DHANALAKSHMI SRINIVASAN ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)

PERAMBALUR - 621212

REGULATIONS – 2023

CHOICE BASED CREDIT SYSTEM

B. E. AERONAUTICAL ENGINEERING

CURRICULUM AND SYLLABI

DEPARTMENT OF AERONAUTICAL ENGINEERING

(Applicable to students admitted from the Academic year 2023 – 2024
And subsequently under Choice Based Credit System)

Discussed in BOS-4 meeting Dated: 17.10.2024/ Aeronautical

Ratified & Approved in Academic Council: 27.02.2025

VISION MISSION OF THE INSTITUTUION

Vision:

An active and committed Centre of advanced learning focused on research and training in the fields ofEngineering, Technology and Management to serve the nation better.

Mission:

- To develop eminent scholar with a lifelong follow up of global standards by offering UG,PG and Doctoral Programmes.
- To pursue Professional and Career growth by collaborating mutually beneficial partnership with industries and higher institutes of research.
- To promote sustained research and training with emphasis on human values and leadership qualities.
- To contribute solutions for the need based issues of our society by proper ways and means as dutiful citizen.

DEPARTMENT OF AERONAUTICAL ENGINEERING

About the Department

Department of Aeronautical Engineering is making great efforts in imparting knowledge and skill to meet the aircraft industry expectation. The department offers theory and lab works as per current trends through the qualified faculty and staff. Aeronautical Engineering department started functioning since 2006.The department has well equipped laboratory facilities and faculty to prepare the students to meet future requirement in the field of aviation.

Vision:

- To develop a global environment for quality education, research and training in the field of Aeronautical engineering

Mission:

- To improve educational quality through industry-institutional interaction in teaching, learning, and research.
- To create opportunities for career growth, and higher education ventures.
- To establish the facility for research and training activities and instill human values, leadership qualities.
- To implement innovations in the field of aeronautical engineering that can benefit society

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO 1	Graduates of the programme will be excellent in fields of research, product development, higher education, and employment.
PEO 2	Graduates of the programme will be able to excel in design, analytical thinking, and problem solving.
PEO 3	Graduates of the programme will have commitment to serving society, a sense of duty to preserve the environment, and moral behaviors in their career.

PROGRAM OUTCOMES (POs)

PO	Graduate Attribute
PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 1	Design and analyze aircraft structures, systems, and components using advanced engineering principles and tools
PSO 2	Apply knowledge of aerodynamics, propulsion, and flight mechanics to optimize aircraft performance, including range, speed, and fuel efficiency

PEO's – PO's & PSO's MAPPING:

PEO	**PO**												**PSO**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
I.	3	3	3	3	2	-	-	-	-	1	1	-	3	2
II.	3	3	3	2	3	2	1	2	-	1	2	2	3	2
III.	1	2	3	-	-	3	3	3	3	3	2	3	-	2

DHANALAKSHMI SRINIVASAN ENGINEERING COLLEGE (AUTONOMOUS), PERAMBALUR – 621 212

B.E. AERONAUTICAL ENGINEERING

REGULATIONS – 2023

CHOICE BASED CREDIT SYSTEM

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	IP3151	Induction Programme	-	-	-	-	-	-
2	U23HST11	Communicative English	HSMC	3	0	0	45	3
3	U23MAT12	Matrices and Calculus	BSC	3	1	0	60	4
4	U23PHT13	Physics for Engineers and Technologists	BSC	3	0	0	45	3
5	U23CYT14	Chemistry for Engineering & Technology	BSC	3	0	0	45	3
6	U23GET16	Engineering Graphics	ES	2	0	4	90	4
7	GE3152	தமிழர் மரபு /Heritage of Tamils	HSMC	1	0	0	15	1
PRACTICAL								
8	U23BSP11	Physics and Chemistry Laboratory	BSC	0	0	4	60	2
9	U23HSP12	English Laboratory	HSMC	0	0	2	30	1
10	U23GEP14	Engineering Practices Laboratory	ES	0	0	4	60	2
			Total	**15**	**01**	**14**		**23**

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23HST21	Professional English	HSMC	2	0	0	45	2
2	U23MAT22	Statistics and Numerical Methods	BSC	3	1	0	60	4
3	U23GET15	Problem Solving and Python Programming	ESC	3	0	0	45	3
4	U23PHT23	Applied Material Science	BSC	3	0	0	45	3
5	U23EET26	Basic Electrical and Digital Engineering	ESC	3	0	0	45	3
6		NCC Credit Course Level 1	-	2	0	0		2*
7	GE3252	தமிழரும் தொழில்நுட்பமும் /Tamils and Technology	HSMC	1	0	0	15	1
PRACTICAL								
8	U23EEP25	Basic Electrical and Digital Engineering Laboratory	ESC	0	0	4	60	2
9	U23HSP22	Communication Laboratory	EEC	0	0	4	60	2
10	U23GEP13	Problem Solving and Python Programming Laboratory	ESC	0	0	4	60	2
			Total	**17**	**1**	**12**		**22**

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23MAT31	Transforms and Partial Differential Equations	BSC	3	1	0	60	4
2	U23AET31	Aero Engineering Thermodynamics	PCC	3	0	0	45	3
3	U23AET32	Solid Mechanics	PCC	3	1	0	60	4
4	U23MET32	Fluid Mechanics and Machinery	ESC	3	0	0	45	3
5	U23AET34	Elements of Aeronautical Engineering	PCC	3	0	0	45	3
6	U23GET41	Environmental Sciences Sustainability	BSC	3	0	0	30	2
PRACTICAL								
7	U23AEP31	Thermodynamics and Strength of Materials Laboratory	PCC	0	0	4	60	2
8	U23AEP32	Fluid Mechanics and Machinery Laboratory	PCC	0	0	4	60	2
			Total	**18**	**02**	**8**		**23**

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23MAT41	Multivariable Calculus and Complex Analysis	BSC	3	1	0	60	4
2	U23AET41	Low Speed Aerodynamics	PCC	3	0	0	45	3
3	U23AET42	Air Breathing Propulsion	PCC	3	0	0	45	3
4	U23AET43	Aircraft Structures - I	PCC	3	0	0	45	3
5	U23AET44	Mechanics of Machines	PCC	3	0	0	45	3
6	U23AET45	Aircraft Systems and Instruments	PCC	3	0	0	45	3
PRACTICAL								
7	U23AEP41	Aerodynamics Laboratory	PCC	0	0	4	60	2
8	U23AEP42	Propulsion Laboratory	PCC	0	0	4	60	2
9	U23AEP43	Aircraft Systems Laboratory	PCC	0	0	4	60	2
			Total	**18**	**01**	**12**		**25**

SEMESTER V

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	U23AET51	High Speed Aerodynamics	PCC	3	0	0	45	3
2.	U23AET52	Aircraft Structures - II	PCC	3	0	0	45	3
3.	U23AET53	Space Propulsion	PCC	3	0	0	45	3
4	U23AET54	Aircraft Materials and Processes	PCC	3	0	0	45	3
5	U23AET55	Control Engineering	PCC	3	0	0	45	3
PRACTICAL								
6	U23AEP51	Structures Laboratory	PCC	0	0	4	60	2
7	U23AEP52	Cad Laboratory	PCC	0	0	4	60	2
			Total	**15**	**0**	**8**		**19**

SEMESTER VI

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23AET61	Aircraft Stability and Controls	PCC	2	1	0	45	3
2	U23AET62	Finite Element Methods	PCC	2	1	0	45	3
3	U23AET63	Composite Materials and Structures	PCC	3	0	0	45	3
4		Professional Elective – I	PEC	3	0	0	45	3
5		Professional Elective – II	PEC	3	0	0	45	3
6		Open Elective - I	OEC	3	0	0	45	3
PRACTICAL								
7	U23AEP61	Aircraft Design Project	PCC	0	0	4	60	2
8	U23AEP62	Airframe and Flight Systems Laboratory	PCC	0	0	4	60	2
			Total	**16**	**2**	**08**		**22**

SEMESTER VII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23GET72	Total Quality Management	HSC	3	0	0	45	3
2	U23AET72	Avionics	PCC	3	0	0	45	3
3	U23AET73	Computational Fluid Dynamics	PCC	3	0	0	45	3
4		Professional Elective – III	PEC	3	0	0	45	3
5		Professional Elective – IV	PEC	3	0	0	45	3
6		Open Elective – II	OEC	3	0	0	45	3
PRACTICAL								
6	U23AEP71	Flight Integration Laboratory	PCC	0	0	4	60	2
7	U23AEP72	Structural and Flow Simulation Laboratory	PCC	0	0	4	60	2
			Total	**18**	**0**	**08**		**22**

SEMESTER VIII

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1		Professional Elective V	PEC	3	0	0	45	3
2		Professional Elective VI	PEC	3	0	0	45	3
PRACTICAL								
3	U23AEP81	Project Work	EEC	0	0	20	300	8
			Total	**6**	**0**	**20**		**14**

VERTICALS – I COMPUTATIONAL ENGINEERING

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23AEV11	Computer Aided Design and Analysis	PEC	3	0	0	45	3
2	U23AEV12	Numerical Methods in Fluid Dynamics	PEC	3	0	0	45	3
3	U23AEV13	Computational Heat Transfer	PEC	3	0	0	45	3
4	U23AEV14	Continuum Mechanics	PEC	3	0	0	45	3
5	U23AEV15	Aircraft System Design and Simulation	PEC	3	0	0	45	3
6	U23AEV16	Computational Modeling and Data Analysis	PEC	3	0	0	45	3

VERTICALS – II AERODYNAMICS AND PROPULSION

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23AEV21	Experimental Aerodynamics	PEC	3	0	0	45	3
2	U23AEV22	Electrical and Plasma Propulsion	PEC	3	0	0	45	3
3	U23AEV23	Industrial Aerodynamics	PEC	3	0	0	45	3
4	U23AEV24	Rocket Propulsion	PEC	3	0	0	45	3
5	U23AEV25	Advanced Propulsion Systems	PEC	3	0	0	45	3
6	U23AEV26	Hypersonic Aerodynamics	PEC	3	0	0	45	3

VERTICALS – III AEROSPACE STRUCTURES

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23AEV31	Fatigue and Fracture Mechanics	PEC	3	0	0	45	3
2	U23AEV32	Experimental Stress Analysis	PEC	3	0	0	45	3
3	U23AEV33	Airframe Design	PEC	3	0	0	45	3
4	U23MEV42	Additive Manufacturing	PEC	3	0	0	45	3
5	U23AEV35	Nanotechnology	PEC	3	0	0	45	3
6	U23AEV36	Aerospace Materials	PEC	3	0	0	45	3

VERTICALS – IV AVIONICS AND DRONE TECHNOLOGY

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23AEV41	Principle of Autonomy and Decision Making	PEC	3	0	0	45	3
2	U23ECT33	Signals and Systems	PEC	3	0	0	45	3
3	U23AEV43	Guidance and Control	PEC	3	0	0	45	3
4	U23AEV44	Navigation and Communication System	PEC	3	0	0	45	3
5	U23AEV45	Design of UAV Systems	PEC	3	0	0	45	3
6	U23AEV46	Aerodynamics of Drones	PEC	3	0	0	45	3

VERTICALS – V AIRCRAFT MAINTENANCE

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23AEV51	Airframe Maintenance and Repair	PEC	3	0	0	45	3
2	U23AEV52	Aircraft General Engineering and Maintenance Practices	PEC	3	0	0	45	3
3	U23AEV53	Civil Aviation Regulations	PEC	3	0	0	45	3
4	U23AEV54	Aircraft Engine Maintenance and Repair	PEC	3	0	0	45	3
5	U23AEV55	Air Traffic Control	PEC	3	0	0	45	3
6	U23AEV56	Airport Management	PEC	3	0	0	45	3

VERTICALS – VI DIVERSIFIED COURSES GROUP 1

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23AEV61	Design of Gas Turbine Engine Components	PEC	3	0	0	45	3
2	U23AEV62	Vibration and Aero Elasticity	PEC	3	0	0	45	3
3	U23MET35	Manufacturing Process	PEC	3	0	0	45	3
4	U23AEV64	Turbo Machines	PEC	3	0	0	45	3
5	U23AEV65	Helicopter Theory	PEC	3	0	0	45	3
6	U23AEV66	Smart Materials and Structures	PEC	3	0	0	45	3

OPEN ELECTIVE - I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23AEO11	Piston Engine and Propeller	OEC	3	0	0	45	3
2	U23AEO12	Gas Turbine Engine	OEC	3	0	0	45	3
3	U23AEO13	Aircraft Communication and Navigation System	OEC	3	0	0	45	3
4	U23AEO14	Airport And Air Traffic Service	OEC	3	0	0	45	3
5	U23AEO15	Air Cargo Management	OEC	3	0	0	45	3

OPEN ELECTIVE - II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1	U23AEO21	Air Travel Management	OEC	3	0	0	45	3
2	U23AEO22	Helicopter Maintenance	OEC	3	0	0	45	3
3	U23AEO23	Fundamentals of Avionics	OEC	3	0	0	45	3
4	U23AEO24	Wind Tunnel Technique	OEC	3	0	0	45	3
5	U23AEO25	Aircraft Maintenance, Ground Handling and Support Equipment	OEC	3	0	0	45	3

SUMMARY

SL. NO.	Subject Area	Credits per semester								Credits Total	Percentage %
		I	II	III	IV	V	VI	VII	VIII		
1	Humanities and Social Sciences	5	3	-	-	-	-	3	-	11	6.47
2	Basic Sciences	12	7	6	4	-	-	-	-	29	17.06
3	Engineering Sciences	6	10	3	-	-	-	-	-	19	11.18
4	Professional Core	-	-	14	21	19	13	10	-	77	45.29
5	Professional Elective	-	-	-	-	-	6	6	6	18	10.59
6	Open Elective	-	-	-	-	-	3	3	-	6	3.53
7	Employability Enhancement Courses	-	2	-	-	-	-	-	8	10	5.88
	Total	**23**	**22**	**23**	**25**	**19**	**22**	**22**	**14**	**170**	**100**

SEMESTER-1

IP3151 INDUCTION PROGRAMME

This is a mandatory 2 week programme to be conducted as soon as the students enter the institution. Normal classes start only after the induction program is over.

The induction programme has been introduced by AICTE with the following objective:

"Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond. The graduating student must have knowledge and skills in the area of his/her study. However, he/she must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he/she would understand and fulfill his/her responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed."

"One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character. "

Hence, the purpose of this programme is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awareness, sensitivity and understanding of the self, people around them, society at large, and nature.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

(i) Physical Activity

This would involve a daily routine of physical activity with games and sports, yoga, gardening, etc.

(ii) Creative Arts

Every student would choose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program. These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, grow into engineering design later.

(iii) Universal Human Values

This is the anchoring activity of the Induction Programme. It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting stay in the hostel and department, be sensitive to others, etc. A module in Universal Human Values provides the base. Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught

through group discussions and real life activities rather than lecturing. Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It would be effective that the faculty mentor assigned is also the faculty advisor for the student for the full duration of the UG programme.

(iv) Literary Activity

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

(v) Proficiency Modules

This would address some lacunas that students might have, for example, English, computer familiarity etc.

(vi) Lectures by Eminent People

Motivational lectures by eminent people from all walks of life should be arranged to give the students exposure to people who are socially active or in public life.

(vii) Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

(viii) Familiarization to Dept./Branch & Innovations

They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilities.

(ix) Department Specific Activities

About a week can be spent in introducing activities (games, quizzes, social interactions, small experiments, design thinking etc.) that are relevant to the particular branch of Engineering/Technology/Architecture that can serve as a motivation and kindle interest in building things (become a maker) in that particular field. This can be conducted in the form of a workshop. For example, CSE and IT students may be introduced to activities that kindle computational thinking, and get them to build simple games. ECE students may be introduced to building simple circuits as an extension of their knowledge in Science, and so on. Students may be asked to build stuff using their knowledge of science.

Induction Programme is totally an activity based programme and therefore there shall be no tests / assessments during this programme.

References:

Guide to Induction program from AICTE

U23HST11	COMMUNICATIVE ENGLISH (COMMON TO ALL B.E./ B.TECH. PROGRAMMES)	L	T	P	C
		3	0	0	3

Objectives:

The main learning objective of this course is to prepare the students for:

1. To enhance students listening ability for academic and Professional purposes.
2. To learn to use basic grammatical structures in suitable contexts
3. To help students acquire the ability to speak effectively in English in real -life situations.
4. To help learners use language effectively in professional contexts.
5. To develop student's ability to read and write complex texts, summaries, articles, definitions, Paragraph user manuals.

UNIT I INTRODUCTION TO EFFECTIVE COMMUNICATION 9

Define communication. Kinds of communication. Quintessential of communication in technical progression. Key characteristics of an effective communicator- listening, attitude modification, way of response with appropriate language, tone modulation.

Listening- Listening to TV news, Guest lectures. Speaking- Answering the Questions.

Reading - Reading brochures and technical magazines (technical context), telephone messages / social media messages relevant to technical contexts and emails, **Writing**-Reading comprehension, Parts of Speech.

UNIT II READING QUEST 9

Listening- listening and responding to video lectures/talks. **Speaking**- Day today conversations. **Reading** –Edison of India-GD Naidu "The Great Inventor". **Writing**- Emails / Informal Letters - Inviting, Congratulating & Thanking, Punctuations.

UNIT III LANGUAGE RESOURCE GROWS CRITICAL JUDGEMENT 9

Listening- listening to specific task-focused audio tracks. Speaking- summary of Robert Frost "Stopping by woods on a snowy evening". Reading – Reading advertisements, gadget reviews; user manuals. Writing – Essay Writing: Analytical essay: Narrative Essay, Developing Hints, Usage of tenses in sentence formation. Voices.

UNIT IV LANGUAGE IN LIFE SKILL 9

Listening- Listening to speech of Great Scholars. Speaking- mechanics of presentation. **Reading** – Newspaper articles, power point presentation. **Writing** – Checklist, Jumbled Sentences-Rearrange the sentences in correct order, WH-Questions-Form questions by using statements, Prefixes and Suffixes.

UNITV IMPROVING SPEAKING &READING 9

Listening- listening to situational based dialogues; **Speaking-** Stating intention to do something-Expressing opinion-asking people to repeat themselves**.** **Reading** – Summary of O.Henry's "The last Leaf". **Writing** – Dialogue Writing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 : Remember appropriate words in a situational conversation.
CO2 : Gain understanding of basic grammatical structures and use them in right context.
CO3 : Read and infer the denotative and connotative meanings of technical texts.
CO4 : Write Dialogue, Letter and paragraphs on various topics.
CO5 : Make the students prepare effective notes for main sources available.
CO6 : Enhance them to give operational talk.

TEXT BOOKS:

1. English for Engineers & Technologists Orient Blackswan Private Ltd. Department of English, Anna University, (2020 edition).
2. English for Science & Technology Cambridge University Press, 2021. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.
3. The Gift of the Magi by O.Henry, McClure,Philips and company.

REFERENCE BOOKS:

1. Technical Communication – Principles And Practices By Meenakshi Raman & Sangeeta Sharma, Oxford Univ. Press, 2016, New Delhi.
2. A Course Book On Technical English By Lakshminarayanan, Scitech Publications (India) Pvt.Ltd.
3. English For Technical Communication (With CD) By Aysha Viswamohan, Mcgraw Hill Education.
4. Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
5 Learning to Communicate – Dr. V. Chellammal, Allied Publishing House, New Delhi, 2003.

U23MAT12 **MATRICES AND CALCULUS**

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
2. To familiarize the students with differential calculus.
3. To familiarize the student with functions of several variables
4. To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.
5. To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems

UNIT I MATRICES **12**

Introduction – Characteristic equation – Eigenvalues and Eigenvectors of a real matrix – Properties of Eigenvalues and Eigenvectors – Cayley Hamilton theorem – Diagonalization of the matrices by Orthogonal Transformations – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II DIFFERENTIAL CALCULUS **12**

Limit of a function – Continuity – Derivatives – Differentiation rules – Implicit differentiation – Logarithmic differentiation – Maxima and Minima of functions of one variable.

UNIT III MULTIVARIABLE CALCULUS **12**

Partial differentiation – Homogeneous functions and Euler's theorem – Total derivative –Jacobians – Taylor's series for functions of two variables – Maxima and minima of functions of two variables and Lagrange's method of undetermined multipliers.

UNIT IV MULTIPLE INTEGRAL AND THEIR APPLICATIONS **12**

Double integrals – Change of order of integration – Double integrals in polar coordinates – Area enclosed by plane curves – Triple integrals – Volume of solids – Change of variables in double and triple integrals.

UNIT V ORDINARY DIFFERENTIAL EQUATIONS **12**

Higher order linear differential equations with constant coefficients– Method of variation of parameters – Homogenous equation of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients – Method of undetermined coefficients.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Use the matrix algebra methods for solving practical problems.

CO2 : Use both the limit definition and rules of differentiation to differentiate functions.

CO3: Apply differential calculus tools in solving various application problems.

CO4: Able to use differential calculus ideas on several variable functions.

CO5: Apply multiple integral ideas in solving areas, volumes and other practical problems.

CO6: Solve the ordinary differential equations using different techniques for that model engineering problems.

TEXT BOOKS:

1. Kreyszig.E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Grewal. B.S., "Higher Engineering Mathematics",Khanna Publishers, New Delhi, 44thEdition, 2018.
3. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015. [For Units II & IV - Sections 1.1, 2.2, 2.3, 2.5, 2.7 (Tangents problems only), 2.8, 3.1 to 3.6 , 3.11, 4.1, 4.3, 5.1 (Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].

REFERENCE BOOKS:

1. Bali. N., Goyal. M. and Watkins. C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt.,Ltd.,), New Delhi, 7th Edition, 2009.
2. Jain. R.K. and Iyengar. S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 5th Edition,2016.
3. Narayanan. S. and Manica vachagom Pillai. T. K.,"Calculus" Volume I and II, S.Viswanathan Publishers Pvt. Ltd., Chennai, 2009.
4. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt.Ltd, New Delhi, 2016.
5. Thomas. G. B., Hass. J, and Weir. M.D,"Thomas Calculus", 14th Edition, Pearson India, 2018.

U23PHT13	PHYSICS FOR ENGINEERS AND TECHNOLOGISTS (COMMON TO ALL B.E./ B.TECH. PROGRAMMES)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To make the students to gain the knowledge in elastics and plastic nature of the materials in the presence and absence of load.
2. To understand the students to know the application of the sound waves in different fields.
3. To motivate the students towards the applications of photo electric phenomena.
4. To know the physical principle of LASER, the working of LASER applications.
5. To understand the propagation of light in optical fibers and its applications.

UNIT I ELASTICITY 9

Introduction- Elasticity - plasticity– Hooke's law - relationship between three Modulii of elasticity (Qualitative) – stress & strain diagram and its uses -Poisson's ratio - factors affecting elasticity - twisting ouple of wire - Torsion Pendulum: theory and experiment.

Beam: Internal bending moment – Cantilever: theory and experiment – Young's Modulus: uniform and non – uniform bending (Qualitative) – I-shaped girders- advantages and applications.

UNIT II ULTRASONICS 9

Introduction – classification of sound- properties of infrasonic, audible and ultrasonics - production: Magnetostriction and Piezoelectric methods – determination of velocity of sound in liquid (Acoustic Grating Method) – general applications – industrial application: Non - Destructive Testing: pulse echo system through transmission and reflection modes. ultrasonic scanning methods – medical application: sonogram.

UNIT III MODERN PHYSICS 9

Introduction –Black Body Radiation – Classical and Quantum Laws of Black Body Radiation - Photon and its Properties - Wave Particle Duality and Matter waves – De - Broglie Wavelength - Schrodinger's Time Independent and Time Dependent Wave Equations - Physical Significance of The Wave Function. Application: Particle in One Dimensional Box - Normalization Process – Photo Electric Effect – Laws Governing the Photoelectric Effect – Einstein's Formula - Derivation – Applications: Solar Cell – Solar Water Heater – Photo resistor (LDR).

UNIT IV LASERS 9

Lasers: Introduction - Properties of Laser-Spontaneous and Stimulated Emission Process - Einstein's Theory of Matter Radiation Interaction & A and B Coefficients; Amplification of Light By Population Inversion – Pumping Methods - Types of Lasers: Solid-State Laser (Homo And Hetero Junction Semiconductor Lasers), Gas Laser (CO_2), Applications: Laser Cutting and Welding, LIDAR and Barcode Scanner.

UNIT V FIBER OPTICS AND APPLICATIONS 9

Optical Fiber: Structure - advantages- Principle [TIR]–Propagation Phenomena in optical fiber - Expression For Acceptance Angle and Numerical Aperture – Relation between Refractive Index of Core, Numerical Aperture and Fractional Index Change – Fabrication: Double Crucible Method - Types: Material, Mode, Refractive Index - Applications: Optical Fiber Communication System – fiber optic sensors (Displacement and pressure sensors) – Medical Endoscope.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1 :** Differentiate the elastic and plastic nature of the materials.
- **CO2 :** Know the experimental techniques in both production and applications of ultrasonic waves.
- **CO3:** Gain knowledge in the basics of quantum mechanics concepts.
- **CO4:** Develop new devices based on LASER source.
- **CO5:** Understand the advantages of optical fiber than metal wire.
- **CO6:** Demonstrate the some useful experiments based on optical fibre

TEXT BOOKS:

1. Dr. P.Mani, "Engineering Physics", Dhanam Publications, 2013.
2. Dr. G. Senthilkumar, "Engineering Physics", VRB Publishers, 2017.
3. K. Thyagarajan, Ajoy Ghatak, "Lasers Fundamentals and Applications" II nd Edition, Springer, 2010.
4. D.K. Bhattacharya, Poonam Tandon," Engineering Physics", Oxford HED Publishers, 2017.

REFERENCE BOOKS:

1. Marikani, "Engineering Physics", PHI, New Delhi, 2013.
2. Bhattacharya & Bhaskaran, "Engineering Physics", Oxford Publications, 2012.
3. R Murugeshan, Kiruthiga, Sivaprasath S, "Modern Physics", Chand Publishing, 2021.
4. S. Rajivgandhi & A. Ravikumar, " Engineering Physics I", RK Publications, 2023
5. Sathyaprakash, "Quantum Mechanics", Pragati Prakashan, Meerut, 2016.

U23CYT14 CHEMISTRY FOR ENGINEERING & TECHNOLOGY

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To inculcate sound understanding of water quality parameters and water treatment techniques.
2. Impart knowledge on the basic principles and preparatory methods of nanomaterial.
3. To introduce the basic concepts and applications of phase rule and composites.
4. To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
5. To familiarize the students with the operating principles, working processes and applications of energy conversion and storage devices.

UNIT I Water Treatment 9

Water: Sources , impurities, Parameters. Types of water Hardness of water -types – expression of hardness – units – Estimation of hardness of water by EDTA. Desalination - Reverse Osmosis. Boiler troubles: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralisation and zeolite process.

UNIT II Electro and Nano chemistry 9

Electrochemical cells – reversible and irreversible cells – EMF – measurement of emf by Poggendorff's compensation principle. Single electrode potential – Nernst equation – reference electrodes -types–Calomel electrode - electrolysis of water.

Nanomaterials: Basics of Nano Chemistry: Distinction between molecules, nanomaterials and bulkmaterials. Preparation of nanomaterials- laser ablation method and Chemical Vapour Deposition (CVD). Application of Nanomaterials in medicine, agriculture, energy, electronics and catalysis.

UNIT III Phase Rule and Composites 9

Phase rule terms with examples. water system; Reduced phase rule Two component system: lead-silver system – Composites, Need, Constitution: Matrix materials, Applications and Reinforcement and applications of Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites - definition and examples.

UNIT IV Fuels & Combustion 9

Fuels –Classification-Coal and coke: Analysis of coal (proximate and ultimate), Carbonization, Manufacture of metallurgical coke (Otto Hoffmann method). Petroleum and Diesel: Manufacture of synthetic petrol (Bergius process), Knocking - octane number, diesel oil - cetane number; Power alcohol and biodiesel.

Combustion of fuels: Introduction: Calorific value - higher and lower calorific values, Theoretical calculation of calorific value; Ignition temperature: spontaneous ignition temperature, Explosive range; Flue gas analysis - ORSAT Method. CO_2 emission and carbon foot print.

UNITV Energy Sources and Storage devices 9

Nuclear energy: light water nuclear power plant, breeder reactor. Solar energy conversion: Principle, working and applications of solar cells; Recent developments in solar cell materials. Wind energy; Geothermal energy;Batteries: Types of batteries, Primary battery - dry cell, Secondary battery - lead acid battery and lithium-ion- battery; Electric vehicles-working principles; Fuel cells: H_2-O_2 fuel cell, microbial fuel cell; Supercapacitors: Storage principle, types and examples.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Develop innovative methods to produce soft water for industrial use and potable water at cheaper cost.

CO2 : Apply the basic knowledge of Corrosion and various electrodes.

CO3: Know the economically and new methods of synthesis nano materials.

CO4: Apply the knowledge of phase rule and composites for material selection requirements.

CO5: Understand the concepts ofsuitable fuels for engineering processes and applications.

CO6: Have the knowledgeof different forms of energy resources and apply them for suitable applicationsin energy sectors.

TEXT BOOKS:

1. P. C. Jain and Monica Jain, "Engineering Chemistry", 17th Edition, DhanpatRai Publishing Company (P) Ltd, New Delhi, 2018.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2008.
3. S.S. Dara, "A text book of Engineering Chemistry", S. Chand Publishing, 12th Edition, 2018.
4. J.Manivel , "Engineering Chemistry" R.K.Publishers, 1st Edition 2022.

REFERENCE BOOKS:

1. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday, "Text book of nanoscience and nanotechnology", Universities Press-IIM Series in Metallurgy and Materials Science, 2018.
2. O.G. Palanna, "Engineering Chemistry" McGraw Hill Education (India) Private Limited, 2nd Edition, 2017.
3. Friedrich Emich, "Engineering Chemistry", Scientific International PVT, LTD, New Delhi, 2014.
4. ShikhaAgarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, Second Edition, 2019.

U23GET16	ENGINEERING GRAPHICS	L	T	P	C
		2	0	4	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To develop in students, graphic skills for communication of concepts, ideas and design of engineering products.
2. To expose them to existing national standards related to technical drawings.
3. Develop proficiency in 2D drafting using drawing tools.
4. Learn sectional views and assembly drawing techniques.
5. Enhance visualization skills for improved problem-solving and communication in engineering.

UNIT I PLANE CURVES AND ORTHOGRAPHIC PROJECTION 6+12

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimension. Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves. Visualization concepts and Free Hand sketching: Visualization principles –Representation of Three-Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects.

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACE 6+12

Orthographic projection- principles-Principal planes-First angle projection-projection of points. Projection of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method (polygonal and circular surfaces) inclined to both the planes.

UNIT III PROJECTION OF SOLIDS 6+12

Projection of simple solids like prisms, pyramids, cylinder, cone and truncated solids when the axis is inclined to one of the principal planes by rotating object method.

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 6+12

Sectioning of above solids in simple vertical position when the cutting plane is inclined to the one of the principal planes and perpendicular to the other – obtaining true shape of section. Development of lateral surfaces of simple solids – Prisms, pyramids cylinders and cones.

UNITV ISOMETRIC PROJECTION 6+12

Principles of isometric projection – isometric scale –Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions-Perspective Projection.

TOTAL: 30+60=90 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1 :** Identify the significance of graphics in engineering applications.
- **CO2 :** Project straight lines inclined to both principal planes and determine true lengths and inclinations.
- **CO3:** Apply orthographic projection techniques to project solids.
- **CO4:** Apply the principles of development to prisms, pyramids, cylinders, and cones.
- **CO5:** Combine two solid objects in simple vertical positions using isometric projection.
- **CO6:** Utilize the isometric scale effectively.

TEXT BOOKS:

1. Natrajan K.V., ―A text book of Engineering Graphics‖, Dhanalakshmi Publishers, Chennai, 2009.
2. Venugopal K. and Prabhu Raja V., ―Engineering Graphics‖, New Age International (P) Limited, 2008

REFERENCE BOOKS:

1. Bhatt N.D. and Panchal V.M., ―Engineering Drawing‖, Charotar Publishing House, 50th Edition, 2010.
2. Basant Agarwal and Agarwal C.M., ―Engineering Drawing‖, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
3. Gopalakrishna K.R., ―Engineering Drawing‖ (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
4. Luzzader, Warren.J. andDuff,John M., ―Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Edition, Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
6. N S Parthasarathy and Vela Murali, ―Engineering Graphics‖, Oxford University, Press, New Delhi, 2015.

GE3152 தமிழர் மரபு

L	T	P	C
1	0	0	1

அலகு I மொழி மற்றும் இலக்கியம் **3**

இந்திய மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழ் செவ்விலக்கியங்கள் - சங்க இலக்கியத்தின் சமயச் சார்பற்ற தன்மை சங்க இலக்கியத்தில் பகிர்தல் அறம் - திருக்குறளில் மேலாண்மைக் கருத்துக்கள் - தமிழ்க் காப்பியங்கள், தமிழகத்தில் சமண பௌத்த சமயங்களின் தாக்கம் பக்தி இலக்கியம், ஆழ்வார்கள் மற்றும் நாயன்மார்கள் - சிற்றிலக்கியங்கள் - தமிழில் நவீன இலக்கியத்தின் வளர்ச்சி - தமிழ் இலக்கிய வளர்ச்சியில் பாரதியார் மற்றும் பாரதிதாசன் ஆகியோரின் பங்களிப்பு.

அலகு II மரபு - பாறை ஓவியங்கள் முதல் நவீன ஓவியங்கள் வரை - சிற்பக் கலை **3**

நடுகல் முதல் நவீன சிற்பங்கள் வரை - ஐம்பொன் சிலைகள்- பழங்குடியினர் மற்றும்அவர்கள் தயாரிக்கும் கைவினைப் பொருட்கள் பொம்மைகள் - தேர் செய்யும் கலை சுடுமண் சிற்பங்கள் - நாட்டுப்புறத் தெய்வங்கள் - குமரிமுனையில் திருவள்ளுவர் சிலை - இசைக் கருவிகள் - மிருதங்கம், பறை, வீணை, யாழ், நாதஸ்வரம் - தமிழர்களின் சமூக பொருளாதார வாழ்வில் கோவில்களின் பங்கு.

அலகு III நாட்டுப்புறக் கலைகள் மற்றும் வீர விளையாட்டுகள் **3**

தெருக்கூத்து,கரகாட்டம், வில்லுப்பாட்டு, கணியான் கூத்து, ஒயிலாட்டம்.தோல்பாவைக் கூத்து, சிலம்பாட்டம், வளரி, புலியாட்டம், தமிழர்களின் விளையாட்டுகள்.

அலகு IV தமிழர்களின் திணைக் கோட்பாடுகள் **3**

தமிழகத்தின் தாவரங்களும், விலங்குகளும் - தொல்காப்பியம் மற்றும் சங்க இலக்கியத்தில் அகம் மற்றும் புறக் கோட்பாடுகள் - தமிழர்கள் போற்றிய அறக்கோட்பாடு - சங்ககாலத்தில் தமிழகத்தில் எழுத்தறிவும், கல்வியும் - சங்ககால நகரங்களும் துறை முகங்களும் - சங்ககாலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - கடல்கடந்த நாடுகளில் சோழர்களின் வெற்றி.

அலகு V இந்திய தேசிய இயக்கம் மற்றும் இந்திய பண்பாட்டிற்குத் தமிழர்களின் பங்களிப்பு **3**

இந்திய விடுதலைப்போரில் தமிழர்களின் பங்கு - இந்தியாவின் பிறப்பகுதிகளில் தமிழ்ப் பண்பாட்டின் தாக்கம் - சுயமரியாதை இயக்கம் - இந்திய மருத்துவத்தில், சித்த மருத்துவத்தின் பங்கு - கல்வெட்டுகள், கையெழுத்துப்படிகள் - தமிழ்ப்புத்தகங்களின் அச்சு வரலாறு.

TOTAL: 15 PERIODS

TEXT-CUM-REFERENCE BOOKS:

1. தமிழக வரலொறு – மக்களும் பண் பொடும் – கக கக பிள்ளள (தவளியீடு: தமிழ் நொடு பொடநூல் மற்றும் கல் வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் – முளனவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி – ளவளக நதிக்களரயில் சங் ககொல நகர நொகரிகம் (ததொல் லியல் Fளற தவளியீடு).
4. தபொருளந – ஆற்றங் களர நொகரிகம் (ததொல் லியல் Fளற தவளியீடு).

GE3152	HERITAGE OF TAMILS	L	T	P	C
		1	0	0	1

UNIT I LANGUAGE AND LITERATURE 3

Language Families in India - Dravidian Languages – Tamil as aClassical Language – Classical Literature in Tamil – Secular Nature of Sangam Literature – Distributive Justice in Sangam Literature - Management Principles in Thirukural - Tamil Epics and Impact of Buddhism & Jainism in Tamil Land - Bakthi Literature Azhwars and Nayanmars - Forms of minor Poetry - Development of Modern literature in Tamil - Contribution of Bharathiyar and Bharathidhasan.

UNIT II HERITAGE - ROCK ART PAINTINGS TO MODERN ART – SCULPTURE 3

Hero stone to modern sculpture - Bronze icons - Tribes and their handicrafts - Art of temple car making - Massive Terracotta sculptures, Village deities, Thiruvalluvar Statue at Kanyakumari, Making of musical instruments - Mridhangam, Parai, Veenai, Yazh and Nadhaswaram - Role of Temples in Social and Economic Life of Tamils.

UNIT III FOLK AND MARTIAL ARTS 3

Therukoothu, Karagattam, Villu Pattu, Kaniyan Koothu, Oyillattam, Leatherpuppetry, Silambattam, Valari, Tiger dance - Sports and Games of Tamils.

UNIT IV THINAI CONCEPT OF TAMILS 3

Flora and Fauna of Tamils & Aham and Puram Concept from Tholkappiyam and Sangam Literature - Aram Concept of Tamils - Education and Literacy during Sangam Age - Ancient Cities and Ports of Sangam Age - Export and Import during Sangam Age - Overseas Conquest of Cholas.

UNITV CONTRIBUTION OF TAMILS TO INDIAN NATIONAL MOVEMENT AND INDIAN CULTURE 3

Contribution of Tamils to Indian Freedom Struggle - The Cultural Influence of Tamils over the other parts of India – Self-Respect Movement - Role of Siddha Medicine in Indigenous Systems of Medicine – Inscriptions & Manuscripts – Print History of Tamil Books.

TOTAL: 15 PERIODS

TEXT-CUM-REFERENCE BOOKS:

1. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
2. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
3. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)

5. Keeladi - ‘Sangam City Civilization on the banks of river Vaigai’ (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
6. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Publishedby: The Author)
7. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Bookand Educational Services Corporation, Tamil Nadu)
8. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) – Reference Book.

U23BSP11	PHYSICS AND CHEMISTRY LABORATORY (COMMON TO ALL B.E. / B.TECH. PROGRAMMES)	L 0	T 0	P 4	C 2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To learn the proper use of various kinds of physics laboratory equipment.
2. To learn how data can be collected, presented and interpreted in a clear and concise manner.
3. To learn problem solving skills related to physics principles and interpretation of experimental data.
4. To determine error in experimental measurements and techniques used to minimize such error.
5. To make the student as an active participant in each part of all lab exercises.
6. To inculcate experimental skills to test basic understanding of water quality parameters, as, acidity, alkalinity, chloride.
7. To Induce the students to analyze the hardness of water
8. To induce the students to familiarize with electro analytical techniques such as, pH metry, conductometry in the determination of impurities in aqueous solutions.

LIST OF EXPERIMENTS

1. Torsion pendulum - Determination of rigidity modulus of wire and moment of inertia of regular disc.
2. Non - Uniform bending–Determination of Young's modulus.
3. Laser – (i) Determination of the wavelength of the laser using grating.
   (ii) Determination of size of the particles using laser source.
4. Air wedge – Determination of thickness of a thin sheet/wire.
5. Determination of Band gap of a semiconductor using PN junction kit.
6. To study the V-I Characteristics of Light Dependent Resistor (LDR).
7. Determination of types and amount of alkalinity in water sample.
8. Determination of total, temporary & permanent hardness of water by EDTA method.
9. Determination of chloride content of water sample by Argentometric method.
10. Determination of strength of given hydrochloric acid using pH meter.
11. Determination of strength of acids in a mixture of acids using conductivity meter.
12. Conductometric titration of barium chloride against sodium sulphate (precipitation titration)

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Torsion pendulum set up (Metal Disc, Symmetrical Mass(2x100g), Stop Clock, Screw Gauge)	**5**
2.	Non – Uniform bending set up (Travelling Microscope, Knife Edges, Weight Hanger with Mass(5x50g), Screw Gauge, Vernier Caliper, Meter Scale)	**5**

3.	Laser set up (Semiconductor Laser, Screen, Grating Stand, Wooden Stand With Meter Scale)	**5**
4.	Air wedge (Air Wedge Set Up, Travelling Microscope, Sodium Vapour Lamp, Transformer)	**5**
5.	Band gap of a semiconductor (PN Junction Kit, Thermometer, Heater, Beaker, Oil)	**5**
6.	Light Dependent Resistor (Power Suppy, Voltmeter, Ammeter, LDR, Bulb, Resistors)	**5**
7.	PH meter	**5**
8.	Conductivity meter	**10**
9.	Common Apparatus(Pipette, Burette, Conical Flask, Porcelain tile, Dropper)	**15**

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Understand the functioning of various physics laboratory equipment.

CO2 : Observe and tabulate experimental data.

CO3: Solve problems individually and collaboratively.

CO4: Analyse the quality of water samples with respect to their acidity, alkalinity

CO5: Determine the amount of hardness in the water

CO6: Analyse quantitatively the impurities in solution by electro analytical techniques

U23HSP12	ENGLISH LABORATORY (COMMON TO ALL B.E. / B.TECH. PROGRAMMES)	L 0	T 0	P 2	C 1

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To improve the communicative competence of learners.
2. To help learners use language effectively in academic /work contexts.
3. To develop various listening strategies to comprehend various types of audio materials like lectures, discussions, videos etc.
4. To build on students' English language skills by engaging them in listening, speaking and grammar learning activities that are relevant to authentic contexts.
5. To use language efficiently in expressing their opinions via various media.

LIST OF EXPERIMENTS

1	Listening for general information-specific details.
2	Conversation: Introduction to classmates.
3	Speaking - making telephone calls-Self Introduction.
4	Talking about current and temporary situations & permanent and regular situations.
5	Listening to podcasts, anecdotes / stories / event narration.
6	Event narration; documentaries and interviews with celebrities.
7	Events-Talking about current and temporary situations & permanent and regular situations.
8	Engaging in small talk.
9	Describing requirements and abilities- Picture description.
10	Discussing and making plans.
11	Talking about tasks- progress- positions -directions of movement.
12	Talking about travel preparations and transportation.
13	Listening to debates/ discussions.
14	Making prediction talking about a given topic.
15	Describing processes.

TOTAL: 30 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Communication laboratory with sufficient computer systems	**30**
2.	Server	**1**
3.	Head phone	**30**
4.	Audio mixture	**1**
5.	Collar mike	**1**
6.	Television	**1**
7.	Speaker set with amplifier	**1**
8.	Power point projector and screen	**1**
9.	Cordless mike	**1**

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Identify and comprehend complex academic texts.

CO2 : Interpret accurately and fluently in formal and informal communicative contexts.

CO3: Demonstrate their opinions effectively in both oral and written medium of Communication.

CO4: Plan travelogue and construct paragraphs on various aspects.

CO5: Develop journal reading skills and small talk.

CO6: Utilizing technical terms and making power point presentations.

U23GEP14 ENGINEERING PRACTICES LABORATORY

L	T	P	C
0	0	4	2

COURSE OBJECTIVES:

The main learning objective of this course is to provide hands on training to the students in:

1. Drawing pipe line plan; laying and connecting various pipe fittings used in common household plumbing work; Sawing; planing; making joints in wood materials used in common house hold wood work.
2. Wiring various electrical joints in common household electrical wire work.
3. Welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts;
4. Soldering and testing simple electronic circuits; Assembling and testing simple electronic components on PCB.
5. Assembling simple mechanical assembly of common household equipments; Making a tray out of metal sheet using sheet metal work.

GROUP – A (CIVIL AND MECHANICAL)

PART I CIVIL ENGINEERING PRACTICES PLUMBING WORK: 30

a. Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in household.
b. Preparing plumbing line sketches.
c. Laying pipe connection to the suction side of a pump
d. Laying pipe connection to the delivery side of a pump.
e. Connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

WELDING WORK:

a) Welding of Butt Joints, Lap Joints, and Tee Joints using arc welding.
b) Practicing gas welding.

BASIC MACHINING WORK:

a) Turning
b) Drilling
c) Tapping

ASSEMBLY WORK:

a) Assembling a centrifugal pump.
b) Assembling a household mixer.

SHEET METAL WORK:

a) Making of a square tray

WOOD WORK:

a. Sawing,
b. Planing and
c. Making joints like T-Joint, Mortise joint and Tenon joint and Dovetail joint.

PART II ELECTRICAL & ELECTRONICS 30

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring
4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5. Measurement of energy using single phase energy meter.
6. Measurement of resistance to earth of an electrical equipment.

ELECTRONICS

1. Study of Electronic components and equipments – Resistor, colour coding measurement of AC signal parameter (peak-peak, rms period, frequency) using CR.
2. Study of logic gates AND, OR, EX-OR and NOT.
3. Generation of Clock Signal.
4. Soldering practice – Components Devices and Circuits Using general purpose PCB.
5. Measurement of ripple factor of HWR and FWR.

TOTAL = 60 PERIODS

LIST OF EQUIPMENT:

(FOR A BATCH OF 30 STUDENTS)

CIVIL

1. Assorted components for plumbing consisting of metallic pipes, plastic pipes, flexible pipes, couplings, unions, elbows, plugs and other fittings. 15Sets.
2. Carpentry vice (fitted to work bench) 15Nos.
3. Standard woodworking tools 15 Sets.
4. Models of industrial trusses, door joints, furniture joints 5each
5. Power Tools: (a) Rotary Hammer 2 Nos (b) Demolition Hammer 2 Nos (c) Circular Saw 2 Nos (d) Planer 2 Nos (e) Hand Drilling Machine 2 Nos (f) Jigsaw 2Nos

MECHANICAL

Arc welding transformer with cables and holders 5 Nos.

1. Welding booth with exhaust facility 5Nos.
2. Welding accessories like welding shield, chipping hammer, wire brush, etc. 5Sets.
3. Oxygen and acetylene gas cylinders, blow pipe and other welding outfit. 2Nos.
4. Centre lathe 2Nos.
5. Hearth furnace, anvil and smithy tools 2Sets.
6. Moulding table, foundry tools 2Sets.
7. Power Tool: Angle Grinder 2Nos
8. Study-purpose items: centrifugal pump, air-conditioner One each

ELECTRICAL

1. Assorted electrical components for house wiring 15Sets
2. Electrical measuring instruments 10Sets
3. Study purpose items: Iron box, fan and regulator, emergency lamp 1 each
4. Megger (250V/500V) 1No.
5. Power Tools:
   a) Range Finder 2Nos
   b) Digital Live-wire detector 2Nos

ELECTRONICS

1. Soldering guns 10Nos.
2. Assorted electronic components for making circuits 50Nos.
3. Small PCBs 10Nos.
4. Multimeters 10Nos.

Study purpose items: Telephone, FM radio, low-voltage power supply.

COURSE OUTCOMES:

Upon completion of this course, the students will be able to:

CO1 :	Draw pipe line plan; lay and connect various pipe fittings used in common household plumbingwork; Saw; plan; make joints in wood materials used in common household woodwork.
CO2 :	Wire various electrical joints in common household electrical wire work.
CO3:	Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly ofcommon Household equipments; Make a tray out of metal sheet using sheet metal work.
CO4:	Solder and test simple electronic circuits; Assemble and test simple electronic components onPCB.
CO5:	Apply fundamental engineering principles to analyze and solve real-world problems.
CO6:	Demonstrate proficiency in using engineering tools and equipment.

U23HST21	PROFESSIONAL COMMUNICATION (COMMON TO ALL B.E. / B.TECH. PROGRAMMES)	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To engage learners in meaningful language activities to improve their reading and writing skills.
2. To learn various reading strategies and apply in comprehending documents in professional context.
3. To help learners understand the purpose, audience, contexts of different types of writing.
4. To enable students write letters and reports effectively in formal and business situations.
5. To demonstrate an understanding of job applications and interviews for internship and placements.

UNIT I PREPARATORY DOCUMENTATIONS 9

Listening- Listening to formal conversations and Participating**. Speaking-** speaking about one's family. **Reading –** Summary of W.W Jacobs "The monkey's paw". **Writing –** Subject verb Agreement, Numerical -Adjectives, Kinds of sentences**,** Writing reviews (book / film), writing Instructions, Writing Recommendation.

UNIT II LECTURA ENRICHMENT AND PASSAGE COMPOSE 9

Listening- listening to lectures on academic topics; **Speaking-** Asking for and giving directions. **Reading -** Reading longer technical texts; **Writing -** Compound words, Homophones and Homonyms, Cause and Effect expressions. Essay Writing, Writing Letter to the Editor (complaint, acceptance, Requesting, Thanking).

UNIT III ANALYTICAL SKILL 9

Listening- Watching videos/documentaries and responding to questions based on them. **Speaking –**Speaking about ones favourite place**. Reading –** Summary of the poem – John keats "Ode to a Nightingale". **Writing-** Purpose statement, Extended Definitions. Writing Job/ Internship application – Cover letter & Resume.

UNIT IV REPORT WRITING 9

Listening- Listening to class room lectures/talks on engineering/technology. **Speaking–** Introduction to technical presentations. **Reading –** Newspaper articles; **Writing –** Comparative Adjectives Direct and Indirect speech**.** Report Writing- Fire Accident Report, Road Accident, Feasibility Report).

UNITV ENABLING LINGUA IDEALITY & INFORMATION 9

Listening- TED/Ink talks. **Speaking –** Making presentation on a given topic. **Reading –**Company profiles, Statement of Purpose, (SOP), **Writing –** Relative Clauses, If conditions, Cause and Effect. Chart Interpretations - Bar Chart, Pie Chart, Flow Chart & Tables.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Compare and contrast products and ideas in technical texts.

CO2 : Identify cause and effects in events, industrial processes through technical texts.

CO3 : Analyze problems in order to arrive at feasible solutions and communicate them orally and in the written format.

CO4 : Motivate students to write reports and winning job applications.

CO5 : Recall and comprehend different discourses and genres of texts.

CO6 : Making the students to become virtuous presenters.

TEXT BOOKS:

1. English for Engineers & Technologists (2020 edition) Orient Blackswan Private Ltd. Department of English, Anna University.
2. English for Science & Technology Cambridge University Press 2021.
3. Authored by Dr. Veena Selvam, Dr. Sujatha Priyadarshini, Dr. Deepa Mary Francis, Dr. KN. Shoba, and Dr. Lourdes Joevani, Department of English, Anna University.

REFERENCE BOOKS:

1. Raman. Meenakshi, Sharma. Sangeeta (2019). Professional English. Oxford university press. New Delhi.
2. Improve Your Writing ed. V.N. Arora and Laxmi Chandra, Oxford Univ. Press, 2001, New Delhi.
3. Learning to Communicate – Dr. V. Chellammal. Allied Publishers, New Delhi, 2003
4. Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
5. Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.

U23MAT22	STATISTICS AND NUMERICAL METHODS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. This course aims at providing the necessary basic concepts of a few statistical tools and give procedures for solving different kinds of problems occurring in engineering and technology.
2. To acquaint the knowledge of classifications of design of experiments in the field of agriculture.
3. To introduce the basic concepts of solving algebraic and transcendental equations.
4. To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering andtechnology disciplines.
5. To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.

UNIT I TESTING OF HYPOTHESIS 12

Introduction – Sampling distributions – Tests for single mean, proportion and difference of means (Large and small samples) – Tests for single variance and equality of variances – Chi square test for goodness of fit – Independence of attributes.

UNIT II DESIGN OF EXPERIMENTS 12

Introduction – Analysis of variance – One way and two way classifications – Completely randomized design – Randomized block design – Latin square design.

UNIT III SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS 12

Solution of algebraic and transcendental equations – Fixed point iteration method – Newton Raphson method – Solution of linear system of equations – Gauss elimination method – Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigen Value of matrices by power method and jacobi's method for Symmetric matrices.

UNIT IV INTERPOLATION, NUMERICAL DIFFERENTIATION AND INTEGRATION 12

Lagrange's and Newton's divided difference interpolations – Newton's forward and backward difference interpolation – Approximation of derivatives using interpolation polynomials – Numerical single and double integrations using Trapezoidal and Simpson's 1/3 rules.

UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 12

Single step methods : Taylor's series method – Euler's method – Modified Euler's method – Fourth order Runge – Kutta method for solving first order differential equations – Multi step methods : Milne's and Adams Bashforth predictor corrector methods for solving first order differential equations.

TOTAL:60 PERIODS

COURSE OUTCOMES:

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

CO1 :	Apply the concept of testing of hypothesis for small and large samples in real life problems.
CO2 :	Apply the basic concepts of classifications of design of experiments in the field of agriculture.
CO3:	Solve the algebraic and transcendental equations.
CO4:	Understand the knowledge of numerical techniques of interpolation in various intervals andapply the numerical techniques of differentiation and integration for engineering problems.
CO5:	Solve the ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.
CO6:	Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.

TEXT BOOKS:

1. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.
2. Johnson , R.A., Miller, I and Freund J., “Miller and Freund’s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.

REFERENCES BOOKS :

1. Burden,R.L and Faires, J.D, "Numerical Analysis”, 9th Edition, Cengage Learning, 2016.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences”, Cengage Learning, New Delhi, 8th Edition, 2014.
3. Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis” Pearson Education, Asia, New Delhi, 7th Edition, 2007.
4. Gupta S.C. and Kapoor V.K., “Fundamentals of Mathematical Statistics”, Sultan Chand & Sons, New Delhi,12th Edition, 2020.
5. Spiegel.M.R.,Schiller.J. and Srinivasan. R.A., "Schaum’s Outlines on Probability and Statistics", Tata McGraw Hill Edition, 4th Edition, 2012.

U23GET15 **PROBLEM SOLVING AND PYTHON PROGRAMMING** **L T P C**
3 0 0 3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To understand the basics of algorithmic problem solving
2. To learn to solve problems using Python conditionals and loops.
3. To define Python functions and use function calls to solve problems.
4. To use Python data structures - lists, tuples, dictionaries to represent complex data.
5. To do input/output with files in Python.

UNIT I COMPUTATIONAL THINKING AND PROBLEM SOLVING 9

Fundamentals of Computing – Identification of Computational Problems -Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II DATA TYPES, EXPRESSIONS, STATEMENTS 9

Python interpreter and interactive mode, debugging; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III CONTROL FLOW, FUNCTIONS, STRINGS 9

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search

UNIT IV LISTS, TUPLES, DICTIONARIES 9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: simple sorting, histogram, Students marks statement, Retail bill preparation.

UNIT V FILES, MODULES, PACKAGES 9

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file, Voter's age validation, Marks range validation (0-100).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1 :** Develop algorithmic solutions to simple computational problems.
- **CO2 :** Develop and execute simple Python programs
- **CO3 :** Write simple Python programs using conditionals and looping for solving problems.
- **CO4 :** Decompose a Python program into functions
- **CO5 :** Represent compound data using Python lists, tuples, dictionaries etc
- **CO6 :** Read and write data from/to files in Python programs.

TEXT BOOKS:

1. Allen B. Downey, "Think Python: How to Think like a Computer Scientist", 2nd Edition, O'Reilly Publishers, 2016.
2. Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and programming", 1st Edition, BCS Learning & Development Limited, 2017.

REFERENCE BOOKS:

1. Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
2. G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021
3. John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data‘‘, Third Edition, MIT Press 2021
4. Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
5. Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

U23PHT23	APPLIED MATERIAL SCIENCE (COMMON TO AERO, AS, MECH, ROBO, CIVIL PROGRAMMES)	L 3	T 0	P 0	C 3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To make the students to understand the basics of crystallography and its importance in studying materials properties.
2. To understand the electrical properties of materials including free electron theory, applications.
3. To expand their knowledge in applications of magnetic and superconducting materials.
4. To instill knowledge on physics of semiconductors, determination of charge carriersand device applications.
5. To inculcate an idea of significance of new materials, nanostructures ensuing nano device applications.

UNIT I CONDENSED MATTER PHYSICS 9

Introduction - Lattice - Unit Cell - Seven Crystal Systems -Bravai's Lattices - Lattice Planes - Calculation of Number of Atoms per Unit Cell, Atomic Radius, Coordination Number and Packing Factor for SC, BCC, FCC and HCP Structures. Miller Indices – Derivation for Inter-Planar Spacing in terms of Miller Indices-Crystal Growth Techniques: Melt Growth Technique (Bridgman and Czochralski Techniques).

UNIT II CONDUCTING AND INSULATING MATERIALS 9

Conducting Materials: Classical Free Electron Theory: Postulates – Derivation of Electrical Conductivity and Thermal Conductivity- Derivation. Wiedemann-Franz Law and Its Verification-Merits and Demerits of Classical Free Electron Theory. Density of States – Carrier Concentration in Metals.

Insulating Materials: Types of Polarization Mechanisms - Langevin- Debye Equation - Internal Field – Clausius - Mossotti Relation – Applications of Insulating Materials.

UNIT III MAGNETIC AND SUPERCONDUCTING MATERIALS 9

Magnetic Materials: Dia, Para and Ferromagnetic Materials and Its Properties – Ferromagnetic Domains – Wiess Theory of Ferromagnetism – Hysteresis - B-H Curve Studies – Soft and Hard Magnetic Materials- Applications.

Superconducting Materials: Properties – Type I and Type II Superconductors – London equations – Applications: Magnetic Levitated Train – Magnetic Resonance Imaging.

UNIT IV PHYSICS OF SEMICONDUCTOR 9

Introduction – Properties - Intrinsic Semiconductors – Energy Band Diagram – Direct and Indirect Band Gap Semiconductors – Carrier Concentration in Intrinsic Semiconductors – Extrinsic Semiconductors - Carrier Concentration in N-Type & P-Type Semiconductors – Variation of Carrier Concentration with Temperature – Carrier Transport in Semiconductors: Drift, Mobility and Diffusion – Hall Effect And Devices.

UNIT V MODERN ENGINEERING MATERIALS 9

Shape Memory Alloys – Structures – Properties – Applications. Metallic Glasses – Preparation and Applications. Ceramics – Types - Properties and Applications.

Nanomaterials – Types – Properties and Applications – Preparation Techniques: Electrodeposition – Pulsed Laser Deposition. CNT – Structure – Types – Properties – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Know basics of crystallography and its importance for varied materials properties.

CO2 : Familiarize with theories of electrical and thermal conduction is solids, basic quantummechanics, and energy bands.

CO3 : Gain knowledge on the magnetic and superconductor properties of materials and theirapplications.

CO4 : Acquire knowledge on basics of semiconductor physics and its applications in various devices.

CO5 : Get knowledge on newly developed materials in micro and nano scale.

CO6 : Understand the different structures of CNT in Nano range

TEXT BOOKS:

1. Charles Kittel, Introduction to Solid State Physics, Wiley India Edition, 2019.
2. Jasprit Singh, Semiconductor Devices: Basic Principles, Wiley (India), 2007.
3. G.W.Hanson. Fundamentals of Nanoelectronics. Pearson Education (Indian Edition), 2009.
4. Dr. P. Mani, “Physics for Electronics Engineering” Dhanam Publications, 2017.
5. Dr. G. Senthilkumar, “Engineering Physics II” VRB Publishers, 2013.

REFERENCE BOOKS:

1. R.Balasubramaniam, Callister’s Materials Science and Engineering. Wiley (Indian Edition), 2014.
2. Wendelin Wright and Donald Askeland, Essentials of Materials Science and Engineering, CL Engineering, 2013.
3. S. Rajivgandhi, Dr. I. Cicil Ignatius & A. Ravikumar, “ Engineering Physics II”, RK Publications, 2023
4. Robert F. Pierret, Semiconductor Device Fundamentals, Pearson, 2006.
5. Ben Rogers, Jesse Adams and Sumita Pennathur, Nanotechnology: Understanding Small Systems, CRC Press, 2017.

U23EET26	BASIC ELECTRICAL AND DIGITAL ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To introduce the basics of electric circuits and analysis
2. To impart knowledge in the basics of working principles and application of electrical machines
3. To introduce analog devices and their characteristics
4. To educate on the fundamental concepts of digital electronics
5. To introduce basic concepts of 8085 microprocessor.

UNIT I ELECTRICAL CIRCUITS 9

DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor – Ohm's Law - Kirchhoff's Laws –Independent and Dependent Sources – Simple problems- Nodal Analysis, Mesh analysis with Independent sources only (Steady state)

Introduction to AC Circuits and Parameters: Waveforms, Average value, RMS Value, Instantaneous power, real power, reactive power and apparent power, power factor – Steady state analysis of RLC circuits (Simple problems only)

UNIT II ELECTRICAL MACHINES 9

Construction and Working principle- DC Separately and Self excited Generators, EMF equation, Types and Applications. Working Principle of DC motors, Torque Equation, Types and Applications. Construction, Working principle and Applications of Transformer, Three phase Alternator, Synchronous motor and Three Phase Induction Motor

UNIT III ANALOG ELECTRONICS 9

Resistor, Inductor and Capacitor in Electronic Circuits- Semiconductor Materials: Silicon & Germanium – PN Junction Diodes, Zener Diode – Characteristics Applications – Bipolar Junction Transistor-Biasing, JFET, SCR, MOSFET,IGBT – Types, I-V Characteristics and Applications, Rectifier and Inverters

UNIT IV DIGITAL ELECTRONICS 9

Review of number systems, binary codes, error detection and correction codes, Combinational logic - representation of logic functions - SOP and POS forms, K-map representations - minimization using K maps (Simple Problems only)

UNITV 8085 MICROPROCESSOR 9

Introduction to Microprocessor – Hardware Architecture, pinouts – Functional Building Block diagram-Instruction format –Addressing Modes-Memory Organization- I/O ports-Timing Diagram-Interrupts.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1:** Compute the electric circuit parameters for simple problems
- **CO2:** Explain the working principle of electrical machines
- **CO3:** Explain the applications of electrical machines
- **CO4:** Analyze the characteristics of analog electronic devices
- **CO5:** Explain the basic concepts of digital electronics
- **CO6:** Explain the basic concepts of 8085 microprocessor

TEXT BOOKS:

1. Kothari DP and I.J Nagrath, "Basic Electrical and Electronics Engineering", Second Edition, McGraw Hill Education, 2020
2. S.K.Bhattacharya "Basic Electrical and Electronics Engineering", Pearson Education, Second Edition, 2017.
3. Sedha R.S., "A textbook book of Applied Electronics", S. Chand & Co., 2008.
4. James A .Svoboda, Richard C. Dorf, "Dorf's Introduction to Electric Circuits", Wiley, 2018.
5. Sunil Mathur &Jeebananda Panda, "Microprocessor and Microcontrollers", PHI Learning Pvt. Ltd, 2016.

REFERENCE BOOKS:

1. Kothari DP and I.J Nagrath, "Basic Electrical Engineering", Fourth Edition, McGraw Hill Education, 2019.
2. Thomas L. Floyd, 'Digital Fundamentals', 11th Edition, Pearson Education, 2017.
3. Albert Malvino, David Bates, 'Electronic Principles, McGraw Hill Education; 7th edition, 2017.
4. Mahmood Nahvi and Joseph A. Edminister, "Electric Circuits", Schaum' Outline Series, McGraw Hill, 2002.
5. Krishna Kant, "Microprocessor and Microcontrollers", Eastern Company Edition, Prentice Hall of India, New Delhi, 2007.

GE3252 தமிழரும் தொழில் நுட்பமும் **L T P C**
1 0 0 1

அலகு I நெசவு மற்றும் பானைத் தொழில்நுட்பம் 3

சங்க காலத்தில் நெசவுத் தொழில் - பானைத் தொழில்நுட்பம் - கருப்பு சிவப்பு பாண்டங்கள் - பாண்டங்களில் கீறல் குறியீடுகள்.

அலகு II வடிவமைப்பு மற்றும் கட்டிடத் தொழில்நுட்பம் 3

சங்க காலத்தில் வடிவமைப்பு மற்றும் கட்டுமானங்கள் & சங்க காலத்தில் வீட்டுப் பொருட்களில் வடிவமைப்பு- சங்க காலத்தில் கட்டுமான பொருட்களும் நடுகல்லும் சிலப்பதிகாரத்தில் மேடை அமைப்பு பற்றிய விவரங்கள் - மாமல்லபுரச் சிற்பங்களும், கோவில்களும் சோழர் காலத்துப் பெருங்கோயில்கள் மற்றும் பிற வழிபாட்டுத் தலங்கள் - நாயக்கர் காலக் கோயில்கள் - மாதிரி கட்டமைப்புகள் பற்றி அறிதல், மதுரை மீனாட்சி அம்மன் ஆலயம் மற்றும் திருமலை நாயக்கர் மஹால் செட்டிநாட்டு வீடுகள் - பிரிட்டிஷ் காலத்தில் சென்னையில் இந்தோ-சாரோசெனிக் கட்டிடக் கலை.

அலகு III உற்பத்தித் தொழில் நுட்பம் 3

கப்பல் கட்டும் கலை - உலோகவியல் - இரும்புத் தொழிற்சாலை - இரும்பை உருக்குதல், எஃகு - வரலாற்றுச் சான்றுகளாக செம்பு மற்றும் தங்க நாணயங்கள் - நாணயங்கள் அச்சடித்தல் - மணி உருவாக்கும் தொழிற்சாலைகள் - கல்மணிகள், கண்ணாடி மணிகள் - சுடுமண் மணிகள் - சங்கு மணிகள் - எலும்புத்துண்டுகள் - தொல்லியல் சான்றுகள் - சிலப்பதிகாரத்தில் மணிகளின் வகைகள்

அலகு IV வேளாண்மை மற்றும் நீர்ப்பாசனத் தொழில் நுட்பம் 3

அணை, ஏரி, குளங்கள், மதகு - சோழர்காலக் குமுழித் தூம்பின் முக்கியத்துவம் கால்நடை பராமரிப்பு - கால்நடைகளுக்காக வடிவமைக்கப்பட்ட கிணறுகள் வேளாண்மை மற்றும் வேளாண்மைச் சார்ந்த செயல்பாடுகள் - கடல்சார் அறிவு - மீன்வளம் - முத்து மற்றும் முத்துக்குளித்தல் - பெருங்கடல் குறித்த பண்டைய அறிவு - அறிவுசார் சமூகம்,

அலகு V அறிவியல் தமிழ் மற்றும் கணித்தமிழ் 3

அறிவியல் தமிழின் வளர்ச்சி -கணித்தமிழ் வளர்ச்சி - தமிழ் நூல்களை மின்பதிப்பு செய்தல் - தமிழ் மென்பொருட்கள் உருவாக்கம் - தமிழ் இணையக் கல்விக்கழகம் - தமிழ் மின் நூலகம் - இணையத்தில் தமிழ் அகராதிகள் - சொற்குவைத் திட்டம்.

TOTAL: 15 PERIODS

TEXT-CUM-REFERENCE BOOKS:

1. தமிழக வரலாறு - மக்களும் பண்பாடும் - கே.கே.பிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2. கணினித் தமிழ் - முனைவர் இல. சுந்தரம். (விகடன் பிரசுரம்).
3. கீழடி - வைகை நதிக்கரையில் சங்ககால நகர நாகரிகம் (தொல்லியல் துறை வெளியீடு).
4. பொருநை ஆற்றங்கரை நாகரிகம். (தொல்லியல் துறை வெளியீடு).

GE3252	TAMILS AND TECHNOLOGY	L	T	P	C
		1	0	0	1

UNIT I WEAVING AND CERAMIC TECHNOLOGY 3

Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.

UNIT II DESIGN AND CONSTRUCTION TECHNOLOGY 3

Designing and Structural construction House & Designs in household materials during Sangam Age - Building materials and Hero stones of Sangam age – Details of Stage Constructions in Silappathikaram - Sculptures and Temples of Mamallapuram - Great Temples of Cholas and other worship places - Temples of Nayaka Period - Type study (Madurai Meenakshi Temple) - Thirumalai Nayakar Mahal - Chetti Nadu Houses, Indo - Saracenic architecture at Madras during British Period.

UNIT III MANUFACTURING TECHNOLOGY 3

Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting,steel -Copper and goldCoins as source of history - Minting of Coins – Beads making-industries Stone beads –Glass beads - Terracotta beads -Shell beads/ bone beats - Archeological evidences - Gem stone types described in Silappathikaram.

UNIT IV AGRICULTURE AND IRRIGATION TECHNOLOGY 3

Dam, Tank, ponds, Sluice, Significance of Kumizhi Thoompu of Chola Period, Animal Husbandry - Wells designed for cattle use - Agriculture and Agro Processing - Knowledge of Sea – Fisheries – Pearl - Conche diving - Ancient Knowledge of Ocean - Knowledge Specific Society

UNIT V SCIENTIFIC TAMIL & TAMIL COMPUTING 3

Development of Scientific Tamil - Tamil computing – Digitalization of Tamil Books – Development of Tamil Software – Tamil Virtual Academy – Tamil Digital Library – Online Tamil Dictionaries – Sorkuvai Project.

TOTAL: 15 PERIODS

TEXT-CUM-REFERENCE BOOKS:

1. Social Life of Tamils (Dr.K.K.Pillay) A joint publication of TNTB & ESC and RMRL – (in print)
2. Social Life of the Tamils - The Classical Period (Dr.S.Singaravelu) (Published by: International Institute of Tamil Studies.
3. Historical Heritage of the Tamils (Dr.S.V.Subatamanian, Dr.K.D. Thirunavukkarasu) (Published by: International Institute of Tamil Studies).
4. The Contributions of the Tamils to Indian Culture (Dr.M.Valarmathi) (Published by: International Institute of Tamil Studies.)
5. Keeladi - 'Sangam City Civilization on the banks of river Vaigai' (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation,Tamil Nadu)

6. Studies in the History of India with Special Reference to Tamil Nadu (Dr.K.K.Pillay) (Published by: The Author)
7. Porunai Civilization (Jointly Published by: Department of Archaeology & Tamil Nadu Text Book and Educational Services Corporation, Tamil Nadu)
8. Journey of Civilization Indus to Vaigai (R.Balakrishnan) (Published by: RMRL) - Reference Book.

U23EEP25	BASIC ELECTRICAL AND DIGITAL ENGINEERING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Using experimental methods to verify the Ohm's.
2. Analysing the behaviour of digital devices.
3. Conducting load tests on electrical machines.
4. Gaining practical experience in characterizing electronic devices.
5. Using 8085 microprocessor for Arithmetic operations

LIST OF EXPERIMENTS

1. Verification of ohms and Kirchhoff's Laws.
2. Load test on DC Shunt Motor.
3. Load test on Self Excited DC Generator.
4. Load test on Single phase Transformer
5. Load Test on Induction Motor
6. Characteristics of PN and Zener Diodes
7. Characteristics of BJT, SCR and MOSFET
8. Half wave and Full Wave rectifiers
9. Study of Logic Gates
10. Implementation of Binary Adder and Subtractor
11. Simple arithmetic operations: addition / subtraction / multiplication / division.
12. Programming with control instructions: (i) Ascending / Descending order, Maximum / Minimum of numbers. (ii) Programs using Rotate instructions. (iii) Hex / ASCII / BCD code conversions.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl. No.	Name of the Equipment	Quantity
1.	DC Regulated Power supply (0 - 30 V variable)	1
2.	DC shunt generator (0- 300V)	1
3.	Wattmeter – 300V, 30 A	1
4.	Single phase Induction motor	1
5.	PN Diodes and Zener diodes	As Required
6.	SCR, MOSFET and transistors	As Required
7.	IC 7400, 7402, 7404,7408,7432,7486	As Required
8.	Transistor	As Required
9.	Resistors	As Required
10.	Ammeter MC	As Required
11.	Voltmeter MC	As Required
12.	Rheostats	As Required
13.	Tachometer	As Required
14.	Connecting wires	As Required
15	8085 microprocessor kit	5

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Use experimental methods to verify the Ohm's Laws.
CO2 : Use experimental methods to verify the Kirchhoff's Laws.
CO3: Analyze experimentally the load characteristics of electrical machines.
CO4: Analyze the characteristics of basic electronic devices.
CO5: Analyze the behavior of digital devices.
CO6: Use microprocessor kit to verify the arithmetic operations

U23HSP22	COMMUNICATION LABORATORY (COMMON TO ALL B.E. / B.TECH. PROGRAMMES)	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. To identify varied group discussion skills and apply them to take part in effective discussions in a professional context.
2. To be able to communicate effectively through writing.
3. Encouraging plan designing and decision making.
4. Understanding and writing technical instruction.
5. To understand the value of letter writing with correct format.

LIST OF EXPERIMENTS:

1. Speaking-Role Play Exercises Based on Workplace Contexts.
2. Talking about competition.
3. Discussing progress toward goals-talking about experiences.
4. Discussing likes and dislikes.
5. Discussing feelings about experiences.
6. Discussing imaginary scenarios.
7. Writing short essays.
8. Speaking about the natural environment.
9. Describing communication system.
10. Describing position and movement- explaining rules.
11. Understanding technical instructions-Writing: writing instructions.
12. Speaking: describing things relatively-describing clothing.
13. Discussing safety issues (making recommendations) talking about electrical devices.
14. Describing controlling actions.
15. Writing a job application (Cover letter + Resume).

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1.	Communication laboratory with sufficient computer systems	**30**
2.	Server	**1**
3.	Head phone	**30**
4.	Audio mixture	**1**
5.	Collar mike	**1**
6.	Television	**1**
7.	Speaker set with amplifier	**1**
8.	Power point projector and screen	**1**
9.	Cordless mike	**1**

COURSE OUTCOMES:

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

- **CO1 :** Distinguish their technical competency through language skill.
- **CO2 :** Predict context effectively in-group discussions held in a formal / semi-formal discussions.
- **CO3:** Understanding candidates' key characteristics.
- **CO4:** Finding personality traits by sharing and comparing thoughts and ability.
- **CO5:** Understanding the value of ethics.(rules and regulations).
- **CO6:** Construct emails and effective job applications**.**

U23GEP13	PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To understand the problem solving approaches.
2. To learn the basic programming constructs in Python.
3. To practice various computing strategies for Python-based solutions to real world problems
4. To use Python data structures - lists, tuples, dictionaries.
5. To do input/output with files in Python.

LIST OF EXPERIMENTS

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same. (Electricity Billing, Retail shop billing, Sin series, weight of a motorbike, Weight of a steel bar, compute Electrical Current in Three Phase AC Circuit, etc.)
2. Python programming using simple statements and expressions (exchange the values of two variables, circulate the values of n variables, distance between two points).
3. Scientific problems using Conditionals and Iterative loops. (Number series, Number Patterns, pyramid pattern)
4. Implementing real-time/technical applications using Lists, Tuples. (Items present in a library/Components of a car/ Materials required for construction of a building –operations of list & tuples)
5. Implementing real-time/technical applications using Sets, Dictionaries. (Language, components of an automobile, Elements of a civil structure, etc.- operations of Sets & Dictionaries)
6. Implementing programs using Functions. (Factorial, largest number in a list, area of shape)
7. Implementing programs using Strings. (reverse, palindrome, character count, replacing characters)
8. Implementing programs using written modules and Python Standard Libraries (pandas, numpy. Matplotlib, scipy)
9. Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word)
10. Implementing real-time/technical applications using Exception handling. (divide by zero error, voter's age validity, student mark range validation)
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Develop algorithmic solutions to simple computational problems
CO2 : Develop and execute simple Python programs.
CO3: Implement programs in Python using conditionals and loops for solving problems.
CO4: Deploy functions to decompose a Python program.
CO5: Process compound data using Python data structures.
CO6: Utilize Python packages in developing software applications.

U23MAT31	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. To introduce the basic concepts of PDE for solving standard partial differential equations.
2. To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
3. To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
4. To acquaint the student with Fourier transform techniques used in wide variety of situations.
5. To enable the students to study the Laplace transforms and some applications tosolve the differential equations.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 12

Formation of partial differential equations by elimination of arbitrary constants and arbitrary functions – Lagrange's linear equation – Solution of homogeneous linear partial differential equations of higher order with constant coefficients of both homogenous and non – homogenous type.

UNIT II FOURIER SERIES 12

Dirichlet's conditions – General Fourier series – Odd and even functions–Half range sine series and cosine series – Parseval's identity – Harmonic analysis.

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 12

Classification of PDE – Method of separation of variables - Fourier series solutions of one dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction (Cartesian coordinates only).

UNIT IV FOURIER TRANSFORMS 12

Statement of Fourier integral theorem – Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem – Parseval's identity.

UNIT V LAPLACE TRANSFORMS 12

Existence conditions – Transforms of elementary functions – Transform of unit step function and unit impulse function – Basic properties – Shifting theorems – Transforms of derivatives and integrals - Initial and final value theorems – Inverse transforms – Convolution theorem–Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1 : Understand how to solve the given standard partial differential equations.

CO2 : Able to solve various types of partial differential equations.

CO3: Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.

CO4: Appreciate the physical significance of Fourier series techniques in solving One and two dimensional heat flow problems and one dimensional wave equations.

CO5: Understand the mathematical principles on transforms would provide them the ability to formulate and solve some of the physical problems of engineering.

CO6: Use the method of Laplace Transform to solve initial value problem for Linear differential equations with constant coefficients.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", 44th Edition, Khanna Publishers , New Delhi ,2018.
2. Kreyszig E, "Advanced Engineering Mathematics", 10th Edition, John Wiley,New Delhi,India,2016.

REFERENCES BOOKS :

1. Andrews. L.C and Shivamoggi .B, "Integral Transforms for Engineers "SPIE Press,1999.
2. Bali. N.P and Manish Goyal, "A Text book of Engineering Mathematics",10th Edition, Laxmi Publications Pvt. Ltd ,2015.
3. James. G., "Advanced Modern Engineering Mathematics", 4th Edition, Pears on Education, New Delhi,2016.
4. Narayanan. S.,Manicavachagom Pillay. T.K and Ramanaiah. G "Advanced Mathematics for Engineering Students",Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
5. Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd,NewDelhi,2018.

U23AET31	AERO ENGINEERING THERMODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Aero Thermodynamics study includes quantitative analysis of machine and processes for transformation of energy and between work and heat.
2. Laws of thermodynamics would be able to quantify through measurement of related properties, to these energies and their interactions.
3. To develop basic concept of air cycle, gas turbine engines and heat transfer.
4. To understand the basic principles of propulsion system of aircraft.
5. Thermodynamics heat transfer process would be able to understand their practical applications and its problems.

UNIT I FUNDAMENTAL CONCEPT AND FIRST LAW 9

Concept of continuum, macroscopic approach, thermodynamic systems – closed, open and isolated. Property, state, path and process, quasi-static process, work, internal energy, enthalpy, specific heat capacities and heat transfer, SFEE, application of SFEE to jet engine components, First law of thermodynamics, relation between pressure, volume and temperature for various processes, Zeroth law of thermodynamics.

UNIT II SECOND LAW AND ENTROPY 9

Second law of thermodynamics – Kelvin Planck and Clausius statements of second law-Reversibility and Irreversibility-Thermal reservoir-Carnot theorem-Carnot cycle-Reversed Carnot cycle-efficiency-COP-Thermodynamic temperature scale - Clausius inequality-Concept of entropy-Entropy change for various processes-Mixing of fluids.

UNIT III AIR STANDARD CYCLES 9

Otto, Diesel, Dual, Ericsson, Atkinson, Stirling and Brayton cycles - air standard efficiency - mean effective pressure.

UNIT IV FUNDAMENTALS OF VAPOUR POWER CYCLES 9

Properties of pure substances – solid, liquid and vapour phases, phase rule, p-v, p-T, T-v, T-s, h-s diagrams, p-v-T surfaces, thermodynamic properties of steam - calculations of work done and heat transfer in non-flow and flow processes - standard Rankine cycle, Reheat and Regeneration cycle. Heat rate, Specific steam consumption, Tonne of refrigeration.

UNITV BASICS OF PROPULSION AND HEAT TRANSFER 9

Classification of jet engines - basic jet propulsion arrangement – Engine station number, thrust equation – Specific thrust, SFC, TSFC, specific impulse, actual cycles, isentropic efficiencies of jet engine components, polytropic efficiency, conduction in parallel, radial and composite wall, basics of convective and radiation heat transfer.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1 :** Relate laws of thermodynamics to jet engine components.
- **CO2 :** Understands principle operation of piston engine and jet engines.
- **CO3:** Identify efficient cycle of air and jet engines.
- **CO4:** Illustrate condition of working medium.
- **CO5:** Recognize and calculate heat transfer in complex systems involving several heat transfer mechanisms.
- **CO6:** Analyse and solve the problems related to flow and non-flow process

TEXT BOOKS:

1. Nag.P.K. "Engineering Thermodynamics", Tata McGraw-Hill, New Delhi, 2013.
2. Radhakrishnan E.,"Fundamentals of Engineering Thermodynamics", Prentice-Hall India, 2010.
3. Yunus A. Cengel and Michael A. Boles, "Thermodynamics: An Engineering Approach" McGraw-Hill Science/Engineering/Math; 7thedition 2010.

REFERENCE BOOKS:

1. Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2003.
2. Holman.J.P. "Thermodynamics", 3rd Edition, McGraw-Hill, 2007.
3. Merala C, Pother, Craig W, Somerton, "Thermodynamics for Engineers", Schaum Outline Series, Tata McGraw-Hill, New Delhi, 2004.
4. Ramalingam K.K. "Thermodynamics", Sci-Tech Publications, 2006

U23AET32	SOLID MECHANICS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. Ability to think, Analyse and solve Engineering Problems expected from the course.
2. Ability to understand stress and strain concepts related to deformable bodies.
3. To enable understanding of the behaviour and response of materials and to allow the student to carry out easy and moderate level structural analysis of basic structural members.
4. To familiarize with the different methods used for beam deflection analysis.
5. To impart knowledge to the students on how structural elements are sized and to enable the student to gain knowledge in how stresses are developed and distributed internally.

UNIT I CONCURRENT AND NON-CONCURRENT 12

Introduction, Concept of FBD, Coplanar Concurrent force system, Moments, Coplanar Non-Concurrent force system and Support Reactions – Application Problems

UNIT II SHEAR FORCE AND BENDING MOMENT, SECOND AREA MOMENT PROBLEMS 12

Analysis of Simple Truss, Shear Force and Bending Moment Diagrams, C.G. and M.I of Plane areas.

UNIT III AXIAL BAR AND MATERIAL MODULUS 12

Simple stress and Strain, Mechanical Properties of Materials, Statically Determinate Problems and Elastic Constants, Tension, Compression, and Shear, Elasticity, Plasticity and Creep, Hooke'sLaw. Allowable stresses.

UNIT IV BEAM BENDING AND TORSION 12

Axially loaded members, Statically indeterminate structures, Thermal effects, misfits, and Pre-strains. Torsion of circular bar, Transmission of power by circular shafts. Stresses in beams, Pure bending and Nonuniform bending, Design of beams for bending stresses,Shear stresses in beams of rectangular cross section.

UNITV STRESS TRANSFORMATION, DEFLECTION OF BEAM AND BUCKLING OF COLUMN 12

Plane stress, Principal stresses, Mohr's circle and Hooke's law for plane stresses. Spherical and Cylindrical pressure vessels. Deflection of beams, Column buckling.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Clear understanding of mechanical behaviour of materials.
CO2 : Knowledge of different structural members and load types.
CO3: Design members under axial loading.
CO4: Design member under torsion loading.
CO5: Calculate beams deflections
CO6: To gain knowledge in how stresses are developed and distributed internally

TEXT BOOKS:

1. Egor P Popov, Mechanics of Materials, Pearson, 2015
2. James M. Gere, Mechanics of Materials, Sixth Edition, Thomson Learning, 2004
3. Ferdinand Beer, E. Russell Johnston Jr., John Dewolf, David Mazurek, Mechanics of Materials, McGraw Hill Education,2014.
4. Russell C Hibbeler, Mechanics of Materials, Pearson, 2013

REFERENCE BOOKS:

1. William F. Riley, Leroy D. Sturges, Don H. Morris, Mechanics of Materials, John Wiley & Sons, 1998.
2. Advanced Mechanics of Materials, 6th Edition, authored by Arthur P. Boresi, Richard J. Schmidt, bearing ISBN: 978-81-947263-9-5, Published by Wiley India Pvt. Limited
3. Mechanics of Materials, 5th Edition, authored by Timothy A. Philpot, Jeffery S. Thomas, bearing ISBN: 978-1-119-85997-0, Published by Wiley India Pvt. Limited.

U23MET32 FLUID MECHANICS AND MACHINERY

L	T	P	C
3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. The properties of fluids and concept of control volume are studied
2. The applications of the conservation laws to flow through pipes are studied.
3. To understand the importance of dimensional analysis
4. To understand the importance of various types of flow in pumps.
5. To understand the importance of various types of flow in turbines

UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 9

Units and dimensions-Properties of fluids-mass density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapour pressure, surface tension and capillarity. Flow characteristics –concept to control volume-application of continuity equation, energy equation and momentum equation.

UNIT II FLOW THROUGH CIRCULAR CONDUITS 9

Hydraulic and energy gradient-Laminar flow through circular conduits and circular annuli-Boundary layer concepts– types of boundary layer thickness–Darcy Weisbach equation–friction factor-Moody diagram- commercial pipes- minor losses–Flow through pipes in series and parallel.

UNIT III DIMENSIONAL ANALYSIS 9

Need for dimensional analysis – methods of dimensional analysis–Similitude–types of similitude-Dimensionless parameters- application of dimensionless parameters–Model analysis.

UNIT IV TURBINES 9

Classification of turbines–heads and efficiencies–velocity triangles .Axial, radial and mixed flow turbines. Pelton wheel, Francis turbine and Kaplan turbines-working principles-workdone by water on the runner–draft tube. Specific speed-unit quantities– performance curves for turbines– governing of turbines.

UNITV PUMPS 9

Classification of pumps - Centrifugal pumps - Working principle - Heads and efficiencies– Velocity triangles - Work done by the impeller - Performance curves - Reciprocating pump working principle - Indicator diagram and it’s variations - Work saved by fitting air vessels - Rotary pumps.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Understand the properties and behaviour in static conditions. Also, to understand the conservation laws applicable to fluids and its application through fluid kinematics and dynamics.

CO2 : Estimate losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel. Also, to understand the concept of boundary layer and its thickness on the flat solid surface.

CO3: Formulate the relationship among the parameters involved in the given fluid phenomenon and to predict the performances of prototype by model studies

CO4: Explain the working principles of centrifugal, reciprocating and rotary pumps and design the centrifugal and reciprocating pumps

CO5: Explain the working principles of various turbines and design the various types of turbines.

CO6: Determine the fluid pressure and use various devices for measuring fluid pressure.

TEXT BOOKS:

1. Modi P.N. and Seth, S.M."Hydraulics and Fluid Mechanics", Standard Book House, New Delhi 2019 (22nd Paperback edition). ISBN: 978-81-89401-26-9.
2. R.K. Bansal.” Fluid Mechanics and Hydraulic Machines” January 2018.
3. John. M. Cimbala Yunus A. Cengel.” Fluid Mechanics: Fundamentals and Applications (4th edition”, May 2019.

REFERENCE BOOKS:

1. Graebel. W.P, "Engineering Fluid Mechanics", Taylor & Francis, Indian Reprint, 2011
2. Kumar K. L., "Engineering Fluid Mechanics", Eurasia Publishing House(p) Ltd., New Delhi 2016
3. Robert W. Fox, Alan T. McDonald, Philip J. Pritchard, “Fluid Mechanics and Machinery”, 2011
4. Streeter, V. L. and WylieE.B.,"Fluid Mechanics",McGraw Hill Publishing Co.2010

U23AET34	ELEMENTS OF AERONAUTICAL ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To acquire the knowledge on the Historical evaluation of Airplanes.
2. To learn the different component systems and function.
3. To know the concepts of basic properties and principles behind the flight.
4. To learn the basics of different structures & construction.
5. To learn the various types of power plants used in aircrafts.

UNIT I HISTORY OF FLIGHT 9

Balloon flight-ornithopter-Early Airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years.

UNIT II AIRCRAFT CONFIGURATIONS AND ITS CONTROLS 9

Different types of flight vehicles, Classifications-Components of an airplane and their functions-Conventional control, powered control- Basic instruments for Flying-Typical systems for control actuation

UNIT III BASICS OF AERODYNAMICS 9

Physical Properties and structures of the Atmosphere, Temperature, pressure and altitude relationships, Newton's Law of Motions applied to Aeronautics-Evolution of lift, drag and moment. Aerofoils, Mach number, Manoeuvres.

UNIT IV BASICS OF AIRCRAFT STRUCTURES 9

General types of construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Metallic and non-metallic materials. Use of Aluminium alloy, titanium, stainless steel and composite materials. Stresses and Strains-Hooke's law- stress-strain diagrams-elastic Constants-Factor of Safety.

UNIT V BASICS OF PROPULSION 9

Basic ideas about piston, turboprop and jet engines – use of propeller and jets for thrust Production - Comparative merits, Principle of operation of rocket, types of rocket and typical applications, Exploration into space.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Illustrate the history of aircraft & developments over the years
CO2 : Ability to identify the types & classifications of components and control systems
CO3: Explain the basic concepts of flight & Physical properties of Atmosphere
CO4: Identify the types of fuselage and constructions.
CO5: Distinguish the types of Engines and explain the principles of Rocket
CO6: Understand the basic aircraft systems

TEXT BOOKS:

1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition, 2015
2. E Rathakrishnan, “Introduction to Aerospace Engineering: Basic Principles of Flight”, John Wiley, NJ, 2021
3. Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

REFERENCE BOOKS:

1. Sadhu Singh, “Internal Combustion Engines and Gas Turbine”, SS Kataraia & Sons, 2015
2. Kermode, “Flight without Formulae”, Pitman; 4th revised edition 1989.

U23GET41 ENVIRONMENTAL SCIENCES SUSTAINABILITY

L	T	P	C
2	0	0	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
2. To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters.
3. To facilitate the understanding of global and Indian scenario of renewable and non renewable resources, causes of their degradation and measures to preserve them.
4. To familiarize the concept of sustainable development goals and appreciate the interdependence of economic and social aspects of sustainability, recognize and analyze climate changes, concept of carbon credit and the challenges of environmental management.
5. To inculcate and embrace sustainability practices and develop a broader understanding on green materials, energy cycles and analyze the role of sustainable urbanization.

UNIT I ENVIRONMENT AND BIODIVERSITY 6

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– ecological succession. Types of biodiversity: genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ.

UNIT II ENVIRONMENTAL POLLUTION 6

Causes, Effects and Preventive measures of Water, Soil, Air and Noise Pollutions. Solid, Hazardous and E-Waste management. Case studies on Occupational Health and Safety Management system (OHASMS). Environmental protection, Environmental protection acts.

UNIT III RENEWABLE SOURCES OF ENERGY 6

Energy management and conservation, New Energy Sources: Need of new sources. Different types new energy sources. Applications of- Hydrogen energy, Ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy.

UNIT IV SUSTAINABILITY AND MANAGEMENT 6

Development , GDP ,Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols-Sustainable Development Goals-targets, indicators and intervention areas Climate change- Global, Regional and local environmental issues and possible solutions-case studies. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry-A case study.

UNITV SUSTAINABILITY PRACTICES 6

Zero waste and R concept, Circular economy, ISO 14000 Series, Material Life cycle assessment, Environmental Impact Assessment. Sustainable habitat: Green buildings, Green materials, Energy efficiency, Sustainable transports. Sustainable energy: Non-conventional Sources, Energy Cycles Carbon cycle, emission and sequestration, Green Engineering: Sustainable urbanization- Socio economic and technological change.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1 :** To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.
- **CO2 :** To identify the causes, effects of environmental pollution and natural disasters and contribute to the preventive measures in the society.
- **CO3:** To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations
- **CO4:** To recognize the different goals of sustainable development and apply them for suitable technological advancement and societal development.
- **CO5:** To demonstrate the knowledge of sustainability practices and identify green materials, energy cycles and the role of sustainable urbanization.
- **CO6:** To explain the integrated themes and biodiversity, natural resources, pollution control and waste management

TEXT BOOKS:

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers ,2018.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Prentice Hall.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, Cengage learning

REFERENCE BOOKS:

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media. 38 . Edition 2010
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, Third Edition, 2015.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 2013.

U23AEP31	THERMODYNAMICS AND STRENGTH OF MATERIALS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To have a practical exposure to the subject of thermodynamics principles.
2. To conduct experiments to find the effectiveness of parallel flow and counter flow heat exchangers.
3. To test the flash point and fire point of oil.
4. To have hands-on experience on various experiments related to solid mechanics
5. To test and quantify the mechanical properties of Engineering Materials.

LIST OF EXPERIMENTS

Thermodynamics Laboratory:

1. Determination of calorific value of a given fuel.
2. Free convective heat transfer from a flat plate
3. Determination of Effectiveness of parallel flow heat exchangers.
4. Forced convective heat transfer from a flat plate.
5. Determination of Effectiveness of a counter flow heat exchanger
6. Determination of Flash point and Fire point of the given oil.

Strength of Materials Laboratory:

7. Tension Test
8. Testing of springs
9. Impact test, Charpy model
10. Deflection of Beams
11. Hardness test.
12. Fatigue test for Elastomers

Any 10 experiments will be conducted from above 12 experiments

TOTAL: 60 PERIODS

LIST OF EQUIPMENT

FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1	Bomb Calorimeter	1
2	Parallel and counter flow heat exchanger test rig	1
3	Flash point apparatus.	1
4	Convective heat transfer	1
5	Universal Tensile Testing machine	1
6	Spring Testing Machine for tensile and compressive loads	1
7	Brinell Hardness Testing Machine	1
8	Rockwell Hardness Testing Machine	1
9	Torsion Testing Machine	1
10	Impact Testing Machine	1

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1 :** Test and quantify the mechanical properties of Engineering Materials
- **CO2 :** Acquire knowledge on bending properties of beams.
- **CO3:** Estimate the performance of heat exchangers.
- **CO4:** Apply principles of convective heat transfer characteristics to practical systems.
- **CO5:** Acquire Knowledge on ignition aspects of fuels and thermal properties of fuels.
- **CO6:** Ability to characteristic materials.

U23AEP32 FLUID MECHANICS AND MACHINERY LABORATORY

L	T	P	C
0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To have practical exposure on pressure measuring instruments
2. To learn about the practical application of Bernoulli's theorem
3. To have a practical knowledge about the Venturimeter and its applications
4. To learn practically about the laminar flow characteristics
5. To have a hands-on experience on the determination of various performance parameters of a centrifugal pump.

LIST OF EXPERIMENTS

Thermodynamics Laboratory:

1. Determination of the Coefficient of discharge of given Orifice meter.
2. Determination of the Coefficient of discharge of given Venturi meter.
3. Calculation of the rate of flow using Rota meter.
4. Determination of friction factor for a given set of pipes.
5. Conducting experiments and drawing the characteristic curves of centrifugal pump/submergible pump
6. Conducting experiments and drawing the characteristic curves of reciprocating pump.
7. Conducting experiments and drawing the characteristic curves of Gear pump.
8. Conducting experiments and drawing the characteristic curves of Pelton wheel.
9. Conducting experiments and drawing the characteristics curves of Francis turbine.
10. Conducting experiments and drawing the characteristic curves of Kaplan turbine.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT

FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1	Orifice meter setup	1
2	Venturi meter setup	1
3	Rotameter setup	1
4	Pipe Flow analysis setup	1
5	Centrifugal pump/submergible pump setup	1
6	Reciprocating pump setup	1
7	Gear pump setup	1
8	Pelton wheel setup	1
9	Francis turbine setup	1
10	Kaplan turbine setup	1

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Operate fluid flow equipment and instrumentation.

CO2 : Analyze data using fluid mechanics principles and experimentation methods.

CO3: Determine the coefficient of discharge for various flow measurement devices.

CO4: Calculate flow characteristics such as Reynolds number, friction factor from laboratory measurements.

CO5: Analyze the performance characteristics of hydraulic pumps.

CO6: Analyze the performance characteristics of hydraulic turbines

23MAT41	MULTIVARIABLE CALCULUS AND COMPLEX ANALYSIS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To acquaint the student with the concepts of grad, div, curl in Cartesian needed for problems in all engineering disciplines.
2. To analysis the analytic functions, conformal mapping and bilinear transformation.
3. To make the student to define a complex function and solving through complex integration and various series.
4. To introduce the effective mathematical tools for the solutions of difference equations that model several physical processes and to develop Z-transform techniques for discrete time system.
5. To analysis the center and circle of curvature.

UNIT I VECTOR CALCULUS 12

Gradient and directional derivative – Divergence and curl - Vector identities – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's, Gauss divergence and Stoke's theorems (without proof).

UNIT II ANALYTIC FUNCTION 12

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates – Properties – Harmonic conjugates – Construction of analytic function –Conformal mapping – Mapping by function w = z+c, az, 1/z, z2 – Bilinear transformation.

UNIT III COMPLEX INTEGRATION 12

Introduction - Line integral - Cauchy's integral theorem (without proof) – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals - Use of circular contour and semicircular contour.

UNIT IV Z-TRANSFORMS AND DIFFERENCE EQUATIONS 12

Definition – Z transform of some basic functions – Elementary properties – Inverse Z transform : Partial fraction method – Residue method – Convolution theorem – Applications of Z-transforms: Solution of difference equations.

UNITV APPLICATIONS OF DIFFERENTIAL CALCULUS 12

Curvature in Cartesian co-ordinates – Centre and radius of curvature. – Circle of curvature – Evolutes – Envelopes – Evolute as envelope of normals.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1 :** Calculate grad, div, curl in Cartesian and gauss, stokes and greens theorems.
- **CO2 :** Express analytic functions, conformal mapping and bilinear transformation.
- **CO3:** Use the concepts of integration to complex functions in certain regions derive various Series.
- **CO4:** Use the effective mathematical tools for the solutions of difference equations by using Z transform techniques for discrete time systems terms.
- **CO5:** Derive the centre and circle of curvature in solving various application problems.
- **CO6:** Calculate evolutes and envelopes of normals by using cartesian co-ordinates.

TEXT BOOKS:

1. Erwin Kreyszig," Advanced Engineering Mathematics ", John Wiley and Sons, 10th Edition, New Delhi, 2016.
2. Grewal B.S., "Higher Engineering Mathematics ", Khanna Publishers, New Delhi, 43rd Edition, 2014.

REFERENCE BOOKS:

1. Sastry, S.S, "Engineering Mathematics", Vol. I & II, PHI Learning Pvt. Ltd, 4th Edition, New Delhi, 2014.
2. Jain R.K. and Iyengar S.R.K., " Advanced Engineering Mathematics ", Narosa Publications, New Delhi , 3rd Edition, 2007.
3. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics ", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
4. Peter V. O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi, 2007.
5. Ray Wylie C and Barrett.L.C, "Advanced Engineering Mathematics" Tata McGraw Hill Education Pvt. Ltd, 6th Edition, New Delhi, 2012.

U23AET41	LOW SPEED AERODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To introduce the concepts of mass, momentum and energy conservation relating to aerodynamics
2. To introduce the Navier Stroke equations and its application
3. To make the student understand the concept of vorticity, irrotationality, theory of airfoil and wing sections.
4. To introduce the basics of viscous flow
5. To make the student to understand the different boundary layers and Blasius Solution

UNIT I INTRODUCTION TO LOW-SPEED FLOW 9

Euler equation, incompressible Bernoulli's equation. circulation and vorticity, green's lemma and Stoke's theorem, barotropic flow, kelvin's theorem, streamline, stream function, irrotational flow, potential function, Equipotential lines, elementary flows and their combinations.

UNIT II TWO DIMENSIONAL INVISCID INCOMPRESSIBLE FLOW 9

Ideal Flow over a circular cylinder, D'Alembert's Paradox, Magnus effect, Kutta Joukowski's Theorem, Starting Vortex, Kutta condition, Real flow over smooth and rough cylinder.

UNIT III AIRFOIL THEORY 9

Cauchy-Riemann relations, Complex Potential, Methodology of Conformal Transformation, Kutta-Joukowski transformation and its applications, Karman Trefftz Profiles, Thin Airfoil theory and its applications.

UNIT IV SUBSONIC WING THEORY 9

Vortex Filament, Biot – Savart Law, Bound Vortex and trailing Vortex, Horse Shoe Vortex, Lifting Line Theory and its limitations

UNIT V INTRODUCTION TO LAMINAR AND TURBULENT FLOW 9

Boundary layer and boundary layer thickness, displacement thickness, momentum thickness, Energy thickness, Shape parameter, Boundary layer equations for a steady, two dimensional incompressible flow, Boundary Layer growth over a Flat plate, Critical Reynolds Number, Blasius solution, Basics of Turbulent flow, Prandtl's mixing length hypothesis, Free shear layers.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1 :** Apply the basics physics for low-speed flows
- **CO2 :** Apply the concept of 2D, inviscid incompressible flows in low-speed aerodynamics.
- **CO3 :** Solve lift generation problems using aerofoil theories.
- **CO4:** Make use of lifting line theory for solving flow properties.
- **CO5:** Solve the boundary layer equations for a steady, two-dimensional incompressible Flow.
- **CO6:** Solve the properties of turbulent flow.

TEXT BOOKS:

1. Anderson, J.D., "Fundamentals of Aerodynamics", McGraw Hill Book Co., 2010.
2. Houghton, E.L., and Caruthers, N.B., "Aerodynamics for Engineering students", Edward Arnold Publishers Ltd., London, 1989.
3. E Rathakrishnan, “Theoretical Aerodynamics”, John Wiley, NJ, 2013

REFERENCE BOOKS:

1. Clancey, L J.," Aerodynamics", Pitman, 1986.
2. John J Bertin., "Aerodynamics for Engineers", Pearson Education Inc, 2002.
3. Kuethe, A.M and Chow, C.Y, “Foundations of Aerodynamics”, Fifth Edition, John Wiley & Sons, 2000.
4. Milne Thomson, L.H., "Theoretical Aerodynamics", Macmillan, 1985.

U23AET42	AIR BREATHING PROPULSION	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To establish fundamental approach and application of jet engine components.
2. To learn about the analysis of flow phenomenon and estimation of thrust developed by jet engine.
3. To introduce about the application of various equations in Gas Turbine Engines.
4. To learn the concepts of jet engine combustion chambers
5. To acquire knowledge on compressors and turbines.

UNIT I PRINCIPLES OF AIR BREATHING ENGINES 9

Illustration of working gas turbine cycle – Thrust equation – Factors affecting thrust – Methods of thrust augmentation – Engine performance parameters – Performance analysis of turboprop, turbofan and turbojet.

UNIT II JET ENGINE INTAKES AND EXHAUST NOZZLES 9

Ram effect, Internal flow and Stall in subsonic inlets – relation between minimum area ratio and eternal deceleration ratio – diffuser performance – modes of operation - supersonic inlets – starting problem on supersonic inlets – shock swallowing by area variation – real flow through nozzles and nozzle efficiency – losses in nozzles – ejector and variable area nozzles - interaction of nozzle flow with adjacent surfaces – thrust reversal.

UNIT III JET ENGINE COMBUSTION CHAMBERS 9

Chemistry of combustion, Combustion equations, Combustion process, classification of combustion chambers – combustion chamber performance – effect of operating variables on performance – flame stabilization, Cooling process, Materials, Aircraft fuels, HHV, LHV, Orsat apparatus

UNIT IV JET ENGINE COMPRESSORS 9

Euler's turbo machinery equation, Principle operation of centrifugal compressor, Principle operation of axial flow compressor– Work done and pressure rise – velocity diagrams – degree of reaction – free vortex and constant reaction designs of axial flow compressor – performance parameters axial flow compressors– stage efficiency.

UNITV JET ENGINE TURBINES 9

Principle of operation of axial flow turbines– limitations of radial flow turbines- Work done and pressure rise – Velocity diagrams – degree of reaction – constant nozzle angle designs – performance parameters of axial flow turbine– turbine blade cooling methods – stage efficiency calculations – basic blade profile design considerations – matching of compressor and turbine

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1:** Apply ideal and actual cycle analysis of a gas turbine engine to relate thrust and fuel consumption.
- **CO2:** Acquire knowledge on the operation of subsonic, supersonic inlets and their operating characteristics.
- **CO3:** Explain the nozzle performance of the engine
- **CO4:** Illustrate the combustion process and fuels used on combustion.
- **CO5:** Understanding the workings of multistage compressor or turbine, and use velocity triangles.
- **CO6:** Understand the working and performance characteristics of the turbines.

TEXT BOOKS:

1. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Pearson education (2009)
2. V.Ganesan "Gas Turbines" Tata McGraw-Hill Education Pvt. Ltd., 2010
3. Ahmed F. El – Sayed, "Aircraft Propulsion and Gas turbine engines", CRC Press Taylor and Francis group, Second Edition 2017

REFERENCE BOOKS:

1. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H. "Gas Turbine Theory", Pearson Education Canada; 6th edition, 2008.
2. Mathur, M.L. and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers & Distributors, Delhi, 2nd edition 2014
3. Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAA Education Series, New York, 1985.
4. "Rolls Royce Jet Engine", Rolls Royce; 4th revised edition, 1986

U23AET43	AIRCRAFT STRUCTURES-I	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To provide the students an understanding on the linear static analysis of determinate and indeterminate aircraft structural components.
2. To provide the students an understanding on energy methods to statically determinate and indeterminate structures
3. To make the students to Create a structure to carry the given load
4. To make the students to Calculate the response of statically indeterminate structures under various loading conditions.
5. To provide the design process using different failure theories

UNIT I STATICALLY DETERMINATE & INDETERMINATE STRUCTURES **9**

Plane truss analysis – method of joints – method of sections – method of shear – 3-D trusses – principle of super position, Clapeyron's 3 moment equation and moment distribution method for indeterminate beams

UNIT II ENERGY METHODS **9**

Strain Energy in axial, bending, torsion and shear loadings. Castigliano's theorems and their applications. Energy theorems – dummy load & unit load methods – energy methods applied to statically determinate and indeterminate beams, frames, rings & trusses.

UNIT III COLUMNS **9**

Euler's column curve – inelastic buckling – effect of initial curvature – Southwell plot – columns with eccentricity – use of energy methods – theory of beam columns – beam columns with different end conditions – stresses in beam columns.

UNIT IV FAILURE THEORIES **9**

Ductile and brittle materials – maximum principal stress theory - maximum principal strain theory - maximum shear stress theory - distortion energy theory – octahedral shear stress theory.

UNITV INDUCED STRESSES **9**

Thermal stresses – impact loading – Fatigue – Creep - Stress Relaxation

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

- **CO1:** Explain the method to analyse the linear static analysis of determinate and indeterminate aircraft structural components
- **CO2 :** Apply the energy methods to determine the reactions of structure
- **CO3:** Analyse the column structure with different end condition.
- **CO4:** Design the component using different theories of failure.
- **CO5:** Create a structure to carry the given load by considering effect of induced stresses
- **CO6:** understanding on the linear static analysis of determinate and indeterminate aircraft structural components

TEXT BOOKS:

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

REFERENCE BOOKS:

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

U23AET44	MECHANICS OF MACHINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To understand the principles in the formation of mechanisms and their kinematics.
2. To learn the basic concepts of toothed gearing and kinematics of gear trains.
3. To study the effect of friction in different machine elements.
4. To analyse the forces and torque acting on simple mechanical systems
5. To understand the importance of balancing and vibration

UNIT I KINEMATIC ANALYSIS IN SIMPLE MECHANISMS AND CAMS 9

Mechanisms – Terminology and definitions – kinematics inversions and analysis of 4 bar and slide crank chain – velocity and acceleration polygons – cams – classifications – displacement diagrams - layout of plate cam profiles

UNIT II TOOTHED GEARING AND GEAR TRAINS 9

Gear terminology – law of toothed gearing – involute gearing – Gear tooth action - Interference and undercutting – gear trains – parallel axis gear trains – epicyclic gear trains.

UNIT III FRICTION ASPECTS IN MACHINE COMPONENTS 9

Surface contacts – Sliding and Rolling friction – Friction drives – Friction in screw threads – Friction clutches – Belt drives – Friction aspects in brakes

UNIT IV STATIC AND DYNAMIC FORCE ANALYSIS 9

Applied and Constrained Forces – Free body diagrams – Static equilibrium conditions – Static Force analysis in simple mechanisms – Dynamic Force Analysis in simple machine members – Inertia Forces and Inertia Torque – D'Alembert's principle.

UNIT V BALANCING OF ROTATING MASSES AND VIBRATION 9

Static and Dynamic balancing – Balancing of revolving masses – Balancing machines – Free vibrations – natural Frequency – Damped Vibration – bending critical speed of simple shaft – Forced vibration – harmonic Forcing – Vibration isolation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Design the linkages and the cam mechanisms for specified output motions.

CO2 : Determine the gear parameters of toothed gearing and speeds of gear trains in various applications.

CO3: Evaluate the frictional torque in screw threads, clutches, brakes and belt drives.

CO4: Determine the forces on members of mechanisms during static and dynamic equilibrium conditions.

CO5: Determine the balancing masses on rotating machineries and the natural frequencies of free and forced vibratory systems

CO6: understand the importance of balancing and vibration

TEXT BOOKS:

1. Uicker, J.J., Pennock G.R and Shigley, J.E., “Theory of Machines and Mechanisms”, Oxford University Press, 2017.
2. Shigley J.E., Pennock G.R and Uicker J.J., ―Theory of Machines and Mechanisms‖, Oxford University Press, 2003

REFERENCE BOOKS:

1. Cleghorn. W. L., Nikolai Dechev, “Mechanisms of Machines”, Oxford University Press, 2015
2. Rao.J.S. and Dukkipati.R.V. “Mechanism and Machine Theory”, New Age International Pvt.Ltd.,2006.
3. Rattan, S.S, “Theory of Machines”, McGraw-Hill Education Pvt. Ltd., 2014
4. Robert L. Norton, Kinematics and Dynamics of Machinery, Tata McGraw-Hill, 2009.
5. Thomas Bevan, “The Theory of Machines”, Pearson Education Ltd., 2010

U23AET45	AIRCRAFT SYSTEMS AND INSTRUMENTS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To impart knowledge of the hydraulic and pneumatic systems components
2. To Study the types of instruments and its operation including navigational instruments.
3. Acquire the knowledge of essential systems of safe aircraft operation.
4. To learn the concepts of display systems
5. To study the various engine systems in aircraft

UNIT I AIRCRAFT SYSTEMS 9

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 AIRPLANE CONTROL SYSTEMS 9

Conventional Systems – Power assisted and fully powered flight controls – Power actuated systems – Engine control systems – Push pull rod system – operating principles – Modern control systems – Digital fly by wire systems – Auto pilot system.

UNIT III ENGINE SYSTEMS 9

Piston and Jet Engines- Fuel systems – Components - Multi-engine fuel systems, lubricating systems – Starting and Ignition systems.

UNIT IV AIRCONDITIONING AND PRESSURIZING SYSTEM 9

Basic Air Cycle systems – Vapour Cycle Systems, Boot-strap air cycle system – Evaporative vapour cycle systems – Evaporation air cycle systems – Oxygen systems – Fire extinguishing system and smoke detection system, Deicing and anti-icing system

UNITV AIRCRAFT INSTRUMENTS 9

Flight Instruments and Navigation Instruments – Accelerometers, Air speed Indicators – Mach Meters – Altimeters - Gyroscopic Instruments– Principles and operation – Study of various types of engine instruments – Tachometers – Temperature and Pressure gauges.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Demonstrate the ability to design a various system using pneumatic and hydraulic components.

CO2 : Keep abreast knowledge on various flight control system and its recent advancements.

CO3: Demonstrate the fundamental understanding of the operation of engine auxiliary systems.

CO4: To understand the various cabin comfort system used in aircraft modern display systems.

CO5: Describe the principle behind the operation of various vital parameter displays and its uses in effective conduct of the flight.

CO6: Describe the inspection procedure and troubleshooting on aircraft

TEXT BOOKS:

1. Mekinley, J.L. and R.D. Bent, Aircraft Power Plants, McGraw Hill, 1993
2. Pallet, E.H.J. Aircraft Instruments & Principles, Pitman & Co, 1993.
3. Irwin Treager, 'Aircraft Gas Turbine Engine Technology', Third Edition, McGraw Hill, 1997
4. Ian Moir and Allan Seabridge, 'Aircraft Systems – Mechanical, electrical and avionics subsystems integration', Second Edition, Professional Engineering Publishing Limited, 2001.

REFERENCE BOOKS:

1. Handbooks of Airframe and Power plant Mechanics, US dept. of Transportation, Federal, Aviation Administration, the English Book Store, New Delhi, 1995.
2. McKinley, J.L. and Bent R.D. Aircraft Maintenance & Repair, McGraw Hill, 1993.
3. Teager, S, "Aircraft Gas Turbine technology, McGraw Hill 1997.

U23AEP41	AERODYNAMICS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To make the students familiarize with the calibration procedures of subsonic and supersonic wind tunnel operations.
2. To enable the students, observe the pressure distribution over the various aerodynamics models.
3. To give students exposure to determine the various kinds of aerodynamic forces and moments acting on the floating bodies.
4. To make the students to learn the principles of various flow visualization techniques to observe the flow patterns of aerodynamic bodies.
5. To make students familiarize with the concept of drag estimation.

LIST OF EXPERIMENTS

Thermodynamics Laboratory:

1. Calibration of a subsonic Wind tunnel.
2. Determination of lift for the given airfoil section
3. Pressure distribution over a smooth circular cylinder.
4. Pressure distribution over a rough circular cylinder.
5. Pressure distribution over a symmetric aerofoil.
6. Pressure distribution over a cambered aerofoil.
7. Force measurement using wind tunnel balancing set up.
8. Flow over a flat plate at different angles of incidence.
9. Flow visualization studies in low speed flows over cylinders.
10. Flow visualization studies in low speed flows over airfoil with different angle of incidence.
11. Study of Supersonic Wind Tunnel.

Any 10 experiments will be conducted from above 11 experiments

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1	Subsonic Wind tunnel	1
2	Models (aerofoil, rough and smooth cylinder, flat plate)	2
3	Angle of incidence changing mechanism	1
4	Multi tube Manometer	1
5	Pitot-Static Tubes	1
6	Cylinder models (Rough and Smooth)	2
7	Wind Tunnel balances (3 or 6 components)	1
8	Smoke Generator	1
9	Water flow channel	1

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Calibrate both low speed and high speed experimental facilities.

CO2 : Identify variation in flow physics due to geometrical modifications and orientations.

CO3: Estimate the various forces and moments acting on aerodynamics bodies.

CO4: Demonstrates the different aspect flow patterns of the aerodynamic bodies.

CO5: Predict and analyse various forms of drag and their contributions.

CO6: Explain the viscous interaction in Various flows

U23AEP42	PROPULSION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To determine the flow behaviour of free and wall jets.
2. To visualize the shock pattern in supersonic flow.
3. To provide an idea of wall pressure distribution on inlets and nozzles
4. To perform testing on compressor blades and basic knowledge on cold flow studies.
5. To develop the ability to analyze and interpret the experimental data using software

LIST OF EXPERIMENTS

1. Study of aircraft piston & gas turbine engines
2. Velocity profile of free jet and wall jet
3. Conduct the performance test on a propeller.
4. Wall pressure measurements of subsonic diffusers
5. Measure the pressure variation on an aero engine compressor
6. Cascade testing of compressor and turbine blades.
7. Flame stabilization studies using conical and hemispherical flame holders.
8. Measurement of burning velocity of Pre-mixed Flame
9. Performance test of a Reaction turbine.
10. Wall Pressure measurements of nozzle.
11. Conduct the performance test on Ramjet
12. Velocity and pressure measurements high speed jets.
13. Flow visualization of supersonic flow.

Any 10 experiments will be conducted from above 13 experiments

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1	Jet engine	1
2	Piston engine	1
3	Propeller blade	1
4	Compressor blade set	
5	Turbine blade set	
6	Hemispherical & Conical flame holder model	1
7	Ramjet facility	1
8	Convergent and C-D nozzle model	1
9	High speed Jet facility with compressor and storage tank	1
10	Pressure scanner, Schlieren, and high- resolution CCD camera flow visualization	1

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1 : Explain the basic fundamental concepts in jet propulsion and hands on experience on jet engine.

CO2 : Analysis the performance of the propeller.

CO3: Measure the wall pressure of the engine components.

CO4: Understand the flame stabilization and Propagation of Pre-mixed Flame.

CO5: Get practical exposures on flow visualization techniques pertaining to supersonic flows.

CO6: Demonstrate the fundamental concepts of low speed and high-speed jets and experimental techniques pertain to measurements.

U23AEP43	AIRCRAFT SYSTEMS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES

The main learning objective of this course is to prepare the students for:

1. To train the students "ON HAND" experience in maintenance of various air frame systems in aircraft and rectification of common snags.
2. To enable the students to understand the performance characteristics of various aircraft engine control systems.
3. To train the students , Demonstrate the operation of aircraft and engine system
4. To make students familiarize in the inspection procedure and troubleshooting on aircraft.
5. To make the students to learn the construction and working principle of conventional aircraft systems

LIST OF EXPERIMENTS

1. Aircraft "Jacking Up" procedure
2. Aircraft "Levelling" procedure
3. Control System "Rigging check" procedure
4. Aircraft "Symmetry Check" procedure
5. "Flow test" to assess of filter element clogging
6. "Pressure Test" To assess hydraulic External/Internal Leakage
7. "Functional Test" to adjust operating pressure
8. "Pressure Test" procedure on fuel system components
9. "Brake Torque Load Test" on wheel brake units
10. Maintenance and rectification of snags in hydraulic and fuel systems.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR BATCH OF 30 STUDENTS

Sl no	Name of the Equipment	Quantity
1	Serviceable aircraft with all above systems	1
2	Hydraulic Jacks (Screw Jack)	5
3	Trestle adjustable	5
4	Spirit Level	2
5	Levelling Boards	2
6	Cable Tensiometer	1
7	Adjustable Spirit Level	1
8	Plumb Bob	1

COURSE OUTCOMES:

At the end of the course the students would be able to

CO1: Perform ground handling procedure for aircraft maintenance.

CO2 : Carry out alignment and symmetry of aircraft.

CO3: Check the pressure variation in aircraft systems

CO4: Test the functions of aircraft systems and maintenance of various air frame systems.

CO5: Identify the problems occurrence and rectifications.

CO6: Recognizes performance of brake and torque produce

U23AET51	HIGH SPEED AERODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

1. To make the student understand the concepts of compressible aerodynamics. Also to introduce the design concepts of transonic and supersonic wing sections.

UNIT I FUNDAMENTAL ASPECTS OF COMPRESSIBLE FLOW 9

Compressibility, Continuity, Momentum and energy equation for steady one dimensional flow compressible Bernoulli's equation-Calorically perfect gas, Mach Number, Speed of sound, Area– Mach number – Velocity relation, Mach cone, Mach angle, One dimensional Isentropic flow through variable area duct, Static and Stagnation properties, Critical conditions, Characteristic Mach number, Area-Mach number relation, Maximum discharge velocity.

UNIT II 1D, NON-ISENTROPIC FLOWS 9

Normal shock waves: basic equations, relations across a normal shock, calculation of normal shock wave properties, measurements of airspeed in supersonic flows. Entropy rise across normal shock and its relation to pressure rise. Hugoniot equation. Moving normal shock waves - one-dimensional piston motion in a constant area tubes, Jump start, propagation of shock wave in front and expansion wave behind, x-t diagram, particle velocity, pressure density & temperature relations. Rayleigh flows and Fanno flows.

UNIT III OBLIQUE SHOCKS AND EXPANSION WAVES 9

Oblique shocks and corresponding equations, Hodograph and pressure turning angle, shock polar, flow past wedges and concave corners, strong, weak and detached shocks, Flow past convex corners, Expansion hodograph, Reflection and interaction of shocks and expansion, waves.

UNIT IV COMPRESSIBLE SUBSONIC, TRANSONIC FLOWS 9

Subsonic Flow: The velocity potential, perturbation potential, linearized governing equation in two dimension, the pressure coefficient-Prandtl-Glauert compressibility correction, application to swept wings, critical Mach no, drag divergence Mach no. Transonic Flow: The sound barrier. Buffeting, supercritical airfoils, swept wings at transonic-speeds, 2nd order equation for transonic flows, Wing-body combination, Whitcomb's Transonic area rule: application to transonic aircraft.

UNIT V INTRODUCTION TO HIGH TEMPERATURE EFFECTS 9

Nature of high temperature flows-chemical effects in air-real and perfect gases-Gibb's free energy and entropy chemically reacting mixtures-recombination and dissociation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Realise the importance of studying the peculiar hypersonic speed flow characteristics pertaining to flight vehicles.
- **CO2:** Provide knowledge on various surface inclination methods for hypersonic inviscid flows.
- **CO3:** Be provided with the knowledge on thermodynamic state of the gas behind normal shock waves, oblique shock waves and expansion waves.
- **CO4:** Arrive at the approximate solution methods for hypersonic flows.
- **CO5:** Impart knowledge on hypersonic viscous interactions.
- **CO6:** Impart knowledge on the effect on aerodynamic heating on hypersonic vehicles.

TEXT BOOKS:

1. Anderson, J.D., Modern compressible Flow with Historical Perspective, third ed., McGraw-Hill, 2017.
2. Rathakrishnan E., Gas Dynamics, Prentice- Hall of India, 2017.

REFERENCE BOOKS:

1. Robert D. Zucker & Oscar Biblarz, "Fundamentals of Gas Dynamics", John Wiley & Sons, 2nd Ed, 2002
2. James E. A. John & Theo G., "Gas Dynamics", Pearson; 3rd edition, 2006.
3. John. D. Anderson. Jr., “Modern compressible flow with historical perspective”, McGraw Hill Publishing Company, New York, 1996
4. Liepmann, H. W., and Roshko, A., Elements of Gas Dynamics, John Wiley, 2013.
5. S. M. Yahya, “Fundamentals of Compressible Flow”, New Age Publications, 2009.

U23AET52	AIRCRAFT STRUCTURES – II	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To provide the students various methods for analysis of aircraft wings and fuselage.
2. To provide the behaviour of major aircraft structural components.

UNIT I UNSYMMETRICAL BENDING 9

Bending of symmetric beams subject to skew loads - bending stresses in beams of unsymmetrical sections – generalized "K" method, neutral axis method, principal axis method.

UNIT II SHEAR FLOW IN OPEN SECTIONS 9

Thin walled beams – concept of shear flow – the shear centre and its determination – shear flow distribution in symmetrical and unsymmetrical thin-walled sections – structural idealization – shear flow variation in idealized sections.

UNIT III SHEAR FLOW IN CLOSED SECTIONS 9

Bredt - Batho theory – single-cell and multi-cell tubes subject to torsion – shear flow distribution in thin-walled single & multi-cell structures subject to combined bending torsion – with walls effective and ineffective in bending – shear centre of closed sections.

UNIT IV BUCKLING OF PLATES 9

Bending of thin plates – rectangular sheets under compression - local buckling stress of thin walled sections – crippling strength estimation — load carrying capacity of sheet stiffener panels – effective width.

UNIT V PLATE THEORY 9

Two Dimensional and Three-Dimensional Transformation of Stresses and strains –Thin Plate Theory – Stress Resultants and Kinematics – Thin Plate Governing Equations and Boundary Conditions.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Perform calculations on unsymmetrical bending.
- **CO2:** Perform shear flow calculations in open sections.
- **CO3:** Perform shear flow calculations in closed sections.
- **CO4:** Perform buckling calculations in plates.
- **CO5:** Perform stress analysis calculations on wing and fuselage structures.
- **CO6:** Solve complex engineering problems, and interpret the results to validate design decisions and optimize system performance.

TEXT BOOKS:

1. Aircraft Structures for Engineering Students, by Megson T M G, Elsevier Ltd, 2007.
2. Aircraft Structures, by Peery, D.J., and Azar, J.J., 2nd edition, McGraw – Hill, N.Y., 1999.
3. Analysis and Design of Flight Vehicles Structures, by Bruhn. E.H., Tri-state off-set Company, USA, 1985.

REFERENCE BOOKS:

1. Theory and Analysis of Flight Structures, by Rivello, R.M., McGraw Hill, 1993.
2. Fundamentals of Aircraft Structural Analysis, by Howard D Curtis, WCB-McGraw Hill, 1997.

U23AET53	SPACE PROPULSION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To learn the principles of operation and design of spacecraft power plants.
2. To explain the basics of hypersonic propulsion.
3. To compare the solid and liquid rocket propulsion.
4. To show the advantages and applications of hydrogen systems and unconventional propulsion in rocket.

UNIT I BASICS OF HYPERSONIC PROPULSION 9

Introduction – Thermodynamic Closed Cycle Analysis – First Law Analysis – Stream Thrust Analysis – Compression Components – Burner Entry Pressure – Fuel-Air Mixing – Combined Mixing and Chemical Kinetics – Supersonic combustion and Scramjet Propulsion.

UNIT II SOLID ROCKET PROPULSION 9

Propulsion Elements for Solid Rocket Motors – Solid Propellant Grain Design – Prediction and Measurement of Specific Impulse – Solid Propellant Combustion and Internal Ballistics of 57Motors –Structural Analysis of Propellant Grains – types of igniters- combustion instability – strand burner and T-burner - Safety Characteristics of Solid Propellants and Hazards of Solid Rocket Motors.

UNIT III LIQUID ROCKET PROPULSION 9

Selection of liquid propellants – Types of Propellants -various feed systems and injectors for liquid propellant rockets -thrust control and cooling in liquid propellant rockets and the associated heat transfer problems – combustion instability in liquid propellant rockets– Propellant Tanks –Engine Support Structure- peculiar problems associated with operation of cryogenic engines.

UNIT IV HYBRID ROCKET PROPULSION 9

Introduction to hybrid rocket propulsion – standard and reverse hybrid systems- combustion mechanism in hybrid propellant rockets – Mechanisms and Measurement Techniques of Solid Fuel Pyrolysis - Phenomena and Regression Rate – Analytical Models - Vortex Injection – High Speed Flow Effects – Combustion Instability and Transient Behaviour- applications and limitations.

UNIT V HYDROGEN SYSTEMS & UNCONVENTIONAL PROPULSION SYSTEMS 9

Introduction – Hydrogen System Components and Applications– Hydrogen fuel cells: principles and types - Electric and Ion Propulsion – Advanced Propulsion Concepts – Alternative Propulsion Methods – Laser Propulsion- Nuclear rocket -Different Types, Advantages and Applications- Solar sail.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Explain hypersonic propulsion systems and their application to aerospace vehicles.
- **CO2:** Understand the traditional propulsion concepts, including liquid, solid, hybrid, ion, and thermal rockets.
- **CO3:** Know the applications and principles of solid, liquid, and hybrid rocket propulsion systems.
- **CO4:** Understand the performances of various rocket propulsion systems.
- **CO5:** Apply the concepts of hydrogen systems and unconventional propulsion in rocket.
- **CO6:** Realise the importance of advanced space propulsion concepts.

TEXT BOOKS:

1. Hypersonic Aerothermodynamics, by John T. Bertin, AIAA Inc., Washington DC, 1994.
2. Rocket Propulsion Elements, by Sutton, G.P., Wiley, New York, 9th Ed., 2017.
3. Advanced Propulsion Systems by Claudio Bruno and Antonio Accettura, 2018.

REFERENCE BOOKS:

1. Hypersonic Air Breathing Propulsion, by Heiser, W. H. and Pratt, D. T., AIAA, 1994.
2. Mechanics and Thermodynamics of Propulsion, by Hill P. G., and Peterson C.R., Pearson Education, 2nd Ed., 2009.
3. Aerothermodynamics of Aircraft Engine Components, by OatesG. C., AIAA Education Series, 1985.

U23AET54 AIRCRAFT MATERIALS AND PROCESSES L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To make familiarize the students in the basic casting techniques.
2. To understand the principle and equipment's involved in various welding processes.
3. To make the students comfortable to execute experiments in machining.
4. To introduce the students about various plastic manufacturing processes.
5. To make the students to understand constructional details and programming of CNC machines.

UNIT I FERROUS AND NON-FERROUS MATERIALS 9

Aluminium alloys, magnesium alloys, titanium alloys, plain carbon and low carbon steels. Super alloys, Nickel based super alloy, cobalt based super alloys and Iron based super alloys-manufacturing process associated with super alloys.

UNIT II CASTING AND JOINING 9

Casting types, types of core making, moulding tools- permanent moulding- pressure die casting, centrifugal casting. Classification of welding processes. Principles of oxy acetylene gas welding, submerged arc welding, TIG – MIG, Laser beam welding, Electron beam welding, and defects in welding.

UNIT III MACHINING 9

General principles (with schematic diagrams only) of working and commonly performed operations in the following machines: Lathe, Shaper, Planer, Horizontal milling machine, Universal drilling machine, Cylindrical grinding machine, Capstan and Turret lathe. General principles and applications of the following processes: Abrasive jet machining, Ultrasonic machining, Electric discharge machining, Electro chemical machining, Plasma arc machining, Electron beam machining and Laser beam machining.

UNIT IV HEAT TREATMENT OF ALLOYS 9

Corrosion resistance materials used for space vehicles heat treatment of carbon steels– aluminium alloys, magnesium alloys and titanium alloys–effect of alloying treatment, heat resistance alloys – tool and die steels, magnetic alloys.

UNIT V CNC MACHINING AND ADVANCED MANUFACTURING 9

Numerical Control machine tools – CNC types, Construction details, Special features, Machining centre – Tool magazines and transfer systems, Automatic tool changer – Part Programming Fundamentals – CNC and Manual part programming – Micro machining – Wafer machining – Rapid prototyping Technology: 3D Printing, Additive layer manufacturing –Rapid Manufacturing, applications and advancements.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Familiarize with the basic casting concepts.
- **CO2:** Know the various welding processes.
- **CO3:** Use different machining process for component production.
- **CO4:** Familiarize with the various plastic moulding processes.
- **CO5:** Understand and carry out simple experiments in CNC machines.
- **CO6:** Have knowledge on the mechanical behaviour of various materials that are used in aircraft and it characteristics.

TEXT BOOKS:

1. Elements of Workshop Technology, by Hajra Choudhury, Vol. I and II, Media Promoters and Publishers Pvt., Ltd., Mumbai, 2005
2. Process and Materials of Manufacture, by Roy. A. Linberg, PHI, 2000.

REFERENCE BOOKS:

1. Production Technology, by Jain.R.K. and S.C. Gupta, Khanna Publishers, 16th Edition,2001
2. Manufacturing Processes for Engineering Materials, by Serope Kalpajian, Steven R.Schmid, Fourth Edition, Pearson Education, Inc. 2007.

U23AET55 CONTROL ENGINEERING L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To introduce the mathematical modelling of systems, open loop and closed loop systems and analyses in time domain and frequency domain.
2. To impart the knowledge on the concept of stability and various methods to analyze stability in both time and frequency domain.
3. To introduce sampled data control system.

UNIT I INTRODUCTION 9

Historical review, Simple pneumatic, hydraulic and thermal systems, Series and parallel system, Analogies, mechanical and electrical components, Development of flight control systems.

UNIT II OPEN AND CLOSED LOOP SYSTEMS 9

Feedback control systems – Control system components - Block diagram representation of control systems, Reduction of block diagrams, Signal flow graphs, Output to input ratios.

UNIT III CHARACTERISTIC EQUATION AND FUNCTIONS 9

Laplace transformation, Response of systems to different inputs viz., Step impulse, pulse, parabolic and sinusoidal inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit.

UNIT IV CONCEPT OF STABILITY 9

Necessary and sufficient conditions, Routh-Hurwitz criteria of stability, Root locus and Bode techniques, Concept and construction, frequency response.

UNIT V SAMPLED DATA SYSTEMS 9

Z-Transforms, sampling and quantization, Introduction to digital control system, converters, sensors and Actuators, Digital Controllers and Digital PID controllers-Adaptive Control.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the importance of mathematical modeling of a system.
CO2: Demonstrate the concept and needs of feedback control systems and its application.
CO3: Determine the response of different order systems for various step inputs.
CO4: Determine the (absolute) stability of a closed-loop control system.
CO5: Introduce sampled data control system.
CO6: Understand the concept of data system sampling and digital controller.

TEXT BOOKS:

1. Azzo, J.J.D. and C.H. Houpis Feed back control system analysis and synthesis, McGraw-Hillinternational 3rd Edition, 1998.
2. OGATO, Modern Control Engineering, Prentice-Hall of India Pvt. Ltd., New Delhi, 1998.

REFERENCE BOOKS:

1. Houpis, C.H. and Lamont, G.B. "Digital control Systems", McGraw Hill Book co., New York, U.S.A. 1995.
2. Kuo, B.C. "Automatic control systems", Prentice-Hall of India Pvt. Ltd., New Delhi, 1998.
3. Naresh K Sinha, "Control Systems", New Age International Publishers, New Delhi, 1998.

U23AEP51 **STRUCTURES LABORATORY** **L T P C**

0 0 4 2

COURSE OBJECTIVE:

1. To experimentally study the unsymmetrical bending of beams, find the location of shear centre; obtain the stresses in circular discs and beams using photo elastic techniques, calibration of photo-elastic materials and study on vibration of beams.

LIST OF EXPERIMENTS:

1. Unsymmetrical bending of beams.
2. Find the shear centre location for open sections.
3. Find the shear centre location for closed sections.
4. Experiment the constant strength beam.
5. Draw the flexibility matrix for cantilever beam.
6. Bending of Rectangular Plates.
7. Deflection of Circular Plates.
8. Buckling of Thin Plates.
9. Vibrations of beams and thin plates.
10. Experiment with the Wagner beam – Tension field beam.

TOTAL: 60 PERIODS

LIST OF EQUIPMENTS:

(For a batch of 30 students)

S. No	Details of Equipment	Qty Req.	Experiment No.
1	Beam Test set –up	2	1, 2, 3,4
2	Unsymmetrical sections like ‘Z’ sections	2	1, 2, 3
3	Channel section and angle section	2	1, 2, 3
4	Dial gauges	12	1, 2, 3
5	Weights 1 Kg	10	1, 2, 3
6	Weights 2 Kg	10	1, 2, 3
7	Strain indicator and strain gauges	One set	4,5
8	Plate testing apparatus	1	6,7,8
9	Amplifier	2	9
10	Exciter	2	9
11	Pick – up	2	9
12	Oscilloscope	2	9
13	Wagner beam	1	10
14	Hydraulic Jack	1	10

COURSE OUTCOMES:

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

- **CO1:** Understand the effects of bending in the aerospace structures.
- **CO2:** Find the shear centre of the aerospace structures.
- **CO3:** Conduct test on beams for the structural analysis.
- **CO4:** Have familiarity with plate theory and its limitations.
- **CO5:** Present the experimental findings in clear oral and concise report.
- **CO6:** Apply finite element methods and analysis tools to simulate and analyze the structural behavior of aerospace components, under various loading conditions, including bending, torsion, and vibration.

U23AEP52 **CAD LABORATORY** **L T P C**

0 0 4 2

COURSE OBJECTIVES:

1. To make the students familiarize with computational fluid dynamics and structural analysis software tools.
2. By employing these tools for Aerospace applications students will have an opportunity to expose themselves to simulation software.

LIST OF EXPERIMENTS:

1. Computer aided design of subsonic and supersonic diffusers.
2. Computer aided design of a compressor blade.
3. Computer aided design of a Converging-diverging nozzle.
4. Computer aided design of typical aircraft wing.
5. Computer aided design of typical fuselage structure.
6. Computer aided design of a landing gear.
7. Computer aided design of a launch vehicle.
8. Computer aided design of re-entry vehicles.
9. Computer aided design of a Missile.
10. Computer aided design of a Satellite.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT:

(for a batch of 30 students)

Sl.No.	Name of the Equipment	Quantity
1	Computer nodes	30
2	CATIA – CAD Packages	1
3	UPS	1
4	Printer	1

COURSE OUTCOMES:

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

- **CO1:** Use commercial design software and understand its structure.
- **CO2:** Design the aircraft and spacecraft components and solve engineering problems.
- **CO3:** Write formal technical report and convey engineering.
- **CO4:** Analyze and evaluate the performance of designed aircraft and spacecraft components using computational fluid dynamics (CFD) and finite element analysis (FEA) tools.
- **CO5:** Integrate multidisciplinary design optimization (MDO) techniques to optimize the design of aircraft and spacecraft components for improved performance, efficiency, and cost-effectiveness.
- **CO6:** Apply this knowledge on real life problems and develop suitable solutions.

U23AET61	AIRCRAFT STABILITY AND CONTROLS	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES:

1. To make the student understand the concepts of stable and non-stable configuration of airplanes.
2. To introduce the concepts of control of airplanes under various operating conditions.

UNIT I STATIC LONGITUDINAL STABILITY AND CONTROL 9

General concepts-Degrees of freedom of a rigid body, Static and dynamic stability, Need for stability in an airplane, inherently and marginally stable airplanes, Stability and Controllability, Requirements of control surfaces, criteria for longitudinal static stability, contribution to stability by wing, tail, fuselage, wing fuselage combination, Total longitudinal stability, Neutral point-Stick fixed and Stick free aspects, Free elevator factor, static margin, Hinge moment, Power effects on stability-propeller and jet aircrafts, longitudinal control.

UNIT II STATIC DIRECTIONAL STABILITY AND CONTROL 9

Directional stability-yaw and sideslip, Criterion of directional stability, contribution to static directional stability by wing, fuselage, tail, Power effects on directional stability-propeller and jet aircrafts, Rudder fixed and rudder free aspects, Rudder lock and Dorsal fin, Directional control, rudder control effectiveness, rudder requirements, adverse yaw, asymmetric power condition, spin recovery.

UNIT III STATIC LATERAL STABILTY AND CONTROL 9

Lateral Stability-Dihedral effect, criterion for lateral stability, evaluation of lateral stability contribution of fuselage, wing, wing fuselage, tail, total static lateral stability, lateral control, aileron control power, aileron effectiveness, strip theory estimation of aileron effectiveness, roll control by spoilers, aileron reversal, aileron reversal speed.

UNIT IV DYNAMIC LONGITUDINAL STABILITY 9

Aircraft Equations of motion, small disturbance theory, Estimation of longitudinal stability derivatives stability derivatives, Routh's discriminant, solving the stability quartic, Phugoid motion, Factors affecting the period and damping.

UNIT V DYNAMIC LATERAL AND DIRECTIONAL STABILITY 9

Dutch roll and spiral instability, Auto rotation and spin, Stability derivatives for lateral and directional dynamics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Understand the contribution to static longitudinal stability from various components of the airplane and the requirements of rudder
- **CO2:** Understand the contribution to directional stability from various components of the airplane and the requirements of rudder.
- **CO3:** Understand the dihedral effect, rolling power and control effectiveness of aileron.
- **CO4:** To get familiarized with the longitudinal, directional and lateral dynamics of the airplane.
- **CO5:** Identify the lateral and longitudinal modes and relate the important physical influences of aircraft properties on these modes.
- **CO6:** Analyze and evaluate the dynamic stability characteristics of an airplane, including the effects of various design parameters and flight conditions on stability modes.

TEXT BOOKS:

1. Perkins C.D. &Hage R.E. Airplane performance, stability and control, John Wiley & Sons 1976.
2. Nelson, R.C. Flight Stability & Automatic Control, McGraw Hill, 1998.

REFERENCE BOOKS:

1. McCormick, B.W. Aerodynamics, Aeronautics & Flight Mechanics John Wiley, 1995.
2. Babister, A.W. Aircraft Stability and response, Pergamon Press, 1980.
3. Etkin, B., Dynamics of Flight Stability and Control, Wiley, third edition 1995.
4. Pamadi,B.N. Performance, Stability, Dynamics, and Control of Airplanes, AIAA Education Series, 2004.

U23AET62	FINITE ELEMENT METHODS	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES:

1. To give exposure various methods of solution and in particular the finite element method.
2. To gives exposure to the formulation and the procedure of the finite element method and its application to varieties of problems.
3. To understand the fundamental concepts and principles of finite element methods, including element formulation, assembly, and solution techniques, and apply them to solve problems in structural mechanics.
4. To analyze and simulate the behavior of complex engineering systems, such as aircraft structures, using finite element methods, and interpret the results to make informed design decisions.

UNIT I INTRODUCTION **9**

Review of various approximate methods – variational approach and weighted residual approach–application to structural mechanics problems. Finite difference methods–governing equation and convergence criteria of finite element method.

UNIT II DISCRETE ELEMENTS **9**

Bar elements, uniform section, mechanical and thermal loading, varying section, 2D and 3D truss element. Beam element - problems for various loadings and boundary conditions – 2D and 3D Frame elements - longitudinal and lateral vibration. Use of local and natural coordinates.

UNIT III CONTINUUM ELEMENTS **9**

Plane stress, plane strain and axisymmetric problems. Derivation of element matrices for constant and linear strain triangular elements and axisymmetric element.

UNIT IV ISOPARAMETRIC ELEMENTS **9**

Definitions, Shape function for 4, 8 and 9 nodal quadrilateral elements, stiffness matrix and consistent load vector, evaluation of element matrices using numerical integration.

UNIT V FIELD PROBLEM AND METHODS OF SOLUTIONS **9**

Heat transfer problems, steady state fin problems, derivation of element matrices for two dimensional problems, torsion problems. Bandwidth – elimination method and method of factorization for solving simultaneous algebraic equations – Features of software packages, sources of error.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Obtain an overall understanding of Finite Element analysis.
- **CO2:** Perform discrete element analysis.
- **CO3:** Perform continuum element analysis.
- **CO4:** Perform isoparametric element analysis.
- **CO5:** Apply FEM methods to typical engineering situations.
- **CO6:** Solve complex engineering problems, and interpret the results to validate design decisions and optimize system performance.

TEXT BOOKS:

1. Tirupathi.R. Chandrapatha and Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", Printice Hall India, Third Edition, 2003.
2. Rao. S.S., "Finite Element Methods in Engineering," Butterworth and Heinemann, 2001
3. Reddy J.N., "An Introduction to Finite Element Method", McGraw Hill, 2000.

REFERENCE BOOKS:

1. Krishnamurthy, C.S., "Finite Element Analysis", Tata McGraw Hill, 2000.
2. Bathe, K.J. and Wilson, E.L., "Numerical Methods in Finite Elements Analysis", Prentice Hall of India, 1985.
3. Robert D Cook, David S Malkus, Michael E Plesha, "Concepts and Applications of Finite Element Analysis", 4th edition, John Wiley and Sons, Inc., 2003.
4. Larry J Segerlind, "Applied Finite Element Analysis", 2ndEdition, John Wiley and Sons, 1984.

U23AET63 COMPOSITE MATERIALS AND STRUCTURES L T P C
3 0 0 3

COURSE OBJECTIVE:

1. To make the student understand the analysis of composite laminates under different loading conditions and different environmental conditions.

UNIT I MICROMECHANICS 9

Introduction - Advantages and application of composite materials - reinforcements and matrices – Introduction to Nano composite -Micro mechanics – Mechanics of materials approach, elasticity approach-Effect of voids - hygro thermal effects on a lamina.

UNIT II MACROMECHANICS 9

Macro mechanics - Generalized Hooke's Law - Elastic constants for anisotropic, orthotropic and isotropic materials - Macro Mechanics – Stress-strain relations with respect to natural axis, arbitrary axis – Determination of material properties - Experimental characterization of lamina.

UNIT III LAMINATED PLATE 9

Governing differential equation for a unidirectional lamina and general laminate, angle ply and cross ply laminate, Failure criteria for composites.

UNIT IV FABRICATION PROCESS AND REPAIR METHODS 9

Various open and closed mould processes, Manufacture of fibers, Types of resins, properties and applications, Netting analysis. importance of repair and different types of repair techniques in composites.

UNIT V SANDWICH CONSTRUCTIONS 9

Basic design concepts of sandwich construction - Materials used for sandwich construction - Failure modes of sandwich panels - Bending stress and shear flow in composite beams.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the mechanics of composite materials.
CO2: Able to analyse the laminated composites for various loading eases.
CO3: Have knowledge gained in manufacture of composites.
CO4: Able to design and optimize composite structures for specific applications, considering factors such as strength, stiffness, weight, and cost.
CO5: Understand the failure mechanisms and damage tolerance of composite materials.
CO6: Able to predict and analyze their behavior under various loading conditions.

TEXT BOOKS:

1. Jones, R.M., "Mechanics of Composite Materials," Taylor & Francis, II Edition, 2000.
2. Madhuji Mukhapadhyay, Mechanics of Composite Materials and Structures, University Press, 2004.

REFERENCE BOOKS:

1. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites," John Wiley and sons. Inc., New York, 1995.
2. Lubin, G., "Handbook on Advanced Plastics and Fibre Glass", Von Nostrand Reinhold Co., New York, 1989.
3. Calcote, L R. "The Analysis of laminated Composite Structures", Von – Nostrand Reinhold Company, New York 1998.
4. Allen Baker, "Composite Materials for Aircraft Structures", AIAA Series, II Edition, 1999.
5. Autar K Kaw, 'Mechanics of Composite Materials", CRC Press, 1997.

U23AEP61 **AIRCRAFT DESIGN PROJECT** **L T P C**

0 0 4 2

COURSE OBJECTIVES:

1. To familiarise with data collections of different airplanes.
2. To get hands on experience in weight estimations and finalize the geometric parameters of airplanes.
3. To familiarize with Lift distribution and structural load distribution in aircraft wing.
4. To gain knowledge in drawing the sheer force and bending moment diagram for wing structure.
5. Enable the student to design the load carrying members such as spars, ribs, stringers in wing and bulkhead design.

LIST OF EXPERIMENTS:

1. Comparative studies of different types of airplanes and their specifications and performance details with reference to the design work under taken.
2. Preliminary weight estimation, Selection of design parameters, power plant selection, aerofoil selection, fixing the geometry of Wing, tail, control surfaces Landing gear selection.
3. Drag estimation, Performance calculations, Stability analysis and V-n diagram.
4. Preliminary design of an aircraft wing – Shrenck's curve, structural load distribution, shear force, bending moment and torque diagrams.
5. Detailed design of an aircraft wing – Design of spars and stringers, bending stress and shear flow calculations – buckling analysis of wing panels.
6. Preliminary design of an aircraft fuselage – load distribution on an aircraft fuselage.
7. Detailed design of an aircraft fuselage – design of bulkheads and longerons – bending stress and shear flow calculations – buckling analysis of fuselage panels.
8. Design of control surfaces – balancing and manoeuvring loads on the tail plane and aileron, rudder loads.
9. Design of wing-root attachment, Landing gear design.
10. Preparation of a detailed design report with CAD drawing.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Carry out the procedure involved in weight estimation, power plant selection, and estimation of the performance parameters.
- **CO2:** Work in a multidisciplinary environment involving the integration of engineering practices in such subjects as aerodynamics, structures, propulsion, and flight mechanics.
- **CO3:** Design the fuselage structure.
- **CO4:** Investigate the shear flow on wing and fuselage structures.
- **CO5:** Design oleo strut used in landing gears.
- **CO6:** Analyze and optimize the structural and mechanical components of an aircraft, considering factors such as weight, strength, stability, and safety, to ensure compliance with regulatory requirements and industry standards.

U23AEP62 AIRFRAME AND FLIGHT SYSTEMS LABORATORY

L	T	P	C
0	0	4	2

COURSE OBJECTIVES:

1. To introduce the knowledge of the maintenance and repair procedures followed for overhaul of aero engines.
2. To train the students "ON HAND" experience in maintenance of various air frame systems in aircraft and rectification of common snags.

LIST OF EXPERIMENTS:

1. Welded single & double V-joints.
2. Fabric & Riveted Patch repairs.
3. Tube bending and flaring.
4. Sheet metal forming
5. Preparation of glass epoxy of composite laminates and specimens.
6. Inspection of Piston Engine - cleaning, and perform NDT checks.
7. Identification of Jet Engine - components & defects.
8. Static balancing of Propeller.
9. Starting procedure of Piston engine in Cessna Aircraft.
10. Performing mooring on bolted and riveted joints.

TOTAL: 60 PERIODS

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl.No.	Name of the Equipment	Quantity
1	Pipe Flaring Tools	1
2	Welding machine	1
3	Glass fibre, epoxy resin	1
4	Strain gauges and strain indicator	1
5	Shear cutter pedestal type	1
6	Drilling Machine	1
7	Bench Vices	1
8	Radius Bend bars	1

COURSE OUTCOMES:

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

- **CO1:** Repair on aircraft structural components.
- **CO2:** Work on aircraft metal components such as tube, pipe, sheet metal etc.
- **CO3:** Fabricate the composite laminates.
- **CO4:** Understand to procedure involved in maintenance of various air frame systems.
- **CO5:** Inspect and evaluate aircraft components and systems for damage, corrosion, or wear, and develop repair plans and estimates for returning aircraft to airworthy condition.
- **CO6:** Apply safety protocols and regulations to ensure that all maintenance and repair work are performed in a safe and responsible manner.

U23GET72	TOTAL QUALITY MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To facilitate the understanding of Quality Management principles and process.
2. To strive for zero defects and error-free performance by designing and implementing processes those prevent defects and errors from occurring, and by continuously monitoring and improving performance to achieve this goal.

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definitions of quality - Dimensions of product and service quality - Basic concepts of TQM - TQM Framework - Contributions of Deming, Juran and Crosby -Barriers to TQM - Customer focus - Customer orientation, Customer satisfaction, Customer complaints, and Customer retention.

UNIT II TQM PRINCIPLES 9

Leadership - Quality Statements, Strategic quality planning, Quality Councils - Employee involvement - Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement - PDCA cycle, 5S, Kaizen - Supplier partnership - Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS AND TECHNIQUES 9

The seven traditional tools of quality - New management tools - Six sigma: Concepts, Methodology, applications to manufacturing, service sector including IT - Bench marking - Reason to bench mark, Bench marking process - FMEA - Stages, Types.

UNIT IV TQM TOOLS AND TECHNIQUES II 9

Quality Circles - Cost of Quality - Quality Function Deployment (QFD) - Taguchi quality loss function - TPM - Concepts, improvement needs - Performance measures.

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000 - ISO 9001-2008 Quality System - Elements, Documentation, Quality Auditing - QS 9000 - ISO 14000 - Concepts, Requirements and Benefits - TQM Implementation in manufacturing and service sectors.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Identify and prioritize quality improvement opportunities.
CO2: Implement Total Quality Management (TQM) principles.
CO3: Apply statistical process control (SPC) techniques.
CO4: Design and implement quality control plans.
CO5: Conduct quality audits and assessments.
CO6: Analyze and interpret quality data for decision-making.

TEXT BOOKS:

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield,Mary B.Sacre,Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Edition, Indian Reprint, Sixth Impression, 2013.
2. Janakiraman. B and Gopal .R.K., "Total Quality Management - Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.

REFERENCE BOOKS:

1. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2. Suganthi.L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.ISO 9001-2015 standards.

U23AET72	AVIONICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To introduce the basic of avionics and its need for civil and military aircrafts.
2. To impart knowledge about the avionic architecture and various avionics data buses.
3. To gain more knowledge on various avionics subsystems.
4. To impart knowledge on feedback systems.
5. To gain knowledge in field of navigation systems.

UNIT I INTRODUCTION TO AVIONICS 9

Need for avionics in civil and military aircraft and space systems – Integrated avionics and weapon systems – Typical avionics subsystems, design, technologies – Introduction to Digital Computer and memories.

UNIT II DIGITAL AVIONICS ARCHITECTURE 9

Avionics system architecture – Data buses – MIL-STD-1553B – ARINC – 420 – ARINC – 629 – AFDX.

UNIT III FLIGHT DECKS AND COCKPITS 9

Control and display technologies: CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil and Military Cockpits: MFDS, HUD, MFK, HOTAS.

UNIT IV INTRODUCTION TO NAVIGATION SYSTEMS 9

Radio navigation – Dead – Reckoning systems, Hyperbolic Navigation - ILS, MLS – Inertial Navigation Systems (INS) – Inertial sensors, INS block diagram – Satellite navigation systems – NAVI GPS.

UNIT V AIR DATA SYSTEMS AND AUTO PILOT 9

Air data quantities – Altitude, Air speed, Vertical speed, Mach number, Auto pilot – Basic principles, Longitudinal and lateral auto pilot.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Apply the basics of avionics subsystems architecture.
- **CO2:** Distinguish between the needs of civil and military avionics systems.
- **CO3:** Acquire knowledge on display technologies.
- **CO4:** Build Digital avionics architecture.
- **CO5:** Design navigation system and ability to design and perform analysis on air data system.
- **CO6:** Integrate and test avionics subsystems, ensuring compliance with safety and regulatory standards, such as those set by FAA or EASA.

TEXT BOOKS:

1. Albert Helfrick.D, Principles of Avionics, Avionics Communications Inc., 7th Edition, 2012.
2. Collinson.R.P.G. Introduction to Avionics, Chapman and Hall, 2003.

REFERENCE BOOKS:

1. Middleton, D.H., Ed., Avionics systems, Longman Scientific and Technical, Longman Group UK Ltd., England, 1989.
2. Pallet.E.H.J., Aircraft Instruments and Integrated Systems, Longman Scientific,1992.
3. Spitzer, C.R. Digital Avionics Systems, Prentice-Hall, Englewood Cliffs, N.J., U.S.A.1993.
4. Spitzer. C.R. The Avionics Hand Book, CRC Press, 2000.

U23AET73	COMPUTATIONAL FLUID DYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To gain basic ideas on numerical fluid dynamics.
2. To acquire knowledge on the basic concepts involved in grid generation in computational fluid dynamics.
3. To impart knowledge on various aspects of time dependent methods.
4. To get insight into finite volume method.
5. To arrive at the solution of fluid flow equations and to apply those concepts for industrial needs.

UNIT I INTRODUCTION TO NUMERICAL METHODS IN FLUID DYNAMICS 9

Introduction to numerical fluid dynamics - Introduction to governing equations of fluid dynamics and modelling of fluid flow – The substantial derivative and the physical meaning of divergence of a vector. Boundary conditions for various types of fluid flow conditions - Introduction to mathematical properties of fluid dynamic equations and classification of partial differential equations - General behaviour of different classes of partial differential equations and their relation to fluid dynamics - A general discussion on hyperbolic, parabolic and elliptic equations.

UNIT II GRID GENERATION 9

Introduction to grid generation in computational fluid dynamics - Structured grid generation techniques – algebraic methods, conformal mapping and methods using partial differential equations - Boundary value problem of numerical grid generation- grid control functions-branch cut - The boundary conditions of first kind - orthogonality of grid lines- boundary point grid control. Unstructured grids, Cartesian grids, hybrid grids, grids around typical 2D and 3D geometries.

UNIT III TIME DEPENDENT METHODS 9

Introduction to time dependent methods - Explicit time dependent methods –Description of Lax Wendroff Scheme and Mac Cormack's two step predictor – corrector method - Description of time split methods. Introduction to implicit methods and respective stability properties of explicit and implicit methods -Construction of implicit methods for time dependent problems - Linearization, choice of explicit operator and numerical dissipation aspects.

UNIT IV FINITE VOLUME METHOD 9

Introduction to Finite volume Method - Different Flux evaluation schemes, central, upwind and hybrid schemes - Staggered grid approach - Pressure-Velocity coupling - SIMPLE, SIMPLER algorithms, pressure correction equation (both incompressible and compressible forms) - Application of Finite Volume Method -artificial diffusion.

UNIT V INTRODUCTION TO CFD COMMERCIAL CODES 9

Basic programming rules, Data type arrays – pointers – operators-code flow chart- Write codes to- impose initial condition, parabolic velocity profile, forward, backward Euler time integration.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Acquire knowledge on the mathematical nature of fluid dynamic equations and to specify boundary conditions.
- **CO2:** Generate grid by using numerical methods.
- **CO3:** Apply time dependant methods for 1-Dand 2-Dflow problems.
- **CO4:** Acquire knowledge on various flux evaluation schemes and on pressure- velocity coupling procedure.
- **CO5:** Gain insights on performance computing and parallelization of complex codes.
- **CO6:** Analyze and validate computational fluid dynamics (CFD) results for various flow problems, including laminar and turbulent flows, and evaluate the accuracy and reliability of the numerical solutions.

TEXT BOOKS:

1. Fletcher C.A.J. , "Computational Techniques for Fluid Dynamics 1" Springer Verlag, 1996.
2. Fletcher C.A.J., "Computational Techniques for Fluid Dynamics 2", Springer Verlag, 1995.
3. Versteeg, H.K., and Malalasekera, W., "An Introduction to Computational Flui Dynamics: The finite volume Method", Pearson Education Ltd. Second Edition – 2007.

REFERENCE BOOKS:

1. Chung T. J., "Computational Fluid Dynamics", Cambridge University Press; 2nd edition, 2010.
2. Hirsch C., "Numerical Computation of Internal and External Flows" Volume-2, John Wile and Sons, 1994
3. Joel H. Ferziger & Milovan Peric, "Computational Methods for Fluid Dynamics" Springer 3rd edition 2002.
4. John F Wendt , "Computational Fluid Dynamics – An Introduction", 3rd Edition, SpringerVerlag, Berlin Heidelberg, 2009.

U23AEP71 **FLIGHT INTEGRATION LABORATORY**

L	T	P	C
0	0	4	2

COURSE OBJECTIVE:

1. To train students, to study about basic digital electronics circuits, various microprocessor applications in Control surface, Displays fault tolerant computers, to study the stability analysis and design using MATLAB.

LIST OF EXPERIMENTS:

1. Addition/Subtraction of 8 bit and 16-bit data for control surface deflection.
2. Sorting of Data in Ascending & Descending order for voting mechanism.
3. Sum of a given series with and without carry for identifying flap data.
4. Greatest in a given series & Multi-byte addition in BCD mode.
5. Addition/Subtraction of binary numbers using adder and Subtractor circuits.
6. Multiplexer & Demultiplexer Circuits
7. Encoder and Decoder circuits.
8. Stability analysis using Root locus, Bode plot techniques.
9. Design of lead, lag and lead –lag compensator for aircraft dynamics.
10. Performance Improvement of Aircraft Dynamics by Pole placement technique.

TOTAL: 60 PERIODS

LIST OF EQUIPMENTS:

(For a batch of 30 students)

S. No	Details of Equipment	Qty Req.	Experiment No.
1	Microprocessor 8085 Kit	10	1, 2, 3,4
2	Adder/Subtractor Binary bits Kit	10	5
3	Encoder Kit	10	7
4	Decoder Kit	10	7
5	Multiplexer Kit	10	6
6	Demultiplexer Kit	10	6
7	Computers	10	8,9,10
8	Regulated power supply	10	5,6,7
9	Standard Mathematical analysis software	-	8,9,10

COURSE OUTCOMES:

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

- **CO1:** Understand digital electronics circuits.
- **CO2:** Perform Multiplexer/demultiplexer, Encoder/decoder, timer & shift register circuits.
- **CO3:** Use microprocessor in Flight control.
- **CO4:** Perform stability analysis.
- **CO5:** Understand the different types of avionics data buses.
- **CO6:** Design and implement avionics systems integration, including the interface between digital electronics, microprocessors, and data buses, to ensure reliable and efficient data communication and control in aircraft systems.

U23AEP72 STRUCTURAL AND FLOW SIMULATION LABORATORY

L	T	P	C
0	0	4	2

COURSE OBJECTIVES:

The main learning objective of this course is to prepare the students for:

1. Analyzing the force and stress in mechanical components.
2. Analyzing deflection in mechanical components.
3. Analyzing thermal stress of mechanical components.
4. Analyzing heat transfer in mechanical components.
5. Analyzing the vibration of mechanical components.

LIST OF EXPERIMENTS:

1. Study of Basics in ANSYS
2. Stress analysis of a plate with a circular hole and rectangular L bracket.
3. Stress analysis of cantilever beam, simply supported beam and fixed beam.
4. Stress analysis of an axisymmetric component.
5. Thermal stress analysis of a 2D component.
6. Conductive and Convective heat transfer analysis of a 2D component.
7. Heat transfer analysis of a 2D component.
8. Mode frequency analysis of cantilever beam and simply supported beam.
9. Harmonic analysis of a 2D component.
10. Stress analysis of a truss.
11. Introduction to MAT LAB.
12. Simulation of Spring-mass system using MAT LAB.
13. Simulation of cam and follower mechanism using MATLAB.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Find out the effect of force and impact of stress on the mechanical components.
CO2: Calculate the deflection occurring on the mechanical components.
CO3: Get a detailed understanding of the thermal stress creation and its mechanism of spreading in mechanical components.
CO4: Gain knowledge regarding the mechanism of heat transfer in mechanical components.
CO5: Find out the vibration effects on mechanical components.
CO6: Design and analyze mechanical components and systems to withstand various types of loading, to ensure safety, reliability, and optimal performance.

U23AEP81	PROJECT WORK	L T P C
		0 0 20 8

COURSE OBJECTIVES:

Students have to do a project work either single or in a group for a period of one semester and submit a project report.

Hardware/ Numerical /Theoretical research and development work is to be allotted. A maximum number of three students may be involved in each project. However, the contribution of the individuals in the project should be clearly brought out. The combined project report is to be submitted as per the university regulations. A seminar has to be presented on the allotted topic. All the students involved in the project will be examined for their contribution.

1. To make students understand the concepts of Project work for planning to execution of projects.
2. To make them understand the feasibility analysis in Project work and network.
3. To enable them to comprehend the fundamentals.
4. To make them capable to analyze, apply and appreciate contemporary project work tools and methodologies.

TOTAL 300 PERIODS

COURSE OUTCOMES:

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

CO1: Demonstrate a sound technical knowledge of their selected project topic.
CO2: Undertake problem identification, formulation, and solution.
CO3: Design engineering solutions to complex problems utilising systems approach.
CO4: Conduct an engineering project.
CO5: Communicate with engineers and the community at large in written and oral forms.
CO6: Demonstrate the knowledge, skills and attitudes of a professional engine.

VERTICALS I
PROFESSIONAL ELECTIVE I

U23AEV11 COMPUTER AIDED DESIGN AND ANALYSIS L T P C
3 0 0 3

COURSE OBJECTIVES:

To familiarize with

1. Concepts of modelling of 2D and 3D geometrical elements.
2. Concepts of computer graphics.
3. CAD Packages and its features.

UNIT I INTRODUCTION 9

Introduction to CAD – I/O devices – various graphics standards – coordinate systems – Geometric Modelling: Introduction – types of geometric modelling – wire frame – surface and solid modelling. Wireframe entities – types of curves and its mathematical representation - linecircle- ellipse- parabola- Cubic spline- Bezier and B-spline (Only Basic treatment). Solid modelling entities - Solid modelling techniques- CSG and BREP - Operations performed in CSG and BREP - Extrude- sweep - linear and Nonlinear- revolve.

UNIT II GRAPHIC CONCEPTS (2D and 3D) 9

Transformations - translation- scaling- reflection- rotation. Concatenated transformation. Inverse transformation. Hidden line removal - Z-Buffer algorithm- brief description of shading and colour rendering techniques. Manipulation and editing of entities - selection methods – dragging -clipping- trimming- stretching- offsetting- pattern- copying- deleting - regenerating- measuring. Brief description of animation- types and techniques.

UNIT III SOFTWARE PACKAGES AND RECENT TECHNOLOGY 9

All about popular commercial solid modelling packages — their salient features- technical comparison- modules and Tools available- brief outline of Data exchange standards. Brief outline of feature technology - classification of features- design by features- applications of features- its advantages- and limitations.

UNIT IV FEM FUNDAMENTALS 9

Introduction to finite element method - principle- Steps involved in FEA - nodes- element and their types- shape function-constraints, forces and nodal displacements-stiffness matrix- solution techniques. Analysis of spring element. Simple problems involving stepped bars subjected to axial loading and simple structural members for triangular element.

UNIT V ANALYSIS 9

Stages of FEA in a CAD environment - Pre-processor- solver and postprocessor. Pre-processing – FEA modelling - geometry generation- node generation- element generationboundary constraints- load constraints- - mesh generation and refining. Solving - performing the actual analysis. Post processing - Types of 0/P available- interpretation of results. Demonstration of the above using any one popular commercial package. Other types of analysis: Brief outline of kinematical analysis- manufacturability analysis and simulation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Prepare and read engineering drawings.
- **CO2:** Visualize an engineering object.
- **CO3:** Understand solid models created in computer.
- **CO4:** Understand the relation between 2D drafting and 3D models.
- **CO5:** Understand the graphical models for further engineering applications.
- **CO6:** Create and modify 2D drawings and 3D models using computer-aided design (CAD) software, and apply dimensioning and tolerancing principles to communicate design intent and specifications.

TEXT BOOKS:

1. Chairs Mcmahon and Jimmie Browne, "CAD / CAM:Principles, Practice and Manufacturing Management", Prentice Hall, 2nd Ed.,1999.
2. Ibrahim Zoid., "CAD / CAM", Theory and Practice, TMH, 2001.
3. Radhakrishnan, P., "CAD / CAM / CIM", New Age International, 2000.

REFERENCE BOOKS:

1. Chandupatla and Bolagundu., "Introduction to Finite Element Methods in Engineering", Pearson Education India, 4th Ed., 2015.
2. Mikell P. Groover, "CAD/CAM: Computer-Aided Design and Manufacturing", PHI, 2003.
3. Newman and Sproull, R.F., "Principles of interactive Computer Graphics", TMH, 1997.

U23AEV12	NUMERICAL METHODS IN FLUID DYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To make students understand the complexity of general fluid dynamic equations in partial differential form in the mathematical nature of the equations.
2. To make students understand the complexity of general fluid dynamic equations under different flow conditions.
3. To impart knowledge to students on the basic aspects of finite differences and finite volume methods.
4. To impart knowledge to students on the basic aspects of finite element methods.
5. To expose the students on obtaining solutions for a set of a large number of algebraic equations using the panel methods as examples and to train them to obtain numerical solutions for steady supersonic flows.

UNIT I MATHEMATICAL NATURE OF FLUID DYNAMIC EQUATIONS 9

Introduction to numerical fluid dynamics - Introduction to governing equations of fluid dynamics and modelling of fluid flow – The substantial derivative and the physical meaning of divergence of a vector. 84 Boundary conditions for various types of fluid flow conditions - Introduction to mathematical properties of fluid dynamic equations and classification of partial differential equations - General behaviour of different classes of partial differential equations and their relation to fluid dynamics - A general discussion on hyperbolic, parabolic and elliptic equations.

UNIT II BOUNDARY CONDITIONS AND CHOICE OF NUMERICAL SCHEMES 9

Importance of boundary conditions in obtaining the numerical solution of fluid dynamic equations- Types of boundary conditions- Boundary conditions for momentum equations for viscous and inviscid flows – Boundary conditions for energy equation for different flow conditions – Practical examples – Symmetry and cyclic boundary conditions – Stability of numerical solution and the choice of numerical schemes for different classes of fluid dynamic equations.

UNIT III INTRODUCTION TO FDM, FVM AND FEM 9

Introduction to finite difference, finite volume and finite element methods and their areas of application-A brief description of implementing methodologies for finite difference method, finite volume method and finite element method – Illustration of the methods using simple one dimensional fluid dynamic problems – Advantages and limitations of these methods.

UNIT IV PANEL METHODS 9

A brief description of source, sink and vortex flows – Application of panel methods – Methodology involved in implementing panel methods – Source panel method and its implementation - Solution methods for solving a set of large number of algebraic equations and their applications for panel methods – Solution example of flow over a circular cylinder – Vortex panel method and its implementation – Vortex lattice method.

UNIT V NUMERICAL METHODS FOR STEADY SUPERSONIC FLOWS 9

Two dimensional irrotational flow – Method of characteristics – Numerical methodology to obtain solution using method of characteristics for supersonic inviscid flows – Supersonic nozzle design using method of characteristics – Application of method of characteristics for axisymmetric irrotational flows – Description of Mc. Cormack's Predictor-corrector technique – Shock capturing and shock fitting techniques.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Understand the importance of numerical methods in finding solutions to complex engineering flow problems.
- **CO2:** Develop interest in lifelong learning on numerical methods and apply the knowledge for the solution of aerospace related fluid dynamic problems.
- **CO3:** Acquire basic knowledge to learn modern engineering tools such as CFD software tools to solve and analyse the flow fields over the airplanes.
- **CO4:** Apply skills to develop algorithms for the solutions of inviscid supersonic flow problems pertaining to aerospace field.
- **CO5:** Create new computational techniques in computational methods such as FVM using the imparted knowledge.
- **CO6:** Analyze the application of air traffic control systems in various weather conditions and evaluate the impact of weather on air traffic management.

TEXT BOOKS:

1. Fletcher C.A.J. , "Computational Techniques for Fluid Dynamics 1" Springer Verlag, 1996.
2. Fletcher C.A.J., "Computational Techniques for Fluid Dynamics 2", Springer Verlag, 1995.

REFERENCE BOOKS:

1. Chung T. J., "Computational Fluid Dynamics", Cambridge University Press; 2nd edition 2010.
2. Hirsch C., "Numerical Computation of Internal and External Flows" Volume-2, John Wiley and Sons, 1994.
3. Joel H. Ferziger & Milovan Peric, "Computational Methods for Fluid Dynamics" Springer; 3rd edition 2002.
4. John F Wendt , "Computational Fluid Dynamics – An Introduction", 3rd Edition, Springer- Verlag, Berlin Heidelberg, 2009.
5. Versteeg H.K. and Malalsekera W. "An Introduction to Computational Fluid Dynamics, The Finite Volume Method", PHI; 2nd edition 2007.

U23AEV13 COMPUTATIONAL HEAT TRANSFER L T P C
3 0 0 3

COURSE OBJECTIVE:

1. To enable the students to study the evolution of Management, to study the functions and principles of management and to learn the application of the principles in an organization.

UNIT I HEAT CONDUCTION 9

Basic Modes of Heat Transfer – One dimensional steady state heat conduction: Composite Medium – Critical thickness – Effect of variation of thermal Conductivity – Extended Surfaces – Unsteady state. Heat Conduction: Lumped System Analysis – Heat Transfer in Semi-infinite and infinite solids – Use of Transient – Temperature charts – Application of numerical techniques.

UNIT II CONVECTIVE HEAT TRANSFER 9

Introduction – Free convection in atmosphere free convection on a vertical flat plate – Empirical relation in free convection – Forced convection – Laminar and turbulent convective heat transfer analysis in flows between parallel plates, over a flat plate and in a circular pipe. Empirical relations, application of numerical techniques in problem solving.

UNIT III RADIATIVE HEAT TRANSFER 9

Introduction to Physical mechanism – Radiation properties – Radiation shape factors – Heat exchange between non – black bodies – Radiation shields.

UNIT IV HEAT EXCHANGERS 9

Classification – Temperature Distribution – Overall heat transfer coefficient, Heat Exchange Analysis – LMTD Method and E-NTU Method.

UNIT V NUMERICAL METHODS IN HEAT TRANSFER 9

System and process of controlling – budgetary and non-budgetary control techniques –use of computers and IT in Management control – Productivity problems and management –control and performance – direct and preventive control – reporting.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Understand the difference between various modes of Heat Transfer and the Resistance Concept used in Heat Conduction.
- **CO2:** Learn to use the basic methods in Conduction. Understand the concept of Lump Parameter analysis and when it is applicable and earn the concepts of boundary layer.
- **CO3:** Learn to apply various correlation used in Convective Heat Transfer and understand the concepts of Black Body, Grey Body, View factor, Radiation shielding.
- **CO4:** Design/size Heat Exchanger and understand the concept of Mass transfer, its types & laws associated with it.
- **CO5:** Learn to apply various technique used for high speed flow heat transfer.
- **CO6:** Apply the principles of heat transfer and mass transfer to design, analyze, and optimize thermal systems, such as heat exchangers, cooling systems, and thermal protection systems, for various engineering applications.

TEXT BOOKS:

1. Sachdeva, S.C., "Fundamentals of Engineering Heat & Mass Transfer", Wiley Eastern Ltd., New Delhi, Fifth Ed, 2017.
2. Holman, J.P. "Heat Transfer", McGraw-Hill Book Co., Inc., New York, 10th Ed., 2017.

REFERENCE BOOKS:

1. David P. Dewitt, Theodore L. Bergman, Adrienne S. Lavine Frank P. Incropera, "Principals of Heat and Mass Transfer" Wiley; Seventh edition (2013) – 2002.
2. Nag P., "Heat and Mass Transfer", Tata-McGraw Hill, 2011.
3. Lienhard, J.H., "A Heat Transfer Text Book", Prentice Hall Inc., 1981.
4. Yunus A. Cengel., "Heat Transfer – A practical approach", Second Edition, Tata McGraw-Hill, 2002.

U23AEV14	CONTINUUM MECHANICS	L T P C
		3 0 0 3

COURSE OBJECTIVES:

1. To make students understand the need for grid generation for numerical solutions.
2. To give them exposure to both structured and unstructured grid generation methods.
3. To impart knowledge on the areas of application and on the implementation methods for structured and unstructured grid generation techniques.
4. To expose the students on the benefits of adaptive meshing and its methodology.
5. To impart training to students on the control of grid quality.

UNIT I BASIC ASPECTS IN GRID GENERATION 9

Introduction and essential mathematics: Concept of continuum, Vectors and Tensors, Indicial notation, Coordinate transformations, Principal values and directions, Invariants of a second-order tensor, Dyadic product, Vector and tensor calculus.

UNIT II STRUCTURED GRID GENERATION 9

Kinematics of deformation: Configurations of a body, displacement, velocity, acceleration, Lagrangian and Eulerian descriptions of ow field. Deformation gradient tensor, Finite strain tensor, Infinitesimal strain, Principal strains, Dilatation, Compatibility equations. Velocity gradient tensor, Rate of deformation tensor, Spin tensor. Example of some simple flows.

UNIT III UNSTRUCTURED GRID GENERATION 9

Stress and conservation laws: Surface traction, Cauchy's stress principle, Symmetry of stress tensor, Principal stresses, Stress invariants, Stress deviator tensor. Some simple states of stress: uniform extension, pure bending, pure torsion, etc. Conservation laws: mass, linear momentum, angular momentum, and energy.

UNIT IV ADAPTIVE MESHING 9

Constitutive law and boundary value problems: Frame indifference, Material symmetry. Constitutive equations for general linear elastic solid: isotropic, orthotropic and transversely isotropic solid.

UNIT V GRID QUALITY AND QUALITY CONTROL 9

Constitutive equation for Newtonian fluid. Incompressibility. Solution of some boundary value problems of solids and fluids.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Acquire knowledge on the basic principles of grid generation and be able to apply preliminary grid selection tasks in aerospace applications.
- **CO2:** Understand the multi-block grid generation procedures and be able to evaluate multi-block grid designs of computational domain in aerospace related problems.
- **CO3:** Evaluate structured and unstructured grid designs and be able to take decisions on selection of suitable grid blocks for the computational domains in aerospace applications.
- **CO4:** Apply adaptive meshing methods for better management of computer resources and cost effective solutions in aerospace engineering.
- **CO5:** Apply skills in ensuring the good quality of grid that is essential to get reasonably accurate numerical solutions for complex aerospace engineering problems.
- **CO6:** Utilize commercial grid generation software and open-source tools to create, edit, and optimize grids for complex aerospace geometries, and integrate the generated grids with computational fluid dynamics (CFD) and other numerical simulation tools.

TEXT BOOKS:

1. Continuum Mechanics: Foundations and Applications of Mechanics (Vol. 1), C. S. Jog. Cambridge University Press.
2. Elasticity: Theory, Applications and Numerics, Martin H. Sadd. Elsevier.
3. Theory of Elasticity, S. Timoshenko and J. N. Goodier. McGraw Hill Education.

REFERENCE BOOKS:

1. Continuum Mechanics, A. J. M. Spencer. Dover Publications, New York.
2. Continuum Mechanics, P. Chadwick. Dover Publications.
3. Continuum Mechanics for Engineers, G. Thomas Mase and George E. Mase. CRC Press

U23AEV15 AIRCRAFT SYSTEM DESIGN AND SIMULATION L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To understand the fundamental principles of aircraft system design and integration.
2. To apply simulation tools and methods to analyze and optimize aircraft systems.
3. To design and evaluate aircraft systems for performance, safety, and efficiency.
4. To integrate multiple aircraft systems to meet overall vehicle requirements.
5. To develop skills in simulation-based design and analysis.

UNIT I INTRODUCTION TO AIRCRAFT SYSTEM DESIGN 9

Aircraft system fundamentals – Design requirements and constraints – System integration and interface – Performance metrics and optimization – Simulation tools and methods.

UNIT II PROPULSION AND FUEL SYSTEMS 9

Propulsion system design – Engine performance simulation – Fuel system design and analysis – Fuel efficiency optimization – Case study: Propulsion system design.

UNIT III ELECTRICAL AND AVIONICS SYSTEMS 9

Electrical power system design – Avionics system architecture – Communication and navigation systems – Electrical system simulation – Case study: Avionics system design.

UNIT IV HYDRAULIC AND FLIGHT CONTROL SYSTEMS 9

Hydraulic system design – Flight control system design – Actuation and control systems – System simulation and analysis – Case study: Flight control system design.

UNIT V SIMULATION-BASED DESIGN AND OPTIMIZATION 9

Simulation tools and techniques – Model validation and verification – Design optimization methods – Multi-disciplinary design optimization – Case study: Simulation-based design.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Design and integrate aircraft systems for performance, safety, and efficiency.
CO2: Apply simulation tools and methods to analyze and optimize aircraft systems.
CO3: Evaluate aircraft system performance using simulation and analysis.
CO4: Integrate multiple aircraft systems to meet overall vehicle requirements.
CO5: Develop simulation-based design and optimization skills.
CO6: Collaborate effectively with multidisciplinary teams to identify system-level requirements, and integrate aircraft systems to meet overall vehicle performance, safety, and efficiency goals.

TEXT BOOKS:

1. Aircraft Systems: Mechanical, Electrical, and Avionics Subsystems Integration by Ian Moir and Allan Seabridge, Wiley, 2017.
2. Simulation of Dynamic Systems with MATLAB and Simulink by Harold K. Perez, Chapman and Hall/CRC, 2017.

REFERENCE BOOKS:

1. Aircraft Design: A Conceptual Approach by Daniel P. Raymer, AIAA, 2012.
2. Flight Simulation: A Perspective edited by David Allerton, Wiley, 2014.
3. Modeling and Simulation of Aerospace Systems" edited by Declan Bates and Martin Hagstrom, AIAA, 2015.

U23AEV16 COMPUTATIONAL MODELLING AND DATA ANALYSIS L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To get familiarize with the procedure to obtain numerical solution to fluid dynamic problems.
2. To gain knowledge on the important aspects of grid generation for practical problems.
3. To get exposure on time dependant and panel methods.
4. To understand the use of computation to understand real world phenomena.
5. To learn the data analysis techniques and its applications to space science.

UNIT I NUMERICAL SOLUTIONS OF SOME FLUID DYNAMICAL PROBLEMS 9

Basic fluid dynamics equations, Equations in general orthogonal coordinate system, Body fitted coordinate systems, mathematical properties of fluid dynamic equations and classification of partial differential equations – Finding solution of a simple gas dynamic problem, Local similar solutions of boundary layer equations, Numerical integration and shooting technique. Numerical solution for CD nozzle isentropic flows and local similar solutions of boundary layer equations Panel methods.

UNIT II GRID GENERATION 9

Need for grid generation – Various grid generation techniques – Algebraic, conformal and numerical grid generation – importance of grid control functions – boundary point control – orthogonality of grid lines at boundaries. Elliptic grid generation using Laplace's equations for geometries like aerofoil and CD nozzle. Unstructured grids, Cartesian grids, hybrid grids, grid around typical 2D and 3D geometries – Overlapping grids – Grids around multi bodies.

UNIT III TIME DEPENDENT METHODS 9

Stability of solution, Explicit methods, Time split methods, Approximate factorization scheme, Unsteady transonic flow around aerofoils. Some time-dependent solutions of gas dynamic problems. Numerical solution of unsteady 2-D heat conduction problems using SLOR methods.

UNIT IV INTRODUCTION TO DATA ANALYSIS 9

An introduction to probability theory-the modelling and analysis of probabilistic systems and elements of statistical inference – Probabilistic models – conditional probability. Discrete and continuous random variables.

UNIT V DATA ANALYSIS IN AEROSPACE APLICATIONS 9

Expectation and conditional expectation, and random variables – Limit Theorems – Bayesian estimation and hypothesis testing – Elements of classical statistical inference – Bernoulli and Poisson processes – Markov chains.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Arrive at the numerical solutions to boundary layer equations.
- **CO2:** Perform numerical grid generation and have knowledge about the mapping techniques.
- **CO3:** Familiarise himself/herself with high performance computing for CFD applications.
- **CO4:** Implement the explicit time dependent methods and their factorization schemes.
- **CO5:** Do the stability analysis and linearization of the implicit methods.
- **CO6:** Develop and apply numerical algorithms for solving complex fluid dynamics problems using computational fluid dynamics (CFD) techniques, and critically evaluate the accuracy, efficiency, and reliability of the numerical solutions.

TEXT BOOKS:

1. Bose. TK, "Numerical Fluid Dynamics",Narosa Publishing House, 2001.
2. Chung. TJ, "Computational Fluid Dynamics", Cambridge University Press, 2010.
3. Hirsch,AA, "Introduction to Computational Fluid Dynamics", McGraw-Hill, 1989.

REFERENCE BOOKS:

1. John D. Anderson, "Computational Fluid Dynamics", McGraw Hill Education, 2017.
2. Anil Maheshwari, Data Analytics, McGraw Hill Education; First edition, 2017
3. Erwin Kreysig, Advanced Engineering Mathematics Wiley 2015.

VERTICALS II
PROFESSIONAL ELECTIVE II

U23AEV21	EXPERIMENTAL AERODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To learn the basic measurement technique in Fluid mechanics.
2. To provide extensive treatment of the operating principles and limitations of pressure and temperature measurements.
3. To cover both operating and application procedures of hot wire anemometer.
4. To describe flow visualization techniques and to highlight in depth discussion of analog methods.
5. To understand the importance of special flows and error analysis.

UNIT I BASIC MEASUREMENTS IN FLUID MECHANICS 9

Objective of experimental studies – Fluid mechanics measurements – Properties of fluids – Measuring instruments – Performance terms associated with measurement systems – Direct measurements - Analogue methods – Flow visualization – Components of measuring systems –Importance of model studies.

UNIT II WIND TUNNEL MEASUREMENTS 9

Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels - Power losses in a wind tunnel – Instrumentation and calibration of wind tunnels –Turbulence- Wind tunnel balance – Wire balance – Strut-type – Platform-type – Yoke-type –Pyramid type – Strain gauge balance – Balance calibration.

UNIT III FLOW VISUALIZATION AND ANALOGUE METHODS 9

Visualization techniques – Smoke tunnel – Hele-Shaw apparatus - Interferometer –Fringe-Displacement method – Schlieren system – Shadowgraph - Hydraulic analogy – Hydraulic jumps – Electrolytic tank.

UNIT IV PRESSURE, VELOCITY AND TEMPERATURE MEASUREMENTS 9

Pitot - static tube characteristics - Velocity measurements - Hot-wire anemometry – Constant current and Constant temperature Hot-Wire anemometer – Pressure measurement techniques -Pressure transducers – Temperature measurements.

UNIT V SPECIAL FLOWS AND UNCERTAINTY ANALYSIS 9

Experiments on Taylor-Proudman theorem and Ekman layer – Measurements in boundary layers - Data acquisition and processing – Signal conditioning – Uncertainty analysis – Estimation of measurement errors – External estimate of the error – Internal estimate of the error – Uncertainty calculation - Uses of uncertainty analysis.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would have:

- **CO1:** Knowledge on measurement techniques in aerodynamic flow.
- **CO2:** Acquiring basics of wind tunnel measurement systems.
- **CO3:** Specific instruments for flow parameter measurement like pressure, velocity.
- **CO4:** Use measurement techniques involved in Aerodynamic testing.
- **CO5:** Analyze the model measurements, Lift and drag measurements through various techniques and testing of different models.
- **CO6:** Apply the Wind tunnel boundary corrections and Scale effects.

TEXT BOOKS:

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

REFERENCE BOOKS:

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

U23AEV22	ELECTRICAL AND PLASMA PROPULSION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To learn the basic measurement technique in Fluid mechanics.
2. To provide extensive treatment of the operating principles and limitations of pressure and temperature measurements.
3. To cover both operating and application procedures of hot wire anemometer.
4. To describe flow visualization techniques and to highlight in depth discussion of analog methods.
5. To understand the importance of special flows and error analysis.

UNIT I FUNDAMENTALS OF ELECTRICAL PROPULSION 9

Introduction to Electric Propulsion - Basics, history, applications – Electric Propulsion Systems - Components, classification – Electromagnetic Fundamentals - Maxwell's equations, Lorentz force – Electric Thrusters - Types (ion, hall effect, MPD) – Performance Parameters - Thrust, efficiency, specific impulse.

UNIT II PLASMA PHYSICS AND PROPULSION 9

Plasma Fundamentals - Definition, properties, generation – Plasma Propulsion Principles - Electrostatic acceleration – Plasma Thrusters - Types (ion, hall effect, pulsed plasma) – Plasma Propulsion Systems - Power processing, control systems – Plasma-Surface Interactions - Charging, sputtering, erosion.

UNIT III ELECTRICAL POWER SYSTEMS FOR PROPULSION 9

Power Electronics - Converters, inverters, switching – Power Processing Units (PPUs) - Design, components, efficiency – Energy Storage Systems - Batteries, capacitors, solar panels – Power Distribution and Control - Circuit protection, wiring, connectors – Electrical System Design Considerations - Reliability, redundancy, fault tolerance.

UNIT IV MISSION ANALYSIS AND DESIGN 9

Mission Requirements and Constraints - Spacecraft design, payload, trajectory – Propulsion System Selection - Trade studies, optimization – Mission Planning and Operations - Trajectory planning, navigation – System Integration and Testing - Validation, verification, interfaces – Case Studies: Successful Missions - Examples (Deep Space 1, SMART-1)

UNIT V ADVANCED TOPICS AND FUTURE DIRECTIONS 9

Advanced Propulsion Concepts - Nuclear electric, fusion, antimatter – New Materials and Technologies - Nanomaterials, metamaterials, additive manufacturing – Plasma Propulsion for Small Satellites - Cubesats, microthrusters – Electric Propulsion for Deep Space Missions - Challenges, opportunities – Future Research Directions - Emerging trends, funding opportunities.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Design and analyze electrical propulsion systems for space applications.
- **CO2:** Evaluate the performance of electrical propulsion systems using key parameters.
- **CO3:** Apply mission analysis principles to select and optimize electrical propulsion systems.
- **CO4:** Identify emerging trends and technologies in electrical and plasma propulsion.
- **CO5:** Communicate technical information effectively through reports, presentations, and discussions.
- **CO6:** Develop and apply system engineering principles to integrate electrical propulsion systems with spacecraft power, communication, and navigation systems, and evaluate their impact on overall spacecraft performance and mission success.

TEXT BOOKS:

1. Electric Propulsion for Space Exploration by Ernest A. Gonzalez and Herman J. Kramer, Springer, 2018.
2. Plasma Propulsion: Principles and Applications by M. Keidar and I. D. Boyd, Wiley, 2015.
3. Fundamentals of Electric Propulsion: Ion and Hall Thrusters by Dan M. Goebel and Ira Kat Wiley, 2008.

REFERENCE BOOKS:

1. Electric Propulsion Systems: A Review edited by A. A. Voevodin and V. S. Zakovorotny, Nova Science Publishers, 2013.
2. Plasma Physics and Engineering by M. A. Lieberman and A. J. Lichtenberg, Springer, 200
3. Space Mission Analysis and Design by James R. Wertz and Wiley J. Larson, Microcosm Press, 2010.
4. Electrical Power Systems for Spacecraft by P. J. Scanlon, CRC Press, 2014.

U23AEV23	INDUSTRIAL AERODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

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

UNIT I ATMOSPHERE **9**

Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows.

UNIT II WIND ENERGY COLLECTORS **9**

Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory.

UNIT III VEHICLE AERODYNAMICS **9**

Power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of trains and Hovercraft.

UNIT IV BUILDING AERODYNAMICS **9**

Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, Building codes, Building ventilation and architectural aerodynamics.

UNIT V FLOW INDUCED VIBRATIONS **9**

Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Use aerodynamics for non- aerodynamics such as vehicle, building.
- **CO2:** Solve the problems and able to analyse vibrations during flow.
- **CO3:** Identify the Atmospheric boundary layer and applications of wind energy collectors.
- **CO4:** Analyze the aerodynamics of road vehicles, buildings and problems of flow induced vibrations.
- **CO5:** Apply computational fluid dynamics (CFD) and wind tunnel testing techniques to investigate and optimize the aerodynamic performance of various structures.
- **CO6:** Evaluate the aerodynamic and aeroacoustic performance of various systems, such as wind turbines, aircraft, and vehicles.

TEXT BOOKS:

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

REFERENCE BOOKS:

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

U23AEV24	ROCKET PROPULSION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To make students understand the basic operating principle of rocket propulsion.
2. To make students understand the parameter required to estimate the performance of rockets.
3. To impart knowledge to students on different types of rocket propulsion systems.
4. To learn the concepts of rocket propulsion applications areas and disadvantages.
5. To expose the students on the methods of multi-staging of rocket vehicles and on the technologies for rocket control using aerodynamic and jet control means.

UNIT I INTERNAL BALLISTICS OF ROCKETS 9

Reaction principle – Rocket performance parameters – specific impulse – Schematic diagrams of solid, liquid and hybrid rocket propulsion systems – Equilibrium chamber pressure – Thrust equation–Characteristic velocity and thrust coefficient – Rocket performance assessment.

UNIT II SOLID ROCKET PROPULSION 9

Selection criteria of solid propellants – Types of solid propellants – Propellant ingredients – Solid propellant regression rate and factors influencing the regression rate – Solid propellant grain configurations – Progressive, regressive and neutral burning of grains- Solid rocket igniters – Basics of solid propellant combustion and combustion instability – Erosive burning – Pressure and regression rate relationship.

UNIT III LIQUID ROCKET PROPULSION 9

Types of liquid propellant combinations – Gas pressure and turbopump fed pressurization systems for liquid propellant rockets – Liquid rocket injectors and water testing – Liquid rocket cooling methods – Basic aspects of thrust chamber design - Thrust control – Advantages of liquid rockets over solid rockets – Combustion instability – Cryogenic rocket engines – Propellant slosh.

UNIT IV HYBRID ROCKET PROPULSION 9

Standard and reverse hybrid systems – Combustion mechanism in hybrid rockets – Limitations and applications of hybrid rockets – Solid grain configurations in hybrid rockets-Solid grain regression rate behavior along the grain length - Local regression rate estimation – Material combinations for hybrid rocket propellants- Estimation of hybrid rocket performance – Performance comparison with solid and liquid rocket systems

UNIT V STAGING AND STEERING OF ROCKETS 9

Need for multi-staging of rocket vehicles – different types of multi-staging - staging optimization methods – estimation of staging performance – stage separation methods in atmosphere and in space -steering methods for rockets – aerodynamic control based steering – types – merits and limitations – jet control based steering – thrust vector control methods – merits and limitations of these methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Explain the basic principles and develop interest to join aerospace industry as a scientist/engineer.
- **CO2:** Develop skills and apply them for conceptual designs of rocket propulsion systems as a design team member.
- **CO3:** Evaluate the performance parameters of rocket propulsion systems and can suggest alternate designs if needed.
- **CO4:** Describe the advanced technology concepts like cryogenic rocket technology and be able to create preliminary designs of solid-cryogenic multi-stage configurations.
- **CO5:** Adapt himself/herself to aerospace industry by the acquired knowledge and apply skills in the preliminary design of rocket subsystems.
- **CO6:** Design and analyze a smart structure using functional materials, such as piezoelectric or shape memory alloy (SMA) materials, for a specific aerospace application

TEXT BOOKS:

1. David H. Heiser and David T. Pratt., "Hypersonic Air breathing Propulsion", AIAA Education Series, 1999.
2. Mathur, M.L. and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers & Distributors, Delhi, 2nd edition 2014.
3. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons; 8th Edition 2010.

REFERENCE BOOKS:

1. Martin J. Chiaverini and Kenneth K. Kuo, "Fundamentals of Hybrid Rocket Combustion an Propulsion", Progress in Astronautics and Aeronautics, 2007.
2. Ramamurthi K, "Rocket Propulsion", Macmillian publishers India Ltd, 1st edition, 2010.

U23AEV25 ADVANCED PROPULSION SYSTEMS L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To impart knowledge on the basic concepts of space propulsion.
2. To learn about the physics of ionized gases.
3. To get familiarize with the types of nuclear rockets and the basic concepts of nuclear propulsion systems.
4. To study about the radioisotope propulsion.
5. To realise the importance of advanced space propulsion concepts.

UNIT I INTRODUCTION TO SPACE PROPULSIONSYSTEMS 9

Historical outline, Scramjet Propulsion-Scramjet Inlets; Scramjet Performance, Chemical rocket Propulsion-Tri-propellants; Metalized Propellants; Free Radical Propulsion, Electric Propulsion, Micro propulsion - Micro Propulsion Requirements, MEMS and MEMS-Hybrid Propulsion Systems.

UNIT II BASIC CONCEPTS OF IONIZED GASES 9

Electromagnetic theory: electric charges and fields, currents, and magnetic fields, and applications to ionized gases. Atomic structure of gases - Ionization processes - Particle collisions in an ionized gas – Electrical conductivity of an ionized gas - Kinetic Theory, Introduction to plasma physics- Electrode phenomena.

UNIT III NUCLEAR ROCKET PROPULSION 9

Nuclear Rocket Engine Design and Performance, Types of Nuclear Rockets, Overall Engine Design, Nuclear Rocket Performance, Component Design, Nuclear Rocket Reactors, General Design Considerations, Reactor Core Materials, Thermal Design, Mechanical Design, Nuclear Design, Shielding, Nuclear Rocket Nozzles, General Design Considerations, Heat-Transfer Analysis, Over- all Problem, Hot-Gas Boundary, Cold-Gas Boundary.

UNIT IV RADIOISOTOPE PROPULSION 9

Alternative Approaches, Direct Recoil Method, Thermal Heating Method, Basic Thruster Configurations, Propulsion System and Upper Stage, Primary Propulsion, Auxiliary Propulsion, Thruster Technology, Design Criteria, Performance, Safety, Heat Source Development, Radioisotope Fuel, Capsule Technology, General Considerations, Thermal Design, Fabrication and Non-Destructive Testing Techniques, Pressure Containment, Heat Source Simulation, Oxidation and Corrosion of Encapsulating Materials, Nozzle Performance.

UNIT V ADVANCED SPACE PROPULSION CONCEPTS 9

Introduction, General Consideration for Propulsion in Space, Power Supply, Propellant Storage and Handling Facilities, Electrostatic and Electromagnetic Thrusters, Advanced Electric Propulsion Systems for Space Vehicles, Sputtering, A Thrust Generation Mechanism, Sputtering Phenomena, Possible Performance of Sputtering Thrusters, Energy Efficiency of the Sputtering Process, Analyses of an Elementary Mission with Different Electric Thrusters, General Consideration, Performance Formula for Electric Thrusters, Optimization with Electric Thrusters.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Have knowledge on the basics and classification of space propulsion.
- **CO2:** Comprehend the physics of ionized gases, their theories and particle collisions.
- **CO3:** Demonstrate the working, types and performance of nuclear rockets with their design considerations.
- **CO4:** Learn the basics of radioisotope propulsion with their performance studies.
- **CO5:** Have knowledge on advanced methods of space propulsion systems with new thrust generation mechanisms.
- **CO6:** Analyze and evaluate the feasibility, efficiency, and limitations of various space propulsion systems, including conventional and advanced concepts, for different space mission requirements and scenarios.

TEXT BOOKS:

1. Czysz, Paul A., Bruno, Claudio, Chudoba, Bernd "Future Spacecraft Propulsion Systems ar Integration", Springer, Praxis Publishing Ltd, 2018.
2. George W. Sutton, "Engineering Magneto hydrodynamics", Dover Publications Inc., New York, 2006.

REFERENCE BOOKS:

1. George P. Sutton & Oscar Biblarz, "Rocket Propulsion Elements, John Wiley & Sons Inc., NewYork, 9th Edition, 2016.
2. Martin Tajmar, "Advanced Space Propulsion Systems" Springer Verlag GmbH, 2003.
3. Robert G. Jahn, "Physics of Electric Propulsion", McGraw-Hill Series, New York, 1968.
4. William J. Emrich, "Principles of Nuclear Rocket Propulsion" Elsevier Science, 2016.

U23AEV26	HYPERSONIC AERODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

1. To introduce fundamental concepts and features peculiar to hypersonic flow to students to familiarize them with the aerodynamical aspects of hypersonic vehicles and the general hypersonic flow theory.

UNIT I FUNDAMENTALS OF HYPERSONIC AERODYNAMICS 9

Introduction to hypersonic aerodynamics – differences between hypersonic aerodynamics and supersonic aerodynamics - concept of thin shock layers and entropy layers – hypersonic flight paths – hypersonic similarity parameters – shock wave and expansion wave relations of inviscid hypersonic flows.

UNIT II SIMPLE SOLUTION METHODS FOR HYPERSONIC INVISCID FLOWS 9

Local surface inclination methods – Newtonian theory – modified Newtonian law – tangent wedge and tangent cone and shock expansion methods – approximate methods - hypersonic small disturbance theory – thin shock layer theory.

UNIT III VISCOUS HYPERSONIC FLOW THEORY 9

Boundary layer equations for hypersonic flow – hypersonic boundary layers – self similar and non-self-similar boundary layers – solution methods for non-self-similar boundary layers – aerodynamic heating and its adverse effects on airframe.

UNIT IV VISCOUS INTERACTIONS IN HYPERSONIC FLOWS 9

Introduction to the concept of viscous interaction in hypersonic flows - Strong and weak viscous interactions - hypersonic viscous interaction similarity parameter – introduction to shock wave boundary layer interactions.

UNIT V HIGH TEMPERATURE EFFECTS IN HYPERSONIC FLOWS 9

Nature of high temperature flows – chemical effects in air – real and perfect gases – Gibb's free energy and entropy - chemically reacting boundary layers – recombination and dissociation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to have:

- **CO1:** Knowledge in basics of hypersonic and supersonic aerodynamics.
- **CO2:** Acquiring knowledge in theory of hypersonic flow.
- **CO3:** Understanding of boundary layers of hypersonic flow and viscous interaction.
- **CO4:** Role of chemical and temperature effects in hypersonic flow.
- **CO5:** Ability to analyze and predict the aerodynamic behavior of hypersonic vehicles, including heat transfer, skin friction, and pressure distribution.
- **CO6:** Familiarity with experimental and computational techniques for investigating hypersonic flows, including wind tunnel testing, computational fluid dynamics (CFD), and numerical simulation methods.

TEXT BOOKS:

1. John D. Anderson. Jr., "Hypersonic and High Temperature Gas Dynamics", Mc.Graw hill Series, New York, 1996.
2. William H. Heiser and David T. Pratt, Hypersonic Air Breathing propulsion, AIAA Education Series, 1994.

REFERENCE BOOKS:

1. John D. Anderson. Jr., "Modern Compressible flow with historical Perspective", Mc.Graw Hill Publishing Company, New York, 1996.
2. John T. Bertin, "Hypersonic Aerothermodynamics", published by AIAA Inc., Washington.D.C., 1994.

VERTICALS III
PROFESSIONAL ELECTIVE III

U23AEV31 FATIGUE AND FRACTURE MECHANICS L T P C
3 0 0 3

COURSE OBJECTIVE:

1. To understand the basic concepts involved in fatigue analysis and to study the importance of fracture mechanics in aerospace applications.

UNIT I FATIGUE OF STRUCTURES 9

S.N. curves - Endurance limits - Effect of mean stress, Goodman, Gerber and Soderberg relations and diagrams - Notches and stress concentrations - Neuber's stress concentration factors – Plastic stress concentration factors - Notched S.N. curves – Fatigue of composite materials.

UNIT II STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR 9

Low cycle and high cycle fatigue - Coffin - Manson's relation - Transition life - cyclic strain hardening and softening - Analysis of load histories - Cycle counting techniques –Cumulative damage - Miner's theory - Other theories.

UNIT III PHYSICAL ASPECTS OF FATIGUE 9

Phase in fatigue life - Crack initiation - Crack growth - Final Fracture - Dislocations - fatigue fracture surfaces.

UNIT IV FRACTURE MECHANICS 9

Strength of cracked bodies - Potential energy and surface energy - Griffith's theory - Irwin – Orwin extension of Griffith's theory to ductile materials - stress analysis of "cracked bodies - Effect of thickness on fracture toughness" - stress intensity factors for typical 'geometries.

UNIT V FATIGUE DESIGN AND TESTING 9

Safe life and Fail-safe design philosophies - Importance of Fracture Mechanics in aerospace structures - Application to composite materials and structures.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Apply mathematical knowledge to define fatigue behaviours
CO2: Perform fatigue design.
CO3: Analyse the fracture due to fatigue.
CO4: Analyse for cumulative damage due to fatigue.
CO5: Analyse for crack initiation & crack growth.
CO6: Analyse damage tolerant structures.

TEXT BOOKS:

1. Barrois W, Ripely, E.L., “Fatigue of aircraft structure," Pergamon press. Oxford, 1983.
2. Prasanth Kumar, "Elements of fracture mechanics", Wheeter publication, 1999.

REFERENCE BOOKS:

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

U23AEV32	EXPERIMENTAL STRESS ANALYSIS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the various experimental techniques involved for measuring displacements, stresses, strains in structural components.
2. To familiarize with the different types of strain gages used.
3. To familiarize with the instrumentation system used for strain gauges.
4. Be able to use photo elasticity techniques and methods for stress analysis.
5. Be able to familiarize with the different NDT techniques.

UNIT I BASICS OF MECHANICAL MEASUREMENTS 9

Basic Characteristics and Requirements of a Measuring System – Principles of Measurements – Precision, Accuracy, Sensitivity and Range of Measurements – Sources of Error – Statistical Analysis of Experimental Data – Contact Type Mechanical Extensometers – Advantages and Disadvantages –Examples of Non -Contact Measurement Techniques.

UNIT II ELECTRICAL-RESISTANCE STRAIN GAUGES 9

Strain Sensitivity in Metallic Alloys – Gage Construction – Gage Sensitivities and Gage Factor – Corrections for Transverse Strain Effects – Performance Characteristics of Foil Strain Gages – Materials Used for Strain Gauges – Environmental Effects – The Three-Element Rectangular Rosette for Strain Measurement – Other Types of Strain Gages – Semiconductor Strain Gages – Grid & Brittle Coating Methods of Strain Analysis.

UNIT III STRAIN-GAUGE CIRCUITS & INSTRUMENTATION 9

The Potentiometer Circuit and Its Application to Strain Measurement – Variations From Basic Circuit –Circuit Output – The Wheatstone Bridge Circuit – Current and Constant Voltage Circuits – Analog to Digital Conversion – Calibrating Strain-Gage Circuits – Effects of Lead Wires and Switches – Electrical Noise -– Strain Measurement in Bars, Beams and Shafts – Circuit Sensitivity & Circuit Efficiency.

UNIT IV PHOTOELASTIC METHODS OF STRESS ANALYSIS 9

Introduction to Photoelastic Methods – Stress-Optic Law – Effects of a Stressed Model in a Plane Polariscope – Effects of a Stressed Model in a Circular Polariscope – Tardy Compensation - Two-Dimensional Photoelastic Stress Analysis – Fringe Multiplication and Fringe Sharpening - Materials for Two-Dimensional Photoelasticity - Properties and Calibration of Commonly Employed Photoelastic Materials – Introduction to Three-Dimensional Photoelasticity.

UNIT V NON-DESTRUCTIVE TESTING 9

Different types of NDT Techniques - Acoustic Emission Technique – Ultrasonics – Pulse-Echo – Through Transmission – Eddy Current Testing – Magnetic Particle Inspection – X-Ray Radiography – Challenges in Non-Destructive Evaluation – Non-Destructive Evaluation in Composites – Image Processing Basics.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Analyse the performance of measuring instrumentation.
- **CO2:** Impart knowledge on different methods of strain measurement.
- **CO3:** Design different strain gauge circuits.
- **CO4:** Use photoelasticity for stress analysis.
- **CO5:** Exposure the different types of non-destructive testing methods.
- **CO6:** Apply modern experimental techniques, including data acquisition and signal processing, to measure and analyze the mechanical behavior of materials and structures, and to validate theoretical models and simulations.

TEXT BOOKS:

1. Dally, J.W., and Riley, W.F., Experimental Stress Analysis, McGraw Hill Inc., Ne York, 1998.
2. Sadhu Singh, Experimental Stress Analysis, Khanna Publishers, New Delhi, 2009
3. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., an Ramachandra,K., Experimental Stress Analysis, Tata McGraw Hill, New Delhi,1984.

REFERENCE BOOKS:

1. Albert S. Kobayashi,' Handbook on Experimental Mechanics, Prentice Hall Publishers,2008.
2. Durelli, A.J.Applied Stress Analysis, Prentice Hall of India Pvt Ltd., New Delhi, 1970.
3. Hetenyi, M., Hand book of Experimental Stress Analysis, John Wiley and Sons Inc., Ne York, 1972
4. James F. Doyle and James W. Phillips,'Manual on Experimental Stress Analysis', 5th Edition,1989.
5. Ramesh, K., Digital Photoelasticity, Springer, New York, 2000.

U23AEV33	AIRFRAME DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the fundamental principles of airframe design, including structural analysis and materials.
2. To apply design methodologies to create efficient airframe structures.
3. To analyze and optimize airframe components for strength, stiffness, and weight.
4. To integrate airframe design with aerodynamic and system requirements.
5. To develop skills in airframe design tools and software.

UNIT I INTRODUCTION TO AIRFRAME DESIGN 9

Airframe design fundamentals – Structural analysis methods – Materials selection – Design for manufacture, assembly, and test – Airframe design software.

UNIT II Structural Analysis and Design 9

Beam and column analysis – Plate and shell analysis – Structural optimization – Finite element analysis – Structural testing.

UNIT III Airframe Components Design 9

Wing design – Fuselage design – Control surface design – Landing gear design – System integration.

UNIT IV Materials and Manufacturing 9

Metallic materials – Composite materials – Manufacturing processes – Joining and assembly – Inspection and testing.

UNIT V Advanced Airframe Design Topics 9

Aerodynamic-structural interaction – Multidisciplinary design optimization – Advanced materials and manufacturing – Sustainable airframe design – Future trends in airframe design.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Design and analyze airframe structures using fundamental principles.
- **CO2:** Apply structural analysis and optimization techniques.
- **CO3:** Select and specify materials for airframe components.
- **CO4:** Integrate airframe design with aerodynamic and system requirements.
- **CO5:** Utilize airframe design software and tools effectively.
- **CO6:** Evaluate and validate airframe design for safety, durability, and performance, using analytical, numerical, and experimental methods, and in compliance with regulatory requirements and industry standards.

TEXT BOOKS:

1. Airframe Structural Design by Michael C. Y. Niu, Composite Materials and Structures, 2014.
2. Aircraft Structures by David J. Peery and Azar J. Azar, McGraw-Hill, 2014.
3. Airframe Design: Design for Manufacture, Assembly and Test by A. K. Rao, Wiley, 2017.

REFERENCE BOOKS:

1. Aircraft Design: A Conceptual Approach by Daniel P. Raymer, AIAA, 2012.
2. Structural Analysis of Aircraft by E. F. Bruhn, Jacobs Publishing, 2014.
3. Composite Materials for Aircraft Structures by Alan Baker, Stuart Dutton, and Donald Kelly, AIAA, 2004.
4. Aircraft Structures for Engineering Students by T. H. G. Megson, Elsevier, 2013.

U23MEV42	ADDITIVE MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To exploit technology used in additive manufacturing.
2. To understand importance of additive manufacturing in advance manufacturing process.
3. To acquire knowledge, techniques and skills to select relevant additive manufacturing process.
4. To explore the potential of additive manufacturing in different industrial sectors.
5. To apply 3D printing technology for additive manufacturing.

UNIT I INTRODUCTION 9

Need - Development of AM systems – AM process chain - Impact of AM on Product Development -Virtual Prototyping- Rapid Tooling – RP to AM -Classification of AM processes- Benefits- Applications.

UNIT II REVERSE ENGINEERING AND CAD MODELING 9

Basic concept- Digitization techniques – Model reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data requirements – Geometric modeling techniques: Wireframe, surface and solid modeling – data formats - Data interfacing, Part orientation and support generation, Support structure design, Model Slicing, Tool path generation-Software for AM- Case studies.

UNIT III LIQUID BASED AND SOLID BASED ADDITIVE MANUFACTURING SYSTEMS 9

Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, part quality and process planning, recoating issues, materials, advantages, limitations and applications.
Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications. Fused deposition Modeling (FDM): Principle, details of processes, process variables, types, products, materials and applications. Laminated Object Manufacturing (LOM): Working Principles, details of processes, products, materials, advantages, limitations and applications - Case studies.

UNIT IV POWDER BASED ADDITIVE MANUFACTURING SYSTEMS 9

Selective Laser Sintering (SLS): Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy, Applications. Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications– Case Studies.

UNIT V OTHER ADDITIVE MANUFACTURING SYSTEMS 9

Three dimensional Printing (3DP): Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder based 3DP systems, strength and weakness, Applications and case studies. Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Define the various process used in Additive Manufacturing.
- **CO2:** Analyse and select suitable process and materials used in Additive Manufacturing.
- **CO3:** Apply knowledge of additive manufacturing for various real-life applications.
- **CO4:** Apply technique of CAD and reverse engineering for geometry transformation in Additive Manufacturing.
- **CO5:** Understand the basic concept of additive manufacturing application.
- **CO6:** Evaluate and optimize the performance, quality, and cost-effectiveness of additive manufactured products, considering factors such as material properties, mechanical integrity, surface finish, and post-processing requirements.

TEXT BOOKS:

1. Chua, C.K., Leong K.F. and Lim C.S., "Rapid prototyping: Principles and applications", second edition, World Scientific Publishers, 2010.
2. Gebhardt, A., "Rapid prototyping", Hanser Gardener Publications, 2003.

REFERENCE BOOKS:

1. Gibson, I., Rosen, D.W. and Stucker, B., "Additive Manufacturing Methodologies: Rapi Prototyping to Direct Digital Manufacturing", Springer, 2010.
2. Hilton, P.D. and Jacobs, P.F., Rapid Tooling: Technologies and Industrial Applications, CRC press, 2005.
3. Kamrani, A.K. and Nasr, E.A., "Rapid Prototyping: Theory and practice", Springer, 200
4. Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool bo for prototype development", CRC Press, 2011.

U23AEV35	NANOTECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the fundamental principles of nanotechnology, including nanoscale materials, devices, and systems.
2. To analyze the properties and applications of various nanomaterials, such as carbon nanotubes, nanoparticles, and nanocrystals.
3. To design and develop innovative nanotechnology-based solutions for real-world problems in fields like energy, medicine, and electronics.

UNIT I NANOMATERIALS 9

Nanomaterials – Types: nanowires, nanotubes, fullerenes, quantum dots, dendrimers, Nanocomposites – Properties – Methods of preparation – Top down, bottom up.

UNIT II ELECTRON MICROSCOPY TECHNIQUES 9

Electron Microscopy Techniques – SEM, TEM, X-ray methods – Optical Methods – Fluorescence Microscopy – Single Molecule Surface Enhanced Resonance Raman Spectroscopy – Atomic Force Microscopy, MRI, STM and SPM.

UNIT III MESOSCOPIC MAGNETISM 9

Mesoscopic magnetism – Magnetic measurements – Miniature Hall Detectors, Integrated DC SQUID – Microsusceptometry – Magnetic recording technology – Biological magnets.

UNIT IV BASICS OF NANOELECTRONICS 9

Basics of nanoelectronics – Single Electron Transistor, Quantum Computation – Parallel architecture for nanosystems – Nanolithography, basic structures and integrated structures – MEMS and NEMS – Dynamics of NEMS - Limits of integrated electronics.

UNIT V BIOMOLECULAR MOTORS 9

Biological structures and functions - Biomolecular motors, Drug delivery systems – Nanofluidics

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand Nanoscale Fundamentals.
CO2: Analyze Nanomaterials and Nanostructures.
CO3: Design and Develop Nanotechnology-Based Solutions.
CO4: Investigate and evaluate the applications of nanotechnology in various fields.
CO5: Assess the societal implications, safety, and ethical considerations of nanotechnology.
CO6: Develop skills in characterization and measurement techniques for nanomaterials and nanostructures, including imaging, spectroscopy, and other analytical methods.

TEXT BOOKS:

1. Nanotechnology: Understanding Small Systems by Ben Rogers, Jesse Adams, and Sumita Pennathur, CRC Press, 2018.
2. Introduction to Nanotechnology by Charles P. Poole and Frank J. Owens, Wiley-Interscience, 2003.
3. Nanotechnology: A Crash Course by Rizwan Uddin and Andrew J. Boydston ,CRC Press, 2015.

REFERENCE BOOKS:

1. Handbook of Nanoscience, Engineering, and Technology edited by William A. Goddard III, Donald W. Brenner, and Sergey E. Lyshevski, CRC Press, 2002.
2. Nanotechnology: An Introduction to Nanostructures, Nanomaterials, and Nanodevices by Ahmed A. El-Gendy and James E. McGrath, Wiley-VCH, 2017.

U23AEV36	AEROSPACE MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the elements of aerospace materials, mechanical behaviour of materials, ceramics and composites.
2. To explain the theory, concepts, principles and governing equations of solid mechanics.
3. To analyse the stresses in simple structures as used in the aerospace industry.

UNIT I ELEMENTS OF AEROSPACE MATERIALS 9

Structure of solid materials – Atomic structure of materials – Crystal structure – Miller indices – Density – Packing factor – Space lattices – X-ray diffraction – Imperfection in crystals – general requirements of materials for aerospace applications.

UNIT II MECHANICAL BEHAVIOUR OF MATERIALS 9

Linear and non-linear elastic properties – Yielding, strain hardening, fracture, Bauchinger's effect – Notch effect testing and flaw detection of materials and components – Comparative study of metals, ceramics plastics and composites.

UNIT III CORROSION & HEAT TREATMENT OF METALS AND ALLOYS 9

Types of corrosion – Effects of corrosion on mechanical properties – Stress corrosion cracking – Corrosion resistance materials used for space vehicles. Heat treatment of carbon steels – aluminium alloys, magnesium alloys and titanium alloys – Effect of alloying treatment, heat resistance alloys – tool and die steels, magnetic alloys, powder metallurgy.

UNIT IV CERAMICS AND COMPOSITES 9

Introduction – physical metallurgy – modern ceramic materials – cermet - cutting tools – glass ceramic –production of semi-fabricated forms - Plastics and rubber – Carbon/Carbon composites, Fabrication processes involved in metal matrix composites - shape memory alloys – applications in aerospace vehicle design.

UNIT V HIGH TEMPERATURE MATERIALS &CHARACTERIZATION 9

Classification, production and characteristics – Methods and testing – Determination of mechanical and thermal properties of materials at elevated temperatures – Application of these materials in Thermal protection systems of Aerospace vehicles – super alloys – High temperature material characterization.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Understand the advanced concepts of aerospace materials.
- **CO2:** Provide the necessary mathematical knowledge that are needed in understanding their significance and operation.
- **CO3:** Have an exposure on various topics such elements of aerospace materials, mechanical behaviour of materials, ceramics and composites.
- **CO4:** Deploy the skills effectively in the understanding of aerospace materials.
- **CO5:** Analyze and evaluate the properties and performance of various aerospace materials, for specific applications.
- **CO6:** Design and select appropriate aerospace materials for given applications, considering factors such as strength, stiffness, toughness, corrosion resistance, and manufacturability, to ensure optimal performance, safety, and cost-effectiveness.

TEXT BOOKS:

1. Engineering Materials, Their properties and Applications, by Martin, J.W., Wykedham Publications (London) Ltd, 1987.
2. Aircraft Materials and Processes5th Ed., by Titterton.G, Pitman Publishing Co., 1998.

REFERENCE BOOKS:

1. Raghavan.V., "Materials Science and Engineering", Prentice Hall of India, 5th Ed., 2011
2. Van Vlack.L.H., "Materials Science for Engineers", Addison Wesley, 1985.

VERTICALS IV
PROFESSIONAL ELECTIVE IV

U23AEV41 PRINCIPLE OF AUTONOMY AND DECISION MAKING L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To understand the principles of autonomy and decision-making in complex systems.
2. To analyze the role of autonomy in decision-making processes.
3. To evaluate the benefits and challenges of autonomous decision-making.
4. To apply decision-making models and techniques to real-world problems.
5. To develop critical thinking and problem-solving skills in autonomous decision-making.

UNIT I INTRODUCTION TO AUTONOMY AND DECISION MAKING 9

Definition and Concepts of Autonomy – Types of Autonomy (Human, Machine, and Hybrid) – Decision-Making Process – Decision-Making Models (Rational, Bounded Rationality, and Intuitive) – Autonomy in Decision-Making – Benefits and Challenges of Autonomous Decision-Making – Case Studies: Autonomous Decision-Making in Real-World Scenarios.

UNIT II DECISION-MAKING THEORIES AND MODELS 9

Expected Utility Theory – Prospect Theory – Decision Trees and Influence Diagrams – Game Theory and Strategic Decision Making – Heuristics and Biases in Decision Making – Case Studies: Application of Decision-Making Theories in Real-World Scenarios.

UNIT III AUTONOMOUS SYSTEMS AND DECISION MAKING 9

Autonomous Systems: Definition and Types – Autonomous Decision-Making: Architectures and Algorithms – Machine Learning and Autonomous Decision Making – Human-Machine Interface and Autonomous Decision Making – Case Studies: Autonomous Decision-Making in Robotics and Drones.

UNIT IV ETHICAL AND SOCIAL IMPLICATIONS OF AUTONOMOUS DECISION MAKING 9

Ethical Theories and Autonomous Decision Making – Moral and Social Implications of Autonomous Decision Making – Accountability and Responsibility in Autonomous Decision Making – Bias and Fairness in Autonomous Decision Making – Case Studies: Ethical Dilemmas in Autonomous Decision Making.

UNIT V APPLICATIONS AND FUTURE DIRECTIONS 9

Applications of Autonomous Decision Making in Various Domains – Future Directions in Autonomous Decision Making – Emerging Trends and Technologies in Autonomous Decision Making – Case Studies: Innovative Applications of Autonomous Decision Making.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would have:

- **CO1:** Understand the principles of autonomy and decision-making in complex systems.
- **CO2:** Analyze the role of autonomy in decision-making processes.
- **CO3:** Evaluate the benefits and challenges of autonomous decision-making.
- **CO4:** Apply decision-making models and techniques to real-world problems.
- **CO5:** Develop critical thinking and problem-solving skills in autonomous decision-making.
- **CO6:** Design and develop autonomous decision-making systems that incorporate ethical considerations, social implications, and technical constraints.

TEXT BOOKS:

1. Autonomous Systems: Foundations, Applications, and Future Prospects by J. Lygeros and K. H. Johansson, 2013.
2. Learning and Memory: An Integrated Approach by J. R. Anderson, 2000.

REFERENCE BOOKS:

1. Artificial Intelligence: A Modern Approach (3rd edition) by S. Russell and P. Norvig, 2009.
2. The Oxford Handbook of Human Motivation by Richard M. Ryan, 2012.
3. Decision Theory: A Formal Introduction by J. C. Harsanyi, 1977.

U23ECT33	SIGNALS AND SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To analyze and design continuous-time and discrete-time signals and systems.
2. To apply mathematical techniques (Fourier transform, Laplace transform, z-transform) to solve signal processing problems.
3. To understand the fundamental concepts of filtering, modulation, and sampling.

UNIT I CLASSIFICATION OF SIGNALS AND SYSTEMS 9

Standard signals – Step, Ramp, Pulse, Impulse, Real and complex exponentials and Sinusoids – Classification of signals – Continuous time (CT) and Discrete Time (DT) signals, Periodic & Aperiodic signals, Deterministic & Random signals, Energy & Power signals – Classification of systems – CT systems and DT systems – Linear & Nonlinear, Time-variant & Time-invariant, Causal & Non-causal, Stable & Unstable.

UNIT II ANALYSIS OF CONTINUOUS TIME SIGNALS 9

Fourier series for periodic signals – Fourier Transform – properties – Laplace Transforms and properties.

UNIT III LINEAR TIME INVARIANT CONTINUOUS TIME SYSTEMS 9

Impulse response – convolution integrals- Differential Equation- Fourier and Laplace transforms in Analysis of CT systems – Systems connected in series / parallel.

UNIT IV ANALYSIS OF DISCRETE TIME SIGNALS 9

Baseband signal Sampling – Fourier Transform of discrete time signals (DTFT) – Properties of DTFT – Z Transform & Properties.

UNIT V LINEAR TIME INVARIANT-DISCRETE TIME SYSTEMS 9

Impulse response – Difference equations-Convolution sum– Discrete Fourier Transform and Z Transform Analysis of Recursive & Non-Recursive systems – DT systems connected in series and parallel.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Analyze continuous-time and discrete-time signals using mathematical techniques (Fourier series, Fourier transform, Laplace transform, z-transform).
- **CO2:** Explain display systems and human-machine interfaces.
- **CO3:** Apply signal processing concepts to real-world problems (image processing, communication systems, control systems).
- **CO4:** Design and analyze linear time-invariant (LTI) systems.
- **CO5:** Implement digital signal processing algorithms using programming languages (e.g., MATLAB, Python) and analyze their performance.
- **CO6:** Evaluate the trade-offs between signal processing system design parameters (e.g., accuracy, speed, complexity, power consumption) and optimize system design for specific applications.

TEXT BOOKS:

1. Signals and Systems by Oppenheim and Willsky, Prentice Hall, 2019.
2. Signals and Systems: A MATLAB Integrated Approach by C. H. Houpis and G. J. Thaler, Wiley, 2018.
3. Discrete-Time Signal Processing by Oppenheim and Schafer, Prentice Hall, 2010..

REFERENCE BOOKS:

1. The Fourier Transform and Its Applications by R. N. Bracewell. McGraw-Hill, 2000.
2. Digital Signal Processing: A Computer-Based Approach by S. K. Mitra, McGraw-Hill, 2011.

U23AEV43	GUIDANCE AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To learn about the aircraft equations of motion and method of linearization.
2. To learn about the operating principle of guidance law.
3. To study about the augmentation systems.
4. To study longitudinal stability and to design the longitudinal autopilot.
5. To study lateral stability and to design the lateral autopilot.

UNIT I INTRODUCTION **9**

Introduction to Guidance and control - Definition, Historical background – Coordinate Frame - Equations of motion – Linearization.

UNIT II AUGMENTATION SYSTEMS **9**

Need for automatic flight control systems, Stability augmentation systems, control augmentation systems, Design of Limited authority and Full Authority Augmentation systems - Gain scheduling concepts.

UNIT III LONGITUDINAL AUTOPILOT **9**

Displacement Autopilot -Pitch Orientation Control system, Acceleration Control System, Glide Slope Coupler and Automatic Flare Control and Flight path stabilization, Longitudinal control law design using back stepping algorithm.

UNIT IV LATERAL AUTOPILOT **9**

Damping of the Dutch Roll, Methods of Obtaining Coordination, Yaw Orientation Control system, turn compensation, Automatic lateral Beam Guidance. Introduction to Fly-by-wire flight control systems, Lateral control law design using back stepping algorithm.

UNIT V MISSILE AND LAUNCH VEHICLE GUIDANCE **9**

Operating principles and design of guidance laws, homing guidance laws- short range, Medium range and BVR missiles, Launch Vehicle- Introduction, Mission requirements, Implicit guidance schemes, Explicit guidance, Q guidance schemes.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Explain the equations governing the aircraft dynamics and the process of linearizing them.

CO2: Define the various guidance schemes and requirements for aircrafts and missiles.

CO3: Apply the principle of stability and control augmentation systems.

CO4: Analyse the oscillatory modes and methods of suppressing them.

CO5: Design the controller for lateral, longitudinal and directional control of aircrafts.

CO6: Evaluate and compare the performance of different autopilot systems and control laws (e.g., PID, LQR, pole placement) for various flight regimes and conditions, and assess their robustness and stability.

TEXT BOOKS:

1. Automatic Control of Aircraft and Missiles, 2nd Ed., by Blakelock, J. H., John Wiley & Sons, 1990.
2. Introduction to Avionics, by Collinson R.P.G, Chapman and Hall, India, 1996.
3. Guided Weapon control systems, by Garnel. P. & East. D. J, Pergamon Press, Oxford, 1977.

REFERENCE BOOKS:

1. Flight Dynamics Principles: A Linear Systems Approach to Aircraft Stability and Control by Michael V. Cook, Elsevier, 2010.
2. Flight stability & Automatic Control, by Nelson R.C, McGraw Hill, 1989.
3. Fundamentals of Aerospace Navigation and Guidance, by Pierre T. Kabamba and Anouck R. Girard, Cambridge University press, 2014.

U23AEV44 NAVIGATION AND COMMUNICATION SYSTEM L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To introduce various types of navigation systems.
2. To understand the dead reckoning navigation system and its error correction.
3. To know satellite navigation and hybrid navigation system integration.
4. To learn the concepts of radio transmitters and receivers.
5. To acquire knowledge about weather radar systems and DME.

UNIT I INERTIAL NAVIGATION SYSTEMS 9

Introduction to navigation – Types -INS components- transfer function and errors - Earth in inertial space - Coriolis Effect – INS Mechanization. Platform and Strap down – Navigation algorithms - INS system block diagram, Different co-ordinate systems – Transformation Techniques - Schuler Tuning – compensation errors - Gimbal lock - Initial calibration and Alignment Algorithms.

UNIT II RADIO NAVIATION & SATELLITE NAVIGATION 9

Different types of radio navigation- ADF, VOR, DME - Doppler – Hyperbolic Navigations - LORAN, DECCA and Omega – TACAN. Introduction to GPS -system description -basic principles -position and velocity determination signal Structure -DGPS, Introduction to Kalman filtering-Estimation and mixed mode navigation Integration of GPS and INS-utilization of navigation systems in aircraft.

UNIT III RADIO TRANSMITTERS AND RECEIVERS 9

Functions of a Radio transmitter, Microphones, types, Block diagram explanation of a Radio transmitter, Modulation and its types and Antenna, Antenna couplers, Qualities of a good Radio receiver, Block diagram of a simple radio receiver and super heterodyne receiver.

UNIT IV AIRCRAFT COMMUNICATION SYSTEMS 9

Basics of aircraft communication system, types Very High Frequency Communication system, Description, Principle, Operation of VHF Communication system and its layout on aircraft, High Frequency communication system, Description, Principle and operation of High Frequency communication system and its layout on aircraft. Satellite communication system, Description, Operation and its layout on aircraft.

UNIT V WEATHER RADAR SYSTEM AND DME 9

Introduction, Description and types of Radar, Primary and Secondary Radar, Weather Radar Description, Analog radar Principal units of Analog radar system. Aircraft weather radar, transmitter-receiver, Indicator, Control panel, Antenna, Radome and wave guide. Radome maintenance and radar safety.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Explain the fundamental principles and components of inertial navigation systems (INS), radio navigation, and satellite navigation systems.
- **CO2:** Identify various types of radio navigation.
- **CO3:** Understand the architecture of radio transmitters and receivers, including modulation techniques, antenna systems, and receiver characteristics.
- **CO4:** Evaluate the performance and limitations of various aircraft communication systems, including VHF, HF, and satellite communication systems, and explain their installation and maintenance requirements.
- **CO5:** Have knowledge of radar systems, including weather radar, primary and secondary radar, and aircraft weather radar systems.
- **CO6:** Integrate knowledge of navigation, communication, and radar systems to design and evaluate aircraft avionics systems, considering factors such as system performance, safety, and regulatory requirements.

TEXT BOOKS:

1. Avionics Navigation Systems by Myron Kayton and Walter R. Fried, 2nd edition, 2005.
2. Aircraft Communications and Navigation Systems by Mike Tooley and David Wyatt, 2nd edition, 2010.
3. Radar Systems by Merrill Ivan Skolnik, 3rd edition, 2001.
4. Inertial Navigation Systems by Jay A. Farrell, 1st edition, 2008.

REFERENCE BOOKS:

1. Aircraft Electricity and electronics by Thomas K Eismin (Fifth edition), McGraw- Hill Book Co., 1994.
2. Aircraft Radio system by James Powell, Sterling book house, Mumbai, Indian edition - 2006.
3. Aircraft Communications and Navigation systems by Mike Tooley and David Wyatt, Reed Elsevier, India, Noida, Edition, 2007.

U23AEV45	DESIGN OF UAV SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To introduce the basic concepts of unmanned aerial vehicles.
2. To make students familiarize with the design aspects of UAV.
3. To impart knowledge on the hardware components and their application in the UAV systems.
4. To infer about the communication and control detail of UAV.
5. To introduce the basic operational futures of UAV systems.

UNIT I INTRODUCTION TO UAV 9

History of UAV –classification – Introduction to Unmanned Aircraft Systems--models and prototypes –System Composition-applications.

UNIT II THE DESIGN OF UAV SYSTEMS 9

Introduction to Design and Selection of the System- Aerodynamics and Airframe Configurations Characteristics of Aircraft Types- Design Standards and Regulatory Aspects-UK,USA and Europe Design for Stealth--control surfaces-specifications

UNIT III AVIONICS HARDWARE 9

Autopilot – AGL-pressure sensors-servos-accelerometer –gyros-actuators- power supply-processor, integration, installation, configuration, and testing.

UNIT IV COMMUNICATION PAYLOADS AND CONTROLS 9

Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequency range –modems-memory system-simulation-ground test-analysis-trouble shooting.

UNIT V THE DEVELOPMENT OF UAV SYSTEMS 9

Waypoints navigation-ground control software- System Ground Testing- System In-flight Testing Future Prospects and Challenges-Case Studies – Mini and Micro UAV.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Acquire knowledge on the importance of UAVs with respect to their applications.
- **CO2:** Identify and distinguish between various subsystems and configurations of UAV.
- **CO3:** Perform ground test and troubleshooting with respect to UAV operation.
- **CO4:** Distinguish between needs of mini and micro UAVs.
- **CO5:** Gain insights with design standards and regulatory aspects of UAVs.
- **CO6:** Design and develop a UAV system, including selecting and integrating components, configuring the autopilot system, and testing and validating the overall system performance, while ensuring compliance with relevant regulations and safety standards.

TEXT BOOKS:

1. Introduction to UAV Systems, by Paul G Fahlstrom and Thomas J Gleason, UAV Systems, Inc, 1998.
2. Unmanned Aircraft Systems: UAV design, development and deployment, by Reg Austin Wiley, 2010.

REFERENCE BOOKS:

1. Design of Unmanned Air Vehicle Systems, by Armand J. Chaput ,Lockheed Martin Aeronautics Company, 2001.
2. Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy, by Kimon P. Valavanis, Springer, 2007.
3. Flight Stability and Automatic Control, by Robert C. Nelson, McGraw-Hill, Inc, 1998.

U23AEV46	AERODYNAMICS OF DRONES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To introduce students to the basic concepts of payloads in UAV.
2. To understand the various sensor system of an UAV.
3. To introduce with the concepts of data algorithms and architectures.
4. To introduce the concepts of artificial neural networks.
5. To expose students to the concept of fuzzy logic.

UNIT I PAYLOAD FOR UAV 9

Introduction – Types – Non-dispensable Payloads - Electro-optic Payload Systems - Electro-optic Systems Integration - Radar Imaging Payloads - Other Non-dispensable Payloads - Dispensable Payloads - Payload Development.

UNIT II SENSOR 9

Data fusion applications to multiple sensor systems - Selection of sensors - Benefits of multiple sensor systems - Influence of wavelength on atmospheric attenuation - Fog characterization - Effects of operating frequency on MMW sensor performance - Absorption of MMW energy in rain and fog - Backscatter of MMW energy from rain - Effects of operating wavelength on IR sensor performance - Visibility metrics - Atmospheric and sensor system computer simulation models.

UNIT III DATA FUSION ALGORITHMS AND ARCHITECTURES 9

Definition of data fusion - Level 1 processing - Detection, classification, and identification algorithms for data fusion - State estimation and tracking algorithms for data fusion - Level 2, 3, and 4 processing - Data fusion processor functions - Definition of an architecture - Data fusion architectures - Sensor-level fusion - Central-level fusion - Hybrid fusion.

UNIT IV ARTIFICIAL NEURAL NETWORKS 9

Applications of artificial neural networks - Adaptive linear combiner - Linear classifiers - Capacity of linear classifiers - Nonlinear classifiers - Madeline - Feedforward network - Capacity of nonlinear classifiers - Supervised and unsupervised learning - Supervised learning rules - Voting Logic Fusion.

UNIT V FUZZY LOGIC AND FUZZY NEURAL NETWORKS 9

Conditions under which fuzzy logic provides an appropriate solution - Illustration of fuzzy logic in an automobile antilock braking system - Basic elements of a fuzzy system - Fuzzy logic processing-Fuzzy centroid calculation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

At the end of the course the students would be able to have:

- **CO1:** Calculate the payloads in UAV.
- **CO2:** Explain the concepts sensor systems.
- **CO3:** Predict the data fusion algorithms and architectures.
- **CO4:** Learn the basics neural network systems.
- **CO5:** Design various network schemes.
- **CO6:** Develop and implement machine learning-based techniques for UAV applications, such as object detection, tracking, and classification, using sensor data fusion and neural network architectures, and evaluate their performance and efficiency.

TEXT BOOKS:

1. Unmanned aircraft systems UAVs design, development and deployment, by Reg Austin Aeronautical Consultant, AJohn , Wiley and Sons, Ltd., Publication,2010.
2. Mathematical Techniques in Multi-sensor Data Fusion, by David L. Hall, Sonya A. H. McMullen, Artech, 2004.
3. Handbook of Multisensor Data Fusion: Theory and Practice, by Martin Liggins II David Hall, James, Second Edition (Electrical Engineering & Applied Signal Processing Series), 2008.

REFERENCE BOOKS:

1. Sensor and Data Fusion: A Tool for Information Assessment and Decision Making, by Lawrence A. Klein, Second Edition, SPIE Press, 2013.
2. Multi-Sensor Data Fusion with MATLAB, by Jitendra R. Raol, CRC Press, 2010.

VERTICALS V
PROFESSIONAL ELECTIVE V

U23AEV51	AIRFRAME MAINTENANCE AND REPAIR	L	T	P	C
		3	0	0	3

COURSE OBJECTIVE:

1. To make the students to understand the Airframe components and the tools used to maintain the components. Defect investigation, methods to carry out investigation and the detailed maintenance and practice procedures.

UNIT I MAINTENANCE OF AIRCRAFT STRUCTURAL COMPONENTS 9

Equipment's used in welding shop and their maintenance - Ensuring quality welds - Welding jigs and fixtures - Soldering and brazing – laser welding. Sheet metal repair and maintenance: Selection of materials; Repair schemes; Fabrication of replacement patches; Tools - power/hand; Repair techniques; Peening - Close tolerance fasteners; Sealing compounds; forming/shaping; Calculation of weight of completed repair; Effect of weight - change on surrounding structure. Sheet metal inspection - N.D.T. Riveted repair design - Damage investigation - Reverse engineering.

UNIT II PLASTICS AND COMPOSITES IN AIRCRAFT 9

Review of types of plastics used in airplanes - Maintenance and repair of plastic components - Repair of cracks and holes - various repairs schemes - Scopes. Cleaning of fibre reinforced plastic (FRP) materials prior to repair; Break test - Repair Schemes; FRP/honeycomb sandwich materials; laminated FRP structural members and skin panels; Tools/equipment; Vacuum-bag process. Special precautions – Autoclaves.

UNIT III AIRCRAFT JACKING, ASSEMBLY AND RIGGING 9

Airplane jacking and weighing and C.G. Location. Balancing of control surfaces – Inspection maintenance. Helicopter flight controls. Tracking and balancing of main rotor.

UNIT IV REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM 9

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. Inspection and maintenance of auxiliary systems - Rain removal system - Position and warning system - Auxiliary Power Units (APUs).

UNIT V SAFETY PRACTICES 9

Hazardous materials storage and handling, Aircraft furnishing practices - Equipments. Trouble shooting. Theory and practices.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Identify and apply the principles of function and safe operation to aircraft as per FAA.
- **CO2:** Describe general airframe structural repairs, the structural repair manual and structural control programme.
- **CO3:** Explain the nature of airframe structural component inspection, corrosion repair and non-destructive inspection
- **CO4:** Evaluate aircraft component disassembly, reassembly and troubleshooting
- **CO5:** Identify, install, inspect, fabricate and repair aircraft sheet metal and synthetic, material structures
- **CO6:** Create maintenance schedules for aircraft structural components, including periodic inspections and preventive measures

TEXT BOOKS:

1. Kroes, Watkins, Delp, "Aircraft Maintenance and Repair", McGraw Hill, New York, 1993.
2. Larry Reithmeir, "Aircraft Repair Manual", Palamar Books, Marquette, 1992.

REFERENCE BOOKS:

1. Brimm D.J. Bogges H.E., "Aircraft Maintenance", Pitman Publishing corp., New York, 1994.
2. Delp. Bent and Mckinely “Aircraft Maintenance Repair”, McGraw Hill, New York, 1998.

U23AEV52	AIRCRAFT GENERAL ENGINEERING AND MAINTENANCE PRACTICES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To carryout aircraft ground handling procedure.
2. To understand about the ground servicing of the various aircraft subsystem
3. To understand the procedure of aircraft system maintenance and safety.
4. To understand the importance of periodic inspection of aircraft.
5. To understand the specification of aircraft hardware components and its materials.

UNIT I AIRCRAFT GROUND HANDLING AND SUPPORT EQUIPMENT 9

Mooring, jacking, leveling and towing operations – Preparation – Equipment – precautions – Engine starting procedures – Piston engine, turboprops and turbojets – Engine fire extinguishing – Ground power unit.

UNIT II GROUND SERVICING OF VARIOUS SUB SYSTEMS 9

Air conditioning and pressurization – Oxygen and oil systems – Ground units and their maintenance.

UNIT III MAINTENANCE OF SAFETY AND AIRCRAFT SYSTEM PROCESSES 9

Shop safety – Environmental cleanliness – Precautions- Hand tools – Precision instruments – Special tools and equipment in an airplane maintenance shop – Identification terminology

UNIT IV INSPECTION 9

Process – Purpose – Types – Inspection intervals – Techniques – Checklist – Special inspection – Publications, bulletins, various manuals – FAR Air worthiness directives – Type certificate Data sheets – ATA Specifications

UNIT V AIRCRAFT HARDWARE, MATERIALS, SYSTEM PROCESSES 9

Specification and correct use of various aircraft hardware (i.e. nuts, bolts, rivets, screws) – American and British systems of specifications – Threads, gears, bearings, – Drills, tapes and reamers – Identification of all types of fluid line fittings. Materials, metallic and non-metallic Plumbing connectors – Cables – Swaging procedures, tests, Advantages of swaging over splicing.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Explain the various ground support systems for aircraft operations.
CO2: Illustrate the ground servicing of critical aircraft systems.
CO3: Inspect the aircraft by considering the FAA airworthiness regulations and the check list.
CO4: Apply the maintenance procedures to the aircraft subsystem and equipment.
CO5: Explain the functions of various aircraft systems, including airframe, engines, electrical, hydraulic, and avionics systems.
CO6: Apply The Aircraft Maintenance Processes.

TEXT BOOKS:

1. Kroes, Watkins, Delp, "Aircraft Maintenance and Repair", McGraw Hill, New York, 1993.
2. Cliff Matthews, “Aeronautical Engineer’s Data Book”, Elsevier Science, Oxford, 2001.

REFERENCE BOOKS:

1. A&P Mechanics, "Aircraft Hand Book", F A A Himalayan Book House, New Delhi, 1996.
2. A&P Mechanics," General Hand Book", F A A Himalayan Bok House, New Delhi, 1996.

U23AEV53	CIVIL AVIATION REGULATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To understand the requirement of airworthiness certification in civil aircraft.
2. To understand how to record the various data for future investigation in civil aircraft.
3. To know the basic requirements and knowledge for institution certification.
4. To provide basic knowledge of eligibility and requirements for maintenance licensing.
5. To explore the various flight testing and basic requirements for safe flying.

UNIT I C.A. R SERIES 'A' - PROCEDURE FOR CIVIL AIR WORTHINESS QUIRMENTS AND ESPONSIBILITY OPERATORS VIS-À-VIS AIR WORTHINESS RECTORATE 9

To introduce the civil aviation regulations followed by directorate general of civil aviation. Module I c.a.r series 'a' - procedure for civil air worthiness requirements and responsibility operators vis-à-vis air worthiness directorate.

UNIT II C.A.R. SERIES 'C' - DEFECT RECORDING, MONITORING, INVESTIGATION AND REPORTING 9

Defect recording, reporting, investigation, rectification and analysis; flight report; reporting and rectification of defects observed on aircraft; analytical study of in-fight readings & recordings; maintenance control by reliability method. C.A.R. SERIES 'D' - AND AIRCRAFT MAINTENANCE PROGRAMMES: reliability programme (engines); aircraft maintenance programme & their approval; on condition maintenance of reciprocating engines; TBO - revision programme; maintenance of fuel and oil uplift and consumption records - light aircraft engines; fixing routine maintenance Total Hours and component tbos initial & revisions.

UNIT III C.A.R. SERIES 'E' - APPROVAL OF ORGANISATIONS 9

Approval of organizations in categories A, B, C, D, E, F, & G; requirements of infrastructure at stations other than parent base. C.A.R. SERIES 'F' - AIR WORTHINESS AND CONTINUED AIR WORTHINESS: Procedure relating to registration of aircraft; procedure for issue / revalidation of type certificate of aircraft and its engines / propeller; issue / revalidation of certificate of airworthiness; requirements for renewal of certificate of airworthiness.

UNIT IV C.A.R. SERIES 'L' - AIRCRAFT MAINTENANCE ENGINEER LICENSING 9

Issue of AME license, its classification and experience requirements, complete Series 'L'. C.A.R. SERIES 'M' MANDATORY MODIFICATIONS AND INSPECTIONS: mandatory modifications / inspections. Procedure for issue of type approval of aircraft components and equipment including instruments.

UNIT V C.A.R. SERIES 'T' - FLIGHT TESTING OF AIRCRAFT 9

Flight testing of (series) aircraft for issue of C of A; fight testing of aircraft for which C or A had been previously issued. C.A.R. SERIES 'X' MISCELLANEOUS REQUIREMENTS: Registration Markings of aircraft; weight and balance control of an aircraft; provision of first aid kits & Physician's kit in an aircraft; use furnishing materials in an aircraft; concessions. Aircraft log books; document to be carried on board on Indian registered aircraft; procedure for issue of taxy permit.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Explain the maintenance requirement for airworthiness of aircraft and systems.
- **CO2:** Describe the procedure followed for airworthiness certificate.
- **CO3:** Describe the Airworthiness procedures based on Regulation Authorities.
- **CO4:** Explain the issuance, renewal and experience requirements of AMEs.
- **CO5:** Classify about the Flight Testing of aircraft.
- **CO6:** Apply the knowledge of CARs to real-world scenarios and demonstrate an understanding of the regulatory framework governing the aviation industry.

TEXT BOOKS:

1. " Aircraft Manual (India) ", Volume - Latest Edition, The English Book Store, 171, Connaught Circus, New Delhi."
2. Civil Aviation Requirements with latest Amendment (Section 2 Airworthiness) Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi. "

REFERENCE BOOKS:

1. Aeronautical Information Circulars (relating to Airworthiness) ", from DGCA."
2. Advisory Circulars ", form DGCA. as Managers – Consulting Engineers as Expert Witnesses and Advisors – Honesty – Moral Leadership Sample Code of Conduct.

U23AEV54 AIRCRAFT ENGINE MAINTENANCE AND REPAIR L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To make the students to familiarize with the Aircraft engine maintenance procedure and practice.
2. To acquire knowledge of basics of Aeronautics and engine components.
3. To learn the concepts of Piston engines.
4. To make students aware of aircraft propellers and repair.
5. To make students aware of aircraft jet engines and repair.

UNIT I PISTON ENGINES 9

Carburation and Fuel injection systems for small and large engines - Ignition system components - spark plug detail - Engine operating conditions at various altitudes – Engine power measurements–Classification of engine lubricants and fuels – Induction, Exhaust and cooling system - Maintenance and inspection check to be carried out. Inspection and maintenance and troubleshooting - Inspection of all engine components - Daily and routine checks – Overhaul procedures - Compression testing of cylinders - Special inspection schedules - Engine fuel, control and exhaust systems - Engine mount and super charger - Checks and inspection procedures.

UNIT II PROPELLERS 9

Propeller theory - operation, construction assembly and installation - Pitch change mechanism- Propeller axially system- Damage and repair criteria - General Inspection procedures - Checks on constant speed propellers - Pitch setting, Propeller Balancing, Blade cuffs, Governor/Propeller operating conditions – Damage and repair criteria.

UNIT III JET ENGINES 9

Types of jet engines – Fundamental principles – Bearings and seals - Inlets – compressors turbines- exhaust section – classification and types of lubrication and fuels- Materials used – Details of control, starting around running and operating procedures – Inspection and Maintenance- permissible limits of damage and repair criteria of engine components- internal inspection of engines- compressor washing- field balancing of compressor fans- Component maintenance procedures - Systems maintenance procedures - use of instruments for online maintenance - Special inspection procedures-Foreign Object Damage - Blade damage.

UNIT IV TESTING AND INSPECTION 9

Symptoms of failure - Fault diagnostics - Case studies of different engine systems – Rectification during testing equipments for overhaul: Tools and equipments requirements for various checks and alignment during overhauling - Tools for inspection - Tools for safety and for visual inspection- Methods and instruments for non-destructive testing techniques - Equipment for replacement of parts and their repair. Engine testing: Engine testing procedures and schedule preparation – Online maintenance.

UNIT V OVERHAULING 9

Engine Overhaul - Overhaul procedures - Inspections and cleaning of components – Repairs schedules for overhaul - Balancing of Gas turbine components. Trouble Shooting: Procedures for trouble shooting - Condition monitoring of the engine on ground and at altitude - engine health monitoring and corrective methods.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Apply maintenance procedure to Aircraft Engines.
- **CO2:** Identify the engine components and faults.
- **CO3:** Apply non-destructive testing procedures to identify the defects.
- **CO4:** Apply overhauling procedure to new engines.
- **CO5:** Apply the compression testing of cylinders.
- **CO6:** Troubleshoot and repair engine systems and components using manufacturer's instructions and industry standards.

TEXT BOOKS:

1. Kroes & Wild, "Aircraft Power plants ", 7th Edition - McGraw Hill, New York, 1994.
2. Delp, Frank, and Kroes, “Aircraft Maintenance and Repair”, 7th edition, McGraw Hill Education, 2017.

REFERENCE BOOKS:

1. Turbomeca, “Gas Turbine Engines ", The English Book Store ", New Delhi, 1993.
2. United Technologies’ Pratt & Whitney, "The Aircraft Gas Turbine Engine and its Operation”, The English Book Store, New Delhi.

U23AEV55	AIR TRAFFIC CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To introduce the basic of air traffic control.
2. To impart knowledge about air traffic systems.
3. To gain more knowledge on flight information systems.
4. To learn about aerodrome data.
5. To gain knowledge on navigation systems.

UNIT I BASIC CONCEPTS 9

Objectives of air traffic control systems - Parts of ATC services – Scope and Provision of ATCs – VFR & IFR operations – Classification of ATS air spaces – Various kinds of separation – Altimeter setting procedures – Establishment, designation and identification of units providing ATS – Division of responsibility of control.

UNIT II AIR TRAFFIC SYSTEMS 9

Area control service, assignment of cruising levels - minimum flight altitude - ATS routes and significant points – RNAV and RNP – Vertical, lateral and longitudinal separations based on time / distance –ATC clearances – Flight plans – position report.

UNIT III FLIGHT INFORMATION SYSTEMS 9

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 co-ordination between radar / non radar control – emergencies – Flight information and advisory service – Alerting service – Co-ordination and emergency procedures – Rules of the air.

UNIT IV AERODROME DATA 9

Aerodrome data - Basic terminology – 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.

UNIT V NAVIGATION AND OTHER SERVICES 9

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 – VASI & PAPI - Visual aids for denoting obstacles; object to be marked and lighter – Emergency and other services.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Classify the requirement of air traffic control systems and types of air traffic control system.
- **CO2:** Explain in flight information systems and rules of air traffic systems.
- **CO3:** Explore the emergency procedure and air rules followed by air traffic control systems.
- **CO4:** Describe the aerodrome data.
- **CO5:** Gain the information of navigation and emergency procedures in the air traffic control systems.
- **CO6:** Analyze the application of air traffic control systems in various weather conditions and evaluate the impact of weather on air traffic management.

TEXT BOOKS:

1. AIP (India) Vol. I & II, "The English Book Store", 17-1, Connaught Place, New Delhi.
2. "Aircraft Manual (India) Volume I", Latest Edition – The English Book Store, 17-1, Connaught Place, New Delhi.

REFERENCE BOOKS:

1. PANS – RAC – ICAO DOC 4444", Latest Edition, The English Book Store, 17-1, Connaught Place, New Delhi.
2. Michael S. Nolan., "Fundamentals of Air Traffic Control", Cengage Learning.
3. Wells .A-Airport Planning and Management, 4th Edition- McGraw-Hill, London-2000.
4. P S Senguttuvaan., "Fundamentals of Air Transport Management", McGraw-Hill, 2003.

U23AEV56	AIRPORT MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To acquire solid background of managerial skills in airport management.
2. To develop personality to face business difficulties.
3. To control multicultural conditions.
4. To identify the relevant analytical and logical skills to deal with problems in the airline industry.
5. To learn the concepts of performing well in teams, professionalism, and the knowledge acquired in the field of airport planning, airport security, passengers forecasting, aerodromes work etc.

UNIT I INTRODUCTION 9

History of Aviation- Organization, Global, Social, & Ethical Environment- History of Aviation in India- Major Players in the Airline Industry- SWOT Analysis of the Different Airline Companies in India- Market Potential of Airline Industry in India- New Airport Development Plans- Current Challenges in the Airline Industry- Competition in the Airline Industry- Domestic and International airlines from Indian Perspective.

UNIT II AIRPORT INFRASTRUCTURE AND MANAGEMENT 9

Airport planning - terminal planning design and operation - airport operations - airport functions - organisation structure in an airline - airport authority of india comparison of global and indian airport management-role of aai -airline privatisation - full privatisation-gradual privatisation - partial privatisation.

UNIT III AIR TRANSPORT SERVICES 9

Various airport services - international air transport services - indian scenario - an overview of airports in delhi, mumbai, hyderabad and bangalore - the role of private operators - airport development fees, rates, tariffs.

UNIT IV INSTITUTIONAL FRAMEWORK 9

Role of dgca slot allocation methodology followed by atc and dgca-management of bilaterals - economic regulations.

UNIT V CONTROLLING 9

Role of air traffic control - airspace and navigational aids - control process-case studies in airline industry- mumbaidelhi airport privatisation - navimumbai airport tendering process - 6 cases in the airline industry.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Interpret business difficulties.
- **CO2:** Dissect multicultural conditions.
- **CO3:** Identify and apply the relevant analytical and logical skills to deal with problems in the airline industry.
- **CO4:** Develop well in teams, professionalism etc.
- **CO5:** Apply the knowledge acquired in the field of airport planning, airport security, passengers forecasting, aerodromes work etc.
- **CO6:** Develop strategic solutions to manage airline operations, including crisis management, risk assessment, and decision-making, to ensure efficient and effective airline management.

TEXT BOOKS:

1. Graham. A. Managing airports: an international perspective-Butterworth-Heinemann, oxford 2001.
2. Wells. A. Airport planning and management, 4th edition McGraw-Hill, London 2000.

REFERENCE BOOKS:

1. Doganis R. The airport business routledge, London 1992.
2. Alexander t. Wells, seth young, principles of airport management, McGraw hill 2003.
3. Ps senguttavan fundamentals of air transport management, excel books 2007.
4. Richard de neufille, airport systems: planning, design and management, McGraw-Hill London 2007.
5. Manual of aerodrome licensing of aai airports-aai website-freely downloadable - issue may 2010.

VERTICALS VI
PROFESSIONAL ELECTIVE VI

U23AEV61 DESIGN OF GAS TURBINE ENGINE COMPONENTS L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To introduce basic design concepts of jet engine and estimation of required thrust to students.
2. To make students familiarize with the design parameter and off design calculations.
3. To give the students adequate exposure to design procedure to the rotating components of engine such as compressor and turbine along with staging.
4. To make the students learn the aspects of combustion processes, flame stabilization issue, igniters design and NOx controls.
5. To make students familiarize with the concept of design inlet and nozzle for various on - off design conditions.

UNIT I GAS TURBINE ENGINE DESIGN FUNDAMENTALS 9

Design Process- compressible flow relationship; Constraint Analysis - Concept-Design tools-preliminary estimates; Mission analysis - Aircraft weight and fuel consumption data-Example problems on Constrain analysis, Mission analysis.

UNIT II ON-DESIGN AND OFF-DESING PARAMETRIC ANALYSIS 9

Total and static properties-corrected mass flow rate-Engine Cycle Design- One-Dimensional Through flow Area-Flow path force on components- aircraft constraint analysis, aircraft mission analysis, engine parametric (design point) analysis, engine performance (off-design) analysis, engine installation drag and sizing.

UNIT III DESIGN OF ROTATING COMPONENTS 9

Fan and Compressor Aerodynamics-Diffusion factor-Aerofoil geometry-Flow path dimension-Radial variation-Turbine Aerodynamics- Constant axial velocity-adiabatic-selected Mach number-Mean line stage Design-stage pressure ratio-Airfoil geometry-radial variation-turbine cooling-range of turbine parameters-Engine life-Design Example –for fan-compressor-turbine.

UNIT IV COMBUSTION CHAMBER DESIGN 9

Design: Combustion system components- Combustion- Chemical reactor theory. Combustor Stability map-Stirring and mixing-Total pressure loss-Fuels-Ignition-Combustion Systems of Main Burner Design: Air partitioning- Main burner component Design: Diffuser-types of burner-inner and outer casing design-Fuel nozzle-Dome and liner-Primary zone- swirler-Secondary holes- Dilution holes-Transition duct-Design of Afterburners-Design parameters-Diffuser-Fuel injection- Ignition-Flame stabilization – Flame spread and after burner length – Examples design calculation.

UNIT V INLET AND NOZZLE DESIGN 9

Inlets and Exhaust Nozzles Design: Elements of a Successful Inlet-Engine Integration Program-Definition of Subsonic Inlet-Engine Operational Requirements- Definition of Supersonic Inlet-Engine Operational Requirements- Engine Impact on Inlet Design- Inlet Impact on Engine Design-Validation of Inlet-Engine System-Exhaust nozzle design-Nozzle types and their design -Jet control methods for reduction of infrared signature.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Do preliminary weight and fuel estimation for an aircraft mission.
- **CO2:** Identify variation in parametric analysis of ON and OFF design calculations.
- **CO3:** Explain the principle design of compressor and turbine and selection of suitable materials.
- **CO4:** Estimate the total pressure losses and able to predict ignition delay.
- **CO5:** Determine the basic design factors affects ON and OFF design operation of inlets and nozzle on engine performance.
- **CO6:** Analyze and optimize the performance of an aircraft engine system, considering factors such as thrust, efficiency, and environmental impact, to meet specific mission requirements.

TEXT BOOKS:

1. Mattingly J.D., Heiser, W.H. and Pratt D.T, 'Aircraft Engine Design', 2nd Edition, AIA Education Series, AIAA, 2002.
2. Oates G.C.,' Aircraft Propulsion Systems Technology and Design',1989, AIAA Education Series.
3. Saravanamuttoo H.I.H and Rogers, G.F.C. "Gas Turbine Technology", Pearso Education Canada; 6th edition, 2008.

REFERENCE BOOKS:

1. Cumpsty N., "Jet Propulsion: A Simple Guide to the Aerodynamics and Thermodynamic Design and Performance of Jet Engines" , Cambridge University Press; 2nd edition, 200
2. Murthy S.N. and Curran E.T.,' High-Speed Flight Propulsion Systems', Volume 137, Progress in Astronautics and Aeronautics, AIAA,1991.
3. Rathakrishnan E, 'Applied Gas Dynamics, John Wiley & Sons (Asia) Pvt Ltd, 2010.
4. Treage I.E, Aircraft Gas Turbine Engine Technology, 3rd edition, Glencoe McGraw-Hil Inc. 1995.

U23AEV62	VIBRATION AND AERO ELASTICITY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To study the effect of time dependent forces on mechanical systems and to get the natural characteristics of system of single degree of freedom system.
2. To study the solving methods of multi degree of freedom systems.
3. To introduce the approximate methods to solve vibration problems.
4. To make the student to understand the solving techniques of vibration of continuous system.
5. To study the aeroelastic effects of aircraft wings.

UNIT I SINGLE DEGREE OF FREEDOM SYSTEMS 9

Introduction to simple harmonic motion, D'Alembert's principle, free vibrations – damped vibrations–forced vibrations, with and without damping – support excitation – transmissibility - vibration measuring instruments.

UNIT II MULTI DEGREE OF FREEDOM SYSTEMS 9

Two degrees of freedom systems - static and dynamic couplings - vibration absorber- Multi degree of freedom systems - principal co-ordinates - principal modes and orthogonal conditions - Eigen value problems - Hamilton's principle - Lagrangean equations and application.

UNIT III CONTINUOUS SYSTEMS 9

Vibration of elastic bodies - Vibration of strings – longitudinal, lateral and torsional vibrations.

UNIT IV APPROXIMATE METHODS 9

Approximate methods - Rayleigh's method - Dunkerley's method – Rayleigh-Ritz method- Holzer method - Matrix iteration method.

UNIT V ELEMENTS OF AEROELASTICITY 9

Vibration due to coupling of bending and torsion - aeroelastic problems - Collars triangle - wing divergence - aileron control reversal – flutter – buffeting – Elements of servo elasticity.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Solve single and multi-degree vibrating systems.
CO2: Distinguish types of vibrations according to dampness and particle motion.
CO3: Solve the different numerical methods to solve continuous system.
CO4: Solve approximate methods to find natural frequency of a system.
CO5: Examine Collars Triangle and Aero Elastic Problems.
CO6: Examine the effect of Aileron reversal, flutter and wing divergence.

TEXT BOOKS:

1. Grover. G.K., “Mechanical Vibrations”, 7th Edition, Nem Chand Brothers, Roorkee, India, 2003.
2. Leonard Meirovitch, "Elements of Vibration Analysis". McGraw Hill International Edition, 2007.
3. Thomson W T, ‘Theory of Vibration with Application’ - CBS Publishers, 1990.

REFERENCE BOOKS:

1. Bisplinghoff R.L., Ashely H and Hogman R.L., "Aeroelasticity", Addision Wesley Publication, New Tork, 1983.
2. Den Hartog, "Mechanical Vibrations" Crastre Press, 2008.
3. TSE. F.S., Morse, I.F., Hinkle, R.T., "Mechanical Vibrations" – Prentice Hall, New York, 1984.
4. William W Seto, "Mechanical Vibrations" – McGraw Hill, Schaum Series.
5. William Weaver, Stephen P. Timoshenko, Donovan H. Yound, Donovan H. Young. ‘Vibration Problems in Engineering’ – John Wiley and Sons, New York, 2001.

U23MET35 MANUFACTURING PROCESS L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To illustrate the working principles of various metal casting processes.
2. To learn and apply the working principles of various metal joining processes.
3. To analyse the working principles of bulk deformation of metals.
4. To learn the working principles of sheet metal forming process.
5. To study and practice the working principles of plastics moulding.

UNIT I METAL CASTING PROCESSES 9

Sand Casting – Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Molding sand Properties and testing – Cores –Types and applications – Molding machines – Types and applications– Melting furnaces – Principle of special casting processes- Shell, investment – Ceramic mould – Pressure die casting – low pressure, gravity- Tilt pouring, high pressure die casting- Centrifugal Casting – CO2 casting –- Defects in Sand casting process-remedies.

UNIT II METAL JOINING PROCESSES 9

Fusion welding processes – Oxy fuel welding – Filler and Flux materials-–Arc welding, Electrodes, Coating and specifications – Gas Tungsten arc welding –Gas metal arc welding - Submerged arc welding– Electro slag welding– Plasma arc welding — Resistance welding Processes -Electron beam welding – Laser beam Welding Friction welding – Friction stir welding – Diffusion welding – Thermit Welding, Weld defects – inspection &remedies – Brazing - soldering – Adhesive bonding.

UNIT III BULK DEFORMATION PROCESSES 9

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging–cold forging- Characteristics of the processes – Typical forging operations – rolling of metals – Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts – Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types – Hot and Cold extrusion. Introduction to shaping operations.

UNIT IV SHEET METAL PROCESSES 9

Sheet metal characteristics – Typical shearing, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes - Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning – Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming – Incremental forming.

UNIT V MANUFACTURE OF PLASTIC COMPONENTS 9

Types and characteristics of plastics – Molding of thermoplastics & Thermosetting polymers– working principles and typical applications – injection molding – Plunger and screw machines – Compression molding, Transfer Molding – Typical industrial applications – introduction to blow molding – Rotational molding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics- duff molding.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Explain the principle of different metal casting processes.
- **CO2:** Describe the various metal joining processes.
- **CO3:** Illustrate the different bulk deformation processes.
- **CO4:** Apply the various sheet metal forming processes.
- **CO5:** Apply suitable molding technique for manufacturing of plastics components.
- **CO6:** Select and justify the most suitable manufacturing process for a given aircraft component or assembly, considering factors such as material, cost, quality, and production rate.

TEXT BOOKS:

1. Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India, 4th Edition, 2013.
2. P.N.Rao Manufacturing Technology Volume 1 Mc Grawhill Education 5th edition, 2018.

REFERENCE BOOKS:

1. Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.
2. S. Gowri P. Hariharan, A.SureshBabu, Manufacturing Technology I, Pearson Education, 2008.
3. Paul Degarma E, Black J.T and Ronald A. Kosher, Eligth Edition, Materials and Processes, in Manufacturing, Eight Edition, Prentice – Hall of India, 1997.
4. HajraChouldhary S.K and Hajra Choudhury. AK., Elements of workshop Technology, volume I and II, Media promoters and Publishers Private Limited, Mumbai, 1997.
5. Sharma, P.C., A Text book of production Technology, S.Chand and Co. Ltd., 2004.

U23AEV64	TURBO MACHINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To study the energy transfer in rotor and stator parts of the turbo machines.
2. To study the function of various elements of centrifugal fans and blowers.
3. To evaluating the working and performance of centrifugal compressor
4. To analyzing flow behavior and flow losses in axial flow compressor.
5. To study the types and working of axial and radial flow turbines.

UNIT I WORKING PRINCIPLES 9

Classification of Turbo machines. Energy transfer between fluid and rotor - Euler equation and its interpretation. Velocity triangles. Efficiencies in Compressor and Turbine stages. Degree of reaction. Dimensionless parameters for Turbo machines.

UNIT II CENTRIFUGAL FANS AND BLOWERS 9

Types – components – working. Flow analysis in impeller blades-volute and diffusers. Velocity triangles- h-s diagram. Stage parameters in fans and blowers. Performance characteristic curves – various losses. Fan – bearings, drives and noise.

UNIT III CENTRIFUGAL COMPRESSOR 9

Components - blade types. Velocity triangles - h-s diagram, stage work. Slip factor and Degree of Reaction. Performance characteristics and various losses. Geometry and performance calculation.

UNIT IV AXIAL FLOW COMPRESSOR 9

Construction details. Work done factor. Velocity triangles - h-s diagram, stage work. Work done factor. Performance characteristics, efficiency and stage losses – Stalling and Surging. Free and Forced vortex flow.

UNIT V AXIAL AND RADIAL FLOW TURBINES 9

Axial flow turbines - Types – Elements - Stage velocity diagrams - h-s diagram, stage work - impulse and reaction stages. Compounding of turbines. Performance coefficients and losses. Radial flow turbines: Types – Elements - Stage velocity diagrams - h-s diagram, stage work Performance coefficients and losses.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Explain the energy transfer in rotor and stator parts of the turbo machines.
- **CO2:** Explain the function of various elements of centrifugal fans and blowers.
- **CO3:** Evaluate the working and performance of centrifugal compressor.
- **CO4:** Analyze flow behavior and flow losses in axial flow compressor.
- **CO5:** Explain the types and working of axial and radial flow turbines.
- **CO6:** Design and analyze a turbo machine (compressor or turbine) for a specific aircraft application, considering factors such as pressure ratio, efficiency, and flow rate.

TEXT BOOKS:

1. BGanesan, V., “Gas Turbines”, 3rd Edition, Tata McGraw Hill, 2011. .
2. Yahya, S.M., “Turbines, Compressor and Fans”, 4th Edition, Tata McGraw Hill, 2011.

REFERENCE BOOKS:

1. Dixon, S.L., “Fluid Mechanics and Thermodynamics of Turbomachinery”, 7th Edition, Butterworth- Heinemann, 2014.
2. Gopalakrishnan. G and Prithvi Raj. D,” A Treatise on Turbomachines”, Scitech Publications (India) Pvt. Ltd., 2nd Edition, 2008.
3. Lewis, R.I., “Turbomachinery Performance Analysis” 1st Edition, Arnold Publisher, 1996.
4. Saravanamutto, Rogers, Cohen, Straznicky., “Gas Turbine Theory” 6th Edition, Pearson Education Ltd, 2009.
5. Venkanna, B.K., “Fundamentals of Turbomachinery”, PHI Learning Pvt. Ltd., 2009.

U23AEV65	HELICOPTER THEORY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

To make the student familiarize with

1. The principals involved in helicopters.
2. The performance and stability aspects of Helicopter under different operating conditions.
3. Understand aerodynamics of rotor blades.
4. Dynamic stability of helicopters.
5. Considerations of helicopter design.

UNIT I INTRODUCTION 9

Helicopter as an aircraft, Basic features, Layout, Generation of lift, Main rotor, Gearbox, tail rotor, power plant, considerations on blade, flapping and feathering, Rotor controls and various types of rotor, Blade loading, Effect of solidity, profile drag, compressibility etc., Blade area required, number of Blades, Blade form, Power losses, Rotor efficiency.

UNIT II AERODYNAMICS OF ROTOR BLADE 9

Aerofoil characteristics in forward flight, Hovering and Vortex ring state, Blade stall, maximum lift of the helicopter calculation of Induced Power, High speed limitations; parasite drag, power loading, ground effect.

UNIT III POWER PLANTS AND FLIGHT PERFORMANCE 9

Piston engines, Gas turbines, Ramjet principle, Comparative performance, Horsepower required, Range and Endurance, Rate of Climb, Best Climbing speed, Ceiling in vertical climb, Autorotation.

UNIT IV STABILITY AND CONTROL 9

Physical description of effects of disturbances, Stick fixed Longitudinal and lateral dynamic stability, lateral stability characteristics, control response. Differences between stability and control of airplane and helicopter.

UNIT V ROTOR VIBRATIONS 9

Dynamic model of the rotor, Motion of the rigid blades, flapping motion, lagging motion, feathering motion, Properties of vibrating system, phenomenon of vibration, fuselage response, vibration absorbers, Measurement of vibration in flight. Rotor Blade Design: General considerations, Airfoil selection, Blade construction, Materials, Factors affecting weight and cost, Design conditions, Stress analysis.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Make use of Aerodynamics calculation of Rotor blade.
- **CO2:** Apply stability and control characteristics of Helicopter.
- **CO3:** Experiment with control Rotor vibration.
- **CO4:** Apply Momentum and simple blade element theories to helicopter's rotor blades.
- **CO5:** Analyse the power requirements in forward flight and associated stability problems of helicopter.
- **CO6:** Design and optimize a helicopter rotor system, considering factors such as performance, stability, control, and vibration, to meet specific mission requirements.

TEXT BOOKS:

1. John Fay, "The Helicopter and How It Flies", Himalayan Books 1995.
2. Lalit Gupta, "Helicopter Engineering", Himalayan Books New Delhi 1996.

REFERENCE BOOKS:

1. Joseph Schafer, "Basic Helicopter Maintenance", Jeppesen 1980.
2. R W Prouty, Helicopter Aerodynamics, Phillips Pub Co, 1993.

U23AEV66 SMART MATERIALS AND STRUCTURES L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To familiarize with the fundamentals of structural health monitoring.
2. To impart knowledge in the areas of Vibration based techniques in structural health monitoring, fibre optics and Piezo electric sensors.
3. To familiarize with the fundamentals of fabrication, modelling, analysis, and design of smart materials and structures.
4. To enable the student to get exposed to the state of the art of smart materials and systems, spanning piezo electrics, shape memory, alloys, electro active polymers.
5. To familiarize with artificial neural networks and image processing.

UNIT I OVERVIEW AND INTRODUCTION 9

Piezoelectric Material Crystal Structure – Fundamentals of Piezoelectricity – Shape Memory Alloys – Fundamentals of Shape Memory Alloy (SMA) Behaviour – Phase Transformation – Lattice Structure and Deformation Mechanism – Electrostrictive Material Systems – ER and MR Fluids – Current Application – Aerospace Field – Machine Tools – Automotive Systems – Medical Systems – Electronics Equipment – Robots – Energy Harvesting Using Smart Materials.

UNIT II PIEZOELECTRIC THEORY 9

Electromechanical Constitutive Equations – Piezo ceramic Actuator & Sensor Equations – Piezoelectric Coupling Coefficients – Actuator Performance and Load Line Analysis – Hysteresis and Nonlinearities in Piezoelectric Materials – Piezo ceramic Actuators – Behavior under Static & Dynamic Excitation Fields – Depoling Behavior and Dielectric Breakdown – Curie Temperature– Power Consumption – Equivalent Circuits to Model Piezo ceramic Actuators – The Bimorph Sensor.

UNIT III BEAM MODELLING WITH PIEZOELECTRIC MATERIAL 9

Basic Definitions of Stress, Strains and Displacements in Beams – Transverse Deflection of Uniform Isotropic Beams – Simple Blocked Force Beam Model (Pin Force Model) – Single Actuator Characteristics – Dual Actuators – Symmetric & Asymmetric Actuation with Differential Voltages – Uniform Strain Model – Euler-Bernoulli Beam Model – Dissimilar Actuators – Embedded Actuators – Testing of a Beam with Surface Mounted Piezoactuators.

UNIT IV UNDERSTANDING SHAPE MEMORY ALLOYS (SMA) 9

Low Temperature Stress-Strain Curve – Origin of the One-Way Shape Memory Effect – Stress Induced Martensite and Pseudoelasticity – Two-Way Shape Memory Effect – All-Round Shape Memory Effect – R-Phase Transformation – Porous SMA – Constrained Behavior of SMA – Free Recovery – Constrained Recovery – Effective Load-Lines of an SMA Wire Actuator – Sample Preparation – Transformation Temperatures under Zero Stress.

UNIT V CONSTITUTIVE MODELLING AND SMA BEHAVIOUR 9

Tanaka Model – Liang and Rogers Model – Brinson Model – Testing of SMA Wires –Variation of Transformation Temperatures with Stress – Stress-Strain Behavior at Constant Temperature – Stress-Temperature Behavior at Constant Strain – Heat Absorbed by the SMA Wire – Thermo mechanical Energy Equilibrium Power Requirements for SMA Activation – Resistance Behavior of SMA Wires – Heat Dissipation – SMA Wire Damping Capacity.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Classify the various forms of functional materials.
CO2: Investigate the Piezoelectric material behaviour.
CO3: Investigate the behaviour of SMA material.
CO4: Model a beam with Piezoelectric patch.
CO5: Impart knowledge on modelling of SMA material.
CO6: Design and analyze a smart structure using functional materials, such as piezoelectric or shape memory alloy (SMA) materials, for a specific aerospace application

TEXT BOOKS:

1. Inderjit Chopra and Jayant Sirohi,' Smart Structures Theory', Cambridge University Press, 2014.
2. Brain Culshaw – Smart Structure and Materials Artech House – Borton. London-1996.
3. L. S. Srinath – Experimental Stress Analysis – Tata McGraw-Hill, 1998.
4. J. W. Dally & W. F. Riley – Experimental Stress Analysis – Tata McGraw-Hill, 1998.

REFERENCE BOOKS:

1. Martin, J.W., Engineering Materials, Their properties and Applications, Wykedham Publications (London) Ltd., 1987.
2. Prasad, N. Eswara, Wanhill, R. J. H, 'Aerospace Materials and Material Technologies – Indian Institute of Metals Series, 2017.
3. Sam Zhang, 'Aerospace Materials Handbook (Advances in Materials Science and Engineering) 1st Edition , 2016.
4. Van Vlack.L.H., Elements of Materials Science and Engineering Prentice Hall; Publishers, Sixth edition, 1989.

OPEN ELECTIVE – I

U23AEO11	PISTON ENGINE AND PROPELLER	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To familiarize with the fundamentals of structural health monitoring.
2. To impart knowledge in the areas of Vibration based techniques in structural health monitoring, fibre optics and Piezo electric sensors.
3. To familiarize with the fundamentals of fabrication, modelling, analysis, and design of smart materials and structures.
4. To enable the student to get exposed to the state of the art of smart materials and systems, spanning piezo electrics, shape memory, alloys, electro active polymers.
5. To familiarize with artificial neural networks and image processing.

UNIT I INTRODUCTION AND CONSTRUCTION 9

Development, classification and characteristics of piston engines. Constructional features of Crank case, crank shaft, cylinder, piston, Connecting rod, cam shaft, valve and valve operating mechanism and their function.

UNIT II ENGINE ACCESSORY SECTION 9

Description of accessory section and propeller reduction gears. General description of induction and exhaust manifold. Supercharger and Turbo charger. Description of engine starter motor, Engine cooling systems - air and liquid. Engine Lubricating System - Need for lubrication. Classification and characteristics of lubricating oil. Principal components of lubricating system and their function.

UNIT III ENGINE FUEL SYSTEM 9

Aviation fuels and its characteristics. Alternative fuels in aviation. Fuel additives. Principle of operation of Float type carburetor, carburetor icing and prevention. Principle of operation and maintenance of fuel injection system.

UNIT IV IGNITION AND STARTING SYSTEM 9

Principles of ignition. Magneto – Type, Characteristics and operation. Description of ignition shielding, Magneto maintenance. Description of spark plugs and its servicing including pressure testing.

UNIT V PROPELLER 9

Propeller theory, terms and definition. Forces acting on propeller in flight. General description of fixed and variable pitch propeller. Propeller controls and operations of pitch changing mechanism.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Competent to understand the basics of Piston engine operation.
- **CO2:** Understand the basic parts of a Piston engine.
- **CO3:** Learn about the purpose of Carburettor's and fuel injection systems in a piston engine.
- **CO4:** Model a beam with Piezoelectric patch.
- **CO5:** Impart knowledge on modelling of SMA material.
- **CO6:** Design and analyze a smart structure using functional materials, such as piezoelectric or shape memory alloy (SMA) materials, for a specific aerospace application

TEXT BOOKS:

1. Fundamentals of Internal Combustion Engines by P.W. Gill, J.H. Smith & E.J. Ziurys**.**
2. Heywood J.B., "Internal combustion Engine Fundamentals", McGraw Hill, 1988.

REFERENCE BOOKS:

1. Airframe and power plant mechanics – power plant hand FAA.
2. Aircraft piston engines – by Herschel smit.
3. Jet Engine Manual by E. Mangham and A Peace.

U23AEO12	GAS TURBINE ENGINE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To explain the Gas Turbine with various operating cycles.
2. Explain different alternate fuels, gas turbines and about jet propulsion.
3. To understand the various classifications of gas turbine.
4. To explain the different performance analysis of gas turbine engines.
5. To be able to analyze overall performance of gas turbine power plant.

UNIT I INTRODUCTION **9**

Principle of Jet Propulsion, Types of gas turbine engines, Principles and operation Ram Jet and scram Jet engines, Factors affecting the thrust and performance of gas turbine engine.

UNIT II TURBINE ENGINE **9**

Construction and working, Description of Air intake, Compressor Diffuser, combustion chamber, Turbine and exhaust nozzles, subsonic and supersonic inlets- Thrust Augmentation devices, Noise suppression system, Thrust reversal mechanisms.

UNIT III TURBOPROPENGINE **9**

Construction and operational features of a Turbo prop engine. Force acting on a propeller. Turbo Propellers working principle and functions of propeller control unit. Propeller horse power calculations.

UNIT IV FUEL SYSTEMS **9**

Types and characteristics of Jet Fuel, Description of fuel control unit and its operation. Electronic engine controls and FADEC systems.

UNIT V ENGINESYSTEMS **9**

Lubrication system: Types of lubricants, lubrication system unit and their functions. Starting system: Types of engine starts, working principle of Air turbine and combustion starters, APU, GPU. Ignition system and its operation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Explain the basic principle of each cycle of the gas turbines.
- **CO2:** Understanding the principles of the construction and operation of the gas turbines.
- **CO3:** Understand how to build and operate a turbo propeller engine.
- **CO4:** Understanding the impact of emission on conventional and unconventional fuels.
- **CO5:** Understand the engine start system of the gas turbines of the aircraft.
- **CO6:** Explain the roles of compressors, combustors, turbines, and exhaust systems.

TEXT BOOKS:

1. Gas Turbine Materials by G, Lueas and J.F. Pollock.
2. Gas turbines–V. Ganeshan Modern Compressible flows–John D.

REFERENCE BOOKS:

1. Aircraft power plants by Kroes wild –1994 (Chapter 11,12,13,14,16)
2. Gas Turbine theory–Kohen & Rogers.
3. Heat engines, by Vasandan & Kumar - Metropolitan Book Co Pvt Ltd – 2000
4. Gas Turbine for Aircraft by A.W. Judge.

U23AEO13 AIRCRAFT COMMUNICATION AND NAVIGATION SYSTEM L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To familiarize about basic radio theory.
2. To familiarize communication systems used in the aircraft.
3. To educate about various navigation systems used in the aircraft.
4. To educate about various radio air safety equipment's used in the aircraft.
5. To educate basic radar and weather radar used in the aircraft.

UNIT I GENERAL 9

Description of radio waves, terms like wave length and frequency, frequency bands, Carrier waves – Ground wave, Sky wave and Space wave and their characteristics. Antenna, Amplifiers and types, microphones and its types, modulation and its various types.

UNIT II COMMUNICATION SYSTEMS 9

Description, theory of operation of Aircraft VHF (Very High Frequency) communication system, HF(High Frequency) and Satellite communication system.

UNIT III NAVIGATION SYSTEMS 9

Description, theory of operation of Automatic Direction Finder (ADF), Radio magnetic Indicator(RMI),Very High Omni Range(VOR), Instrument landing system(ILS), Distance Measuring Equipment, Marker beacon system. Principle of operation of Inertial Navigation system (INS), Global Positioning System (GPS) and Doppler Navigation system, Microwave landing system(MLS) and advantages.

UNIT IV RADIO EQUIPMENT (OPERATIONS) 9

Description and operation of ATC transponder, various modes like A, C, S and its operation Traffic Alert and collision avoidance system (TCAS) ,Radio altimeter system, Ground proximity Warning system(GPWS).

UNIT V WEATHER RADAR SYSTEM 9

Radar, radar bands, description of principal units of analog radar system, Aircraft weather radar system, its units and its operation, wave guides, flat plate antenna.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand about basic radio theory.
CO2: Acquire the knowledge about communication systems used in aircraft.
CO3: Acquire knowledge on the various navigation systems.
CO4: Analysis on radio air safety equipment.
CO5: Acquire knowledge on basic radar and weather radar used in the aircraft.
CO6: Understand the working principles of inertial navigation system.

TEXT BOOKS:

1. Aircraft instruments and avionics Max F. Henderson, Jeppesen.
2. Aircraft radio Systems by James Powell.

REFERENCE BOOKS:

1. Aircraft Electricity & Electronics by Thomas KE is min
2. Aircraft instruments and integrated system E H J Pallett, Pearson.
3. Aircraft instrumentation and system,S Nagabhushana and L. K. Sudha, I. K. International Pvt Ltd.

U23AEO14 AIRPORT AND AIR TRAFFIC SERVICE L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To explain international procedures and practices governing the movement of air traffic.
2. To impart knowledge about air traffic systems.
3. To gain more knowledge on flight information systems.
4. To gain knowledge on aircraft lighting and support services.
5. To impart knowledge about ground handling operations.

UNIT I AIRPORT GENERAL 9

Airport Definition- History and Development of Airport, Principles of Airport Layout, Categories of Airport, Principles of Airport Management, Functions of Airport, Aerodrome Reference Point, Environmental Factors, Air Freedom Rights, Functions of ICAO, IATA, DGCA, AAI.

UNIT II RUNWAY AND TAXIWAY 9

Runway Configuration, Runway Orientation, Runway Markings, Relationship between Aircraft and Airport, Weight Components, Taxiway Configuration, Taxi way Markings, Stop way and Clearway, Load Classification Number.

UNIT III AIRPORT OPERATIONS 9

Lay out of Apron, Holding Apron, Terminal Apron, Aircraft Parking Configuration, Terminal Configuration, Terminal Passenger Flows, Ramp Safety, Ramp Ground Support Equipments, Definition of Gate and Gate Capacity.

UNIT IV AIRPORT LIGHTING AND SUPPORT SERVICES 9

Visual Approach Slope Indicator (VASI), Precision Approach Path Indicator (PAPI), Approach Lighting System, Runway Lighting System, Taxiway Lighting System, Obstruction Lighting System, Aerodrome Beacon, Airport Lighting, Airport Security System.

UNIT V AIR TRAFFIC CONTROL AND NAVIGATION 9

ATC- General, Need for Air Traffic Control, Air Traffic Control Network, Air Traffic Control Aids, ATC and Surveillance Facilities, Air Traffic Services- Objectives and its Features, Air Space Classes, ATS Routes, Controlled Airspace and Uncontrolled Air Space, Terms Used in ATC Operations, Visual Flight Rules(VFR) and Instrument Flight Rules(IFR).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Classify the various forms of functional materials.
- **CO2:** Investigate the Piezoelectric material behaviour.
- **CO3:** Investigate the behaviour of SMA material.
- **CO4:** Model a beam with Piezoelectric patch.
- **CO5:** Impart knowledge on modelling of SMA material.
- **CO6:** Design and analyze a smart structure using functional materials, such as piezoelectric or shape memory alloy (SMA) materials, for a specific aerospace application

TEXT BOOKS:

1. The Airport Business – Dogains R.
2. Airport Operations – Ashford, Station & More. Cleared for takeoff behind the scene of Air Travel – Barlay.

REFERENCE BOOKS:

1. Airport Engineering – Norman Ashford & Paul HW right.
2. Airport Planning & Management – Seth B Young & Alexander T. Wells
3. Airport Planning & Design–S. K. Khanna-M. G. Arora- S. S. Jain
4. AIP (India) Vol. I & II, "The English Book Store", 17-1, Connaught Place, New Delhi.
5. Michael S. Nolan., "Fundamentals of Air Traffic Control", Cengage Learning

U23AEO15	AIR CARGO MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To equip the student with knowledge and skills used in Air Cargo Management with systematic process involved in this process.
2. T familiarize students with the operations and management of different types of cargo, terminologies used in cargo operation, air cargo rates and documentations, packaging, IATA cargo handling and acceptance, dangerous goods.

UNIT I INTRODUCTION TO LOGISTICS 9

Logistics- Meaning- Scope and Significance- Functions of Logistics System – Transportation, Warehousing, Order processing, Information handling and procurement- Logistics management objectives- Customer service - Expectation and Fulfillment levels - Customer service for competitiveness.

UNIT II SUPPLY CHAIN MANAGEMENT 9

Supply chain management: Meaning – Supply chain linkages- Role of logistics in supply chain -E business solution to supply chain – Warehousing :- Functions of warehouse – Types – Site selection – Layout – Costing - Material handling system - Material storage system - Virtual warehouse – Warehouse decision models.

UNIT III TRANSPORTATION 9

Transportation:- Transportation infrastructure - Freight management, Introduction and functions of the freight forwarders, Evolving Role of Freight Forwarder - Factors influencing freight cost – Transportation networks - Route planning - Containerization- Logistical Packaging: Packaging as utilization – Designs – Packaging.

UNIT IV AIR CARGO MANAGEMENT 9

Introduction to Cargo, mode and means of transportation, air cargo operation in India. Significance of air transportation in Logistics: Utility created by air transportation in Logistics – Air Transportation as a means of conquering time and space – Features and facilities offered by Air Cargo-ways- Factors influencing growth in Air Logistics.

UNIT V DOCUMENTATION FOR AIR CARGO TRANSPORT 9

Shipper’s Export Declaration, Certificate of Origin, Export license, Commercial Invoice, Certificate of origin, Import License, Consular invoice, Air way bills- format, boxes, contents, completion of Air waybill, mandatory information, Types of Air waybills (MAWB/HAWB).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the basic concepts of Logistics Management.
CO2: Learn SCM, Warehouse functions and Inventory Management.
CO3: Understand the concept transportation.
CO4: Learn the importance of Air Cargo Transportation and the Functions.
CO5: Understand the different types of documentation for Air cargo transportation.
CO6: Understand the role and significance of air cargo in global trade and logistics.

TEXT BOOKS:

1. International Air Transport Association (IATA) – Cargo John G. Wensveen. (2007).
2. Air Transportation: a management Perspective, 6th Edition, Ashgate.Clearwater Drive, 2000, Air Cargo Guide, Oak Brook, IL 60521.

REFERENCE BOOKS:

1. V.V.Sople – Logistics Management – Pearson.
2. Alan Rushton and John Oxley – Hand book of Logistics and Distribution – Kogen page.
3. Coyle etal – The Management of Business Logistics, Thompson Learning.
4. Bowersox – Logistical Management – Mc Graw Hill, 2000.
5. Chi Chu,C.Leung, Van Hui & Cheung, 4th Party Cyber Logistics for Air Cargo, Spring,2004
6. Air Cargo Industry Master Operating Plan: A description of the air cargo industry transportation business process, (2014).

OPEN ELECTIVE – II

U23AEO21 AIR TRAVEL MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES:

1. To enable the students to learn the modes of transportations.
2. To learn the different types of travel documents required for air travel.
3. To acquire knowledge in Travel information manual.
4. To describe the development of Air transport and its planning.
5. To understand the concept of Air freight and distribution channel.

UNIT I TRANSPORTATION AND MARKET SEGMENTATION 9

Air Transportation Industry - Land Transportation Industry -Sea Transportation Industry - Multi-modal Transportation - Marketing and Marketing mix – Application of Marketing Principles to Airline management-Airline Business and its Customers – Market segmentation - PESTE Analysis.

UNIT II TRAVEL DOCUMENTS AND MARKETING STRATEGIES 9

Passport – VISA's - Airlines Ticket or Authorization - Health Documents - Michel Porter's Five Factors and their Application to Airline – Cost leadership –Focus strategies- Airline Business and Market Strategies – Common Mistake-Concept of Product and Relation to Airline.

UNIT III TRAVEL INFORMATION MANUAL 9

Referring the TIM - Passport Requirements: Different Nations - VISA Requirements: Different Nations - Tax, Currency, Customs, Immigration requirements - Referring the OAG - Aircraft Types and Codes - World Terminals -Calculation of Flying time, Ground Time and Elapsed Time.

UNIT IV DEVELOPMENT OF AIR TRANSPORT AND PLANNING 9

Introduction – Growth of air transport, Airport organization and associations, Classification of airports airfield components, Air traffic Zones and approach areas. Context of Airport system planning.

UNIT V AIR FREIGHT MARKET AND DISTRIBUTION CHANNELS 9

Building Block in Airline Pricing Policy-Uniform and Differential Pricing- The Structure of Air Freight Policy- Distribution Channel Strategies-Travel Agency Distribution System- Selling and Distribution Channel in Air Freight Market.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the modes of transportation.
CO2: Gain knowledge about maintenance documentations.
CO3: Apply the knowledge in production planning and control.
CO4: Make use of various maintenance control centres.
CO5: Analyse various Quality Assurance and Quality control.
CO6: Study ICAO, IATA, FAA, and DGCA regulations governing air travel.

TEXT BOOKS:

1. Sethi, Praveen "Strategies for the Future of Travel and Tourism" Rajat Publication, 1999.
2. Sethi, Praveen, "Handbook of Effective Travel and Tourism", Rajat Publication,1999.
3. Bhatia, A.K., "International Tourism, Fundamentals and Practices", Sterlings Publishers, 1991.
4. Krishan, K., Kamra, Chand Mohinder, "Basic of Tourism; Theroy Operation and Practice.

REFERENCE BOOKS:

1. Airline Industry: The Official Guide to Airline Management – Elnora Singleton – Routledge, 2015.
2. Travel & Tourism Management – Barkat A.M.A, Prentice Hall India Learning Pvt Ltd, 2015.
3. Kandari, O.P. Chandra Ashish, "Tourism Development; Principles and Practices", Shree Publishers, 2004
4. Gill, S. Pushpinder, "Tourism Planning and Management", Anmol Publications, 2003.

U23AEO22	HELICOPTER MAINTENANCE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To familiarize with the principals involved in helicopters.
2. To understand aerodynamics of rotor blades.
3. To educate on controls in helicopter.
4. To understand the Transmission system of helicopter.
5. To familiarize with the general concepts and fundamentals of the helicopter construction.

UNIT I HELICOPTER AERODYNAMICS 9

Helicopter configuration & its main parts, Dissymmetry of lift, Blade flapping and conning, Coriolis effect, Translational lift, Ground effect and auto rotation, pitch angle, Thrust-collective pitch, Gyroscopic precession and torque.

UNIT II MAIN ROTOR SYSTEM 9

Main rotor head and rotor blades, Blade alignment, tracking, static and dynamic balancing, Blade sweeping, Electronic balancing, Dampener maintenance, counterweight adjustment, Autorotation adjustment.

UNIT III MAST AND FLIGHT CONTROLS 9

Mast, Stabilizer bar, Dampeners, Swash plate, Flight control systems- Collective, cyclic, push-pull tubes, Torque tubes, Bell cranks, Mixer box, Gradient unit, Control boosts, Maintenance and Inspection, Control rigging.

UNIT IV TAIL ROTOR AND TRANSMISSION SYSTEM 9

Tail rotor drive shaft, tail gear box, rotor blades, pitch change mechanism & its operation. Engine transmission couplings, Drive shaft, Clutch mechanism and freewheeling units.

UNIT V AIRFRAME AND RELATED SYSTEMS 9

Tubular construction, Sheet metal construction, Bonded construction, stress and loads, Wheel and skid gear, Visibility, Structural components and materials, Fuselage maintenance, Airframe systems, Special purpose equipment.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand and give a detailed description on Helicopter aerodynamics.
CO2: Understand the main rotor system of helicopter.
CO3: Apply stability and control characteristics of Helicopter.
CO4: Understand the tail rotor and transmission system of helicopter.
CO5: Analyse the basic helicopter construction.
CO6: Learn about helicopter vibration sources and mitigation techniques.

TEXT BOOKS:

1. Helicopter Maintenance-by Joseph Schafer (Order No.EA-HF-2) IAP Inc., 1980.
2. Helicopter Aerodynamics-by R.W.Prouty,2nd edition, Eagle eye solutions, 448, North Church Drive, Lebanon, 2004.
3. Aviation Maintenance Technician Handbook: Airframe, Volume 1: FAA-H-8083-31A, Author: Aviation Supplies & Academics (ASA); Publisher: Federal Aviation Administration (FAA) Edition Date: 20 November 2018.

REFERENCE BOOKS:

1. Basic Helicopter Hand Book-by Federal Aviation Administration (FAA), U.S. Department of Transportation Flight Standard Service, 1978
2. Basic Helicopter Aerodynamics-by J.Seddon (BSP Professional Books), American Institute of Aeronautics and astronautics, 1990.
3. Foreman Civil Aircraft Inspection Procedure (CAP 459) Part II Aircraft, Aircraft, Civil Aviation Authority (CAA), London, UK, Himalayan books, Ist edition, 2010.

U23AEO23 **FUNDAMENTAL OF AVIONICS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

1. To introduction of the basic avionics and the need for civil and military aircraft.
2. To provide information on the Avionics Architecture and various Databases.
3. To get a better understanding of the different avionics subsystems.
4. To understanding the concept of navigation systems.
5. To learn how to operate an autopilot system.

UNIT I INTRODUCTION TO AVIONICS **9**

Need for avionics in civil and military aircraft and space systems – integrated avionics and weapon systems – typical avionics subsystems, design, technologies – Introduction to digital computer and memories.

UNIT II DIGITAL AVIONICS ARCHITECTURE **9**

Avionics system architecture – data buses – MIL-STD-1553B – ARINC – 420 – ARINC – 629.

UNIT III FLIGHT DECKS AND COCKPITS **9**

Control and display technologies: CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil and Military Cockpits: MFDS, HUD, MFK, HOTAS.

UNIT IV INTRODUCTION TO NAVIGATION SYSTEMS **9**

Radio navigation – ADF, DME, VOR, LORAN, DECCA, OMEGA, ILS, MLS – Inertial Navigation Systems (INS) – Inertial sensors, INS block diagram – Satellite navigation systems – GPS.

UNIT V AIR DATA SYSTEMS AND AUTO PILOT **9**

Air data quantities – Altitude, Air speed, Vertical speed, Mach Number, Total air temperature, Mach warning, Altitude warning – Auto pilot – Basic principles, Longitudinal and lateral auto pilot. Behavior of SMA Wires – Heat Dissipation – SMA Wire Damping Capacity.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Build Digital avionics architecture.
CO2: Design Navigation system.
CO3: Use data bus interfaces to integrate avionics systems.
CO4: Develop an analysis of the performance of various cockpit display technologies.
CO5: Design of autopilot for small aircraft.
CO6: Understand the fundamentals of avionics and their importance in aviation.

TEXT BOOKS:

1. Aircraft instruments and avionics Max F. Henderson, Jeppesen.
2. Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989.

REFERENCE BOOKS:

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

U23AEO24 **WIND TUNNEL TECHNIQUE** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

1. To learn the Types of low-speed Wind tunnels and non-dimensional numbers with its applications.
2. To learn the Types of high-speed Wind tunnels and with its calibration methods.
3. To Understand the Special Wind tunnels and with its calibration methods with its design methods.
4. To describe flow visualization techniques and data acquisition methods.
5. To understand the functions of various instruments associated with wind tunnel.

UNIT I LOW SPEED WIND TUNNELS **9**

Classification –non-dimensional numbers-types of similarities - Layout of open circuit and closed-circuit subsonic wind tunnels – design parameters-energy ratio - HP calculations - Calibration methods.

UNIT II HIGH SPEED WIND TUNNELS **9**

Blow down, in draft and induction tunnel layouts and their design features -Transonic, and supersonic tunnels- peculiar features of these tunnels and operational difficulties.

UNIT III SPECIAL WIND TUNNEL TECHNIQUES **9**

Types of Special Wind Tunnels – Hypersonic, Gun and Shock Tunnels – Design features and calibration methods- Intake tests – store carriage and separation tests - wind tunnel model design for these tests.

UNIT IV WIND TUNNEL INSTRUMENTATION **9**

Instrumentation and sensors required for both steady and unsteady measurements – Force measurements using three component and six component balances.

UNIT V FLOW VISUALIZATION AND NON-INTRUSIVE FLOW DIAGNOSTICS **9**

Smoke and Tuft grid techniques – Dye injection special techniques – Oil flow visualization and PSP techniques - Optical methods of flow visualization – PIV and Laser Doppler techniques.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1: Understand the uses of various types of tunnels and its losses
CO2: Experiment with calibration of different types of high-speed tunnels.
CO3: Make use of various special tunnels and its applications.
CO4: Make use of various measurement techniques of instruments of wind tunnel.
CO5: Can use various techniques for aerodynamic data generation.
CO6: Study lift, drag, and moment measurement techniques in wind tunnel testing.

TEXT BOOKS:

1. NAL-UNI Lecture Series 12:" Experimental Aerodynamics", NAL SP 98 01 April 1998.
2. Rae, W.H. and Pope, A., "Low Speed Wind Tunnel Testing", John Wiley Publication, 1984.
3. Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", John Wiley, 1985.

REFERENCE BOOKS:

1. Bradsaw "Experimental Fluid Mechanics".
2. Lecture course on Advanced Flow diagnostic techniques 17-19 September 2008 NAL, Bangalore.
3. Rathakrishnan, E., “Instrumentation, Measurements, and Experiments in Fluids,” CRC Press – Taylor & Francis, 2007.
4. Short term course on Flow visualization techniques, NAL , 2009.

U23AEO25 AIRCRAFT MAINTENANCE, GROUND HANDLING AND SUPPORT EQUIPMENT

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To understand the fundamentals of Aircraft Maintenance.
2. To Acquire Knowledge on Landing Gear Maintenance.
3. To Learn about the Aircraft Structural Repairs.
4. To Understand the Ground Handling Procedures.
5. To Learn the Ground Equipment's and functions.

UNIT I GENERAL **9**

Maintenance concept, inspection periodicity for types of aircraft like Annual Inspection. Inspection schedule and operational life of components.

UNIT II MAINTENANCE OF LANDING GEARS **9**

Inspection and maintenance of landing gear - struts, wheel assembly, and brake system. Landing gear retraction test and its procedure. Special inspection after heavy handling, lightning strike and turbulent weather.

UNIT III AIRCRAFT STRUCTURAL REPAIRS **9**

Basic Principles of sheet metal repair, Maintaining the original strength and determination of Rivet Dia, and number of rivets for repair, Classification of structural damage, special tools and devices for sheet metal, Metal working machines, Forming operations, Rivet layout, Riveting tools.

UNIT IV GROUND HANDLING **9**

Fire safety – classification of fire and extinguishing agents, Movement of Aircraft - Towing operation and precautions taxing and taxing signals, Aircraft tie down - Normal Tie down procedure, securing Light aircraft.

UNIT V GROUND EQUIPMENTS **9**

Description and Maintenance of ground support equipment's – Electrical power unit, Air start unit, Hydraulic power unit, Pre-oiling equipment, Air conditioning and heating unit, Aircraft jacks.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

- **CO1:** Understand the fundamentals of Aircraft Maintenance.
- **CO2:** Acquire Knowledge on Landing Gear Maintenance.
- **CO3:** Learn about the Aircraft Structural Repairs.
- **CO4:** Understand the Ground Handling Procedures.
- **CO5:** Learn the Ground Equipment's and functions.
- **CO6:** Learn about automation in ground handling, robotics in maintenance, and sustainable airport operations.

TEXT BOOKS:

1. Inderjit Chopra and Jayant Sirohi,' Smart Structures Theory', Cambridge University Press, 2014.
2. P.S.Senguttuvan –Fundamentals of Airport Transport Management – McGraw Hill 2003.
3. Aviation Maintenance Management – Harry A. Kinnison – McGraw Hill.

REFERENCE BOOKS:

1. Aircraft basic Science– Kroes & Rardon– 1993
2. Aircraft maintenance and repair –Kroes–Delp–1993.
3. Airframe handbook– FAA–ACC65– 15A-1994
4. Airframe & Power plant mechanics–General Hand bookAC65-9A
5. Airport operation by Noman J. Ashford-McGraw Hill 2003.