introduction to 2 Degree of Freedom system. Vibration absorber, Numerical methods- Stodola , **Holzer Method**, N**umerical.**

	Books
	Text Books:
1.	**H.G. Phakatkar," Theory of machines –I Nirali Prakashan; 6th edition (2012)**
2.	**Rattan S.S., Theory of Machines, McGraw Hill Education; Fourth edition (1 July 2017). ISBN-13: 978-9351343479**
	Reference Books:
1.	**J.J. Uicker, G.R. Pennock, J.E. Shigley, Theory of Machines & Mechanisms, OXFORD 3rd Edition, 2009**
2.	**G. K. Grover, Mechanical Vibrations, Nem Chand and Bros, 6th Edition, 1996.**
3.	**S. Graham Kelly, Fundamentals of Mechanical Vibration, Tata McGraw-Hill, 2000.**
4.	**Sadhu Singh, Theory of Machines, Pearson Education India; 3 edition (2011) ISBN-13: 978-8131760697**
5.	**W. T. Thomson, M. D.Dahleh and C. Padmanabhan, Theory of Vibration with Applications,**
	E-resourses (NPTEL/SWAYAM. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: IIT Bombay https://nptel.ac.in/courses/112101096/
2.	**NPTEL:** Online Resources: Lecture by: Prof. Rajiv Tiwari, IIT Guwahati https://nptel.ac.in/courses/112103112/

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Analyze** mechanisms for static and dynamic forces	**L3**
2.	**Determine** unbalance rotating masses in same and different planes	**L3**
3.	**Solve** forces in governors and couples in gyroscope	**L3**
4.	**Interpret** undamped single degree of freedom systems.	**L3**
5.	**Apply** the theoretical principles of vibration and vibration analysis techniques.	**L3**

	Program Outcome of this course (POs)	**PO No.**
1.	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2.	Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**
3.	**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.	**PO3**
4.	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.	**PO12**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment / Case Study
3.	3. Quiz
4.	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Aircraft Structures-I

Course Code	18AE44	**Credits**	4
Course type	PC	**CIE Marks**	50 marks
Hours/week: L-T-P	4-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 50 Hrs; Tutorial = 0 Hrs Total = 50 Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

1. Understand the aircraft structural components and its behavior under different loading conditions.
2. Comprehend the basic concepts of stress and strain Aircraft Structures components.
3. Acquire the knowledge of types of loads on aerospace vehicles.
4. Obtain knowledge in plate buckling and structural instability in airframe structural analysis& study of Energy Methods

Unit – I 10 Hours

Loads on Aircraft and Aircraft Materials Loads on Aircraft: Structural nomenclature, Types of loads, load factor, Aerodynamics loads, Symmetric maneuver loads, v-n diagram, Function of structural components. Aircraft Materials: Metallic and non-metallic materials, Use of Aluminum alloy, titanium, stainless steel and composite materials. Desirable properties for aircraft application. Fracture and Fatigue, Stress Intensity Factor, Crack Growth Rate Derivation.

Unit – II 12 Hours

Shearing stress and Impact Strength: Introduction, vertical and horizontal shear stresses, distribution of shear stress over rectangular, circular and I sections. Impact stresses due to axial, bending and torsional loads, effect of inertia. Fatigue Strength: Introduction, S-N Diagram, Low cycle fatigue, Endurance limit, modifying factors, Goodman and Soderberg relationship, stresses due to combined loading, cumulative fatigue damage.

Self-learning topics: High cycle fatigue

Unit – III 8 Hours

Design for Static Strength Introduction: Normal, shear, Stress tensor, Principal Stresses, Stress Analysis, Design considerations, Codes and Standards. Static Strength: Static loads and factor of safety, Theories of failure: Maximum normal stress theory, Maximum shear stress theory, Maximum strain theory, Strain energy theory, and Distortion energy theory, failure of brittle and ductile materials.

Self-learning topics: biaxial and tri-axial stresses

Unit – IV 12 Hours

Analysis of perfect frames, strain energy and Resilience: Statically determinate and indeterminate structures, perfect frames, Analysis of perfect frames, analysis of plane truss using method of joints and method of sections. Strain energy and, inelastic strain energy, strain energy

of prismatic bars and varying sections, non-prismatic bar with varying axial force, prismatic bar hanging under its own weight, freely hanging prismatic bar with an axial loads, stress due to gradual, sudden impact loadings, shear resilience.
Self-learning topics: resilience

Unit – V **8 Hours**

Energy Methods and Columns Energy Methods: Strain Energy due to axial, bending Castigliano's theorem, Maxwell's Reciprocal theorem, Unit load method Columns: Columns with various end conditions, Euler's Column curve, Rankine's formula, Column with initial curvature, south-well plot.

Books	
	Text Books:
1.	Megson, T.M.G 'Aircraft Structures for Engineering Students', Elsevier India (2005) ISBN-13: 978-9382291053
2.	Timoshenko and Goodier," 'Theory of Elasticity', McGraw Hill Co.
3.	Donaldson, B.K., "Analysis of Aircraft Structures – An Introduction", Cambridge University Press; 2 edition (24 March 2008). ISBN-13: 978-0521865838
4.	Timoshenko, S., "Strength of Materials", McGraw Hill Education; 3 edition (1 July 2017)ISBN-13: 978-0070701229
5.	V.B. Bhandari, 'Design of Machine Elements', Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.
	Reference Books:
1.	Peery, D.J., and Azar, J.J., "Aircraft Structures", McGraw Hill Education (23 December 2013). ISBN-13: 978-9332902602
2.	Bruhn. E.H. "Analysis and Design of Flight vehicles Structures", Tri – state off set company, USA, 1985.
3.	Robert L. Norton , Machine Design, , Pearson Education Asia, 2001.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://online-learning.tudelft.nl/courses/introduction-to-aerospace-structures-and-materials/
2.	Instructor : https: Fu-Kuo-Chang, stanford.edu https://online.stanford.edu/courses/aa240-analysis-structures

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Analyze** the aircraft structural components and their loads acting.	**L4**
2. **Solve** the forces in different stages of flight envelope.	**L3**
3. **Calculate** axial and shear problems at various sections of aircraft.	**L3**
4. **Deduce** the perfect frames and truss structures problems	**L4**
5. **Apply** the strain energy methods and proof resilience	**L3**
6. **Interpret** the various failure theories for a given engineering structure.	**L3**

Program Outcome of this course (POs)

	PO No.
1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**

3. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice. **PO8**
4. 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. **PO12**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment / Case Study
3.	3. Quiz
4.	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Average of two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :50	15+15 = 30	10	10	50
Writing two IA tests is compulsory. Minimum marks required to qualify for SEE : 20 out of 50 marks				

Semester End Examination (SEE):

1. It will be conducted for 3 hours duration and 100 marks. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum passing marks required to be scored in SEE: 40 out of 100 marks
3. Question paper will have 10 questions carrying 20 marks each. Students have to answer FIVE full questions selecting at least one full question from each unit.

Low Speed Aerodynamics

Course Code	18AE45	**Credits**	4
Course type	PC	**CIE Marks**	50 marks
Hours/week: L-T-P	4-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 50 Hrs; Tutorial = 0 Hrs Total = 50 Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

1. To understand the basic concepts of control volume approaches & flow properties
2. To understand the governing equations used in aerodynamics.
3. Acquire knowledge on two-dimensional Inviscid Incompressible Flows & Flow properties
4. To understand the flow over the cylinder & airfoil characteristics
5. Acquire knowledge on wind tunnel equipment & its measuring techniques.

Unit – I 12 Hours

Review of Basic Fluid Mechanics: Introduction, Flow similarities, Types of Flow, Control volume approach to continuity, momentum and energy equations. Path lines, Streamlines and Streak lines, Angular velocity, Vorticity, Circulation, and Stream function, Velocity potential and Relationship between them. Numerical

Applications based study: Flow Similarity activities to get to know design activity of solid body

Self-learning topics: Mach number & Mach number regimes

Unit – II 10 Hours

Two-Dimensional Inviscid Incompressible Flows: Bernoulli‟s equation, Laplace equation for flow and boundary conditions. Uniform flow, two dimensional source, sink and doublet flows, non-lifting flow over a two-dimensional circular cylinder, D‟Alembert‟ s paradox and vortex flow. Numerical

Applications based study: Construction and simple problems on duct wind tunnel, pitot-tube measurement of airspeed based on Bernoulli‟s equation.

Unit – III 10 Hours

Flow over Circular Cylinders: Lifting flow over a two-dimensional circular cylinder, Kutta-Joukowski theorem and generation of lift.

Airfoil Characteristics: Fundamental aerodynamic variables, aerodynamic forces and moments, centre of pressure, pressure coefficient, types of drags, calculation of airfoil lift and drag from measured surface pressure distributions, typical airfoil aerodynamic characteristics at low speeds. Numerical

Applications based study: Formulate and apply appropriate aerodynamic models to predict the forces on and performance of realistic three-dimensional configurations.

Self-learning topics: airfoil section geometry and wing plan-form geometry.

Unit – IV 08 Hours

Incompressible Flow over Airfoils: Kelvin‟s circulation theorem and the starting vortex,

vortex sheet, vortex filaments, Kutta condition, Classical Thin airfoil theory for symmetric airfoil.

Applications based study: Assess the applicability of aerodynamic models to predict the forces on and performance.

Unit – V **10 Hours**

Introduction to Aerodynamic Testing: Principles of wind tunnel flow simulation, open and closed circuit wind tunnels, and Major features of low speed, transonic and supersonic wind tunnels, smoke and tuft flow visualization techniques, Pressure and Aerodynamic load measurements on a model, total drag determination of two dimensional bodies using wake survey at low speeds.

Self-learning topics: Various types of visualization techniques used for high speed flow.

Books	
	Text Books:
1.	Anderson, Jr. J.D. "Fundamentals of Aerodynamics", McGraw-Hill Education / Asia; 5 edition (16 May 2011). ISBN-13: 978-0071289085
2.	Houghton E.L and Carpenter P.W. "Aerodynamics for Engineering Students, Elsevier; Sixth edition (2012) ISBN-13: 978-9382291176
	Reference Books:
1.	Pope A. and Harper, J J. "Low Speed Wind Tunnel testing", John Wiley Inc. New York, 1966
2.	Anderson, Jr. J.D. "Introduction to Flight", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2007. (Special Indian Edition)
3.	Schlichting, H. "Boundary Layer Theory" McGraw Hill, NewYork, 2004.
4.	Pope A. and Goin, KL. "High Speed Wind Tunnel Testing", John Wiley & Sons Inc. New York.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof Prof. Job Kurian IIT Madras https://nptel.ac.in/courses/101106040/,
2.	**NPTEL:** Online Resources: Lecture by: Prof.K P Sinha Mahapatra, IIT kharagpur. https://nptel.ac.in/courses/101105059/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Apply** the control volume approaches & flow properties	**L3**
2. **Interpret** the governing equations used and its important in fluid flow.	**L3**
3. **Compare** the different types of flow over the different bodies	**L3**
4. **Relate** the different principles used in flow with concept of vortex , vortex Sheet, circulations	**L4**
5. **Illustrate** different wind tunnels, working & its applications	**L3**

Program Outcome of this course (POs)	**PO No.**
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **Problem analysis:** Identify, formulate, research literature, and analyze	**PO2**

	complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	
3.	**Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.**	**PO9**
4.	**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.**	**PO12**

Course delivery methods	**Assessment methods**
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment / Case Study
3.	3. Quiz
4.	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Attendance/conduct of lab	Journal	Lab project	Total Marks
Maximum marks :25	10	10	5	25
Submission and certification of journal is compulsory to qualify for SEE Minimum marks required to qualify for SEE : 10 out of 25 marks				

Semester End Examination (SEE):

1.	It will be conducted for 50 marks having 3 hours/2 hours duration. It will be reduced to 25 marks for the calculation of SGPA and CGPA.		
2.	Only one experiment to be conducted. In case, there are two parts then one experiment from each part.		
3.	Initial write up	10 marks	50 marks
	Conduct of experiment(s), result and conclusion	20 marks	
	One marks question	10 marks	
	Viva-voce	10 marks	
4.	Viva voce is conducted for individual student and not in group		
5.	Minimum passing marks to be scored in SEE: 20 out of 50 marks		

Aerodynamics-I Laboratory

Course Code	18AEL46	**Credits**	1.5
Course type	PC	**CIE Marks**	25 marks
Hours/week: L-T-P	0-0-3	**SEE Marks**	25 marks
Total Hours:	36	**SEE Duration**	3 Hours/2 Hours for 50 marks

Course learning objectives

1. To understand the basics of aerodynamics and parts of sub sonic wind tunnel.
2. To understand the flow visualization techniques on various models.
3. To have the knowledge of measuring pressure distribution of symmetrical and unsymmetrical airfoil and 2D cylinder.
4. Understand the various methods of wind tunnel measuring instruments

Pre-requisites : Fluid Dynamics, Aerodynamics

List of experiments

Introduction to Wind Tunnel equipment and measuring techniques

1. Calibration of a subsonic wind tunnel by inclined manometer
2. Smoke flow visualization studies on a two-dimensional circular cylinder at low speeds.
3. Smoke flow visualization studies on a two dimensional symmetrical airfoil at different angles of incidence at low speeds
4. Smoke flow visualization studies on a two dimensional camber airfoil at different angles of incidence at low speeds
5. Study of flow over aircraft & car by Smoke flow visualization (Small Models)
6. Tuft flow visualization on a flat plate model at different angles of incidence at low speeds: identify zones of attached and separated flows.
7. Surface pressure distributions on a two-dimensional circular cylinder at low speeds and calculation of pressure drag.
8. Surface pressure distributions on a two-dimensional symmetric airfoil at zero incidences at low speeds.
9. Surface pressure distributions on a two-dimensional cambered airfoil at different angles of incidence and calculation of lift and pressure drag.
10. Calibration of a subsonic wind tunnel by projection manometer & pitot tube

Books	
1.	Lab Manual of The Aeronautical Engineering Department
2.	Anderson, Jr. J.D. “Fundamentals of Aerodynamics”, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2007 (Special Indian Edition).
3.	Houghton E.L and Carpenter P.W. “Aerodynamics for Engineering Students”, CBS Publications and Distributors, 8 1993 (4th Edition).
4.	Rae, W.H. and Pope, A., Low Speed Wind Tunnel Testing, John Wiley Publication,

	1984.
	E-Recourses
1.	**NPTEL:** Online Resources: Lecture by: Prof Prof. Job Kurian, IIT Madras https://nptel.ac.in/courses/101106040/,
2.	**NPTEL:** Online Resources: Lecture by: Prof.K P Sinha Mahapatra, IIT kharagpur https://nptel.ac.in/courses/101105059/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Demonstrate** the principle of wind tunnel and classify the wind tunnel	**L3**
2. **Interpret** the flow visualization of airfoil and bluff bodies at different angle of attacks	**L3**
3. **Operate** the various measuring techniques used in wind tunnel	**L3**
4. **Examine** the pressure distribution of symmetrical and unsymmetrical airfoil and 2D cylinder.	**L4**
5. **Evaluate** the design parameters by flow visualization & analytical techniques.	**L5**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
3. **Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.**	**PO9**
4. **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.**	**PO12**

Assessment methods

1. Conduct of Experiment
2. Journal evaluation/assessment
3. Open ended experiments
4. Viva-voce

Scheme of Continuous Internal Evaluation (CIE):

Components	Attendance/conduct of lab	Journal	Lab project	Total Marks
Maximum marks :25	10	10	5	25
Submission and certification of journal is compulsory to qualify for SEE Minimum marks required to qualify for SEE : 10 out of 25 marks				

Semester End Examination (SEE):

1.	It will be conducted for 50 marks having 3 hours/2 hours duration. It will be reduced to 25 marks for the calculation of SGPA and CGPA.		
2.	Only one experiment to be conducted. In case, there are two parts then one experiment from each part.		
3.	Initial write up	10 marks	50 marks
	Conduct of experiment(s), result and conclusion	20 marks	
	One marks question	10 marks	
	Viva-voce	10 marks	
4.	Viva voce is conducted for individual student and not in group		
5.	Minimum passing marks to be scored in SEE: 20 out of 50 marks		

Theory of Machines Lab

Course Code	18AEL47	**Credits**	1.5
Course type	PC	**CIE Marks**	25 marks
Hours/week: L-T-P	0-0-3	**SEE Marks**	25 marks
Total Hours:	36	**SEE Duration**	3 Hours/2 Hours for 50 marks

Course learning objectives

1. Use the theoretical principles and demonstrate balancing of rotating masses.
2. Understand the principles of governors, gyroscope and analyze forces in governors and couples in gyroscope.
3. Understand the concept of vibration and analyze un damped single degree of freedom systems
4. Understand the whirling of shaft of various loadings

Pre-requisites: Basic knowledge of Theory of Machines.

List of experiments	
1.	Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal)
2.	Determination of natural frequency in a single degree of freedom undamped vibrating systems (longitudinal)
3.	Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (torsional)
4.	Experimentation on Balancing of rotating masses setup for static balancing at a plane.
5.	Determination of equilibrium speed, sensitiveness, power and effort of Porter Governor.
6.	Determination of equilibrium speed, sensitiveness, power and effort of Hartnel Governor.
7.	Determine gyroscopic couple on Motorized Gyroscope.
8.	Determine critical speed or whirling speed of a rotating shaft and to verify the value theoretically

Books	
1.	Rattan S.S., Theory of Machines, Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, 2009
2.	G. K. Grover, Mechanical Vibrations, NemChand and Bros, 6th Edition, 1996.
3.	S. Graham Kelly, Fundamentals of Mechanical Vibration, Tata McGraw-Hill, 2000.
	E-Recourses
1.	**NPTEL:** Online Resources: Lecture by: Prof. Rajiv Tiwari, IIT Guwahati https://nptel.ac.in/courses/112103112/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Solve** vibrations induced in a system and **explain** different parameters associated with it.	**L3**
2. **Calculate** critical speed of shafts and can **locate** masses to balance a system.	**L3**
3. **Compare** different types of Governors	**L3**
4. **Analyze** the rotating mass.	**L4**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
3. **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.	**PO7**
4. **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.	**PO4**
5. **Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.**	**PO9**
6. **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.**	**PO12**

Assessment methods

1. Conduct of Experiment
2. Journal evaluation/assessment
3. Open ended experiments
4. Viva-voce

Scheme of Continuous Internal Evaluation (CIE):

Components	Attendance/conduct of lab	Journal	Lab project	Total Marks
Maximum marks :25	10	10	5	25
Submission and certification of journal is compulsory to qualify for SEE Minimum marks required to qualify for SEE : 10 out of 25 marks				

Semester End Examination (SEE):

1.	It will be conducted for 50 marks having 3 hours/2 hours duration. It will be reduced to 25 marks for the calculation of SGPA and CGPA.		
2.	Only one experiment to be conducted. In case, there are two parts then one experiment from each part.		
3.	Initial write up	10 marks	50 marks
	Conduct of experiment(s), result and conclusion	20 marks	
	One marks question	10 marks	
	Viva-voce	10 marks	
4.	Viva voce is conducted for individual student and not in group		
5.	Minimum passing marks to be scored in SEE: 20 out of 50 marks		

Aircraft Structures Laboratory

Course Code	18AEL48	**Credits**	1
Course type	PC	**CIE Marks**	25 marks
Hours/week: L-T-P	0-0-2	**SEE Marks**	25 marks
Total Hours:	24	**SEE Duration**	3 Hours/2 Hours for 50 marks

Course learning objectives

1. Understand the basics of different theorems of determining the young's modulus and respective deflections.
2. Understand the structural properties.
3. Have the knowledge of vibrations, strength of materials and buckling of columns.

Pre-requisites : Aircraft structures , Mechanics of Materials

List of experiments

1. **Deflection Test :**Stress and deflections of beams for various end conditions, verification of Maxwell's theorem
2. **Deflection Test :**Stress and deflections of beams for various end conditions, verification of principle of superposition
3. **Wagner beam test:** Investigate the behavior of semi tension field
4. **Deflection Test :**Stress and deflections of beams for various end conditions, verification of Castigliano's theorem
5. **Young's Modulus Test:** Conducting deflection test on hinged supported beam and find the Young's modulus
6. **Free Vibration Test:** To verify the free longitudinal vibration
7. **Forced Vibration Test:** To verify the damped and undamped forced vibration setup
8. **Buckling Test:** Compression tests on short columns, Crippling loads.
9. **Buckling Test:** Compression tests on Long columns, Crippling loads with Hinged-hinged condition.
10. **Buckling Test:** Buckling tests on Long columns, Crippling loads with Hinged-Fixed condition

Books	
1.	Lab Manual of The Aeronautical Engineering Department
2.	Megson, T.H.G., Aircraft Structures for Engineering Students, 4th edn., Elsevier, 2007, ISBN 0-750667397.
3.	Peery, D.J. and Azar, J.J., Aircraft Structures, 2nd edn, McGra-Hill, 1982, ISBN 0-07-049196-8
4.	Bruhn. E.H, Analysis and Design of Flight Vehicles Structures, Tri-state Off-set Company, USA, 1965.
5.	Lakshmi Narasaiah, G., Aircraft Structures, BS Publications, 2010.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Analyze** and **interpret** the variation of Stress and deflections of beams for various end conditions.	**L3,L4**
2. **Illustrate** the Compression tests on long columns and Unsymmetrical buckling test under various conditions	**L3**
3. **Deduce** the semi tension fields in a beam	**L4**
4. **Examine** the natural frequency of beams under free and forced vibration using.	**L4**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
3. **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.	**PO4**
4. **Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.**	**PO9**
5. **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.**	**PO12**

Assessment methods

1. Conduct of Experiment
2. Journal evaluation/assessment
3. Open ended experiments
4. Viva-voce

Scheme of Continuous Internal Evaluation (CIE):

Components	Attendance/conduct of lab	Journal	Lab project	Total Marks
Maximum marks :25	10	10	5	25
Submission and certification of journal is compulsory to qualify for SEE Minimum marks required to qualify for SEE : 10 out of 25 marks				

Semester End Examination (SEE):

<table>
<tr><td>1.</td><td colspan="3">It will be conducted for 50 marks having 3 hours/2 hours duration. It will be reduced to 25 marks for the calculation of SGPA and CGPA.</td></tr>
<tr><td>2.</td><td colspan="3">Only one experiment to be conducted. In case, there are two parts then one experiment from each part.</td></tr>
<tr><td rowspan="4">3.</td><td>Initial write up</td><td>10 marks</td><td rowspan="4">50 marks</td></tr>
<tr><td>Conduct of experiment(s), result and conclusion</td><td>20 marks</td></tr>
<tr><td>One marks question</td><td>10 marks</td></tr>
<tr><td>Viva-voce</td><td>10 marks</td></tr>
<tr><td>4.</td><td colspan="3">Viva voce is conducted for individual student and not in group</td></tr>
<tr><td>5.</td><td colspan="3">Minimum passing marks to be scored in SEE: 20 out of 50 marks</td></tr>
</table>

Syllabus of 5th Semester

Partial Differential Equations Z -Transforms and Stochastic Processes
(Only for Diploma Students)

Course Code	18DMATAE51	Credits	4
Course type	BS	CIE Marks	50 marks
Hours/week: L-T-P	4-0-0	SEE Marks	50 marks
Total Hours:	Lecture = 50 Hrs; Tutorial = 0 Hrs Total = 50Hrs	SEE Duration	3 Hours for 100 marks

Course learning objectives

Enable Students to

1. Get acquainted with joint probability distribution
2. Study the concept of stochastic processes.
3. Understand the concept of partial differential equations
4. Apply partial differential equations to solve practical problems.
5. Study the concept of Z-transforms and its applications

Pre-requisites : Partial differentiation , Basic probability, probability distributions, Basic integration

Unit-I **10 Hours**

Joint PDF: Discrete joint PDF, conditional joint PDF, expectations (Mean), Variance and Covariance.

Unit-II **10 Hours**

Stochastic Processes: Definition and classification of stochastic processes. Discrete state and discrete parameter stochastic process, unique fixed probability vector, regular stochastic matrix, transition probability, Markov chains.

Unit-III **10 Hours**

Partial Differential Equations: Formation of PDE by elimination of arbitrary constants and functions. Solution of non-homogeneous PDE by direct integration, solution of homogeneous PDE involving derivative with respect to one independent variable.

Unit-IV **10 Hours**

Applications of Partial Differential Equations: Derivations of one dimensional Heat and Wave equations. Solutions of one dimensional heat and wave equations. Solution of two dimensional Laplace equations by the method of separation of variables. Numerical solution of one dimensional heat and wave equations, two dimensional Laplace equations by finite differences.

Unit-V **10 Hours**

Z-Transforms: Definition, Z-transforms of standard functions, linearity, damping rule, shifting properties, initial and final value theorems with examples. Inverse Z-transforms and solution of difference equations by Z-transforms.

Books	
	Text Books:
1.	B.S. Grewal – Higher Engineering Mathematics, Khanna Publishers, 42nd Edition, 2012 and onwards.
2.	Erwin Kreyszig –Advanced Engineering Mathematics, John Wiley & Sons Inc., 9th Edition, 2006 and onwards.
3.	B. V. Ramana - Higher Engineering Mathematics, Tata McGraw-Hill Education Private Limited, Tenth reprint 2010 and onwards.
	Reference Books:

1.	P. N. Wartikar & J. N. Wartikar – Applied Mathematics (Volume I and II) Pune Vidyarthi Griha Prakashan, 7th Edition 1994 and onwards.
2.	Peter V. O' Neil –Advanced Engineering Mathematics, Thomson Brooks/Cole, 7th Edition, 2011 and onwards.
3.	Glyn James – Advanced Modern Engineering Mathematics, Pearson Education, 4th Edition, 2010 and onwards.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Apply** joint probability distribution to solve relevant problems	**L2**
2. **Apply** stochastic processes to solve relevant problems	**L1, L2**
3. **Form** and **Solve** partial differential equations.	**L1, L2**
4. **Develop** heat and wave equations	**L2, L3**
5. **Apply** partial differential equations to solve practical problems.	**L3**
6. **Apply** Z-Transforms to solve engineering problems.	**L1, L2**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**

Course delivery methods

1. Chalk and board
2. PPT

Assessment methods

1. Assignments
2. Quizzes
3. IA tests
4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Computer Aided Aircraft Components Drawing

Course Code	18AE51	**Credits**	4
Course type	PC	**CIE Marks**	50 marks
Hours/week: L-T-P	2-0-4	**SEE Marks**	50 marks
Total Hours:	Lecture = 24 + 48 Hrs; Tutorial = 0 Hrs Total = 72Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Introduce Bureau of Indian Standards on drawing practices and standard components.
2. Impart knowledge of Machine component and its conversion into 2D drawing.
3. Familiarize various thread forms and representation of standard thread components.
4. Make awareness of structural riveted joints along with their standard empirical relations.
5. Model parts and create assembly using standard CAD packages like CATIA.
6. Familiarize with standard components and their assembly of an aircraft.

02 Hours

Introduction

Introduction to BIS Specification for line conventions, dimensioning, Tolerance representation, Surface finish representation. Conventional representation of common features, Introduction to limits, fits and tolerances (No questions are to be set from this section).

PART A

Unit – I **08 Hours**

Sections of Solids: Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting on their base only (No problems on spheres and hollow solids).True shape of sections.
Self-learning topics: Sections of Tetrahedrons and Cylinders

Unit – II **08 Hours**

Orthographic Views: Conversion of pictorial views into orthographic Projections of simple machine parts with and without section. (Bureau of Indian Standards conventions are to be followed for the drawings)Precedence of lines Basics of geometric dimensions

PART B

Unit – III **08 Hours**

Thread Forms and Fasteners: Thread terminology, Thread conventions, ISO Metric (Internal & External), BSW (Internal &External) Square, Acme and Sellers Thread. Representation of Hexagonal headed bolt and nut assembly with washer, simple assembly of stud with hexagonal nut and lock nut.
Self-learning topics: Simple assembly of stud with hexagonal nut and lock nut.

Unit – IV **06 Hours**

Riveted Joints: Single and double riveted lap joints, butt joints with Single/double cover straps of equal width(Chain and Zigzag riveting arrangement using snap head rivets).
Self-learning topics: Butt joints with double cover straps (Chain and Zigzag, using snap head rivets)

PART C

Unit – V **45 Hours**

Assembly of Machine & Aeronautical Components (Using the given part drawings) :

1. Screw jack (Bottle type)
2. Plummer block (Pedestal Bearing).
3. Design of propeller and hub assembly
4. Design of wing assembly
5. Design of fuselage assembly
6. Design of main rotor blade assembly of helicopter
7. Design of Landing Gear Assembly

Self-learning topics: Design of Engine Mounts, I.C. Engine connecting rod

Books	
	Text Books:
1.	N.D.Bhat&V.M.Panchal,'Machine Drawing', Charotar Publications, 26thEdn. 1991.
2.	K.R. Gopal Krishna, Subhash Publication.,2003
	Reference Books:
1.	S. Trymbaka Murthy 'A Text Book of Computer Aided Machine Drawing', CBS Publishers, New Delhi, 2007
2.	N. Siddeshwar, P. Kanniah, V.V.S. Sastri,'Machine Drawing', published by Tata McGraw Hill, 2006

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Visualize** and prepare detail drawing of a given object.	**L4**
2.	**Read and interpret** a given production drawing.	**L2**
3.	**Identify** standard parts / components.	**L1**
4.	**Draw** details and assembly of mechanical & aeronautical systems.	**L4**
5.	**Create** 2-D and 3-D models by standard CAD software with manufacturing considerations.	**L4**

	Program Outcome of this course (POs)	PO No.
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2.	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
3.	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.	**PO5**
4.	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	**PO8**
5.	**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.	**PO10**
6.	**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.	**PO12**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment, Quiz
3. Working Models	3. Course Seminar
4. Videos	4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

AIRCRAFT PERFORMANCE

Course Code	18AE52	Credits	4
Course type	PC	CIE Marks	50 marks
Hours/week: L-T-P	4-0-0	SEE Marks	50 marks
Total Hours:	Lecture = 50 Hrs; Tutorial = 0 Hrs Total = 50Hrs	SEE Duration	3 Hours for 100 marks

Course learning objectives

Enable Students to

1. Understand the aircraft performance in steady un accelerated and accelerated flight.
2. List the airplane performance parameters.
3. Acquire the knowledge on aircraft maneuver performance.
4. Identify the performance parameters for different configuration aircrafts

Unit-I **10 Hours**

The Equations of Motion Steady Uncelebrated Flight: Introduction, four forces of flight, General equation of motion, Power available and power required curves. Thrust available and thrust required curves. Conditions for power required and thrust required minimum. Thrust available and maximum velocity, Stall phenomena. Power available and maximum velocity, Altitude effects on power available and power required; thrust available and thrust required.

Unit-II **10 Hours**

Steady Performance: Level Flight, Climb & Glide Performance: Equation of motion for Rate of climb- analytical approach -Absolute ceiling, Service ceiling, Time to climb – analytical approach , climb performance graph (hodograph diagram); maximum climb angle and rate of climb Gliding flight, Range during glide, minimum rate of sink and shallowest angle of glide. Effect of wind on climb and decent performance.

Unit-III **10 Hours**

Fundamental Airplane Performance Parameters: Thrust– to–weight ratio, Wing loading, Drag polar and lift-to–drag ratio. Minimum velocity. Aerodynamic relations associated with lift-to-drag ratio. **Range And Endurance:** Propeller driven Airplane: Physical consideration, Quantitative formulation, Breguet equation for Range and Endurance, Conditions for maximum range and endurance. Tail wind and head wind effects on Range and Endurance Performance.
Case Study**:** Jet Airplane: Physical consideration, Quantitative formulation, Equation for Range and Endurance

Unit-IV **10 Hours**

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.

Unit-V **10 Hours**

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). Performance in accelerated climb from energy point of view, Energy height.
Self-Studies Topics: Limiting case for large load factor. The V-n diagram. Limitations of pull up and push over. Spin phenomena. Maneuver performance of supersonic flights.

Books	
	Text Books:
4.	Anderson, J.D. Jr., ―Aircraft Performance and Design‖, International edition McGraw Hill, 1st Edition, 1999, ISBN: 0-07-001971-1.
5.	Eshelby, M.E., ―Aircraft Performance theory and Practice‖, AIAA Education Series, AIAA, 2nd Edition, 2000, ISBN: 1-56347-398-4.
6.	McCormick, B.W, ―Aerodynamics, Aeronautics and Flight Mechanics‖, John Wiley, 2nd Edition, 1995, ISBN: 0-471-57506-2.
	Reference Books:
4.	Yechout, T.R. et al., ―Introduction to Aircraft Flight Mechanics‖, AIAA Education Series, AIAA, 1st Edition, 2003, ISBN: 1-56347-577-4.
5.	Shevel, R.S., ―Fundamentals of Flight‖, Pearson Education, 2nd Edition, 1989, ISBN: 81-297-0514-1.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. A K Ghosh, IIT Kanpur https://nptel.ac.in/courses/101104007/

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	Describe the influence of atmosphere and aircraft configuration on aircraft performance.	**L2**
2.	Calculate the flight vehicle performance in steady level flight.	**L2**
3.	Estimate the time to climb and descent and gives the relation between rate of climb and descent and time to climb and descent at different altitudes.	**L3**
4.	Examine the performance characteristics of accelerated and un accelerated flight.	**L4**

	Program Outcome of this course (POs)	PO No.
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	PO1
2.	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	PO2
3.	Design/ Development 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	PO3

Course delivery methods	Assessment methods
1. Chalk and board	1. Assignments
2. PPT	2. Quizzes
	3. IA tests
	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Course Code	18AE53	**Credits**	4
Course type	PC	**CIE Marks**	50 marks
Hours/week: L-T-P	4-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 50 Hrs; Tutorial = 0 Hrs Total = 50Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand the basic principle and theory of aircraft propulsion.
2. Learn the purpose of propeller theory and selection of propellers
3. Gain the knowledge of different inlets and their operations
4. Understand of a centrifugal, axial compressor, axial and radial turbines.
5. Comprehend the types of combustors, nozzles and their working conditions

Unit – I **08 Hours**

Fundamentals of air breathing engines: Classification of jet engines -Brayton Cycle analysis, illustration of working of gas turbine engines and their performance characteristics –thrust equation – Engine performance parameters, specific thrust, specific fuel consumption and specific impulse, thermal efficiency, propulsive efficiency, methods of thrust augmentation

Unit – II **10 Hours**

Propeller Theories & Jet propulsion: Types of propeller, Propeller thrust: momentum theory, Blade element theories and propeller selection.

Subsonic and Supersonic inlets: Internal flow and Stall in Subsonic inlets, Relation between minimum area ratio and external deceleration ratio. Supersonic inlets, Shock swallowing by area variation,. Modes of inlet operation.

Nozzles: Theory of flow in isentropic nozzles, Convergent nozzles and nozzle choking, Nozzle efficiency, Losses in nozzles. Thrust reversal method.

Self-learning topics: Over-expanded and under-expanded nozzles, Ejector and variable area nozzles,

Unit – III **12 Hours**

Gas Turbine Engine Compressors: Centrifugal compressors: Principle of operation of centrifugal compressors. Work done and pressure rise -Velocity diagrams, Diffuser vane design considerations, problems.

Axial flow compressors: Elementary theory of axial flow compressor, Velocity triangles, Degree of reaction, Air angle distribution for free vortex and constant reaction designs, problems.

Unit – IV **10 Hours**

Combustion chambers: Classification of combustion chambers, important factors affecting combustion chamber design, Combustion process, Combustion chamber performance Effect of operating variables on performance – Flame tube cooling.

Turbines: Introduction, types of turbines, Turbine stage, Multi-staging of turbine, Exit flow conditions, Turbine cooling, Heat transfer in turbine cooling.

Self-learning topics: Flame stabilization, Use of flame holders

Unit – V **10 Hours**

Ramjet Propulsion: Operating principle –Sub critical, critical and supercritical operation – Combustion in ramjet engine –Ramjet performance–Preliminary concepts in supersonic combustion –Integral ram-rocket

Fundamentals of Rocket Propulsion Types and Classification of rockets Operating principle – Specific impulse of a rocket –Rocket nozzle classification.

Books

	Text Books:
1.	Bhaskar Roy, "Aircraft propulsion", Elsevier (2011), ISBN-13: 9788131214213
2.	V. Ganesan, "Gas Turbines", Tata McGraw-Hill, 2010, New Delhi, India, ISBN: 0070681929, 978007068192
	Reference Books:
1.	Hill, P.G. & Peterson, C.R., "Mechanics & Thermodynamics of Propulsion" Addison – Wesley Longman INC, 1999, ISBN-13: 978-0201146592.
2.	Irwin E. Treager, "Gas Turbine Engine Technology" GLENCOE Aviation Technology Series, 7th Edition, Tata McGraw Hill Publishing Co.Ltd. Print 2003, ISBN-13: 978-0028018287
3.	Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H., "Gas Turbine Theory", Longman, 1989, ISBN 13: 9780582236325.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. Bhaskar Roy , Prof. A M Pradeep, IIT Bombay https://nptel.ac.in/courses/101101002/
2.	**NPTEL:** Online Resources: Lecture by: Prof. Vinayak N. Kulkarni , IIT Guwahati https://swayam.gov.in/nd1_noc19_me76/preview

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Apply** the basic principle and theory of aircraft propulsion.	**L3**
2.	**Classify** the types of propeller and explain their theories.	**L2**
3.	**Describe** the types of inlets and explain their operations.	**L2**
4.	**Explain** the functions of centrifugal, axial compressors , axial and radial turbines	**L2**
5.	**Analyze** the performance of nozzles and combustion chamber	**L4**

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2.	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**

Course delivery methods	**Assessment methods**
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment, Quiz
3. Working Models	3. Course Seminar
4. Videos	4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10%

weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Course Code	18AE54	**Credits**	3
Course type	PC	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs; Tutorial = 0 Hrs Total = 40 Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Comprehend the basic concepts and equations of viscous flow.
2. Acquire the knowledge of laminar boundary layer and its equations.
3. Understand the Flow of Real Fluids
4. Learn the turbulence, instrumentation and measurements.

Pre-requisites: Fluid Mechanics & Aerodynamics

Unit – I **8 Hours**

Basics of Compressible Flow: Basics of thermodynamics-definition and basic relation, Conservative Energy Equation- For flow and non-flow process, adiabatic energy equation, reference velocities, Bernoulli's equation, Effect of Mach number on Compressibility, application of energy equations to turbo machines, combustors and diffusers.

Self-learning topics: stagnation: pressure, temperature, density

Unit – II **10 Hours**

Fanno Flow: Flow with friction in constant area duct. Fanno lines. Fanno equation. Definition of friction constant, Frictional loss. Effect of wall friction on flow properties. Friction parameter. Local flow properties in terms of local Mach number.

Rayleigh Flow: Flow with heating or cooling in ducts like combustor and afterburner. Governing equations. Heating relations for a perfect gas. Slope of Rayleigh line. Entropy considerations. Maximum heat transfer. Numericals.

Unit – III **8 Hours**

Differential Equations of Motion for Steady Compressible Flows Basic potential equations for compressible flow. Linearization of potential equation- small perturbation theory. Methods for solution of nonlinear potential equation -Introduction. Boundary conditions. Pressure coefficient expression for compressible flow.

Unit – IV **6 Hours**

Flow of Real Fluids: Wave – Boundary layer interaction. Experimental characteristics of airfoils in compressible flow. Nature of pressure distribution over airfoil. Energy Equation for real fluid. Numericals.

Unit – V **8 Hours**

Measurements in Compressible Flow: Optical methods of flow visualization-shadow technique, Mach zender interferometer, Schileren technique. Wind tunnel Instrumentation and measurements-Pressure, Temperature, Flow rate, Hot-wire anemometer, Velocity measurements, Particle image velocimetry. Numericals on schlieren, shadowgraph and Hot wire anemometer.

Books

	Text Books:
1.	Radhakrishnan, E., "Gas Dynamics", PHI Learning (2017), ISBN-13: 978-8120353169
2.	Yahya, S.M., "Fundamentals of Compressible flow", New Age International Publishers; Sixth edition (1 January 2018), ISBN-13: 978-9386649911.
	Reference Books:
1.	John D Anderson, "Modern Compressible Flow", Mc Graw Hill 1999. ISBN: 978-8-0072424430.
2.	Ascher.H.Saphiro, "Dynamics and Thermodynamics of Compressible fluid flow", Ronald Press, 1953. ISBN: 978-0471066910.
3.	H.W. Liepmann and A.Roshko, "Elements of Gas Dynamics", New york: Wiley & sons, Inc. 1957. ISBN: 978-0-486-41963-3
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1	**NPTEL:** Online Resources: Lecture by: Dr. A Sameen, IIT Madras by https://nptel.ac.in/courses/112106196/
2	**NPTEL:** Online Resources: Lecture by: Dr. T M Muruganandam, IIT Madras https://nptel.ac.in/courses/101106044/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Understand** the basic concept of Compressible Flow	**L2**
2. **Apply** and **Analyse** the concept of various condition of flow for problems	**L4**
3. **Solve** the real fluid flow problems	**L3**
4. **Use** the various flow measurement techniques	**L3**

Program Outcome of this course (POs)	PO No.
1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. Problem analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
3. 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.	**PO3**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment
3.	3. Quiz & Course Activity
4.	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10%

weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**25**	**20**	**15**	**20**

Course Code	18AE5511	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs; Tutorial = 0 Hrs Total = 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand the basic concepts of control systems and mathematical models.
2. Acquire the knowledge on block diagrams and signal flow graphs.
3. Familiar with frequency response analysis and various types of plots.
4. Describe the various control systems

Pre-requisites: Basic knowledge of Electrical Engineering & Mathematics

Unit – I **08 Hours**

Introduction to Control Systems and Mathematical Models

Introduction: Concept of controls, Open loop and closed loop systems with examples, Concepts of feedback and basic structure of feedback control system, requirements of an ideal control system.

Mathematical Models: Transfer function models of mechanical systems, electrical circuits, Launch vehicles and missiles

08 Hours

Unit – II

Block Diagrams and Signal Flow Graphs

Transfer functions definition and its properties, block representation of control systems and terminologies, and block diagram algebra and reduction of block diagrams, Signal flow graph method.

Transient and Steady State Response Analysis Introduction, type and order of systems, time response specifications, first order and second order system response to step, ramp and impulse inputs, doublet input concepts of time constant and its importance in speed of response

Unit – III **08 Hours**

Root Locus Plots Definition of root loci, General rules for constructing root loci, Analysis using root locus plots, Determination of desired gain, limit gain, gain margin and conditional stability.

Frequency Response Analysis Using Bode Plots: Bode attenuation diagrams for first and second order systems Simplified Bode diagrams, Stability analysis using Bode plots and determination of phase margin and gain margin and gain System stability analysis using Routh's – Hurwitz Criterion

Unit – IV **08 Hours**

Frequency Response Specification and Analysis using Polar plots:

Specification: Frequency response definition, frequency response specifications and its relationship with time response specifications. **Analysis:** Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin, M&N circles

Unit – V **08 Hours**

Feedback control systems:

Types of controllers – Proportional, Integral, Derivative controllers, Proportional – Integral, Proportional – Integral – Derivative controllers; **State Variable Characteristics of Linear Systems;** Introduction to concepts of states and state variable representation of linear systems.

Autopilots Stability augmentation systems-pitch damper and yaw damper.

Self-learning topics: Compensation methods – Series and feedback compensation, Lead, Lag and Lead-Lag Compensators.

Books	
	Text Books:
1.	U.A. Bakshi and V.U. Bakshi, Control Engineering, Technical Publications, ISBN: 978-93-5099-657-7
2.	A. Nagoor Kani, Control Systems Engineering, RBA Publications, 2014
	Reference Books:
1.	Katsuhiko Ogatta, Modern Control Engineering, Pearson Education,2004
2.	I.J. Nagrath and M. Gopal,Control Systems Engineering, New Age Publishers, 2017
3.	Richard.C.Dorf andRobert.H. Bishop, Modern Control Systems, Addison Wesley, 1999.
4.	N.S. Nise, Control SystemsEngineering, 6th Edition, Wiley, 2012.
5.	Stevens, B.L. and Lewis, F.L., ―Aircraft Control and Simulation, John Wiley,1992.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Dr. S D Agashe, IIT Bombay https://nptel.ac.in/courses/108101037/
2.	**NPTEL:** Online Resources: Lecture by: Prof. Madan Gopal, IIT Delhi https://nptel.ac.in/courses/108102043/

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Apply** the concepts of control systems	**L3**
2.	**Construct** the block diagrams and signal flow graphs.	**L3**
3.	**Determine** the frequency response analysis by using various types of plots.	**L4**
4.	**Analyze** the various control system problems	**L3**
5.	**Describe** the principle of approximations to aircraft transfer functions, Control surface actuators	**L2**

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2.	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
3.	**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.	**PO3**

Course delivery methods	**Assessment methods**
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment, Quiz
3. Working Models	3. Course Seminar
4. Videos	4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Course Code	18AE5512	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand the basic structural members subjected to various loadings.
2. Study the importance of Discretization of body using different finite elements
3. Acquire the knowledge of different loading and boundary conditions
4. Interpret the governing equation and methods of finite element analysis
5. Understand the different types of elements and related field problems

Pre-requisites**:** Basic knowledge of Mechanics of Materials & Mathematics

Unit-I **08 Hours**

Introduction: Basic Concepts, Background Review**:** Plane stress, Plane strain, Potential energy and Equilibrium. Rayleigh - Ritz Method, Numerical.

Construction or discrete models - sub domains and nodes, simple elements for the FEM - Simplex, complex and multiples elements.

Unit-II **08 Hours**

Fundamentals of Finite Element Method: Elements and shape functions and natural coordinates, Use of local and natural coordinates, compatibility and convergence requirements of shape functions.

Construction of shape functions for bar element, stiffness matrix for bar element, uniform bar elements.

Unit-III **08 Hours**

Analysis of Two and Three dimensional Elements: Shape functions of Triangular, Rectangular and Eight-Noded Hexahedral Element (HEXA 8), Serendipity family, Lagrange family

Unit-IV **08 Hours**

Theory of Iso-parametric Elements and Axi-symmetric: Iso parametric, sub parametric and super-parametric elements, pre and post processing, computer program for FEM analysis, Axisymmetric formulation finite element modeling of triangular element.

Unit-V **08 Hours**

Field Problems: Heat transfer problems, Steady state fin problems, 1-D heat conduction governing equation, Numerical.

Books	
	Text Books
1.	Chandrupatla T. R., “Finite Elements in engineering”, PHI, 3rd edition, 2002, ISBN-13: 978- 8120321069.
2.	Bhavikatti, Finite element Analysis, New Age International,3rd edition,2015,ISBN-13: 978- 8122436716
	Reference Books:
3.	Rajasekharan. S - "Finite element analysis in engineering design", Wheeler Publishers

4.	Bathe. KJ , "Finite Element Procedures", PHI Pvt. Ltd., New Delhi,1996,ISBN-13: 978-8126529988
5.	Zienkiewicz. O.C. - "The Finite Element Method", Elsevier,7th edition,2013,ISBN-13: 978- 9351071587
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/105106051/: Finite element analysis course at IIT Madras by Dr. B N Rao
2.	https://nptel.ac.in/courses/112104193/: Finite element analysis course at IIT Kanpur by Prof. Nachiketa Tiwari

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Understand** the finite element methods and its applications	**L1**
2. **Recognize** the Discretization technique for domain decomposition.	**L2**
3. **Understand** the effects of different loading and boundary conditions	**L1**
4. **Interpret** the governing equations of finite element analysis	**L3**
5. **Acquire** the knowledge of various engineering field problems	**L3**

Program Outcome of this course (POs)	**PO No.**
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	PO1

Course delivery methods

1. Chalk and board
2. PPT

Assessment methods

1. Assignments
2. Quizzes
3. IA tests

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:40**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Fracture Mechanics

Course Code	18AE5513	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs; Tutorial = 0 Hrs Total = 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand the principles of fracture mechanics
2. Solve the structural members with cracks and its growth rate
3. Illustrate the elastic plastic facture and fracture resistance materials
4. Compare the different testing procedures for fracture in experimental and analytical stream

Pre-requisites: Mechanics of Materials, Aircraft Structures

Unit – I **8 Hours**

Fracture Mechanics Principle: Introduction, Mechanisms of Fracture, and a crack in structure, the Griffith's criterion and validation of Griffith's criteria, modern design – strengths, stiffness and toughness. Stress intensity approach.
Self-learning topics: Stress Tensor

Unit – II **8 Hours**

Strain Analysis for members with cracks: Linear elastic fracture mechanics, Crack tip stress and deformations, Relation between stress intensity factor and fracture toughness, Crack tip plastic zone estimation, the thickness effect, tearing mode analysis, superposition of stress intensity factor.

Unit – III **8 Hours**

Elastic Plastic Fracture Mechanics & Crack arrest: Elasto–plastic factor criteria crack resistance curve, J-integral approach, Crack opening displacement, crack tip opening displacement. Importance of R-curve in fracture mechanics.
Self-study: the principles of crack arrest

Unit – IV **8 Hours**

Crack growth rate: The dynamic stress intensity and elastic energy release rate, crack branching, the principles of crack arrest, the dynamic fracture toughness, Fracture criteria, fatigue cracking criteria, effect of alloying and second phase particles, effect of processing and anisotropy, effect of temperature.
Self-study: Accident Investigation

Unit – V **8 Hours**

Toughness testing and computational approach: Specimen size requirements, various test procedures, effects of temperature, loading rate and plate thickness on fracture toughness. Fracture testing in shear modes, fatigue testing, Overview of numerical methods, traditional methods in computational fracture mechanics–stress and displacement marching, finite element implementation.

Books	
	Text Books:
1.	Barrels, W., and Ripley, E.L., "Fatigue of Aircraft Structures", Pergamon Press, Oxford, 1983.
2.	T L Anderson, "Fracture Mechanics: Fundamentals and Applications", 3rd Edition, CRC Press, ISBN: 978-0849316562.
	Reference Books:
1.	Prasanth Kumar, "Elements of fracture mechanics", Wheeter publication, 1999
2.	Knott, J.F., "Fundamentals of Fracture Mechanics", Butterworth & Co., (Publishers) Ltd., London, 1983
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1	https://nptel.ac.in/courses/112106065/: Fracture Mechanics course at IIT Madras by Prof. K Ramesh

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Illustrate** various principles of fracture mechanics and fatigue.	**L2**
2. **Apply** the various analysis methods of fractures for different materials	**L3**
3. **Solve** the fracture related problems considering growth rate and elastic materials.	**L3**
4. **Use** the computational methods to **analyze** the fatigue and fracture problems	**L3**
5. **Compare** the concepts to arrest the crack and increase fatigue strength	**L3**

Program Outcome of this course (POs)	PO No.
1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment
3.	3. Quiz & Case Study
4.	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Turbo Machines

Course Code	18AE5514	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs; Tutorial = 0 Hrs Total = 40 Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand the basics of turbo machines, the energy transfer and energy transformation in them.
2. Acquire the knowledge on design of centrifugal and axial turbo machines
3. Study hydraulic pumps and turbines.
4. Study the compression and expansion processes.
5. Understand the design and performance of compressors.

Unit – I **8 Hours**

Introduction to turbo machines: Classification and parts of a turbo machines; comparison with positive displacement machines; dimensionless parameters and their physical significance; specific speed; illustrative examples on dimensional analysis and model studies. Energy transfer in turbo machines: Basic Euler turbine equation and its alternate form; components of energy transfer; general expression for degree of reaction.

Self-learning topics: components of energy transfer

Unit – II **8 Hours**

Compression process: Overall isentropic efficiency of compression; stage efficiency; comparison and relation between overall efficiency and stage efficiency; pre heat factor.

Expansion process: Overall isentropic efficiency for a turbine; stage efficiency for a turbine; comparison and relation between stage efficiency and overall efficiency; reheat factor for expansion process.

Unit – III **8 Hours**

Performance analysis of compressors: Types, design parameters, flow analysis in impeller blades, volutes and diffusers, losses, slip factor, characteristic curves, surging, choking. Construction details.

Performance analysis of fans and compressors: enthalpy-entropy diagrams, stage losses and efficiency, work done.

Unit – IV **8 Hours**

Performance analysis of turbines: Turbine stage, work done, flow passage; subsonic, transonic and supersonic turbines; exit flow conditions; and performance analysis of radial turbines: Thermodynamics and aerodynamics of radial turbines; radial turbine characteristics; losses and efficiency.

Unit – V **8 Hours**

Performance of axial flow compressor and turbine: Stage velocity diagrams, performance characteristics, instability in axial compressors, degree of reaction, losses and efficiency Construction details, multi-staging of turbine, turbine cooling. Construction of velocity triangles for different values of degree of reaction.

Self-learning topics: turbine cooling

	Books
	Text Books:
1.	S.M. Yahya, "Turbines, Compressors & Fans", Tata-McGraw Hill Co., 2nd Edition (2002),ISBN 13: 9780070707023.
2.	D.G. Shephered, "Principles of Turbo Machinery", The Macmillan Company (1964), ISBN-13:978-0024096609.
	Reference Books:
1.	V.Kadambi and Manohar Prasad, "An introduction to Energy conversion, Volume III, TurboMachinery ", Wiley Eastern Ltd. (1977), ISBN: 9780852264539.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. DhimanChatterjee , Prof. Shamit Bakshi, IIT Madras https://nptel.ac.in/courses/112/106/112106200/
2.	**NPTEL:** Online Resources: Lecture by: Prof. Bhaskar Roy , Prof. A M Pradeep, IIT Bombay https://nptel.ac.in/courses/101101058/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Compute** the energy transfer and energy transformation in turbo machines.	**L2**
2. **Analyse** the performance of turbo machine blades.	**L4**
3. **Apply** hydraulic pumps and turbines for specific requirements	**L3**
4. **Analyse** the performance of compressors	**L4**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment, Quiz
3. Working Models	3. Course Seminar
4. Videos	4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Aircraft Systems and Instruments

Course Code	18AE5515	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40Hrs; Tutorial = 0Hrs Total = 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand the different aircraft mechanical systems.
2. Learn various electronic instruments and systems.
3. Illustrate the operation of engine related and landing gear related systems.
4. Recognize flight instruments and navigation systems of flight.

Pre-requisites: Elements of Aeronautics

Unit – I **08 Hours**

Aircraft systems: Hydraulic systems, Study of typical systems, components, hydraulic systems controllers, modes of operation, pneumatic systems, working principles, typical pneumatic power system, brake system, components, landing gear systems, classification shock absorbers, retractive mechanism.

Unit – II **08 Hours**

Airplane control systems: Conventional Systems, power assisted and fully powered flight controls, power actuated systems, engine control systems, operating principles, modern control systems, digital fly by wire systems, auto pilot system, active control technology

Self-study: push pull rod system

Unit – III **08 Hours**

Engine systems: FADEC, Fuel systems, piston and jet engines: components, lubricating system, starting, ignition systems, multi-engine fuel systems.

Air conditioning and pressurizing system: Basic air cycle systems, vapour cycle systems, boot-strap air cycle system, evaporative vapour cycle systems, evaporation air cycle systems, oxygen systems, fire protection systems, deicing and anti-icing system

Unit – IV **08 Hours**

Aircraft Cockpit Instruments: Principle and working- Turn and slip indicator, Heading indicator, artificial horizon, Direction indicator, vertical speed indicator, attitude indicator, magnetic compass, variometer.

Unit – V **08 Hours**

Aircraft Instruments: Principle and working- Flight instruments and navigation instruments, accelerometers, air speed indicators, Mach meters, altimeters, principles and operation, various types of engine instruments, tachometers, temperature gauges, pressure gauge.

Books	
	Text Books:
1.	BaMekinley, J.L. and R.D. Bent, "Aircraft Power Plants", McGraw Hill 1993.ldev Raj, T. Jayakumar, M. Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2009.
2.	Treager, S., "Gas Turbine Technology", McGraw Hill 1997.
	Reference Books:
1.	E H J Pallet, “Aircraft instruments”, 2nd edition, Pearson, ISBN: 978-8131728130
2.	Mckinley, J.L. and Bent R.D. "Aircraft Maintenance & Repair", McGraw Hill,1993.

	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1	https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-885j-aircraft-systems-engineering-fall-2005/
2	https://www.cranfield.ac.uk/courses/short/transport-systems/safety-assessment-of-aircraft-systems

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Describe** various types of hydraulics systems and instruments	**L2**
2. **Illustrate** the various pneumatic systems.	**L2**
3. **Understand** various aircraft measurement systems.	**L2**
4. **Recognize** the operations of instruments used in aircraft.	**L2**
5. **Learn** the importance and need of various aircraft systems and instruments.	**L2**

Program Outcome of this course (POs)	PO No.
1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. Problem analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment
	3. Quiz&Case Study
	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	1	2	3	4	5
Marks	25	20	15	20	20

Wind Tunnel Techniques

Course Code	18AE5611	**Credits**	3
Course type	OE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Learn the basic concept of Wind tunnel and its principles
2. Understand the various types of wind tunnels and its functions
3. Acquire the knowledge of calibration and measurement techniques.
4. Learn the advanced types of wind tunnel.

Pre-requisites**:** Basic knowledge of Fluid Mechanics & Aerodynamics

Unit-I **07 Hours**

Introduction to Wind Tunnels &Principles of Model Testing, Wind Tunnels and its functional parts**,** Non dimensional numbers, Scale effect, Geometric Kinematic and Dynamic similarities.

Unit-II **08 Hours**

Types and Functions of Wind Tunnels**,**Classification and types special problems of testing in subsonic, transonic, supersonic and hypersonic speed regions Layouts

Unit-III **08 Hours**

Calibration of Wind Tunnels: Test section speed, Horizontal buoyancy, Flow angularities, Flow uniformity & turbulence measurements, Associated instrumentation – Calibration of subsonic & supersonic tunnels.

Unit-IV **09 Hours**

Conventional measurement techniques: Force measurements and measuring systems, Multi component internal and external balances, Pressure measurement system - Steady and Unsteady Pressure- single and multiple measurements - Velocity measurements, Intrusive and Non-intrusive methods, Particle image velocimetry.

Unit-V **08 Hours**

Advanced wind tunnel techniques Intake tests store carriage and separation tests, Unsteady force and pressure measurements, wind tunnel model design. Hot wire anemometer working and principles

Books	
	Text Books:
1.	Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", Krieger Pub Co (June 1, 1978), ISBN-13: 978-0882757278
2.	Rae, W.H. and Pope, A., "Low Speed Wind Tunnel Testing", Wiley India Pvt Ltd; Third edition (16 March 2010) ISBN-13: 978-8126525683
	Reference Books:
1.	NAL-UNI Lecture Series 12:" Experimental Aerodynamics", NAL SP 98 01 April 1998
2.	Lecture course on Advanced Flow diagnostic techniques 17-19 September 2008 NAL, Bangalore

	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. Prof. Job Kurian ,IIT Madras https://nptel.ac.in/courses/101106040/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Understand** the concepts of aerodynamics and types of wind tunnels**.**	**L1**
2. **Understand** the calibrations and its functions used in wind tunnels.	**L1**
3. **Understand** the different approaches of measurements**.**	**L1**
4. **Apply** the concept of aerodynamics in of advance wind tunnel.	**L2**

Program Outcome of this course (POs)	**PO No.**
1. **Engineering knowledge:**Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to the solution ofcomplex engineering problems.	**PO1**
2. 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.	**PO12**

Course delivery methods	**Assessment methods**
1. Chalk and board	1. Assignments
2. PPT	2. Quizzes
3.	3. IA tests
	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE: 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**25**	**20**	**15**	**20**	**20**

Metrology and Measurements

Course Code	18AE5612	**Credits**	3
Course type	OE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40Hrs; Tutorial = 0Hrs Total = 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand the different Measurement terminologies.
2. Learn various measurement instruments.
3. Illustrate the operation of various sensors and gauges.
4. Describe standards and comparators.

Unit – I **08Hours**

Introduction to Measurement System: Definition, Requirements and Significance of measurement system, Methods of measurements, Generalized measurement systems, Definition and basic concepts of Accuracy, Precision, Calibration, threshold, sensitivity, hysteresis, repeatability, linearity, System response, delay, Classifications of errors.

Transducers: Definition, Classifications of transducers, Mechanical transducers, Electrical transducers, piezo-electric transducers, Electronic transducers, amplifiers, rectifiers.

Self-learning topics: Errors in measuring instruments

Unit – II **08 Hours**

Measurement of Force, Torque and Pressure: Introduction, Analytical Balance, Platform Balance, Proving Ring, Types of Dynamometers, Mechanical Dynamometers, Hydraulic Dynamometers, Fan Brake Dynamometers, Electric Dynamometers – Eddy Current and DC Dynamometers, Mc Leod Gauge. The Bridgman Gauge, Thermal Conductivity Gages - Pirani Thermal Conductivity Gage, Thermocouple Vacuum Gage.

Unit – III **08Hours**

Temperature Measurements and Strain Gage: Introduction, Electrical Resistance thermometer, Thermoelectric Effects, Thermocouple, Laws of Thermocouples, Thermocouple materials and construction, Optical Pyrometers and Radiation Pyrometers.

Introduction, Mechanical Strain Gages, Optical Strain Gages, and Electrical Resistance Strain Gages and Piezo-resistive strain gages Preparation and Mounting of strain Gages, Gage Factor, Strain Measurement using wheat stone bridge, Calibration of Strain Gages.

Unit – IV **10 Hours**

Metrology Standards and Systems of Limits, Fits and Tolerances: Introduction, objectives of metrology, Standards of Length – International Proto type meter, Imperial Standard Yard, Subdivision of standards – Line Standard and End Standard, Slip Gauges, Wringing Phenomena, Indian Standards (M-81, M-112), Numerical Problems on Building of Slip Gages, GD&T.

Introduction, Need for Limit System, Definition of Limits, Concept of Limits of Size and Tolerance, Definition of Fit, Types of Fit and their designation, Special Types of Fit. Definition of Tolerance, Unilateral and Bilateral Tolerance, Concept of Interchangeability and Selective Assembly, Hole Basis System.

Self-learning topics: Wavelength standard, Calibration of End bars, Shaft Basis System

06 Hours

Unit – V

Comparators: Introduction, Characteristics, Classifications of Comparators, Mechanical Comparators – Johansson Microkator Comparators, Sigma Comparators, Dial Indicator, Optical Comparators – Zeiss Ultra Comparators, LVDT, Pneumatic Comparators, Back Pressure Comparators, Solex Gages.

Books	
	Text Books:
1.	Beckwith Marangoni and Lienhard, **"**Mechanical measurements", Pearson Education, 6th Ed., 2006.
2.	R.K. Jain , "Engineering Metrology", Khanna Publishers, 1994
	Reference Books:
1.	I.C. Gupta**, "**Engineering Metrology", DhanpatRai Publications, Delhi.
2.	Ernest O, Doblin, "Measurement Systems Applications and Design", Mc GRAW Hill Book Co.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://swayam.gov.in/nd1_noc19_me70/preview
2.	https://www.mooc-list.com/tags/metrology

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Compare** various terminologies and standards.	**L2**
2. **Describe** the various transducers and instruments.	**L2**
3. **Illustrate** various sensors and tolerances.	**L2**
4. **Understand** the operations of comparators and gauges.	**L2**

Program Outcome of this course (POs)	PO No.
1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**
3. 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.	**PO12**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment
3.	3. Quiz&Case Study
4.	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**25**	**15**

Course Code	18AE5613	**Credits**	3
Course type	OE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs; Tutorial = 0 Hrs Total = 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand the different types of composite materials and methods.
2. Learn different approaches of mechanics for every material.
3. Understand mathematical governing equations and failure criteria.
4. Apply their knowledge in sandwich composite constructions.
5. Learn fabrication processes for different conditions of composite preparations.

Unit – I **8 Hours**

Stress Strain Relations: Introduction- Advantages and application of composite materials, reinforcements and matrix - Generalized Hook's Law, Hook's law for 2D and 3D material- Elastic constants for anisotropic, orthotropic and isotropic materials.

Unit – II **8 Hours**

Fabrication Process: Various types of Open and closed mould processes and process variables, Manufacture of fibers - Types of resins and properties and applications - Netting analysis.

Unit – III **8 Hours**

Methods of Analysis: Micro mechanics - Mechanics of materials approach, elasticity approach to determine material properties - Macro Mechanics - Stress-strain relations with respect to neutral axis, arbitrary axis - Determination of material properties. Experimental characterization of lamina.

Self-learning topics: Experimental characterization of lamina.

Unit – IV **8 Hours**

Metal Matrix composites and ceramic matrix composites: Material properties and applications, various types of composites, governing differential equation and stress strain relation, failure modes.

Unit – V **8 Hours**

Sandwich Constructions: Basic design concepts of sandwich construction -Materials used for sandwich construction – maximum stress and maximum strain types of Failure modes in sandwich panels. Laminated Plates: Governing differential equation for a general laminate, angle ply and cross ply laminates. Failure criteria for composites.

Self-learning topics: Tsai Hill failure theory, Tsai Wu failure theory

Books	
	Text Books:
1.	A K Kaw, "Mechanics of Composite Materials" Taylors and Francis.
2.	Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites", John Wiley and sons. Inc., New York, 1995.
	Reference Books:
1.	Jones, R.M., "Mechanics of Composite Materials", McGraw-Hill, Kogakusha Ltd.,

	Tokyo, 1915.
2.	Calcote, L R. "The Analysis of laminated Composite Structures" Von - Noastrand Reinhold Company, New York 1991.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof.Nachiketa Tiwari, IIT Kanpur https://nptel.ac.in/courses/112104229/
2.	**NPTEL:** Online Resources: Lecture by: Prof. P M Mohite, IIT Kanpur https://nptel.ac.in/courses/101104010/

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Describe** various types of composite materials used in Aeronautical industries.	**L2**
2.	**Summarize** the process of composite material preparations.	**L2**
3.	**Apply** mechanics approach for analyzing the composite material.	**L3**
4.	**Utilize** mathematical equations estimating the composite material properties.	**L3**
5.	**Apply** the material and manufacturing knowledge in fabrication process of composite material.	**L3**

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2.	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**

Course delivery methods	**Assessment methods**
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment, Quiz
3. Working Models	3. Course Seminar
4. Videos	4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.

2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Aerodynamics Laboratory-II

Course Code	18AEL56	**Credits**	1.5
Course type	PC	**CIE Marks**	25 marks
Hours/week: L-T-P	0-0-3	**SEE Marks**	25 marks
Total Hours:	36	**SEE Duration**	3 Hours for 50 marks

Course learning objectives

Enable students to

1. Understand the basics of aerodynamics and study of wind tunnel Techniques.
2. Understand the flow visualization techniques on various models.
3. Acquire the knowledge on drag force calculations by probe wake survey methods.
4. Calculate the various loads on airfoil by making some arrangements
5. Understand the measurements used in wind tunnel.

Pre-requisites: Basic knowledge of Fluid Mechanics & Aerodynamics

List of experiments

1. Calculation of total drag of a two-dimensional Flat plate and cylinder at low speeds using pitot-static probe wake survey.
2. Calculation of total drag of a two-dimensional symmetric and cambered airfoil at low speeds using pitot-static probe wake survey.
3. Calculation of total drag of tapered wing at low speeds using pitot-static probe wake survey.
4. Estimation of drag over streamlined body by force balance method.
5. Study of the characteristics of three dimensional airfoil involving measurement of lift, drag, pitching moment using force balance method**.**
6. Measurement of the Velocity profile on smooth and rough plates using projection Manometer
7. Smoke flow visualization studies on a two dimensional multi element airfoil with flaps and slats at different angles of incidence at low speeds
8. Calculation of aerodynamic coefficients forces acting on a model aircraft using force balance at various speed.
9. Calculation of aerodynamic coefficients forces acting on a model aircraft using force balance at various angles of incidence (AoA and Yaw Angle)

	Books
	Text Books:
1.	Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", John Wiley, 1985.
2.	Fundamental of Aerodynamics Anderson J.D. Jr,-, Mcgraw-Hill, New York.
3.	Manual of Dept of Aeronautical Engineering

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Understand** the knowledge of various wind tunnel measurements.	**L2**
2. **Analyze** the various engineering field problems related to Aerodynamics	**L3**
3. **Execute** the design parameter related to the air flow	**L4**

Program Outcome of this course (POs)	**PO No.**
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**

2. **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences. **PO2**
3. **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. **PO4**
4. **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. **PO5**
5. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings. **PO9**
6. **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. **PO12**

Course delivery methods	**Assessment methods**
1. Chalk and board	1. Conduct of experiments
2. PPT	2. Journal write up
	3. Viva-voce

Scheme of Continuous Internal Evaluation (CIE):

Components	Conduct of the lab	Journal submission	Mini Project	Total Marks
Maximum Marks: 25	10	10	5	25
➢ Submission and certification of lab journal is compulsory to qualify for SEE. ➢ **Minimum marks required to qualify for SEE : 10**				

Scheme of Semester End Examination (SEE):

1. It will be conducted for 50 marks of 3 hours duration**. It will be reduced to 25 marks for the calculation of SGPA and CGPA.** Single Experiment to be conducted in SEE.
2. **Minimum marks required in SEE to pass:20**
3.

Initial write up	10 marks	
Conduct of experiment	20 marks	**50** marks
Viva- voce	10 marks	
Quiz	10 marks	

Aircraft Propulsion lab-1

Course Code	18AEL57	**Credits**	1.5
Course type	PC	**CIE Marks**	25 marks
Hours/week: L-T-P	0-0-3	**SEE Marks**	25 marks
Total Hours:	36	**SEE Duration**	3 Hours for 50 marks

Course learning objectives

Enable students to

1. Understand the flame lift off and blow off phenomenon for different air fuel mixture
2. Study the performance characteristics of IC engines
3. Find out the calorific value of different fuels using bombs calorimeter
4. Find out the viscosity of lubricating oil using different apparatus
5. Determine the natural and forced heat transfer coefficient

Pre-requisites : Engineering thermodynamics

List of experiments

1. Study of the flame lift off and blow off phenomenon for various air/fuel ratio premixed flame.
2. Performance characteristics of diesel engine working on mechanical loading
3. Performance characteristics and Heat Balance sheet on twin engine.
4. Calculation of calorific value of solid and liquid fuel using digital bomb calorimeter
5. Determination of Viscosity of a lubricating oil using Redwoods Viscometers
6. Determination of Viscosity of a lubricating oil using Saybolts Viscometers
7. Flash and fire point using different apparatus cleave land and pensky martin apparatus
8. Study of simplex type of fuel injection characteristics
9. Determine the free convection heat transfer coefficient from the surface of the aerofoil in both vertical and horizontal position
10. Determine the convective heat transfer coefficient in forced convection on a flat plate

Books	
	Text Books:
1.	Claus Borgnakke, Richard Sonntag, "Fundamentals of thermodynamics", 7th edition, John Wiley & sons 2009. ISBN-13: 978-8126521524
2.	Bhaskar Roy, "Aircraft propulsion", Elsevier (2011), ISBN-13: 9788131214213
3.	V. Ganesan, "Gas Turbines", Tata McGraw-Hill, 2010, New Delhi, India, ISBN: 0070681929, 978007068192
	E-Recourses
1.	**NPTEL:** Online Resources: Lecture by: Prof. Pradip Dutta, IISc Bangalore https://nptel.ac.in/courses/112108149/
2.	**NPTEL:** Online Resources: Lecture by: Prof. Pranab Kumar Mondal , IIT Guwahati https://nptel.ac.in/courses/112/103/112103262/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Analyze** the fuel injection characteristics	**L4**
2. **Analyze** the free and forced convective heat transfer	**L4**
3. **Determine** the performance characteristics of diesel engine working on	**L3**

mechanical loading and twin cylinder engine

4. **Determine** viscosity of given fuel using different apparatus **L3**
5. **Understand** the flame lift and blow off for different air fuel mixture **L4**
6. **Analyze** the free and forced convective heat transfer **L4**

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2.	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
3.	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	**PO9**
4.	**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.	**PO12**

Assessment methods

1. Conduct of Experiment
2. Journal evaluation/assessment
3. Open ended experiments
4. Viva-voce

Scheme of Continuous Internal Evaluation (CIE):

Components	Conduct of the lab	Journal submission	Mini Project	Total Marks
Maximum Marks: 25	10	10	5	25
➢ Submission and certification of lab journal is compulsory to qualify for SEE. ➢ **Minimum marks required to qualify for SEE : 10**				

Scheme of Semester End Examination (SEE):

1. It will be conducted for 50 marks of 3 hours duration**. It will be reduced to 25 marks for the calculation of SGPA and CGPA.** Single Experiment to be conducted in SEE.
2. **Minimum marks required in SEE to pass:20**
3.

Initial write up	10 marks	
Conduct of experiment	20 marks	**50** marks
Viva- voce	10 marks	
Quiz	10 marks	

Communicative English(Only for Diploma students)

Course Code	18AE59	**Credits**	--
Course type	HS	**CIE Marks**	25 marks
Hours/week: L-T-P	MNC	**SEE Marks**	--
Total Hours:	Lecture = 30 Hrs; Tutorial = 0 Hrs Total = 30Hrs	**SEE Duration**	--

Course learning objectives

Enable students to

1. **Assist** the students in developing necessary language skills in the areas like vocabulary, grammar, presentation and interactive communication.
2. **Enable** them to express their ideas coherently.
3. **Help to comprehend** and write effectively.
4. **Aid them in understanding** the importance of verbal and non-verbal communication.

Pre-requisites : Basic knowledge of English Language, Conversant with Basic English Grammar, Ability to frame sentence in English

Unit – I Grammar and Vocabulary 05 Hours

Frame grammatically acceptable sentences using Articles, Prepositions, Tenses, Modals and Subject-Verb agreement.

Enhance day to day general vocabulary and business vocabulary using every day words, appropriate collective nouns, idioms, phrases and phrasal verbs.

Self learning topics: Improve vocabulary by reading.

Unit – II Reading Skills 05 Hours

Comprehend and interpret the texts such as notices, advertisements, memos, emails, charts etc. using reading techniques like skimming and scanning.

Using the knowledge of Phonetics to identify the right pronunciation from a dictionary.

Reading to enrich work place / business vocabulary.

Self-learning topics: Solve reading assignments from Cambridge Business BENCHMARK Pre-intermediate to Intermediate.

Unit – III Listening Skills 07 Hours

Interpret recorded audio-video scripts in order to pick specific information in a short extract.

Listening exercises to understand factual information like dates, prices, telephone numbers etc.

Listening for gist (general meaning) to understand the speaker's opinions and pick out the specific information.

Self learning topics: Solve listening exercises from www.cambridge.org and www.businessenglishsite.com.

Unit – IV Speaking Skills 08 Hours

Interact effectively as an individual and also as a member in a team using correct grammar using wide range of vocabulary and avoiding common errors in English.

Design and formulate presentations using Microsoft PowerPoint and Non-Verbal communication cues (Kinesics, Proxemics, Chronemics and Paralinguistic).

Speak in a logical way and speak for the right amount of time with proper pronunciation on general topics and business topics.

Self-learning topics: Self evaluation by recording their speech.

Unit – V Writing Skills **05 Hours**

Write Business Letters, Emails, Memos and Notes using British English Standards/Etiquettes. Writing skills using appropriate registers (formal and informal), correct grammar, correct spelling, vocabulary, linking words and phrases.

Self learning topics: Practice e-mail, memos, and report writing.

Books	
	Text Books:
1.	Prof. M.B. Kudari, "Passage to English" Self Publication, Gokak, 2011.
2.	T. M. Farhathulla, "Communication Skills for Undergraduates" - RBA-Chennai, 2006.
	Reference Books:
1.	K.R. Lakshminarayanan, "English for Technical Communication", Scitech-Chennai, 2002.
2.	Prof. G.S. Mudambadithya, "Functional English", Sapana- Bangalore,
3.	Norman Whitby, "Cambridge English Business Benchmark", Cambridge University Press, 3rd Printing 2014.

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Define** various grammatical concepts such as Articles, Prepositions, Subject-Verb Agreement, and Tenses.	**L1**
2.	**Explain** their ideas in their own words in English.	**L2**
3.	**Interpret** the given information or data in the form of reading or listening materials.	**L3**
4.	**Distinguish** among the various grammatical concepts like sentence patterns, sub-verb agreement, tenses etc.	**L4**
5.	**Evaluate** the grammatically acceptable sentences, and **Defend** their view-points.	**L5**
6.	**Design** and **Formulate** oral and written presentations.	**L6**

	Program Outcome of this course (POs)	**PO No.**
1.	**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.	**PO10**
2.	**Life-long learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	**PO12**

Course delivery methods	**Assessment methods**
1. Lecture	1. Individual speech
2. Learnsoft Software	2. PPT (Group activity)
3. PPT	3. Writing assignment
4. Vocabulary activities/games/videos	4. Online Quiz

Scheme of Continuous Internal Evaluation (CIE):

Components	**Individual activity - Speech**	**Group Activity – Power Point Presentation**	**Writing Skills – email/memo/letters**	**Class Performance (Attendance)**	**Online Test**	**Total**

Maximum Marks (25)	5	15	10	5	15	50

Continuous Internal Evaluation (CIE) is of 50 marks. It will be reduced to 25 marks for the calculation of SGPA and CGPA.

Syllabus of 6th Semester

Gas Turbine Technology

Course Code	18AE61	**Credits**	4
Course type	PC	**CIE Marks**	50 marks
Hours/week: L-T-P	4-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 50Hrs; Tutorial = 0Hrs Total = 50Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Comprehend the types of engines and its applications.
2. Understand the materials required for engine manufacturing.
3. Impart the knowledge of general engine performance
4. Learn the testing and performance evolution of specific engine components
5. Illustrate the concept of engine testing with different types testing methods

Pre-requisites: Aircraft Propulsion

Unit – I 09Hours

Types, Variation & Applications: Operating parameters. Energy distribution of turbojet, turboprop and turbofan engines. Comparison of thrust and specific fuel consumption. Thrust, pressure and velocity diagrams. Engine Parts: Compressor assembly, types of burners: advantages and disadvantages. Influence of design factors on burner performance. Effect of operating variables on burner performance. Performance requirements of combustion chambers. Construction of nozzles. Impulse turbine and reaction turbine. Exhaust system, sound suppression. Thrust reversal: design & systems. Methods of thrust augmentation, after burner system.

Self-learning topics: Types of engines showing arrangement of parts, Thrust reversal: types

Unit – II 09Hours

Materials and Manufacturing: Criteria for selection of materials. Heat ranges of metals, high temperature strength. Surface finishing. Powder metallurgy. Use of composites and Ceramics. Super alloys for Turbines. Systems: Fuel systems and components. Sensors and Controls. FADEC interface with engine. Typical fuel system. Oil system components. Typical oil system. Starting systems. Typical starting characteristics. Various gas turbine starters.

Unit – III 12Hours

Engine Performance: Design & off - design Performance. Surge margin requirements, surge margin stack up. Transient performance. Qualitative characteristics quantities. Transient working lines. Starting process& Wind milling of Engines. Thrust engine start envelope. Starting torque and speed requirements Calculations for design and off design performance from given test data– (case study for a single shaft Jet Engine).Engine performance monitoring.

Unit – IV 11 Hours

Compressor: Compressor MAP. Surge margin, Inlet distortions. Testing and Performance Evaluation. Combustor: Combustor MAP, Pressure loss, combustion light up test. Testing and Performance Evaluation. Turbines: Turbine MAP. Turbine Testing and Performance Evaluation. Inlet duct & nozzles: Ram pressure recovery of inlet duct. Propelling nozzles, after burner, maximum mass flow conditions. Testing and Performance Evaluation

Unit – V 09 Hours

Engine Testing: Proof of Concepts: Design Evaluation tests. Structural Integrity. Environmental Ingestion Capability. Preliminary Flight Rating Test, Qualification Test, Acceptance Test. Reliability figure of merit. Durability and Life Assessment Tests, Reliability Tests. Engine testing with simulated inlet distortions and, surge test. Estimating engine operating

limits. Types of engine testing's: Normally Aspirated Testing, Open Air Test Bed, Ram Air Testing, Altitude Testing, Altitude test facility, Flying Test Bed, Ground Testing of Engine Installed in Aircraft, Flight testing.

Self-learning topics: Methods of displacing equilibrium lines.

	Books
	Text Books:
1.	Irwin E. Treager, 'Gas Turbine Engine Technology ', Mc Graw Hill Education,3rd edition, 2013, ISBN-13: 978-1259064876
2.	P.P Walsh and P. Peletcher, 'Gas Turbine Performance' Blackwell Science, 1998, ISBN0632047843.
	Reference Books:
1.	J P Holman, 'Experimental methods for Engineers ', Tata Mc Graw Hill,7th edition,2007, ISBN13: 978-0070647763
2.	Michael J.Kores, and Thomas W.Wild ,' Aircraft Power Plant', GLENCOE Aviation Technology Series, 7th Edition, Tata Mc Graw Hill Publishing Co.Ltd.2002
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1	**NPTEL:** Online Resources: Lecture by: Prof. Pranab Mondal, IIT Guwahati https://nptel.ac.in/courses/112103262/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Identify** the types of engines and describe their applications	**L1**
2. **Select** the suitable materials for engine manufacturing.	**L3**
3. **Evaluate** the performance of the engine.	**L4**
4. **Evaluate** the performance of specific engine components	**L4**
5. **Test** the engine using several types of engine testing methods.	**L3**

Program Outcome of this course (POs)	**PO No.**
1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
3. **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.	**PO3**

Course delivery methods	**Assessment methods**
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment / Case Study
3.	3. Quiz
4.	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory.				

It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**18**	**18**	**24**	**22**	**18**

Aircraft Structures II

Course Code	18AE62	**Credits**	4
Course type	PC	**CIE Marks**	50 marks
Hours/week: L-T-P	4-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture =50 Hrs; Tutorial = 0 Hrs Total = 50 Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand the different components of an aircraft and loads acting on them
2. Enhance their knowledge on Bending and Shear flow in sections
3. Know the buckling of plates and crippling stress methods
4. Conduct the stress analysis of wing and fuselage
5. Design the aircraft structure and study Joints and Fittings

Pre-requisites: Aircraft Structures, Mechanics of Materials

Unit – I **10 Hours**

Introduction to Aircraft Structural Design and Unsymmetrical Bending: Structural layout of the Airplane and Components, Concepts of allowable stress and margin of safety. Bending Stress in beams of unsymmetrical sections-Bending of symmetric sections with skew loads, Numericals.

Self-learning topics: loads acting on major components, V-n diagram

Unit – II **10 Hours**

Shear flow in Open and Closed Sections: Thin walled beams, shear flow, shear center, Elastic axis, unsymmetrical bending sections, Bredt-Batho formula, approximate methods, shear flow in multi-cell structures under torsion and under bending with walls effective, Numericals.

Unit – III **10 Hours**

Stress Analysis in Wing and Fuselage: Procedure- shear and bending moment distribution for semi cantilever types of wings and fuselage, thin webbed beam. With parallel and non-parallel flanges, shear resistant web beams, tension field web beams (Wagner's), Numericals.

Unit – IV **10 Hours**

Design of Aircraft Structures: Design Criteria, safety Factor, Analysis Method, Life Assessment Procedures, Design principle, future airworthiness requirements, two bay crack criteria, wide spread fatigue damage, Numericals.

Self-learning topics: Design life criteria

Unit – V **10 Hours**

Buckling of Plates, Joints and Post Buckling: Local buckling stress of thin walled section, crippling stress by Needham's and Gerard's methods, thin walled column strength, sheet stiffener panels, General theory for design of fittings, design of riveted, bolted, welding joints, Numericals.

Books	
	Text Books:
1.	Megson, T.M.G., "Aircraft Structures for Engineering Students"' Elsevier India (2005), ISBN-13: 978-9382291053.
2.	Peery, D.J., and Azar, J.J., "Aircraft Structures", McGraw Hill Education (23 December 2013), ISBN-13: 978-9332902602.
	Reference Books:
1.	Bruhn. E.H. "Analysis and Design of Flight vehicles Structures", Tri-state off set

	company, USA, 1985.
2.	Rivello, R. M., "Theory and Analysis of Flight Structures", McGraw Hill, 1993.
3.	D Williams & Edward Arnold, "An Introduction to the Theory of Aircraft Structures".
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/101105022/: Aircraft Structural Dynamics course at IIT Kharagpur

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Understand** the loads acting on the structural component of Aircraft	**L2**
2. **Solve** the numerical consisting bending, torsion and buckling phenomena	**L3**
3. **Analyze** the design aspects of wing and fuselage for various types of loads	**L4**
4. **Analyze** the aircraft structural design considering safety factor, airworthiness and life assessment procedure	**L4**
5. **Apply** different analyzing methods and formulas for different aircraft structures	**L3**
6. **Select** fastening methods used for various types of loads in aircraft structures	**L4**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**
3. **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	**PO3**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment
	3. Quiz & Case Study
	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

AIRCRAFT STABILITY & CONTROL

Course Code	18AE63	**Credits**	4
Course type	PC	**CIE Marks**	50 marks
Hours/week: L-T-P	4-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 50 Hrs; Tutorial = 0 Hrs Total = 50 Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Analyze the moments and forces in aircraft stability and the trimming required
2. Explain the static stability of an aircraft in all the three dimensions
3. Understand the dynamic stability of a typical aircraft
4. Estimate the dynamic stability derivative
5. Describe the different aircraft components and the principles of aircraft stability

Unit – I **10 Hours**

Static Stability: Historical perspective, equilibrium condition, static stability, longitudinal static stability, stability criteria, contribution of airframe components, wing contribution, tail contribution, fuselage contribution, power effects- propeller airplane and jet airplane.

Unit – II **10 Hours**

Static Longitudinal Stability and Control Stick Fixed: Introduction, trim condition, static margin, stick fixed neutral points, longitudinal control, elevator power, elevator required for landing, restriction on forward C.G. and aft C.G., Hinge moment parameters, estimation of hinge moment, trim tabs, stick force gradient in unaccelerated flight, Numericals.

Self-learning topics: neutral point, Aerodynamic balance.

Unit – III **10 Hours**

Static Directional and Lateral Stability and Control: Introduction, Definition of directional and roll stability, static directional stability rudder fixed, estimation of dihedral effect, wing sweep, flaps and power, balancing the aileron, contribution of airframe components, directional control, rudder power, stick-free directional stability, requirements for directional control, rudder lock, Dorsal fin, in operation condition, weather cocking effect, coupling between rolling and yawing moments, adverse yaw effects, Numericals.

Self-learning topics: Aileron reversal

Unit – IV **10 Hours**

Dynamic Lateral, Longitudinal and Directional Stability: dynamic longitudinal stability, types of modes of motion, airplane equation for longitudinal motion, derivation of rigid body equation, orientation of position of plane, small disturbance theory, Routh's criteria, factors affecting period and damping of oscillations, effects of wind shear, flying qualities in pitch, cooper Harper scale, aileron step function response, Dutch roll and spiral instability, Auto-rotation and spin, roll-pitch-yaw inertial coupling, simple Numericals.

Self-learning topics: Small disturbance theory, effect of wing sweep

Unit – V **10 Hours**

Estimation of Dynamic Derivatives: Aerodynamic force and moment representation, derivatives due to change in forward speed, pitching velocity, time rate of change of angle of attack, rolling rate and due to yawing rate. Significance of aerodynamic derivatives with case study. flight dynamic phenomena of the low-angle-of-attack F-18 model

Books

	Text Books:
1.	Nelson R. C., "Flight Stability and Automatic Control", McGraw Hill Education; 2 edition (1 July 2017), ISBN-13: 978-0070661103.
2.	Perkins, C. D., and hage, R. E., "Airplane performance stability and control", John Wiley & Sons (1 January 1966), ISBN-13: 978-0471680468.
	Reference Books:
1.	Bernard Etkin, "Dynamics of flight stability and control", John Wiley and Sons, Second edition, 1982.
2.	Bandu N. Pamadi, "Performance Stability, Dynamics and Control of Airplanes", AIAA, 2004.
3.	Barnes W. McMormick, "Aerodynamics, Aeronautics and Flight Mechanics", John Wiley & Sons, Inc. 1995.
4.	Nandan K. Sinha and N. Ananthkrishnan "Advanced Flight Dynamics with Elements of Flight Control" CRC Press 2017.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. E G Tulapurkara, IIT Madras https://nptel.ac.in/courses/101106043/
2.	**NPTEL:** Online Resources: Lecture by: Prof. A K Ghosh, IIT Kanpur https://nptel.ac.in/courses/101104062/

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Describe** the necessity of stability for dynamic systems like Aircraft.	**L2**
2.	**Apply** the rigid body dynamics to aircraft for representing aircraft in mathematical model.	**L3**
3.	**Calculate** the control surfaces control power for different aircraft configurations.	**L3**
4.	**Estimate** the longitudinal and directional parameters with the help of the linearzed equations of aircraft motion.	**L4**
5.	**Analyze** the different type of modes in longitudinal, lateral and directional motion of aircraft, and recovery from those modes.	**L4**

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2.	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
3.	**Design/ Development 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.	**PO3**

Course delivery methods	**Assessment methods**
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment, Quiz
3. Working Models	3. Course Seminar
4. Videos	4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Course Code	18AE6411	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs, Tutorial = 0 Hrs Total=40 Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand the maintenance, repair and overhaul process.
2. Learn different departments merged to function as maintenance team.
3. Recognize different types of checks, components and computer network.
4. Study assembly and rigging process of aircraft components.
5. Learn safety measures of aircrafts and inspection process.

Pre-requisites: Elements of Aeronautics

Unit – I **07 Hours**

Introduction: Rules and Regulation of Civil Aviation, Federal Aviation Administration, Zones of aircraft, Soft life components, Hard Time Components, consumables.

Self-learning topics: FAA chapters

Unit – II **09 Hours**

Maintenance Team and Checks: Maintenance departments: Planning, Logistics, Quality, Tech Service, ground maintenance team, line maintenance team. Aircraft Maintenance operating system, Checks: A-type, B-type, C-type and D-type

Unit – III **08 Hours**

Aircraft Jacking, Assembly and Rigging Airplane jacking and weighing, Balancing of control surfaces – Inspection maintenance. Helicopter flight controls. Tracking and balancing of main rotor.

Self-learning topics: C.G location

Unit – IV **08 Hours**

Review of Hydraulic and Pneumatic System Trouble shooting and maintenance practices – Service and inspection. – Inspection and maintenance of landing gear systems. – Inspection and maintenance of air-conditioning and pressurization system, water and waste system. Installation and maintenance of Instruments – handling – Testing – Inspection.

Unit – V **08 Hours**

Inspection And Maintenance Of Auxilary Systems: Inspection and maintenance of auxiliary systems – Fire protection systems – Ice protection system – Rain removal system – Position and warning system – Auxiliary Power Units (APUs), Safety Practices Hazardous materials storage and handling, Aircraft furnishing practices –Equipments. Troubleshooting - Theory and practices.

Books	
	Text Books:
1.	Kroes, Watkins, Delp, “Aircraft Maintenance and Repair”, Mcgraw-Hill, New York 1992.
2.	Brimm D.J. Bogges H.E., “Aircraft Maintenance”, Pitman Publishing Corp. New York, 1940.
	Reference Books:
1.	Larry Reithmeir, “Aircraft Repair Manual”, Palamar Books, Marquette, 1992
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links

1	**NPTEL:** Online Resources: Lecture by: Prof. Vipul Mathur, IIT Kanpur https://nptel.ac.in/courses/101104071/3

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Describe** the maintenance procedure.	**L2**
2. **Illustrate** the major zones of aircrafts and components.	**L2**
3. **Compare** the different types of checks and their importance.	**L2**
4. **Understand** safety practice, inspection and assembly procedure.	**L2**

	Program Outcome of this course (POs)	**PO No.**
1.	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2.	Problem analysis: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**
3.	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.	**PO12**

Course delivery methods	**Assessment methods**
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment
	3. Quiz & Case Study
	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**18**	**22**	**20**	**20**	**20**

Non Destructive Testing

Course Code	18AE6412	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs; Tutorial = 0 Hrs Total = 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand the different non-destructive methods.
2. Learn non-intrusive type of non-destructive methods.
3. Illustrate the Optical and electrical type of methods and their applications.
4. Compare particular type of method for appropriate materials.

Pre-requisites: Elements of Aeronautics, Aircraft material and Processes

Unit – I **08 Hours**

Overview: Introduction, NDT vs. Mechanical testing, NDT for detection of manufacturing defects, material characterization, visual inspections aided and unaided, types of dye and method of application.

Unit – II **08 Hours**

Surface NDE Methods: Liquid Penetrant Testing, types and properties of liquids, advantages and limitations of various methods, results interpretation, Magnetic particle testing, inspection in Magnetization methods, principles and methods of demagnetization, residual magnetism.

Self-learningtopics: Field indicators, magnetism theory.

Unit – III **08 Hours**

Thermography and Eddy current Testing: principles, contact and non-contact inspection methods, liquid crystals applications, infrared radiation and detection, Faraday's Law, Lenz's law, generation & property of eddy current, sensing element, probes, instrumentations and arrangements, advantages and limitations, interpretation

Unit – IV **08 Hours**

Ultrasonic testing and Acoustics: basics of ultrasonic waves, pulse and beam shapes, Principle, transducers, transmission and pulse echo methods, straight beam and angle beam, instrumentation and data representation, phased array ultrasound, acoustic emission techniques, principles and application, Kaiser-Felicity theory

Self-learningtopics: Time of flight diffraction

Unit – V **08 Hours**

Radiography: Principle, Interaction of X-ray with matter and properties, X-ray absorption and scattering, Imaging, Filmless techniques, filters and screens, geometric factor, inverse square law, Characteristics of films, Fluoroscopy, zero-radiography, computed radiography, computed tomography

Books	
	Text Books:
1.	Joseph R Davis et al, "Non-destructive evaluation and quality control", vol. 17, ASM International, 9th edition, ISBN: 978-0871700230
2.	Ravi Prakash, "Non-Destructive Testing Techniques", 1st Revised Edition, New Age International Publishers, 2010
	Reference Books:
1.	Paul E Mix, "Introduction To Non-Destructive Testing: A Training Guide", Wiley, 2nd Edition New Jersey, 2005

2.	Louis Cartz, "Non Destructive Testing", ASM International.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1	https://nptel.ac.in/courses/113106070/: Theory and practice of Non-destructive Testing course at IIT Madras by Ranjit Bauri.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Describe** various types of Non-destructive techniques.	**L2**
2. **Compare** the various NDTs used in Aeronautical Industries.	**L2**
3. **Illustrate** mechanical, electrical and optical types of NDTs.	**L2**
4. **Explain** the nonintrusive type of NDTs.	**L2**
5. **Understand** the basic principles in calibration of destructive methods.	**L2**
6. **Select** appropriate techniques for fault/ defects detection.	**L3**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment
3.	3. Quiz & Case Study
4.	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

FLIGHT TESTING

Course Code	18AE6413	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs; Tutorial = 0 Hrs Total = 40 Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Comprehend the basic concepts of flight test instrumentation.
2. Impart the knowledge of performance flight testing and stability control.
3. Impart the knowledge of stability control of flight in different method
4. Understand the flying qualities and hazardous flight testing

Unit – I 08 Hours

Introduction: Sequence, Planning and governing regulations of flight testing. 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. Flight test instrumentation: Planning flight test instrumentation, Measurement of flight parameters. Onboard and ground based data acquisition system. Radio telemetry.

Unit – II 08 Hours

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. Estimation of range, endurance and climb performance. Performance flight testing - take-off, landing, turning flight: Maneuvering performance estimation. Take-off and landing methods, procedures and data reduction

Self-learning topics: Take-off and landing methods, procedures and data reduction

Unit – III 08 Hours

Stability and control - longitudinal and maneuvering: Static & dynamic longitudinal stability: - methods of flight testing and data reduction techniques. Stick free stability methods. Maneuvering stability methods & data reduction.

Unit – IV 08 Hours

Stability and control - lateral and directional: Lateral and directional static & dynamic stability: - Coupling between rolling and yawing moments. Steady heading slide slip. Definition of Roll stability. Adverse yaw effects. Aileron reversal. Regulations, test techniques and method of data reduction.

Self-learning topics: test techniques and method of data reduction

Unit – V 08 Hours

Flying qualities: MIL and FAR regulations. Cooper-Harper scale Pilot Rating. Flight test procedures. Hazardous flight testing: Stall and spin- regulations, test and recovery techniques. Test techniques for flutter, vibration and buffeting.

Case study: Simulate the Flight tests to estimate stick free and fixed, neutral and maneuvering points, Static Longitudinal, Lateral and Directional Stability derivatives.

Books	
	Text Books:
1.	Ralph D Kimberlin, Flight Testing of Fixed Wing Aircraft, AIAA educational Series, 2003.
2.	Benson Hamlin, Flight Testing- Conventional and Jet Propelled Airplanes, Mac Millan,1946.
	Reference Books:
1.	AGARD, Flight Test Manual Vol. I to IV
2.	A.J. Keane, A. Sobester, Small Unmanned fixed-wing Aircraft Design, Wiley, 2017
3.	A. Filippone, Flight Performance of Fixed and Rotary Wing Aircraft, AIAA Series, 2006.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by:
2.	**NPTEL:** Online Resources: Lecture by:

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Measure** the flight parameters.	**L1**
2. **Estimate** the performance of flight.	**L2**
3. **Describe** the stability control of flight in different directions	**L2**
4. **Apply** the FAR regulations and rate the pilot	**L3**
5. **Describe** hazardous flight testing techniques	**L2**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2. **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment, Quiz
3. Working Models	3. Course Seminar
4. Videos	4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Course Code	18AE6414	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives

Enable students to

1. **Apply** the thermodynamics laws for heat and mass transfer.
2. **Understand** the conduction process
3. **Understand** the concept of free convection and forced convection over plates and pipes
4. **Gain** the knowledge of heat transfer through radiation
5. **Gain** the knowledge of heat transfer problems in combustion chambers.

Unit – I 08 Hours

Conduction: Different modes of heat transfer and mass and momentum transfer, General Differential Equation of Heat Conduction, Cartesian And Polar Coordinates, One Dimensional Steady State Heat Conduction, Plane And Composite Systems – heat transfer through composite structures, Concept of the critical radius.

Unit – II 08 Hours

Convection: Concepts of Continuity, Momentum and Energy Equations. Application for developing non-dimensional correlation for convective heat transfer. Free Convection**:** Development of Hydrodynamic and thermal boundary layer along a vertical plate.

Unit – III 08 Hours

Forced Convection: External Flows, Concepts of hydrodynamic and thermal boundary layer and use of empirical correlations for Flat plates and Cylinders.

Unit – IV 08 Hours

Radiation Heat Transfer: Emission characteristics, Laws of black-body radiation, Irradiation, Total and Monochromatic quantities, Laws of Planck, Wien, Kirchhoff, Lambert, Stefan and Boltzmann, Heat exchange between two black bodies. Radiation Heat Transfer in Space Engineering

Unit – V 08 Hours

Heat and Mass Transfer Problems in Aerospace Engineering: Aerodynamic heating, Ablative heat transfer. Mass Transfer**:** Introduction, Ficks law, Species conservation equation, Introduction to convective and diffusive mass transfer.

Books	
	Text Books:
1.	Yunus A. Cengel, ―Heat Transfer- A Practical Approach‖, Tata McGraw hill Education (P) Ltd, New Delhi, India. 4th Edition, 2012.
2.	R. C. Sachdeva, ―Fundamentals of Engineering, Heat and Mass Transfer, New Age, New Delhi, India, 3rd edition, 2012
3.	Holman, ―Heat Transfer Tata McGraw Hill education (P) Ltd, New Delhi, India. 10 Edition, 2012.
4.	M.N. Ozisik, 'Heat Transfer, A Basic Approach', McGraw Hill Publishers, International edition, 1985.
5.	S.P. Sukhatme, 'A Text Book on Heat Transfer', Universities Press, 4th Edition, 2005.
6.	C.P. Kothandaraman and S. Subramanyan, 'Heat and Mass Transfer Data Book', New Age International Publishers, 8th Edition, 2016

	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/112101097/: Introduction to heat and mass transfer course at IIT Bombay by Prof. S P Sukhatme
2.	https://nptel.ac.in/courses/112108149/: Heat and mass transfer course at IISc Bengaluru.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Describe** the fundamentals of heat and mass transfer.	**L2**
2. **Analyse** the process of conduction process convection and radiation	**L3**
3. **Analyse** the process of free and forced convection	**L3**
4. **Analyse** the radiation heat transfer mode	**L3**
5. **Analyze** the problems due to heat and mass transfer in several areas.	**L3**

Program Outcome of this course (POs)	**PO No.**
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**

Course delivery methods

1. Black Board Teaching
2. Power Point Presentation

Assessment methods

1. Internal Assessment
2. Assignment / Case Study
3. Quiz
4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:40**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Theory of Combustion

Course Code	18AE6415	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs; Tutorial = 0 Hrs Total = 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand the basics of combustion and thermochemistry
2. Learn the chemical kinetics and mechanisms for different system
3. Understand the characteristics of laminar premixed flames
4. Understand the characteristics of laminar diffusion flames
5. Gain the knowledge about turbulent flows

Unit – I **08 Hours**

Introduction to Combustion and Thermochemistry: Review of Property Relations, Reactant and Product Mixtures, Adiabatic Flame Temperatures, Chemical Equilibrium, Equilibrium Products of Combustion, Rudiments of Mass Transfer, Liquid – Vapor Interface Boundary Conditions, Droplet Evaporation

Unit – II **08 Hours**

Chemical Kinetics and Mechanisms: Global versus Elementary Reactions, Elementary Reaction Rates, Rates of Reaction for Multi – step Mechanisms, The H2 – O2 System, Carbon Monoxide Oxidation, Oxidation of Higher Paraffins, Methane Combustion, Oxides of Nitrogen Formation

Self-learning topics: Oxides of Nitrogen Formation

Unit – III **08 Hours**

Laminar Premixed Flames: Physical Description, Simplified Analysis, Factors Influencing Flame Velocity and Thickness, Flame Speed Correlations for Selected Fuels, Quenching, Flammability and Ignition, Flame Stabilization

Unit – IV **08 Hours**

Laminar Diffusion Flames – Burning Jets: Non reacting Constant – Density Laminar Jet, Jet Flame Physical Description, Simplified Theoretical Descriptions, Flame Lengths for Circular – Port and Slot Burners, Soot Formation and Destruction

Self-learning topics: Soot Formation and Destruction

Unit – V **08 Hours**

Introduction to Turbulent Flows: Definition of Turbulence, Length Scales in Turbulent flows, Analysing Turbulent Flows, Axisymmetric Turbulent Jet Definition of Turbulent Flame Speed, Structure of Turbulent Premixed Flames, Wrinkled Laminar Flame Regime, Distributed Reaction Regime, Flame lets in Eddies Regime, Flame Stabilization, Jet Flames, Applications of Turbulent Premixed Flames

Self-learning topics: Applications of Turbulent Premixed Flames

Books	
	Text Books:
1.	An Introduction to Combustion – Concept and Applications, Stephen R Turns, McGraw-Hill
2.	Principles of Combustion, Kenneth K. Kuo, John Wiley & Sons

	Reference Books:
1.	Combustion: Physical and Chemical Fundamentals, Modeling and Simulation, Experiments, Pollutant Formation, Warnatz, J., Maas, Ulrich, Dibble, Robert W., Springer
2.	Understanding Combustion (English) 2nd Edition, H S Mukunda, Universities Press
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. D P Mishra, IIT Kanpur https://nptel.ac.in/courses/101104070/
2.	**NPTEL:** Online Resources: Lecture by: Prof. Ashok De, IIT Kanpur https://nptel.ac.in/courses/112104272/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Apply** the basics of combustion	**L3**
2. **Apply** the chemical kinetics and mechanisms for different system	**L3**
3. **Explain** the characteristics of laminar premixed flames	**L2**
4. **Explain** the characteristics of laminar diffusion flames	**L2**
5. **Apply** the basics of turbulent flows	**L3**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment, Quiz
3. Working Models	3. Course Seminar
4. Videos	4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	1	2	3	4	5
Marks	20	20	20	20	20

Course Code	18AE6511	**Credits**	3
Course type	PE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. To understand the knowledge of vibrations and analyse un damped single degree of freedom systems
2. To study theoretical principles of vibration and vibration analysis techniques for damped and forced vibration problems.
3. To understand the vibration measuring devices and the concept of critical speeds of shafts.
4. To study the analysis of two degree of freedom vibrating systems
5 To study the importance and use of numerical methods in the analysis of multi degree freedom systems and noise legislations

Pre-requisites : Simple harmonic motion, Fourier Series and differential equations

Unit - I **08 Hours**

Introduction:Principle of super position applied to SHM, Beats, Fourier's theorem and problems.

Undamped (Single Degree of Freedom) Free Vibrations: Derivations for spring mass systems, Methods of Analysis, Natural frequencies of simple systems, Springs in series and parallel, Torsional and transverse vibrations, Effect of mass of spring and Problems.

Unit - II **08 Hours**

Damped free vibrations (1DOF): Introduction to free vibration. Forced Vibrations (1DOF):Introduction, Analysis of forced vibration with constant harmonic excitation - magnification factor, rotating and reciprocating unbalances, excitation of support (relative and absolute amplitudes), force and motion transmissibility,

Unit - III **08 Hours**

Vibration Measuring Instruments and Whirling of shafts: Seismic Instruments: Vibrometers, Accelerometer, Frequency measuring instruments and Problems. Whirling of shafts with and without damping, discussion of speeds above and below critical speeds and Problems.

Unit - IV **08 Hours**

Non-Linear Vibrations: Non Linear Vibrations: Introduction, Sources of nonlinearity, Qualitative analysis of nonlinear systems

Noise: Human response to noise (OSHA standards), Room acoustics, Environmental noise, noise legislation.

Unit - V **08 Hours**

Acoustics: Plane acoustic waves, Sound speed, characteristic acoustic impedance of elastic media, sound intensity, dB scale, Transmission Phenomena, transmission from one fluid medium to another.

Books	
	Text Books:
1.	W. T. Thomson, M. D.Dahleh and C. Padmanabhan, Theory of Vibration with Applications, Pearson Education Inc, 5th Edition, 2008.
2.	S. S. Rao, Mechanical Vibrations, Pearson Education Inc, 4th Edition, 2003.
	Reference Books:
1.	V. P. Singh, Mechanical Vibrations, DhanpatRaiandCompany, 3rd Edition, 2006.
2.	G. K.Grover, Mechanical Vibrations, Nem Chand and Bros, 8th Edition, 2009.
3.	S. Graham Kelly, Fundamentals of Mechanical Vibration, Tata McGraw-Hill, 2000.
4.	Colin Hansen, Noise Control, from Concept to Applications, Taylor and Francis, 2005.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	http://www.nptel.ac.in/courses/112103111/

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Analyze** undamped single degree of freedom systems.	**L3**
2.	**Apply** the theoretical principles of vibration and vibration analysis techniques for damped and forced vibration problems.	**L3**
3.	**Explain** the principle used in vibration measuring devices and the concept of critical speeds of shafts.	**L1, L2**
4	**Analyze** two degree of freedom vibrating systems for natural frequencies	**L2, L3**
5	**Apply** numerical methods in the analysis of multi degree freedom systems for natural frequencies	**L3**

	Program Outcome of this course (POs)	PO No.
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2.	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**
3	**Environment & Sustainability :** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development	**PO7**
4.	**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	**PO12**

Course delivery methods

1. Black Board Teaching
2. Power Point Presentation
3. Working Models
4. Videos

Assessment methods

1. Internal Assessment
2. Assignment
3. Seminar
4. Mini-project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of assignments (Two) / activity	Course project/Seminar	Total Marks
Maximum Marks: 50	30+30	10+10	20	100
Writing two IA test is compulsory. **CIE marks will be reduced to 50 marks** **Minimum marks required to qualify for SEE: 40 out of 50**				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass: 40 out of 100**
3. Question paper contains 10 questions, 2 from each unit. Students have to answer FIVE full questions choosing one from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Course Code	18AE6512	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs; Tutorial = 0 Hrs Total = 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand the types of space launch vehicles and missiles.
2. Gain the knowledge of solid and liquid rocket propulsion system.
3. Comprehend the aerodynamic aspects of missile bodies.
4. Understand the attitude control of rockets and missiles

Unit – I **8 Hours**

Introduction : Classification of launch vehicles and missiles, rocket systems, airframe components, forces and moments acting on a rocket, propulsion, aerodynamics, inertial and non-inertial frames, coordinate transformation, equations of motion for three-dimensional motion through atmosphere and vacuum, earth's atmosphere, numerical problems.

Self-learning topics: Earth's atmosphere.

Unit – II **8 Hours**

Solid Propulsion: Solid propellant rockets, classification, components and their design considerations, propellant grain design, grain mechanical properties, ballistics and burn rate design issues, igniters design requirements, types of nozzles.

Unit – III **8 Hours**

Liquid Propulsion: Liquid propellant rockets, classification and components, thrust chamber, feed systems, propellant tanks, turbo-pumps, types of valves and applications, design considerations. Different bipropellant systems like cryogenics and their characteristics.

Unit – IV **8 Hours**

Aerodynamics Of Rockets And Missiles: Classification of missiles. Airframe components of missiles, Forces acting on a missile while passing through atmosphere, method of describing aerodynamic forces and moments, lateral aerodynamic moment, lateral damping moment, lift and drag forces, drag estimation, body up wash and downwash in missiles.

Unit – V **8 Hours**

Attitude Control Of Rockets And Missiles: Rocket Thrust Vector Control – Methods of Thrusts Vector Control for solid and liquid propulsion systems, thrust magnitude control, thrust termination; stage separation dynamics, separation techniques.

Self-learning topics: Rocket dispersion, rocket re-entry

Books	
	Text Books:
1.	Turner, M.J.L., ―Rocket and Spacecraft Propulsion, 2nd Edition, MIT Press, 1922.
2.	Sutton, G.P., ―Rocket Propulsion Elements‖ John Wiley & Sons Inc., New York, 5th Edition, 1993.
	Reference Books:
1.	Mathur, M.L., and Sharma, R.P., ―Gas Turbine, Jet and Rocket Propulsion‖, Standard Publishers and Distributors, Delhi, 1988.
2.	Jack N Neilson, 'Missile Aerodynamics', AIAA, 1st edition, 1988,ISBN-13: 9780962062902.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links

1.	**NPTEL:** Online Resources: Lecture by: Prof. D P Mishra, IIT Kanpur https://nptel.ac.in/courses/101104078/
2.	**NPTEL:** Online Resources: Lecture by: Prof. K Ramamurthi, IIT Madras https://nptel.ac.in/courses/112106073/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Describe** the types of space launch vehicles and missiles.	**L2**
2. **Compare** the solid and liquid propellant system.	**L4**
3. **Analyse** the aerodynamics characteristics of missiles	**L3**
4. **Describe** the attitude control of rockets and missile	**L3**

	Program Outcome of this course (POs)	PO No.
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2.	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment, Quiz
3. Working Models	3. Course Seminar
4. Videos	4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Air Traffic Control

Course Code	18AE6513	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours	Lecture = 40Hrs; Tutorial = 0Hrs Total = 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand Air traffic control systems.
2. Learn Flight information system.
3. Identify the Aerodrome systems.
4. Compare the Navigation systems

Pre-requisites: Elements of Aeronautics

Unit – I **08Hours**

Objectives of air traffic control systems - Parts of ATC services, Visual flight rules (VFR) & Instrument flight rules (IFR) operations, Classification of Air traffic services (ATS) air spaces, Various kinds of separation, Altimeter setting, procedures, Establishment, designation and identification of units providing ATS, Division of responsibility of control.

Self-learning topics: Scope and Provision of ATCs

Unit – II **08 Hours**

Air traffic system: Area control service, assignment of cruising levels, minimum flight altitude, ATS routes and significant points, area navigation (RNAV) and required navigation performance (RNP), Vertical, lateral and longitudinal separations based on time / distance, ATC clearances, Flight plans, position report

Unit – III **08Hours**

Flight Information systems: Radar service, Basic radar terminology, Identification procedures using primary / secondary radar,performance checks, use of radar in area and approach control services, assurance control and coordination between radar / non radar control, emergencies, Flight information and advisory service, Alerting service, Co-ordination and emergency procedures, Rules of the air.

Unit – IV **08 Hours**

Aerodrome Data: Aerodrome data, Aerodrome reference code, Aerodrome reference point, Aerodrome elevation,Aerodrome reference temperature, Instrument runway, physical Characteristics; length of primary / secondary runway, Width of runways, Minimum distance between parallel runways etc. obstacles restriction.

Self-learning topics: Aerodrome basic terminology

Unit – V **08 Hours**

Navigation and Other services: Visual aids for navigation Wind direction indicator, Landing direction indicator, Location and characteristics of signal area, Markings, general requirements, Various markings, Lights, general requirements, Aerodrome beacon, identification beacon, Simple approach lighting system and various lighting systems, visual approach slope indicator (VASI) & precision approach path indicator (PAPI), Visual aids for denoting obstacles; object to be marked and lighter, Emergency and other services.

Books

	Text Books:
1.	AIP (India) Vol. I & II, "The English Book Store", 17-1, Connaught Circus, New Delhi.
2.	"Aircraft Manual (India) Volume I", 1st Edition, The English Book Store, 17-1 Connaught Circus, New Delhi.
	Reference Books:
1.	"PANS RAC ICAO DOC 4444", Latest Edition, The English Book Store, 17-1, Connaught Circus, New Delhi.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-72-air-traffic-control-fall-2006/
2.	https://www.atc-network.com/atc-courses

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Illustrate** basic concepts of ATC.	**L2**
2. **Compare** the various air traffic systems.	**L2**
3. **Describe** flight information systems and subsystems.	**L2**
4. **Quantify** Aerodrome Data.	**L2**
5. **Recognize** Navigation and other services of aircraft systems.	**L2**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **Problem analysis**: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**
3. **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.	**PO12**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment
3.	3. Quiz&Case Study
4.	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**

3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No.	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Satellite Communication

Course Code	18AE6514	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours	Lecture =40Hrs; Tutorial = 0Hrs Total= 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Comprehend the basics of satellite communications and different satellite communication orbits
2. Understand the satellite segment and earth segment
3. Describe the treatment of satellite communication systems operation and planning
4. Learn the various methods of satellite access and Link budgets & planning
5. Review the state of the art in new research areas such as speech and video coding, satellite networking and satellite personal communications
6. Learn Digital audio/video broadcasting using satellites and understand various applications of satellite communications

Unit – I **08Hours**

Introduction to Satellite Communication: Historical background, Basic concepts of Satellite Communications, Communication Networks and Services, Comparison of Network Transmission technologies, Orbital and Spacecraft problems, Growth of Satellite communications. Orbits and Launching Methods: Introduction, Kepler's First Law, Kepler's Second Law, Kepler's Third Law, Definitions of Terms for Earth-Orbiting Satellites, Orbital Elements, Apogee and Perigee Heights, Orbit Perturbations, Effects of a non-spherical earth, Atmospheric drag.

Self-learning topics: Effects of a non-spherical earth, Atmospheric drag.

Unit – II **08 Hours**

The Geostationary Orbit: Introduction, Antenna Look Angles, The Polar Mount Antenna, Limits of Visibility, Near Geostationary Orbits, Earth Eclipse of Satellite, Sun Transit Outage, Launching Orbits, Radio Wave Propagation: Introduction, Atmospheric Losses, Ionospheric Effects, Rain Attenuation, Other Propagation Impairments, Polarization: Introduction, Antenna Polarization, Polarization of Satellite Signals, Cross Polarization, Discrimination, Ionospheric Depolarizaon, Rain Depolarization, Ice Depolarization

Unit – III **08Hours**

The Space Segment: Introduction, The Power Supply, Attitude Control, Spinning satellite stabilization, Momentum wheel stabilization, Station Keeping, Thermal Control, TT&C Subsystem, Transponders, The wideband receiver, The input demultiplexer, The power amplifier, The Antenna Subsystem, The Earth Segment: Introduction, Receive-Only Home TV Systems, The outdoor unit, The indoor unit for analog (FM) TV, Master Antenna TV System, Community Antenna TV System, Transmit-Receive Earth Station

Unit – IV **08 Hours**

The Space Link: Introduction, Equivalent Isotropic Radiated Power, Transmission Losses, Free-space transmission, Feeder losses, Antenna misalignment losses, Fixed atmospheric and ionospheric losses, The Link-Power Budget Equation, System Noise, Carrier-to-Noise Ratio, The Uplink, Saturation flux density, Input back off, Downlink, Output back-off, Combined Uplink and Downlink C/N Ratio, Satellite Access: Introduction, Single Access, Pre assigned FDMA, Demand Assigned ,FDMA, Spade System, TDMA, Pre assigned TDMA, Demand-

assigned TDMA, Satellite-Switched TDMA, Code Division Multiple Access

Unit – V **08 Hours**

Satellite Telemetry, Tracking And Telecommand: Introduction to telemetry systems, Aerospace transducer, signal conditioning, Analog and digital telemetry, Command line and remote control system, Application of telemetry in spacecraft systems, Base Band Telemetry system, Computer command & Data handling , Satellite command system, Issues, Applications in Aerospace domain

Books	
	Text Books:
1.	Satellite Communications, by Dennis Roddy, McGraw Hill Education; 4 editions (1 July 2017), ISBN-13: 978-0070077850.
2.	Satellite Communication Systems Engineering, by Wilbur L. Pritchard, Henri G. Suyderhoud, Robert A. Nelson Pearson Education India; 2 edition (2003), ISBN-13: 978-8131702420.
	Reference Books:
1.	Satellite Communication, by Timothy Pratt, Charles Bostian, Jeremy Allnutt (Second Edition), John Wiley & Sons.
2.	Satellite Technology, Principles and Applications, by Anil K. Maini, Varsha Agarwal (Second Edition)
3.	Wiley Elbert, Bruce R, Satellite communication applications handbook, Artech house Boston 2004.Publishers, New Delhi 1991
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. Kalyan Kumar BandyoPadhyay, IIT Kharagpur https://nptel.ac.in/courses/117105131/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Describe** the principle, working and operation of various sub systems of satellite as well as the earth station.	**L2**
2. **Apply** various communication techniques for satellite applications	**L3**
3. **Analyse** and design satellite communication link	**L3**
4. **Learn** advanced techniques and regulatory aspects of satellite communication	**L3**
5. **Identify** the satellite communication in Aerospace domain.	**L2**

Program Outcome of this course (POs)	**PO No.**
1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **Problem analysis**: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**

Course delivery methods

1. Black Board Teaching
2. Power Point Presentation

Assessment methods

1. Internal Assessment
2. Assignment
3. Quiz&Case Study
4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Course Code	18AE6515	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours	Lecture =40Hrs; Tutorial = 0Hrs Total= 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand the different aircraft control systems.
2. Learn aircraft control technology.
3. Recognize the hydraulic and pneumatic systems.
4. Identify the auxiliary systems of aircraft.
5. Learn the communication systems and landing gear systems.

Pre-requisites: Elements of Aeronautics

Unit – I **08Hours**

Aircraft control systems- Cockpit controls, connecting linkages, mechanisms to control aircraft, primary and secondary systems, flight control systems (FCS), Flight control computer (FCC), Autopilot systems

Self-learning topics: Push pull rod system

Unit – II **08 Hours**

Hydraulic & pneumatic systems- hydraulic and pneumatic fluids, hydraulic systems, pneumatic systems, brake fires, power systems, Application of Pascal's law, specific pneumatic systems, Actuators and valves, system signs and notations.

Unit – III **08Hours**

Fuel systems- Types of fuels, their properties and testing, color codes, fuel requirements, various pumps, fuel transfer systems, fuel tanks, plumbing, valves, indications and warnings systems

Unit – IV **08 Hours**

Auxiliary system- Various types systems, components and operation of air-conditioning System, Pressurization System, Oxygen Systems, Fire Protection Systems, De-icing and Anti Icing systems. Seat Safety System: Ejection seats, survival packs, parachutes, pilot's personal equipment, life rafts, doors, windows, emergency exits and seat belts

Unit – V **08 Hours**

Landing Gear systems - Classification – Shock absorbers - Retractive mechanism. Anti-skid system, wheels and brake, steering systems, indications.

Introduction to Communication and Navigation systems Instrument, landing systems, VOR - CCV case studies.

Books	
	Text Books:
1.	Ian Moir and Allan Seabridge, "Aircraft systems", John Wiley & Sons, ISBN: 978-8126535217
2.	E H J Pallet, "Aircraft instruments", 2nd edition, Pearson, ISBN: 978-8131728130
	Reference Books:
1.	Scheppler& Robert, "Aircraft Oxygen System" Himalayan Books.
2.	Jeppeson, "A & P Technician Airframe Text book", 2nd edition, Iap, 1992, ISBN: 978-0891003953
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links

1.	https://www.cranfield.ac.uk/courses/short/transport-systems/safety-assessment-of-aircraft-systems
2.	https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-885j-aircraft-systems-engineering-fall-2005/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Illustrate** various types of aircraft systems.	**L2**
2. **Describe** the various Mechanical and Electronic systems.	**L2**
3. **Comprehend** the Auxiliary systems of aircraft.	**L2**
4. **Compare** the communication systems used in aircraft.	**L2**
5. **Understand** the hydraulic and fuel systems of aircraft.	**L2**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **Problem analysis**: Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment
	3. Quiz&Case Study
	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	1	2	3	4	5
Marks	20	20	20	20	20

Introduction to Aerospace Engineering

Course Code	18AE6611	**Credits**	3
Course type	OE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives

Enable students to

1. Understand the Aerospace vehicles and its components
2. Understand the basics of flight principles within and beyond atmosphere
3. Describe the various propulsion systems of Aerospace
4. Know the stability and performance parameters of Aerospace vehicles
5. Learn the basics of vehicles used for space and the satellites.

Unit – I **08 Hours**

Introduction: History of Aerospace, Atmosphere, Classification of Aerospace vehicles, basic components of aircrafts and spacecraft, vehicle control surfaces and systems, introduction to Indian Aerospace sector, major Aerospace industry and manufacturers, aerospace material technology.

Unit – II **08 Hours**

Flight Principle: Significance of speed of sound, standard atmosphere, Bernoulli's principle, Aerodynamic forces acting on aircrafts and spacecraft, aerofoil nomenclature, pressure and velocity distribution, aerodynamic forces, generation of lift and drag, supersonic effects, aerodynamic center, aspect ratio, center of pressure, center of gravity.

Unit – III **08 Hours**

Aero-Propulsion: Propulsion systems, classifications of propulsion system, location and principle of operation. Basic principle of aircraft and spacecraft thrust production, Brayton cycle and Humphrey cycle, jet engines, propeller engines, rocket engines, Ramjet and Scramjet

Unit – IV **08 Hours**

Performance & Stability: Steady level flight, thrust - power curves, maximum and minimum speed of aircraft during steady state, Static and Dynamic stability, longitudinal, lateral and directional stability, effects of secondary control surfaces, maneuvers.

Unit – V **08 Hours**

Launch vehicles and Satellites: Rockets and satellite materials, launch vehicle dynamics, basic orbital mechanics, satellite applications and orbits, future challenges in aerospace engineering.

Books	
Text Books:	
1	John D Anderson, "Introduction to flight", McGraw Hill Education; 6 edition (1 July 2017), ISBN-13: 978-0070700116
2.	Turner, M. J. L., "Rocket and Spacecraft Propulsion: Principle, Practice and New-Devel-opments", Springer; Softcover reprint of hardcover 3rd ed. 2009 edition (22 November 2010), ISBN-13: 978-3642088698.
	Reference Books:
1.	Sutton G. P., "Rocket Propulsion Elements", John Wiley, New York, 8th Ed., 2011.
2.	Anderson, D. F. and Eberhardt, S., "Understanding Flight, 2nd Edition. McGraw Hill (2009).
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. Bhaskar Roy , Prof. A M Pradeep, IIT

	Bombay https://nptel.ac.in/courses/101101002/
2.	**NPTEL:** Online Resources: Lecture by: Prof. Vinayak N. Kulkarni , IIT Guwahati https://swayam.gov.in/nd1_noc19_me76/preview

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Understand** the current trends of Aerospace engineering	**L1**
2. **Apply** the basic physics in understanding the principles of vehicles	**L3**
3. **Apply** the laws of motions to the propulsion systems	**L3**
4. **Apply** the fluid mechanics concepts to understand the Aerodynamics	**L3**
5. **Understand** the working of aerospace vehicle and satellite	**L1**
6. **Understand** the application of aircraft and aerospace vehicles	**L1**

Program Outcome of this course (POs)	**PO No.**
1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	PO1
2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	PO2

Course delivery methods	**Assessment methods**
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment
	3. Quiz

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:40**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No.	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Unmanned Aerial Vehicles And Applications

Course Code	18AE6612	**Credits**	3
Course type	OE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs; Tutorial = 0 Hrs Total = 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Comprehend the basic aviation history and UAV systems.
2. Acquire the knowledge of basic aerodynamics, performance, stability and control.
3. Understand the propulsion, loads and structures.
4. Describe the importance of controller design for unmanned aerial vehicles.

Unit – I **08 Hours**

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

Unit – II **08 Hours**

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

Unit – III **08 Hours**

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.

Case Study: Flight PID Controller Design For 6 DOF UAV

Self-learning topics: Sensors Supporting the Autopilot

Unit – IV **08 Hours**

Mission Planning and Control**:** Air Vehicle and Payload Control, Reconnaissance/Surveillance Payloads, Weapon Payloads, Other Payloads, Data-Link Functions and Attributes, Data-Link Margin, Displacement Autopilot-Pitch Orientation Control system, Acceleration Control System

Unit – V **08 Hours**

Materials used in IC engines, gas turbine engines, applications of super alloys; nickel alloys, titanium alloys and ceramics, composites.

Books	
	Text Books:
1.	Paul Gerin Fahlstrom , Thomas James Gleason, Introduction To UAV Systems, 4th Edition, Wiley Publication, 2012 John Wiley & Sons, Ltd
2.	Landen Rosen, Unmanned Aerial Vehicle, and Publisher: Alpha Editions, ISBN13: 9789385505034.
	Reference Books:
1.	Unmanned Aerial Vehicles: DOD's Acquisition Efforts, Publisher: Alpha Editions, ISBN13: 9781297017544.
2.	Valavanis, Kimon P., Unmanned Aerial Vehicles, Springer, 2011.
3.	Valavanis**,** K., Vachtsevanos, George J., Handbook of Unmanned Aerial Vehicles, Springer, 2015.
4.	Smart autonomous aircraft Stables, K.J. and Rolfe, J.M. "Flight Simulation", Cambridge

	University Press, 1998

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Interpret** the mission planning and control of UAV	**L2**
2. **Understand** the basic aerodynamics, performance, stability and control required for UAV	**L2**
3. **Select** the propulsion system and material for structures.	**L3**
4. **Apply** the basic concepts of control theory to design classical controls for UAV	**L3**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment, Quiz
3. Working Models	3. Course Seminar
4. Videos	4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	1	2	3	4	5
Marks	20	20	20	20	20

Air Breathing Engine

Course Code	18AE6613	Credits	3

Course type	OE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs; Tutorial = 0 Hrs Total = 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand the basic principle of IC engines.
2. Gain the knowledge of gas turbine and their working principle
3. Understand the working principle of aircraft power plants
4. Learn the theory behind gas turbine working
5. Acquire the knowledge about various material used in air breathing engines.

Unit – I **08 Hours**

Classification, I.C. Engines parts, 2 and 4 stroke petrol and 4-stroke diesel engines. P-V diagrams of Otto and Diesel cycles. Simple problems on indicated power, brake power, indicated thermal efficiency, brake thermal efficiency, mechanical efficiency and specific fuel consumption

Unit – II **08 Hours**

Gas turbines: Classification, Working principles and Operations of Open cycle and closed cycle gas turbines. Aircraft power plants, classification based on power plant and location and principle of operation.

Unit – III **08 Hours**

Aircraft power plants – basic principles of piston, & jet engines; radial piston engines, turbojet engine, turboprop engine, turbofan engine, turbo shaft engine, ram jet and scram jet.
Self-learning topics: scram jet.

Unit – IV **08 Hours**

Brayton cycle and its application to gas turbine engines; use of propellers and jets for production of thrust, Advance engines and simple problems.

Unit – V **08 Hours**

Materials used in IC engines, gas turbine engines, applications of super alloys; nickel alloys, titanium alloys and ceramics, composites.

Books	
	Text Books:
1.	Bhaskar Roy, "Aircraft propulsion", Elsevier (2011), ISBN-13: 9788131214213
2.	V. Ganesan, "Gas Turbines", Tata McGraw-Hill, 2010, New Delhi, India, ISBN: 0070681929, 978007068192
	Reference Books:
1.	Hill, P.G. & Peterson, C.R., "Mechanics & Thermodynamics of Propulsion" Addison – Wesley Longman INC, 1999, ISBN-13: 978-0201146592.
2.	Irwin E. Treager, "Gas Turbine Engine Technology" GLENCOE Aviation Technology Series, 7th Edition, Tata McGraw Hill Publishing Co.Ltd. Print 2003, ISBN-13: 978-0028018287
3.	Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H., "Gas Turbine Theory", Longman, 1989, ISBN 13: 9780582236325.
4.	
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. Bhaskar Roy , Prof. A M Pradeep, IIT

	Bombay https://nptel.ac.in/courses/101101002/
2.	**NPTEL:** Online Resources: Lecture by: Prof. Vinayak N. Kulkarni , IIT Guwahati https://swayam.gov.in/nd1_noc19_me76/preview

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Explain** the basic principle of IC engines.	**L2**
2. **Describe** the working principle of gas turbine	**L2**
3. **Explain** the working principle of aircraft power plants	**L2**
4. **Explain** the theory behind gas turbine working	**L2**
5. **Identify** the various material used in air breathing engines.	**L3**

Program Outcome of this course (POs)	**PO No.**
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**

Course delivery methods	**Assessment methods**
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment, Quiz
3. Working Models	3. Course Seminar
4. Videos	4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.

2. **Minimum marks required in SEE to pass:**

3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Simulation Lab

Course Code	18AEL67	**Credits**	1
Course type	PC	**CIE Marks**	25 marks
Hours/week: L-T-P	0-0-2	**SEE Marks**	25 marks
Total Hours:	24	**SEE Duration**	3 Hours/2 Hours for 50 marks

Course learning objectives

Enable students to

1. Familiarize with the MATLAB/SIMULINK Software.
2. Understand the computational approach for structural and aerodynamic problems.
3. Apply the knowledge to simulate the engineering problem.
4. Develop Numerical simulation skills to solve Aeronautical engineering problems.

Pre-requisites : Control Engineering

List of experiments

1. Falling Sphere (Rain Drop) with various drag-investigate the velocity verses time plot and simulate the fall.
2. Frequency response for spring mass system, simulation of the oscillations
3. Simulation of poles and zeros of a transfer function.
4. Stability analysis using root locus using MATLAB
5. Simulation of Aircraft Longitudinal modes and Analyze the Response
6. Simulate a bomb drop from an aircraft on a moving tank for pure-pursuit motion
7. Simulation of Lateral directional modes Analyze the Response
8. Simulate runway and a point take off from runway
9. Simulate a range and endurance of commercial aircraft

Books	
	Text Books:
1.	U.A. Bakshi and V.U. Bakshi, Control Engineering, Technical Publications, ISBN: 978-93-5099-657-7
2.	A. Nagoor Kani, Control Systems Engineering, RBA Publications, 2014
	Reference Books:
1.	Katsuhiko Ogatta, Modern Control Engineering, Pearson Education,2004
2.	I.J. Nagrath and M. Gopal,Control Systems Engineering, New Age Publishers, 2017

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Construct** mathematical models for various engineering systems	**L3**
2.	**Construct** linear mathematical models both in frequency and time domain with suitable assumptions	**L3**
3.	**Simulate** flight mechanism, aerodynamics, controls, and structural dynamics problems.	**L3**
4.	**Apply** numerical Discretization techniques to simulate linear systems.	**L3**
5.	**Recognize** the broader use of modern tools to go beyond the prescribed	**L3**

syllabus.

6. **Analyzing** the dynamics response of the aircraft modes. **L4**

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2.	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
3.	**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.	**PO5**
4.	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	**PO9**
5.	**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.	**PO12**

Assessment methods

1. Conduct of Experiment
2. Journal evaluation/assessment
3. Open ended experiments
4. Viva-voce

Scheme of Continuous Internal Evaluation (CIE):

Components	Conduct of the lab	Journal submission	Mini Project	Total Marks
Maximum Marks: 25	10	10	5	25
➢ Submission and certification of lab journal is compulsory to qualify for SEE. ➢ **Minimum marks required to qualify for SEE : 10**				

Scheme of Semester End Examination (SEE):

1. It will be conducted for 50 marks of 3 hours duration**. It will be reduced to 25 marks for the calculation of SGPA and CGPA.** Single Experiment to be conducted in SEE.
2. **Minimum marks required in SEE to pass:20**
3.

Initial write up	10 marks	**50** marks
Conduct of experiment	20 marks	
Viva- voce	10 marks	
Quiz	10 marks	

Course Code	18AEL68	**Credits**	1
Course type	PC	**CIE Marks**	25 marks
Hours/week: L-T-P	0-0-2	**SEE Marks**	25 marks
Total Hours:	24	**SEE Duration**	3 Hours/2 Hours for 50 marks

Course learning objectives

The course will enable the students to

1. Understanding the propeller theories
2. Study the pressure distribution over compressor and turbine cascade
3. Analyse the performance of diffuser and axial flow compressor
4. Study the performance characteristics of free and wall jet and for converging nozzle
5. Find velocity of a flame

Pre-requisites : Aircraft Propulsion

List of experiments

1. Study the performance of propeller at different speeds and measure the thrust force.
2. Study the pressure distribution on a cascade unit at different incidence angle of an axial compressor blade
3. Study the pressure distribution on a cascade unit at different incidence angle of an axial turbine blade
4. Performance studies on two dimensional diffuser for stable flow
5. Performance studies on two dimensional diffuser for separated flow
6. Calculation of the Mechanical efficiency of axial compressor- power required, power Available, Compression Ratio
7. Determine the velocity profile or decaying velocity of free jet of different sizes
8. Study the characteristics plots of wall jet.
9. Determine the pressure distribution and velocity profile of a flow in the convergent nozzle.
10. Experimentally determination of the burning velocity of premixed flame by measuring the cone angle.

	Books
1.	Bhaskar Roy, "Aircraft propulsion", Elsevier (2011), ISBN-13: 9788131214213
2.	V. Ganesan, "Gas Turbines", Tata McGraw-Hill, 2010, New Delhi, India, ISBN: 0070681929, 978007068192
3.	Hill, P.G. & Peterson, C.R., "Mechanics & Thermodynamics of Propulsion" Addison – Wesley Longman INC, 1999, ISBN-13: 978-0201146592.
4.	Irwin E. Treager, "Gas Turbine Engine Technology" GLENCOE Aviation Technology Series, 7th Edition, Tata McGraw Hill Publishing Co.Ltd. Print 2003, ISBN-13: 978-0028018287
	E-Recourses
1.	**NPTEL:** Online Resources: Lecture by: Prof. Bhaskar Roy , Prof. A M Pradeep, IIT Bombay https://nptel.ac.in/courses/101101002/
2.	**NPTEL:** Online Resources: Lecture by: Prof. Vinayak N. Kulkarni , IIT Guwahati https://swayam.gov.in/nd1_noc19_me76/preview

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Determine** the propeller efficiency and thrust for different speed	**L3**
2. **Determine** the performance of 2D diffuser for stable and separated flow	**L3**
3. **Calculate** the output of axial compressor	**L3**
4. **Analyse** the flow through the converging nozzle	**L4**
5. **Analyse** the flow over turbine and compressor cascade	**L4**
6. **Determine** the flame velocity characteristics	**L4**
7. **Determine** the Velocity profile (or Decaying Velocity) of the Free Jet of different sizes.	**L4**

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2.	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
3.	**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.	**PO5**
4.	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.	**PO9**
5.	**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.	**PO12**

Assessment methods

1. Conduct of Experiment
2. Journal evaluation/assessment
3. Open ended experiments
4. Viva-voce

Scheme of Continuous Internal Evaluation (CIE):

Components	Conduct of the lab	Journal submission	Mini Project	Total Marks
Maximum Marks: 25	10	10	5	25
➢ Submission and certification of lab journal is compulsory to qualify for SEE. ➢ **Minimum marks required to qualify for SEE : 10**				

Scheme of Semester End Examination (SEE):			
1.	It will be conducted for 50 marks of 3 hours duration**. It will be reduced to 25 marks for the calculation of SGPA and CGPA.** Single Experiment to be conducted in SEE.		
2.	**Minimum marks required in SEE to pass:20**		
3.	Initial write up	10 marks	**50** marks
	Conduct of experiment	20 marks	
	Viva- voce	10 marks	
	Quiz	10 marks	

Constitution Of India, Professional Ethics And Human Values

Course Code	18AE69	**Credits**	1
Course type	HS	**CIE Marks**	25 marks
Hours/week: L-T-P	1-0-0	**SEE Marks**	25 marks
Total Hours:	Lecture = 30 Hrs; Tutorial = 0 Hrs Total = 30Hrs	**SEE Duration**	2 Hours

Course learning objectives

Enable students to

1. To provide basic information about Indian Constitution.
2. To identify individual role and ethical responsibility towards society

Unit – I Human Values **08 Hours**

Chapter 1: Objectives, Morals , Values, Ethics, Integrity, Work ethics, Service learning, Virtues, Respect for others, Living peacefully, Caring, Sharing, Honesty, Courage ,Valuing time, Cooperation, Commitment, Empathy, Self-confidence, Challenges in the work place, Spirituality.

10 Hours

Unit – II Professional Ethics

Chapter 2: Engineering Ethics: Overview, senses of engineering ethics, variety of moral issues, types of enquiries, moral dilemma, moral autonomy, moral development (theories), consensus and controversy, profession, models of professional roles, responsibility,

Chapter 3:

Theories about right action (ethical theories), self-control, self-interest, customs, religion, self-respect, case studies (Choice of the Theory), engineering as experimentation, engineers as responsible experimenters.

Chapter 4: Codes of ethics, Environmental ethics, Computer ethics, Engineers as managers, Ethics and code of business conduct in MNC.

Unit – III Constitution of India **12 Hours**

Chapter 5: Introduction to Constitution of India- Formation and Composition of the Constituent Assembly –Salient features of the Constitution- Preamble to the Indian Constitution-Fundamental Rights- Fundamental Duties - Directive principles of state policy.

Chapter 6: Parliamentary system of governance-Structure of Parliament- Loksabha and Rajyasabha- Functions of Parliament- Legislative, Executive, Financial functions, Powers of Loksabha and Rajyasabha- Procedure followed in parliament in making law- Lokpal and functionaries.

Structure of union executive- Power and position of President, Vice President, Prime Minister and council of Ministers. Structure of Judiciary- Jurisdiction and functions of Supreme Court, High Court and subordinate courts.

Chapter 7: Federalism in Indian Constitution, Division of Powers- Union List, State List and Concurrent List, Structure of State legislation, Legislative Assembly and Legislative Council, Functions of State legislature, Structure of State Executive- Powers and positions of Governor, Speaker, Deputy Speaker, Chief Minister and Council of Ministers.

Local self government- meaning- Three tier system- Village Panchayat- Taluka Panchayat- Zilla Panchayat- Local Bodies- Muncipalities and Corporations, Bruhath Mahanagara Palike. Functions of Election Commission, UPSC, KPSC.

Books	
	Text Books:
1.	Durga Das Basu : " Introducing to the Constitution on India', (Students Edn.) Prentice – Hall EEE, 19th / 20th Edn., 2001
2.	Raman B.S. and Yagi R.K., Constitutional Law and Professional Ethics, United Publishers, 2005
	Reference Books:
1.	Rajaram M., Constitution of India and Professional Ethics, New Age International Publishers, 3rd Ed.,
2.	Nagarazan R.S., Professional Ethics and Human Values, New Age International Publishers Pvt.Ltd. 2006

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Know and explain** state and central policies, fundamental duties.	**L1,L2**
2. **Know and explain** the functioning of the democracy in the country	**L1,L2**
3. **Appreciate and practice** the ethical issues	**L3**
4. **Know and apply** the code of ethics practiced in the professional bodies.	**L1,L3**

Program Outcome of this course (POs)		PO No.
1.	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.	**6**
2.	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	**8**

Course delivery methods

1. Lecture
2. Presentation
3. Expert talks

Assessment methods

1. Internal Assessment
2. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best 2 out of 3 IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :25	25	--	--	25
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 10 out of 25 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 50 marks of 2 hours duration. It will be reduced to 25 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Syllabus of 7th semester

Airport Planning and Management

Course Code	18AE71	**Credits**	3
Course type	HS	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives

Enable students to

1. Gain the knowledge of airport and its systems
2. Understand the components of airport
3. Learn the management of airport operations and finance
4. Impart the knowledge of airport capacity and delay

Unit – I **08 Hours**

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.

Unit – II **08 Hours**

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 Current and future enhancements to air traffic control; Airport terminals and ground access, Run ways and its operations.

Unit – III **08 Hours**

Airport Operations: Airport operations management: Introduction, pavement management, aircraft rescue and fire fighting (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.

Unit – IV **08 Hours**

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.

Unit – V **08 Hours**

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, small aircraft transportation systems.

Books	
Text Books:	
1	Alexander T Wells, Ed. D Seth Young, ―Airport planning and Management, 6th Edition, 2011.
2.	Norman J. Ashford, H. P. Martin Stanton, Clifton A. Moore, Pierre Coutu, ―Airport Operations‖, McGraw Hill, 3rd Edition, 2013.

	Reference Books:
1.	Robert M. Horonjeff, Francis X. McKelvey, William J Sproule, Seth Young, "Planning and Design of Airports", fifth edition, McGraw Hill Professional, 2010.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: . Manoj Kumar Mondal , IIT Kharagpur https://swayam.gov.in/nd1_noc20_ge08/preview
2.	**NPTEL:** Online Resources: Lecture by: Prof. Mukesh Kumar Barua, IIT Roorkee https://nptel.ac.in/courses/110/107/110107081/
3.	**NPTEL:** Online Resources: Lecture by: Prof. Rajat Agrawal and Vinay sharma , IIT Roorkee https://nptel.ac.in/courses/110/107/110107094/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Recognize** the airport and its operations	**L2**
2. **Understand** the different airport systems and its components	**L2**
3. **Illustrate** the management skills in airport operations and finance	**L3**
4. **Identify** the capacity of the airport and delay factors	**L1**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **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.	**PO6**
3 **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.	**PO11**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment / Case Study
	3. Quiz
	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10%

weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:40**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Course Code	18AE72	**Credits**	4
Course type	PC	**CIE Marks**	50 marks
Hours/week: L-T-P	4-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture =50 Hrs; Tutorial = 0 Hrs Total = 50 Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand the need for avionics in civil, military and space systems
2. Understand the use of microprocessors, data buses and avionics system architectures.
3. Understand the inertial navigation system and electronic flight control system
4. Provide the knowledge of flight instrumentation avionics subsystems
5. Acquire the knowledge of display technologies, communication and navigation systems

Unit – I **10 Hours**

Power Distribution System: Bus Bar, split bus bar system, special purpose cables. Electrical diagram and identification scheme. Circuit controlling devices. Power utilization-typical application to avionics. Need for Avionics in civil and military aircraft. Safety measures.

Self-learning topics: Safety measures.

Unit – II **10 Hours**

Inertial Navigation System: Gyroscopic versus Inertial platform. Structure of stable platform. Inertial Navigation units. Inertial alignment. Inertial interface system. Importance of Compass swing

Electronic Flight Control System: Fly-by-wire system: Basic concept and features. Pitch and Roll rate: - command and response. Control Laws. Frequency response of a typical FBW actuator. Cooper Harper scale. Redundancy and failure survival. Common mode of failures and effects analysis

Unit – III **10 Hours**

Principles of Digital Systems: Digital Computers, Microprocessors, Memories

Flight Deck and Cockpits: Control and display technologies CRT, LED, LCD, EL and plasma panel, Touch screen, Direct voice input (DVI) -Civil cockpit and military cockpit : MFDS, HUD, MFK, HOTAS

Unit – IV **10 Hours**

Electronic Flight Instrument Systems: Display -units, presentation, failure, and annunciation. Display of air data. Introduction to Avionics Sub Systems and Electronic Circuits: Typical avionics subsystems. Amplifier, oscillator, aircraft communication system, transmitter, receiver, antenna.

Unit – V **10 Hours**

Avionics Systems Integration: Avionics equipment fit. Electrical data bus system. Communication Systems, Navigation systems, Flight control systems, Radar, Electronic Warfare, and fire control system. Avionics system architecture, Data buses, MIL–STD 1553 B.

Auto Flight Systems: Traffic alert and collision avoidance systems (TCAS)-Enhanced ground proximity warning systems-Air traffic control systems, predictive wind shear warning systems, ILS.

Books

	Text Books:
1.	Moir, I. and Seabridge, A., Civil Avionics Systems, Wiley-Blackwell; 2nd edition (11 October 2013), ISBN-13: 978-1118341803
2.	R.P.G. Collinson., "Introduction to Avionics Systems", Springer; 3rd ed. 2011 edition (15 October 2014), ISBN-13: 978-9400792593.
	Reference Books:
1.	Ian Moir, Allan Seabridge, Aircraft Systems: Mechanics, Electrical and Avionics Subsystems Integration, Wiley, 3rd Edition, 2012.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. debasish Ghose, IISc Bengaluru https://nptel.ac.in/courses/101108056/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Recognize** the importance of avionics in aerospace sector	**L2**
2. **Select** the suitable data bus based on the application.	**L2**
3. **Identify** the suitable navigation systems.	**L2**
4. **Describe** the display technologies, communication and navigation systems	**L2**
5. **Distinguish** the avionics system architecture.	**L3**

Program Outcome of this course (POs)	**PO No.**
1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**

Course delivery methods	**Assessment methods**
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment
	3. Quiz & Case Study
	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.

2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	1	2	3	4	5
Marks	20	20	20	20	20

Flight Vehicle Design

Course Code	18AE73	Credits	4

Course type	PC	**CIE Marks**	50 marks
Hours/week: L-T-P	4-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 50 Hrs; Tutorial = 0 Hrs Total = 50 Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Comprehend the flight vehicle design process.
2. Acquire the knowledge of vehicle configuration and structural components.
3. Understand the stability & control and subsystems
4. Investigate the difficulties in designing of a flight vehicle.

Pre-requisites**:** Elements of Aeronautics, Aerodynamics, Aircraft structures

Unit – I **10 Hours**

Overview of Design Process: Introduction, Requirements, Phases of design, Conceptual Design Process, Initial Sizing, Take-off weight build up, Empty weight estimation, Fuel fraction estimation, Take- off weight calculation. Thrust to Weight Ratio & Wing Loading: Thrust to Weight Definitions, Statistical Estimate of T/W. Thrust matching, Spread sheet in design, Wing Loading and its effect on Stall speed, Take-off Distance, Catapult take-off, and Landing Distance. Wing Loading for Cruise, Loiter, Endurance, Instantaneous Turn rate, Sustained Turn rate, Climb, & Glide, Maximum ceiling.

Unit – II **10 Hours**

Configuration Layout & loft: Conic Lofting, Conic Fuselage Development, Conic Shape Parameter, Wing-Tail Layout & Loft. Aerofoil Linear Interpolation. Aerofoil Flat-wrap Interpolation. Wing aerofoil layout-flap wrap. Wetted area determination.

Case Studies: Configuration Layout: Aerodynamic, Structural, Detect ability. Crew station, Passenger, and Payload arrangements**.**

Design of Structural Components: Fuselage, Wing, Horizontal &Vertical Tail. Spreadsheet for fuselage design. Tail arrangements, Horizontal & Vertical Tail Sizing. Tail Placement.

Self-learning topics: Loads on Structure. V-n Diagram, Gust Envelope. Loads distribution, Shear and Bending Moment analysis.

Unit – III **10 Hours**

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

Case studies: Engine Selection Spread Sheet

Unit – IV **10 Hours**

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

Unit – V **10 Hours**

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

Case study: Estimate the performance parameters for a Jet or Propeller driven Aircraft for a Specific Application.

Self-Learning Topics: Air Pressurization and Air Conditioning System

Books	
	Text Books:
1.	Daniel P. Raymer, "Aircraft Design - A Conceptual Approach"- AIAA Education Series, IV Edition, 2006.
2.	Thomas C Corke, "Design of Aircraft"- Pearson Edition. 2003.
	Reference Books:
1.	J Roskam, "Aero plane Design"2nd edition, Darcorporation, 2003, ISBN-13: 978-1884885242.
2.	John Fielding, "Introduction to Aircraft Design" - Cambridge University Press, 2009
3.	Jenkinson "Aircraft Design Projects for Engineering Students-AIAA
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. E G Tulapurkara, IIT Madras https://nptel.ac.in/courses/101106041/
2.	**NPTEL:** Online Resources: Lecture by: Prof. Nandan Kumar Sinha, IIT Madras https://nptel.ac.in/courses/101106042/

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Acquire** the knowledge of the flight design process	**L3**
2.	**Calculate** the thrust to weight ratio and wing loading.	**L3**
3.	**Recognize** the need configuration layout used in the design process.	**L2**
4.	**Acquire** the knowledge of engine selections based on design	**L3**
5.	**Compute** the flight vehicle performance.	**L3**
6.	**Analyze** the design performance parameters of an aircraft for a given application.	**L4**

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2.	**Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
3.	**Design/ Development 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.	**PO3**

Course delivery methods	**Assessment methods**
1. Black Board Teaching	1. Internal Assessment

2. Power Point Presentation	2. Assignment, Quiz
3. Working Models	3. Course Seminar
4. Videos	4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Helicopter dynamics

Course Code	18AE7411	**Credits**	3
Course type	PE	**CIE Marks**	50 marks

Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture =40 Hrs; Tutorial = 0 Hrs Total = 40 Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Comprehend the basic concepts of helicopter dynamics.
2. Acquire the knowledge of critical speed and rotor bearing system.
3. Understand the turbo rotor system and blade vibration.
   List the performance parameter of helicopter.
4. Comprehend the basic concepts of helicopter dynamics.

Unit – I **10 Hours**

Introduction: History of helicopter flight. Fundamentals of Rotor Aerodynamics; Momentum theory analysis in hovering flight. Disc loading, power loading, thrust and power coefficients. Figure of merit, rotor solidity and blade loading coefficient. **Blade Element Analysis:** Blade element analysis in hovering and forward flight. Rotating blade motion. Types of rotors. Concept of blade flapping, lagging and coning angle.

Self-learning topics: lagging and coning angle

Unit – II **08 Hours**

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

Unit – III **06 Hours**

Rotor Wakes and Blade Tip Vortices: Characteristics of rotor wake in hover, and forward flight. Other characteristics of rotor wake. Flow visualization techniques of Rotor Wakes and Blade Tip Vortices

Unit – IV **08 Hours**

Basic Helicopter Performance: Forces acting on helicopters in forward flight. Methods of achieving translatory flight. Controlling cyclic pitch: Swash-plate system. Lateral tilt wit and without conning. Lateral and longitudinal asymmetry of lift in forward flight

Unit – V **08 Hours**

Helicopter Stability and Control. Forward speed disturbance, vertical speed disturbance, pitching angular velocity disturbance, side-slip disturbance, yawing disturbance. Static stability of helicopters: longitudinal, lateral directional and directional.

Self-learning topics: Dynamic stability aspects. Main rotor and tail rotor control

Books	
	Text Books:
1.	J. Gordon Leishman, Principles of Helicopter Aerodynamics, Cambridge University Press; 2nd edition (15 December 2016), ISBN-13: 978-1107013353.
2.	George H. Saunders, Dynamics of Helicopter Flight, John Wiley & Sons (1 January 1975), ISBN-13: 978-0471755098.
	Reference Books:
1.	W Z Stepniewski and C N Keys, Rotary Wing Aerodynamics, Dover Publications, Inc, New York, 1984.
2.	ARS Bramwell, George Done, and David Balmford, Helicopter Dynamics, 2nd Edition, Butterworth-Heinemann Publication, 2001
3.	John, M. Seddon and Simon Newman, Basic Helicopter Aerodynamics, Wiley, 2011.
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. C Venkatesan, IIT Kanpur https://nptel.ac.in/courses/101104017/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Explain** the basic concepts of helicopter	**L2**
2. **Describe** the aerodynamics of Rotor Airfoil	**L2**
3. **Interpret** the **Flow visualization of** blade tip vortices	**L2**
4. **Summarizing** the performance of helicopter	**L2**
5. **Acquire** the knowledge of helicopter stability and control	**L3**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment
	3. Quiz & Case Study
	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Computational Fluid Dynamics

Course Code	18AE7412	**Credits**	3

Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Know the basic of computational techniques in field of engineering
2. Acquire the knowledge of Discretization and Mathematical modeling
3. Know the basics of Finite difference method schemes
4. Understand the various types of grids and its uses.
5. Understand the various models and its applications.

Pre-requisites**:** Basic knowledge of Fluid Mechanics & Mathematics

Unit-I **08 Hours**

Introduction: CFD Applications. Continuity, Momentum, and Energy Equations-Derivation in Differential forms. Integral versus Differential form of equations. Comments on governing equations. Physical boundary conditions.

Unit-II **08 Hours**

Mathematical Behavior of Partial Differential Equations: Classification of partial differential equations. Cramer Rule and Eigen value methods for classification. Hyperbolic, parabolic, and elliptic forms of equations.

Case studies: steady inviscid supersonic flow, unsteady inviscid flow, steady boundary layer flow, and unsteady thermal conduction, steady subsonic inviscid flow

Unit-III **08 Hours**

Discretization: Finite differences methods, and difference equations. Explicit and Implicit approaches. Explicit versus Implicit Scheme. Errors and stability analysis. Time marching and space marching.

Unit-IV **08 Hours**

Grid Generation: Needfor grid generation and Body-fitted coordinate system. Structured Grids-essential features.Importance, Structured Vs. Unstructured Grids, Major Tasks of generation, Analytical Transformation, Grid Quality, Concept of Multi-blocking, Adaptive grids, Surface grid generation

Unit-V **08 Hours**

Calculation of fluid flow: Representation of the pressure - Gradient term and continuity equation – Staggered grid - Momentum equations - Pressure and velocity corrections - Pressure Correction equation - Numerical procedure for SIMPLE algorithm - Boundary conditions for the pressure correction method.

Books

Text Books:	
1.	Computational Fluid Dynamics – The basics and applications, McGraw Hill Education (1 July 2017), ISBN-13: 978-1259025969.
2.	An introduction to CFD, H. Versteeg and W. Malalasekra, Pearson; 2 edition (2008), ISBN-13: 978-8131720486.
3.	Introduction to Computational Fluid Dynamics, PradipNiyogi, S.K. ChakrabarthyandM.K. Laha, Pearson Education, 2006.
	Reference Books:
1.	Fletcher, C.A.J., "Computational Techniques for Fluid Dynamics", Springer, Berlin,2nd edition,2002,ISBN-13: 978-3540543046
	E-resources (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/103106073/: Computational fluid dynamics course at IIT Madras by Prof. Srinivas Jayanti
2.	https://nptel.ac.in/courses/112105045/: Computational fluid Dynamics course at IIT Kharagpur by Dr. Suman Chakraborthy

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Understand** the need of CFD and its applications	**L1**
2. **Apply** mathematical knowledge to modeling of physical problems.	**L3**
3. **Evaluate** the effects of different approaches and boundary conditions	**L4**
4. **Acquire** the knowledge of grids and its uses	**L4**
5. **Apply** the concept of fluid flow in CFD and its solving techniques	**L3**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
3. **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.	**PO12**

Course delivery methods

1. Chalk and board
2. PPT

Assessment methods

1. Assignments
2. Quizzes
3. IA tests
4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA				

Minimum marks required to qualify for SEE : 20 out of 50 marks

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:40**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Course Code	18AE7413	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs; Tutorial = 0 Hrs, Total = 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand effect of aero elasticity in aircraft design and its stability
2. Learn the structural dynamic and steady and unsteady aerodynamics aspects of airframe and its components and their role in aero elasticity.
3. Comprehend theoretical basis for the solution of static aero elastic problems.
4. Apply the knowledge to solve flutter problems and estimate of flutter speeds

Pre-requisites: Aircraft Structures and Aerodynamics

Unit – I **08 Hours**

Aeroelastic Phenomena : Stability versus response problems; The aeroelastic triangle of forces; Aero elasticity in aircraft design; Prevention of aero elastic instabilities; Influence and stiffness coefficients; Coupled oscillations.

Unit – II **08 Hours**

Divergence of A Lifting Surface: Simple two dimensional idealizations; Strip theory, integral equation of the second kind exact solutions for simple rectangular wings, Semi rigid assumption and approximate solutions; Generalized coordinates, numerical approximations using matrix equations.

Self-learning topics: Successive approximations

Unit – III **08 Hours**

Steady State Aero elastic Problems: Loss and reversal of aileron control, critical aileron reversal speed, aileron efficiency, semi rigid theory and successive approximations. Lift distribution; Tail efficiency, effect of elastic deformation on static longitudinal stability.

Self-learning topics: rigid and elastic wings

Unit – IV **08 Hours**

Flutter Phenomenon: Non-dimensional parameters, stiffness criteria, dynamic mass balancing, and dimensional similarity; Flutter analysis, two dimensional thin airfoils in steady incompressible flow, quasi steady aerodynamic derivatives.

Unit – V **08 Hours**

Galerkin method for critical flutter speed, stability of disturbed motion, solution of the flutter determinant, methods of determining the critical flutter speeds, flutter prevention and control. Case studies on aircraft wing, aircraft engine, turbo machines.

Books	
	Text Books:
1.	Y.C. Fung, ―An Introduction to the Theory of Aero elasticity, John Wiley & Sons Inc., New York, 2008.
2.	E.G. Broadbent, ―Elementary Theory of Aeroelasticity, Bun Hill Publications Ltd., 1986.
	Reference Books:
1.	R.L. Bisplinghoff, H. Ashley, and R.L. Halfmann, ―Aeroelasticity‖, 2nd Edition Addison Wesley Publishing Co., Inc., 1996.
2.	R.H. Scanlan and R. Rosenbaum, ―Introduction to the study of Aircraft Vibration and

	Flutter‖, Macmillan Co., New York, 1981.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1	https://nptel.ac.in/courses/101104005/: Aero Elasticity course at IIT Kanpur by Prof. C Venkatesan

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Describe** effect of aeroelasticity in aircraft design and its stability	**L2**
2. **Comprehend** structural dynamic and steady and unsteady aerodynamics aspects of airframe and its components and their role in aeroelasticity.	**L2**
3. **Illustrate** theoretical basis for the solution of static aeroelastic problems an estimate loads and other critical speeds.	**L2**
4. **Discuss** theoretical basis for the solution of flutter problems and estimate of flutter speeds	**L2**
5. **Deduce** effect of aeroelasticity in aircraft design and its stability	**L2**

Program Outcome of this course (POs)	**PO No.**
1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**

Course delivery methods	**Assessment methods**
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment
	3. Quiz & Case Study
	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	1	2	3	4	5
Marks	20	20	20	20	20

Course Code	18AE7414	**Credits**	3
Course type	PE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Provide knowledge of the basics of industrial automation and control systems
2. Provide knowledge of industrial robotics and its industrial applications
3. Make students understand the basics of PLC and control using PLC
4. Understand the concepts of material transport and storage system used in industries
5. Impart the knowledge of Flexible Manufacturing System.

Pre-requisites : Fundamentals of manufacturing processes

Unit - I **08 Hours**

Introduction to Automation : Basic elements of an automated system: power to accomplish the automated process, program of instructions, control system, types of automation, reasons for automation, advanced automation functions: safety monitoring, maintenance and repair diagnostics, error detection and recovery

Industrial Control Systems: Process industries versus discrete manufacturing industries, continuous versus discrete control, computer process control.

Self-learning topics: levels of automation.

Unit – II **08 Hours**

Industrial Robotics : Robot anatomy and related attributes: Joints and links, common robot configurations, notations, joint drive system, robot control systems: limited sequence control, play back with point to point control, play back with continuous path control, intelligent control, end effectors: grippers and tools, sensors in robots, industrial robot applications: material handling applications, processing operations, assembly and inspection, robot programming: lead through programming, simulation and offline programming, robot accuracy and repeatability. programming languages.

Unit – III **08 Hours**

Discrete control using PLC and personal computers : Discrete process control, ladder logic diagram, Programmable logic controller: hardware, internal architecture, input/output devices, ladder diagram, logic functions, latching, multiple outputs, entering program, function block, program examples, instruction list, sequential function charts, structured text, internal relays, ladder programs, battery backed relays, one shot operation, set and reset, master control relay,

Self-learning topics: personal computers using soft logic.

Unit – IV **08 Hours**

Material transport system: Introduction to material handling, material transport equipment, analysis of material transport system.

Storage systems: Storage system performance and location strategies, conventional storage methods and equipments, automated storage systems, engineering analysis of storage systems.

Unit – V **08 Hours**

Flexible Manufacturing Systems : Definition of FMS, basic components of FMS, different types of FMS, types of FMS layouts, factors influencing FMS layout, aim and principle objectives of FMS, FMS applications, FMS advantages and disadvantages, various equipments and their functions required for FMS, FMS planning and implementation issues, quantitative analysis of FMS.

Books	
	Text Books:
1.	M. P. Groover , Automation, Production system & Computer Integrated manufacturing, Person India, 2007, 3rd edition .
2.	W. Bolton, Programmable Logic Controller, 2006, 4th edition
	Reference Books:
3.	R. K. Mittal and I. J. Nagrath, Robotics and Control, McGraw Hill Education, 2007, 6th reprint
4.	H. K. Shivanand, M. M. Benal, V. Koti, Flexible Manufacturing System, New Age International Limited, 2006
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/112/102/112102011/
2.	https://nptel.ac.in/courses/112/103/112103174/
3.	https://swayam.gov.in/nd1_noc20_me03/preview

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Demonstrate** the basics of industrial automation and discrete control systems	**L2**
2.	**Describe** industrial robotics and its applications and programming	**L2**
3.	**Describe** industrial control using PLCs	**L2**
4.	**Identify** the material transport and storage systems	**L3**
5.	**Discuss** the Flexible Manufacturing system and its implementation	**L3**

	Program Outcome of this course (POs)	PO No.
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2.	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**
3.	**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	**PO5**
4.	**Life-long learning**: Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.	**PO12**

	Course delivery methods		Assessment methods
1.	Black Board Teaching	1.	Internal Assessment
2.	Power Point Presentation	2.	Assignment
3.	Working Models	3.	Seminar
4.	Videos	4.	Mini-project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:40**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Airworthiness And Certification

Course Code	18AE7415	**Credits**	3

Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs; Tutorial = 0 Hrs Total = 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Collaborate effective implementation of the safety related airworthiness rules, regulations.
2. Understanding the national documents and standards.
3. Learn the fundamental principles related to engineering activities of the operators, maintenance and other related organizations, safety hazard.

Pre-requisites: Elements of Aeronautics

Unit – I **08 Hours**

Basic Concepts: Introduction to aircraft rules as far as they relate to airworthiness and safety of aircraft; airworthiness requirements for civil and military aircraft CAA, FAA, JAR and ICAO regulations; defence standards; military standards and specifications.

Unit – II **08 Hours**

Responsibilities of AME Licenses: 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

Self-learning topics: airworthiness knowledge of log book, journey log book, technical log book

Unit – III **08 Hours**

Certification: 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.

Unit – IV **08 Hours**

Registration Procedure: certification, identification and marking of aircraft; modification, concessions, airworthiness directives, service bulletins; crew training and their licenses, approved inspection, approved materials, identification of approved materials; bonded and quarantine stores; storage of various aeronautical products like rubber goods, various fluids.

Unit – V **08 Hours**

Case Studies and Investigations: Accident investigation procedures; circumstances under which C of A is suspended; ICAO and IATAregulations, Chicago and Warsaw conventions; familiarization of recent issues of advisory circulars, dgca rules for drones.

Self-learning topics: Civil aviation requirements section 2-airworthiness.

Books	
	Text Books:
1.	DGCA, ―Aircraft Manual (India): The Aircraft Act 1934 Along With the Aircraft Rules, 1937‖,Sterling Book House, 2009.
2.	Civil Aviation Contingency Operations Manual of Planning, Training and Operations, Transport Canada publication, 1999.
3.	Civil Aircraft Airworthiness Information and Procedures (CAP 562), safety and airspace regulation group, Version 4.1, 2016.
	Reference Books:
1.	Richard S. Leavenworth, Eugene Lodewick Grant, ―Statistical quality control‖,

	McGraw-Hill Education, 2000.
2.	Parker E.R., ―British Civil Airworthiness Requirements‖, Civil Aviation Authority, revised edition, 2001.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. A K Ghosh , Prof.Vipul Mathur, IIT Kanpur https://nptel.ac.in/courses/101104071/

Course Outcome (Cos)

At the end of the course, the student will be able to		Bloom's Level
1.	**Explain** the safety related airworthiness rules, regulations.	**L2**
2.	**Understand** the national documents and standards.	**L2**
3.	**Explain** the fundamental principles related to engineering activities of the operators	**L2**
4.	**Apply** airworthiness rules &regulations	**L3**

	Program Outcome of this course (Pos)	**PO No.**
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2.	**Problem analysis:** Identify, formulate, research literature, and nalyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
3.	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	**PO8**

Course delivery methods	**Assessment methods**
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment, Quiz
3. Working Models	3. Course Seminar
4. Videos	4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Experimental Aerodynamics

Course Code	18AE7511	**Credits**	3
Course type	PE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives

Enable students to

1. Describe basic fundamentals of Aerodynamics experiments, their need in comparison with numerical computation and theoretical studies.
2. Develop concepts of flow similarity and evaluate the loss coefficients of wind tunnel components.
3. Analyze the concept of force and moment measurements using wind tunnel balance and extrapolate it to new balance development.
4. Summarize various techniques for calculation of pressure, velocity, and flow visualization.

Pre-requisites: Fluid Mechanics and Aerodynamics

Unit – I **06 Hours**

Fundamentals of Experiments In Aerodynamics: Forms of aerodynamic experiments, observations, measurement objectives, model testing, wind tunnel principles, scaling laws. Special tunnels: low turbulence tunnels, high Reynolds number tunnels, environmental tunnels, automobile tunnels, distinctive features, application.

Self-learning topics: Wind tunnels: low speed tunnel, high speed tunnels, transonic, supersonic and hypersonic tunnels, shock tubes.

Unit – II **10 Hours**

Wind Tunnel Experimentation Considerations: principal components. Function, description, design requirements, constraints and loss coefficients. Wind tunnel performance flow quality, power losses, wind tunnel corrections, sources of errors, buoyancy, solid blockage, wake blockage, streamline curvature causes, estimation and correction.

Unit – III **08 Hours**

Wind Tunnel Balance Load measurement: low speed wind tunnel balances, mechanical & Strain gauge types, null displacement methods & strain method, sensitivity, weigh beams, steel yard type and current balance type, balance linkages, levers and pivots. Model support three point wire support, three point strut support, platform balance, yoke balance, strain gauge, 6-component strain gauge balance, description, application.

Unit – IV **08Hours**

Measurements techniques:static pressure, surface pressure orifice, static probes, pitot probe for total pressure, static pressure and transducers, hot wire anemometry, laser doppler anemometry, projection manometer, multi-tube manometers wake rake apparatus to calculate the drag, calibration, measurement, data processing (DAS), applications.

Unit – V **08 Hours**

Flow Visualization Techniquesnecessity, streamlines, streak lines, path lines, time lines, tufts, china clay, oil film, smoke, hydrogen bubble. Optical methods: density and refractive index, schlieren system, convex lenses, concave mirrors, shadowgraph, interferometry, working principle, description, setting up, operation, observation, recording, interpretation of imagery, relative merits and applications, PIV (particle image velocity)

Books

	Text Books:
1.	Gorlin S M &Slezinger I I, ―Wind tunnels & Their Instrumentations‖, NASA publications, translated version, 1966.
	Reference Books:
1.	Jorge C Lerner &UlfilasBoldes, ―Wind Tunnels and Experimental Fluid Dynamics Research‖,InTech, 1st Edition, 2011.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. Job Kurian, IIT Madras https://nptel.ac.in/courses/101106040/

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Apply** the basic knowledge of aerodynamics in experiments in wind tunnel.	**L2**
2.	**Understand** the various components its functions in wind tunnels.	**L1**
3.	**Understand** the different types measuring techniques used in wind tunnels.	**L1**
4.	**Learn** the different techniques of measurements in wind tunnels.	**L1**

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2.	**Problem analysis**: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**

Course delivery methods	**Assessment methods**
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment
3.	3. Quiz

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:40**

3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Air Transportation System

Course Code	18AE7512	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40Hrs; Tutorial = 0Hrs Total = 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand the different aircraft transportation organizations.
2. Learn airline economics.
3. Compare the various airline scheduling.
4. Illustrate the aircraft reliability.
5. Describe the aircraft maintenance.

Pre-requisites: Elements of Aeronautics, Air traffic control & Aircraft maintenance repair and overhaul

Unit – I **08Hours**

Development of air transportation, comparison with other modes of transport, Role of IATA, ICAO The general aviation industry airline, Factors affecting general aviation, use of aircraft, airport: airline management and organization, levels of management, functions of management, Principles of organization planning the organization chart.

Self-study: staff departments and line departments

Unit – II **08 Hours**

Forecasting Fleet size, Fleet planning, the aircraft selection process, operating cost, passenger capacity, load factor etc.Passenger fare, Influence of geographical, economic and political factors on routes and routeselection. Fleet Planning: The aircraft selection process, Fleet commonality, factors affecting choice of fleet, route selection and Capital acquisition, Cost planning, Aircrew evaluation, Route analysis, Aircraft evaluation.

Self-study: Valuation and Depreciation, Budgeting

Unit – III **08Hours**

Equipment maintenance, Flight operations and crew scheduling, Ground operations and facility limitations equipments and types of schedule, hub and spoke scheduling, advantages / disadvantages and preparing flight plans, Aircraft scheduling in line with aircraft maintenance practices.

Unit – IV **08 Hours**

Aircraft reliability, The maintenance schedule and its determinations, Condition monitoring maintenance, Extended range operations (EROPS) and ETOPS, Ageing aircraft maintenance production.

Unit – V **08 Hours**

Airlines scheduling (with reference to engineering), Product support and spares, Maintenance sharing, Equipments and tools for aircraft maintenance, Aircraft weight control, Budgetary control. On board maintenance systems, Engine monitoring, Turbine engine oil maintenance, Turbine engine vibration monitoring in aircraft, Life usage monitoring, Current capabilities of NDT,Helicopter maintenance, Future of aircraft maintenance.

Books	
	Text Books:
1.	Fedric, J.H., “Airport Management”, English Book House, New Delhi-I.
2.	Gene Krope., “Airline Procedures”, English Book House, New Delhi-I.

	Reference Books:
1.	Wilson and Bryon, "Air Transportation", English Book House, New Delhi-I.
2.	Philip Lockin D, "Economics of Transportation", English Book House, New Delhi-I.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1	https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-886-air-transportation-systems-architecting-spring-2004/
2.	https://www.icao.int/safety/ngap/Pages/Fundamentals-of-the-Air-Transport-System-(FATS)-eLearning-Course.aspx

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Interpret** various organizations in aircraft transportations.	**L2**
2. **Describe** the various fleet economics and ergonomics.	**L2**
3. **Discuss** the principles of aircraft scheduling.	**L2**
4. **Quantify** the reliability of aircraft and range of operation.	**L2**
5. **Illustrate** the technologies used in aircraft maintenance.	**L2**

Program Outcome of this course (POs)	PO No.
1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. Problem analysis: Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences	**PO2**
3. 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.	**PO12**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment
	3. Quiz&Case Study
	4. SEE

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	1	2	3	4	5
Marks	20	20	20	20	20

Flight dynamics

Course Code	18AE7513	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs; Tutorial = 0 Hrs Total = 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Study the performance of airplanes under various operating conditions
2. List & understand the different types of drags
3. Describe the static and dynamic response of aircraft for both voluntary and involuntary changes in flight conditions
4. Understand the response of aircraft under various flight conditions

Unit – I 08 Hours

Cruising Flight Performance: Forces and moments acting on a flight vehicle Equation of motion of a rigid flight vehicle – Different types of drag –estimation of parasite drag co-efficient by proper area method- Drag polar of vehicles from low speed to high speeds - Variation of thrust, power with velocity and altitudes for air breathing engines.

Self-learning topics: power with velocity and altitudes for air breathing engines.

Unit – II 08 Hours

Maneuvering Flight Performance: Range and endurance - Climbing and gliding flight (Maximum rate of climb and steepest angle of climb, minimum rate of sink and shallowest angle of glide) -Turning performance (Turning rate turn radius).

Self-learning topics: Bank angle and load factor – limitations on turn - V-n diagram and load factor

Unit – III 08 Hours

Static Longitudinal Stability: Degree of freedom of rigid bodies in space – Static and dynamic stability - Purpose of controls in airplanes -Inherently stable and marginal stable airplanes – Static, Longitudinal stability - Stick fixed stability - Basic equilibrium equation - Stability criterion Effects of fuselage and nacelle - Influence of CG location

Lateral and Directional Stability: Dihedral effect - Lateral control – Coupling between rolling and yawing moments - Adverse yaw effects - Aileron reversal - Static directional stability - Weather cocking effect - Rudder requirements.

Case Studies**:** One engine inoperative condition - Rudder lock.

Unit – IV 08 Hours

Modeling and Interpreting the Aerodynamics: Definition and modeling of Aerodynamic coefficients, Static and dynamic Aerodynamic coefficients Terms and flow curvature coefficient terms. Sample simulation.

Unit – V 08 Hours

Dynamic Stability: Introduction to dynamic longitudinal stability: - Modes of stability, effect of freeing the stick – Brief description of lateral and directional stability. Dynamic stability - Spiral, divergence, Dutch roll, auto rotation and spin.

Books	
	Text Books:
1.	Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley & Son:,Inc, NY, 1988.
2.	Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 2004
3.	McCornick. W., "Aerodynamics, Aeronautics and Flight Mechanics", John Wiley, NY, 1979.
	Reference Books:
1.	Etkin, B., "Dynamics of Flight Stability and Control", Edn. 2, John Wiley, NY, 1982.
2.	Babister, A.W., "Aircraft Dynamic Stability and Response", Pergamon Press, Oxford, 1980.
3.	Nandan K. Sinha and N. Ananthkrishnan "Advanced Flight Dynamics with Elements of Flight Control" CRC Press 2017.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Dr. Nandan Kumar Sinha, IIT Madras https://nptel.ac.in/courses/101106042/
2.	**NPTEL:** Online Resources: Lecture by: Prof. E G Tulapurkara, IIT Madras https://nptel.ac.in/courses/101106043

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2.	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**

Course delivery methods	**Assessment methods**
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment, Quiz
3. Working Models	3. Course Seminar
4. Videos	4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100

Writing two IA tests is compulsory.
It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA
Minimum marks required to qualify for SEE : 20 out of 50 marks

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for

the calculation of SGPA and CGPA.

2. **Minimum marks required in SEE to pass:**

3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Hydraulics and pneumatics

Course Code	18AE7514	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs; Tutorial = 0 Hrs Total = 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Gain the knowledge on the application of fluid power in process, construction and manufacturing Industries.
2. Understand of the fluids and components utilized in modern industrial fluid power system.
3. Develop a measurable degree of competence in the construction and operation of fluid power circuits.

Unit – I **08 Hours**

Introduction to Fluid power – Advantages and Applications – Fluid power systems – Types of fluids - Properties of fluids and selection – Basics of Hydraulics – Pascal's Law – Principles of flow - Friction loss – Work, Power and Torque Problems, Sources of Hydraulic power : Pumping Theory – Pump Classification – Construction, Working, Advantages, Disadvantages, Performance, Selection criteria of Linear and Rotary – Fixed and Variable displacement pumps – Problems.

Self-learning topics: Fixed and Variable displacement pumps

Unit – II **08 Hours**

Hydraulic Actuators: Cylinders – Types and construction, Application, Hydraulic cushioning – Hydraulic motors - Control Components : Direction Control, Flow control and pressure control valves – Types, Construction and Operation – Servo and Proportional valves – Applications – Accessories : Reservoirs, Pressure Switches – Applications – Fluid Power ANSI Symbols – Problems.

Self-learning topics: Pressure Switches – Applications

Unit – III **08 Hours**

Accumulators, Intensifiers, Industrial hydraulic circuits – Regenerative, Pump Unloading, Double Pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-Safe, Speed Control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical hydraulic servo systems.

Unit – IV **08 Hours**

Compressor – Filters, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust Valves, Pneumatic actuators, Design of Pneumatic circuit – Cascade method – Electro Pneumatic System – Elements – Ladder diagram – Problems, Introduction to fluidics and pneumatic logic circuits.

Unit – V **08 Hours**

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems, hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Pneumatic circuits for Pick and Place applications and tool handling in CNC Machine tools – Low cost Automation – Hydraulic and Pneumatic power packs.

Books	
	Text Books:
1.	Anthony Esposito, "Fluid Power with Applications", Pearson Education 2005.
2.	Majumdar S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGrawHill, 2001.
3.	Majumdar S.R., "Pneumatic systems – Principles and maintenance", Tata McGraw Hill, 1995
	Reference Books:
1.	Anthony Lal, "Oil hydraulics in the service of industry", Allied publishers, 1982.
2.	Dudelyt, A. Pease and John T. Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. R.N. Maiti, IIT Karagpur https://nptel.ac.in/courses/112105046/
2.	**NPTEL:** Online Resources: Lecture by: Prof. R.N. Maiti, IIT Karagpurhttps://www.youtube.com/watch?v=2__g1Fntx4o

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Explain** the Fluid power and operation of different types of pumps.	**L2**
2.	**Summarize** the features and functions of Hydraulic motors, actuators and Flow control valves	**L2**
3.	**Describe** the different types of Hydraulic circuits and systems	**L2**
4.	**Explain** the working of different pneumatic circuits and systems	**L2**
5.	**Describe the** various trouble shooting methods and applications of hydraulic and pneumatic systems.	**L2**

	Program Outcome of this course (POs)	**PO No.**
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2.	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**

Course delivery methods	**Assessment methods**
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment, Quiz
3. Working Models	3. Course Seminar
4. Videos	4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100

Writing two IA tests is compulsory.
It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA
Minimum marks required to qualify for SEE : 20 out of 50 marks

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Course Code	18AE7515	**Credits**	3
Course type	PE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs; Tutorial = 0 Hrs Total = 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand the different types of additives and its preparation process.
2. Learn different intrusive and non-intrusive methods of additive preparation.
3. Understand rapid manufacturing techniques used in Aeronautical Engineering.
4. Apply their knowledge in using manufacturing software.

Unit – I **08 Hours**

Introduction: Definition of Prototype, Types of prototype, Need for the compression in product development, History of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems. Stereo lithography Systems: Principle, Process parameter, process details, Data preparation, data files and machine details, Application.

Self-learning topics: Data preparation

Unit – II **08 Hours**

Selective Laser Sintering: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, fusion deposition modeling: Principle, Process parameter, Path generation, Applications.

Unit – III **08 Hours**

Solid Ground Curing: Principle of operation, Machine details, Applications, Laminated Object Manufacturing: Principle, of operation, LOM materials, process details, applications. Concepts Modelers: Principle, Thermal jet printer, Sander‘s model market, 3-D printer, GenisysXs printer HP system 5, object Quadra systems, Laser Engineering Net Shaping (LENS)

Self-learning topics: Laser Engineering Net Shaping (LENS)

Unit – IV **08 Hours**

Rapid Tooling : Indirect Rapid tooling -Silicon rubber tooling —Aluminum filled epoxy tooling Spray metal tooling, Cast kirksite, 3D keltooletc, Direct Rapid Tooling — Direct, AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, ProMetal, Sand casting tooling, Laminate tooling soft Tooling vs. hard tooling.

Unit – V **08 Hours**

Software For RP: Stl files, Overview of Solid view, magics, imics, magic communicator, etc. Internet based software, Collaboration tools, RAPID Manufacturing Process Optimization: factors influencing accuracy, data preparation errors, Part building errors, Error in finishing, influence of build orientation. Allied Processes: vacuum, casting, surface digitizing, surface generation from point cloud, surface modification — data transfer to solid models.

Self-learning topics: vacuum, casting, surface digitizing

Books	
	Text Books:
1.	Paul F. Jacobs: ―Stereo 1ithography and other RP & M Technologies‖-SME NY, 1996.
2.	Flham D.T &Dinjoy S.S ―Rapid Manufacturing- Verlog London 2001.
	Reference Books:

1.	Terry Wohler's ―Wohler's Report 2000‖- Wohler's Association 2000
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. G Saravana Kumar, IIT Madras https://www.youtube.com/watch?v=gcia0aqZMf0
2.	**NPTEL:** Online Resources: Lecture by: Prof. ShanthanuBattacharya, IIT Kanpur http://www.digimat.in/nptel/courses/video/112104204/L47.html

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Understand** various types of additives and its manufacturing methods	**L2**
2. **Understand** the process involved in currying and tooling.	**L2**
3. **Give a detail presentation** of current rapid manufacturing systems used in various industries with some case studies	**L2**
4. **Evaluate** the best rapid tooling method for product development make use of current software tools	**L3**
5. **Analyze** rapid prototyping systems for new product development and give a detailed technical report on current research	**L4**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment, Quiz
3. Working Models	3. Course Seminar
4. Videos	4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.

2. **Minimum marks required in SEE to pass:**

3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Introduction To Rocket Propulsion

Course Code	18AE7611	**Credits**	3
Course type	OE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs; Tutorial= 0 Hrs Total = 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Describe various types of propulsion system with their merits of challenges.
2. Understand the solid propellant rocket system
3. Understand the liquid propellant rocket system
4. Understand the hybrid propellant rocket system
5. Comprehend the basic requirements of the test facilities for rocket propulsion system.

Unit – I **08 Hours**

Introduction to Propulsion: Rocket Propulsion –Definition, Principle, Classification, Description and Application; Electrical, Nuclear and other Advanced Propulsion Systems

Unit – II **08 Hours**

Solid Propellant Rockets: Application and Classification of Solid Propellant Rocket Motors; Propellants and Characteristics; Ingredients and Processing; Propellant Burning Rate; Propellant Grains and Grain Configurations.

Unit – III **08 Hours**

Liquid Propellant and their Properties; Liquid Propellant Feed Systems; Injectors; Thrust Chamber Shapes and Characteristic Length, types of propellant and oxidizers and applications.

Unit – IV **08 Hours**

Hybrid PropellantRocket Motors; Gaseous Propellant Rocket Motors and Reaction Control Systems, structure of Hybrid Rocket, types of propellant and oxidizers and applications.

Unit – V **08 Hours**

Rocket Testing: Types of Tests; Test Facilities and Safeguards; Safety and Environmental Concerns; Monitoring and Control of Toxic Materials and Exhaust Gases; Instrumentation and Data Management; Reliability and Quality Control; Flight Testing.

Books	
	Text Books:
1.	Rocket Propulsion Elements, Sutton, G.P., Biblarz, O., 7thEd. John Wiley & Sons, Inc., New York, 2001.
2.	Rocket Propulsion, Barrere, M., Jaumotte, A., Fraeijs de Veubeke, B.,Vandenkerckhove J., Elsevier Publishing Company, 1960
	Reference Books:
1.	Terry Wohler‘s ―Wohler’s Report 2000‖- Wohler‘s Association 2000
2.	Rocket and Spacecraft Propulsion: Principle, Practice and New Developments, Turner, M. J. L., SpringerVerlag. 2000
3.	Understanding Chemical Rocket Propulsion, Mukunda, H.S., I K International Publishing House, 2017.
4.	Rocket Propulsion, Ramamurthi, K., 2ndEdition, Trinity Press of Laxmi Publications Private Limited, India, 2016.

	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. D P Mishra, IIT Kanpur https://nptel.ac.in/courses/101104078/
2.	**NPTEL:** Online Resources: Lecture by: Prof. K Ramamurthi, IIT Madras https://nptel.ac.in/courses/112106073/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Analyze** the propulsion system along with the advanced propulsion system.	**L3**
2. **Understand and examine** various parameters used in solid rocket motor.	**L3**
3. **Explain** the liquid propellant rocket system	**L2**
4. **Comprehend and illustrate** the working of hybrid rocket	**L2**
5. **Relate** the significance of test facilities and their associated parameters	**L3**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment, Quiz
3. Working Models	3. Course Seminar
4. Videos	4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.

2. **Minimum marks required in SEE to pass:**

3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Airport operations

Course Code	18AE7612	**Credits**	3
Course type	OE	**CIE Marks**	50 marks
Hours/week: L-T-P	3-0-0	**SEE Marks**	50 marks
Total Hours:	Lecture = 40 Hrs; Tutorial = 0 HrsTotal = 40Hrs	**SEE Duration**	3 Hours for 100 marks

Course learning objectives

Enable students to

1. Understand the airport and its operations
2. Acquire the knowledge of Ground Handling and Baggage Handling
3. Understand the various Operations and Technical Services
4. Acquire the knowledge of Operational Administration and Performance

Unit – I **08 Hours**

The Airport as a Operational System: Private airports and public use airports, commercial service airports and primary commercial service airports, general aviation airports, reliever airports, Hub classification, large hubs, medium hubs, small hubs, non-hubs, Components of an airport, airside, landside, Airport as a system, function of the airport complexity of airport operation, Airport planning, environmental planning.

Unit – II **08 Hours**

Ground Handling and Baggage Handling

Ground handling: Passenger handling; Ramp handling; Aircraft ramp servicing, Departure control, Division of ground handling responsibilities, Control of ground handling efficiency, Baggage handling processes; Equipment, systems and technologies, process and system design drivers; Organization; Management and performance metrics.

Unit – III **08 Hours**

Passenger Terminal and Cargo Operations

Passenger terminal operations: Terminal functions; Direct passenger services; Airline related passenger services; Airline related operational functions; Government requirements; Non-passenger related airport authority functions; Space components and adjacencies. Hubbing considerations; Cargo operations: Expediting the movement; Flow through the terminal; Unit load devices; Handling within the terminal; Cargo apron operation.

Unit – IV **08 Hours**

Airport Technical Services and Access

The scope of technical services; Safety management system; Air traffic control; Tele communications; Meteorology; Aeronautical information; Airport access: Access as part of the airport system; Access interaction with passenger; Access modes; In town and other off; Airport terminals; Factors affecting access.

Unit – V

08 Hours

Operational Administration and Performance

Strategic context; Tactical approach to administration of airport operations; Managing operational performance, Key success factors for high Performance; Airport operations control centers: airport operations control system; The airport operations consideration; Airport performance monitoring, human resources considerations;

Books	
	Text Books:
1.	Norman J. Ashford, H. P. Martin Stanton, Clifton A. Moore, Pierre Coutu, ―Airport Operations‖,McGraw Hill, 3rd Edition, 2013.
2.	R. Horonjeff, F. X. McKelvey, W. J. Sproule, S. B. Young, ―Planning and Design of Airports‖,McGraw Hill, 5th Edition, 2010.
	Reference Books:
1.	A. Kazda, R. E. Caves, ―Airport Design and Operation‖, Elsevier, 2nd Edition, 2007.
2.	A. T. Wells, S. B. Young, ―Airport Planning and Management‖, McGraw Hill, 6th Edition, 2011.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Acquire** the knowledge of the Airport Operations	**L3**
2. **Understand** the various Handling techniques in airport	**L3**
3. **Recognize** the need Technical Services in airport**.**	**L2**
4. **Acquire** the knowledge Operational Administration	**L3**

Program Outcome of this course (POs)		PO No.
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems	**PO1**
1.	**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.	**PO6**
2.	**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.	**PO7**
3.	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.	**PO8**
4.	**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.	**PO11**
5.	**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.	**PO12**

Course delivery methods

1. Black Board Teaching
2. Power Point Presentation
3. Working Models
4. Videos

Assessment methods

1. Internal Assessment
2. Assignment, Quiz
3. Course Seminar
4. Course project

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Two assignments	Quiz/Seminar/Course Project	Total Marks
Maximum marks :100	30+30 = 60	10+10	20	100
Writing two IA tests is compulsory. It will be conducted for 100 marks and will be reduced to 50 marks for the calculations of SGPA and CGPA Minimum marks required to qualify for SEE : 20 out of 50 marks				

Self-study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. **Minimum marks required in SEE to pass:**
3. Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

Marks split-up

Unit No	**1**	**2**	**3**	**4**	**5**
Marks	**20**	**20**	**20**	**20**	**20**

Aircraft General Maintenance

Course Code	18AE7613	**Credits**	3
Course type	OE	**CIE Marks**	50
Hours/week: L-T-P	3-0-0	**SEE Marks**	50
Total Hours:	40	**SEE Duration**	3 Hours for 100 marks

Course Learning Objectives

Enable students to

1. Understand the maintenance, repair and overhaul process.
2. Learn different departments merged to function as maintenance team.
3. Understand different types of checks, components and computer network.
4. Understand assembly and rigging process of aircraft components.
5. Learn safety measures of aircrafts and inspection process.

Unit – I **06 Hours**

Introduction: function of Director general of civil aviation, role of Federal Aviation Administration, Zones of aircraft, classifications of aircraft components, certification for maintenance, Aircraft handling in airport, initial maintenance check up (Commercials and military standards)

Unit – II **10 Hours**

Maintenance Team and Checks: Maintenance departments: Planning, Logistics, Quality, line maintenance. Computer tool Aircraft Maintenance operating system, Checks: C-type and D-type check of aircraft in hanger. Tracking life of components, interchangeability of components

Unit – III **08 Hours**

Aircraft Jacking, Assembly and Rigging Airplane jacking and weighing, Balancing of control surfaces, Inspection maintenance. Helicopter flight controls. Tracking and balancing of main rotor, C G Location ,various instruments in helicopters

Unit – IV **08Hours**

Review of Hydraulic and Pneumatic System Trouble shooting and maintenance practices – Service and inspection. Inspection and maintenance of landing gear systems. Inspection and maintenance of air-conditioning and pressurization system, water and waste system. Installation and maintenance of Instruments handling Testing Inspection.

Unit – V **08 Hours**

Inspection And Maintenance Of Auxiliary Systems: Inspection and maintenance of auxiliary systems Fire protection systems, Ice protection system, Position and warning system, Auxiliary Power Units (APUs)Safety Practices Hazardous materials storage and handling, Aircraft furnishing practices Equipments. Troubleshooting - Theory and practices.

Books	
	Text Books:
1.	Kroes, Watkins, Delp, "Aircraft Maintenance and Repair", Mcgraw-Hill, New York 1992.
2.	Brimm D.J. Bogges H.E., "Aircraft Maintenance", Pitman Publishing Corp. New York, 1940.
	Reference Books:
1.	Larry Reithmeir, "Aircraft Repair Manual", Palamar Books, Marquette, 1992
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Mr. VipulMathur, IIT Kanpur https://nptel.ac.in/courses/101104071/

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Understand** the maintenance procedure.	**L1**
2. **Understand** the major zones of aircrafts and components.	**L1**
3. **Understand** the different types of checks and their importance.	**L1**
4. **Understand** safety practice, inspection and assembly procedure.	**L1**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **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.	**PO12**

Course delivery methods	Assessment methods
1. Black Board Teaching	1. Internal Assessment
2. Power Point Presentation	2. Assignment
3.	3. Quiz

Scheme of Continuous Internal Evaluation (CIE):

Components	Average of best two IA tests out of three	Average of two assignments	Quiz	Class Performance	Total Marks
Maximum Marks: 50	25	10	5	10	50

- Writing two IA test is compulsory.
- Minimum marks required to qualify for SEE : Minimum IA test marks (Average) 10 out of 25 AND total CIE marks 20

Self-Study topics shall be evaluated during CIE (Assignments and IA tests) and 10% weightage shall be given in SEE question paper.

Scheme of Semester End Examination (SEE):

1. It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2. Minimum marks required in SEE to pass: 40 out of 100

3. Question paper contains 10 questions each carrying 20 marks. Students have to answer FIVE full questions selecting one from each unit.

Marks split-up

Unit No	1	2	3	4	5
Marks	20	20	20	20	20

Advanced Flight Simulator and Control Lab

Course Code	18AEL77	**Credits**	1
Course type	PC	**CIE Marks**	25 marks
Hours/week: L-T-P	0-0-2	**SEE Marks**	25 marks
Total Hours:	24	**SEE Duration**	3 Hours for 50 marks

Course learning objectives

Enable students to

1. To introduce the basic Application of Flight simulators in Aerospace domain.
2. Introduce the basic concepts of cockpit instruments; avionic interfaces communication and navigation systems.
3. Have hands on experience on Flight Simulator.
4. Develop conceptual skills in data transfer which is applicable to aeronautical domain.

List of experiments

1. Effect of speed on Glide Performance
2. Calculation of CL and CD Using the speed Power method
3. Effect of Velocity on Climb Rate
4. Effect of Altitude on Range & Endurance Of the Aircraft
5. Aircraft Maneuver Performance
6. Effect of high lift devices and weight on takeoff performance
7. Effect of high lift devices and weight on Landing performance
8. Simulation of Longitudinal Stability Modes
9. Simulation of Lateral-Directional Stability Modes
10. Study of various display systems in cockpit when aircraft is in steady Flight condition.
11. Study of Various Input systems in Cockpit to Simulate Aircraft Take off and landing Phase.

Books	
	Text Books:
1.	Moir, I. and Seabridge, A., Civil Avionics Systems, Wiley-Blackwell; 2nd edition (11 October 2013), ISBN-13: 978-1118341803
2.	R.P.G. Collinson., "Introduction to Avionics Systems", Springer; 3rd ed. 2011 edition (15 October 2014), ISBN-13: 978-9400792593.

Course Outcome (COs)

At the end of the course, the student will be able to		Bloom's Level
1.	**Understand** the Mathematical Modeling of Flight dynamics	**L2**
2.	**Determine** and **analyze** the Rate of climb and glide performance using Flight Simulator	**L3**
3.	**Analyze** the Takeoff and Landing Performance	**L3**
4.	**Analyze** the Longitudinal, Lateral –Directional Modes of Aircraft.	**L3**
5.	**Understand** various display systems in cockpit	**L2**

Program Outcome of this course (POs)	PO No.
1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
4. 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.	**PO5**
6. 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.	**PO12**

Course delivery methods	Assessment methods
1. Chalk and board	1. Conduct of experiments
2. PPT	2. Journal write up
3. **Video**	3. Viva-voce

Scheme of Continuous Internal Evaluation (CIE):

Components	Conduct of the lab	Journal submission	Mini Project	Total Marks
Maximum Marks: 25	10	10	5	25
➢ Submission and certification of lab journal is compulsory to qualify for SEE. ➢ **Minimum marks required to qualify for SEE : 10**				

Scheme of Semester End Examination (SEE):

1. It will be conducted for 50 marks of 3 hours duration**. It will be reduced to 25 marks for the calculation of SGPA and CGPA.** Single Experiment to be conducted in SEE.
2. **Minimum marks required in SEE to pass:20**
3.

Initial write up	10 marks	**50** marks
Conduct of experiment	20 marks	
Viva- voce	10 marks	
Quiz	10 marks	

Design, Modeling and Analysis Laboratory

Course Code	18AEL78	**Credits**	1
Course type	PC	**CIE Marks**	25 marks
Hours/week: L-T-P	0-0-2	**SEE Marks**	25 marks
Total Hours:	24	**SEE Duration**	3 Hours for 50 marks

Course learning objectives

Enable students to

1. Apply the knowledge of FEM to construct finite element models using the library of finite elements available in the software
2. Choose suitable number of finite elements for the given domain to form meshes
3. Apply the knowledge of CFD to construct model of fluid flow
4. Analyze the boundary conditions for the given problem and generating results
5. Compare the results analytically or experimental techniques

Pre-requisites: Basic knowledge of Finite Elements Analysis, Aerodynamics

List of experiments

1. Structural Modeling of Sandwich Beam having square Cross-Section and Analyze for Stresses.
2. Structural Modeling and Stress Analysis of a Fuselage Bulk Head.
3. Structural Modeling of a Three Dimensional Wing and analyze the modal frequency.
4. Structural Modeling and Stress Analysis of a wing with double engine at certain distance from fixed end.
5. Structural modeling and stress analysis of a tapered I section spar
6. Flow analysis of Symmetric Aerofoil of Inviscid flow
7. Flow analysis of Cambered Aerofoil of viscid flow
8. Flow Analysis of Symmetric Aerofoil of compressible flow (Supersonic Flows)
9. Heat transfer analysis of rectangular isotropic materials(pin-fins)
10. 2-D Convergent- Divergent Nozzle and Analyses of Flow for Adiabatic Conditions.

Books	
	Text Books:
3.	Chandrupatla T. R., "Finite Elements in engineering", PHI, 3rd edition, 2002, ISBN-13: 978- 8120321069.
4.	Anderson J D Jr "Computational Fluid Dynamics – The basics and applications", (1995), Mcgraw-Hill, New York.

Course Outcome (COs)

At the end of the course, the student will be able to	Bloom's Level
1. **Understand** the knowledge of various software used in industries	**L2**
2. **Analyze** the various engineering field problems	**L3**
3. **Execute** the various field problems using software.	**L3**
4. **Compare** the result values of field problem	**L4**
5. **Analyze** the results based on the experimental/ analytical values	**L4**

	Program Outcome of this course (POs)	PO No.
1.	**Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.	**PO1**
2.	**Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.	**PO2**
4.	**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.	**PO5**
6.	**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.	**PO12**

Course delivery methods	Assessment methods
1. Chalk and board	1. Conduct of experiments
2. PPT	2. Journal write up
3. **Video**	3. Viva-voce

Scheme of Continuous Internal Evaluation (CIE):

Components	Conduct of the lab	Journal submission	Mini Project	Total Marks
Maximum Marks: 25	10	10	5	25
➢ Submission and certification of lab journal is compulsory to qualify for SEE. ➢ **Minimum marks required to qualify for SEE : 10**				

Scheme of Semester End Examination (SEE):

1. It will be conducted for 50 marks of 3 hours duration**. It will be reduced to 25 marks for the calculation of SGPA and CGPA.** Single Experiment to be conducted in SEE.
2. **Minimum marks required in SEE to pass:20**
3.

Initial write up	10 marks	**50** marks
Conduct of experiment	20 marks	
Viva- voce	10 marks	
Quiz	10 marks	