KCG
COLLEGE OF TECHNOLOGY
AFFILIATED TO ANNA UNIVERSITY | AUTONOMOUS

REGULATIONS - 2023

CURRICULUM AND SYLLABI

(2023-2024)

B.E. AEROSPACE ENGINEERING

KCG College of Technology was founded in 1998 to fulfill the Founder-Chairman, Dr. KCG Verghese's vision of **"To Make Every Man a Success and No Man a Failure".** It is a Christian minority institution, affiliated to Anna University (Autonomous), Chennai and approved by AICTE, New Delhi.

VISION OF KCG

KCG College of Technology aspires to become a globally recognized centre of excellence for science, technology & engineering education, committed to quality teaching, learning and research while ensuring for every student a unique educational experience which will promote leadership, job creation, social commitment and service to nation building.

MISSION OF KCG

- Disseminate knowledge in a rigorous and intellectually stimulating environment.
- Facilitate socially responsive research, innovation and entrepreneurship.
- Foster holistic development and professional competency.
- Nurture the virtue of service and an ethical value system in the young minds.

VISION OF AEROSPACE ENGINEERING

The Department envisions becoming a center of excellence, equipping the students with value and skill based education, pursuing globally relevant research and producing professionals committed to nation building.

MISSION OF AEROSPACE ENGINEERING

- Impart quality technical education and unique interdisciplinary experiences
- Develop the analytical, computational and design capabilities to provide sustainable solutions
- Expose the students to the current trends and opportunities in the global Aerospace industry
- Inculcate professional responsibility based on an innate ethical value system

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

The graduates will:

PEO 1	Have a knowledge about aerospace enterprise and rise to the positions of leadership.
PEO 2	Have a strong interest on research that is both at the cutting edge and applicable to satisfying societal needs.
PEO 3	Exhibit ethical values, professional attitude and engage in lifelong learning.

PROGRAM OUTCOMES (POs)

Engineering graduates will be able to:

PO 01	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 02	Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 03	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.
PO 04	Use research based knowledge and methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 05	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO 06	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.

PO 07	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 08	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 09	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	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.
PO 11	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.
PO 12	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadcast context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO 01	Model and examine complex problems in Aerospace structures, Aerodynamics, Space Mechanics and Aerospace Propulsion.
PSO 02	Use CFD, FEM and mathematical programming language tools for design, simulation and analysis of Aerospace engineering.
PSO 03	Follow the AIAA Code of Ethics in their future career.

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KCG COLLEGE OF TECHNOLOGY (AUTONOMOUS)
REGULATIONS 2023
B.E. AEROSPACE ENGINEERING
CHOICE BASED CREDIT SYSTEM
CURRICULUM FOR SEMESTERS I TO VIII
SEMESTER – I

Sl. No	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
	23IP101	Induction Programme		-	-	-	-	-
THEORY								
1	23HS101	Essential Communication	HSMC	3	0	0	3	3
2	23MA101	Matrices and Calculus	BSC	3	0	0	3	3
3	23AD101	Programming in Python	ESC	3	0	0	3	3
4	23HS102	Heritage of Tamils	HSMC	1	0	0	1	1
THEORY AND PRACTICALS								
5	23PH111	Engineering Physics	BSC	3	0	2	5	4
6	23CY111	Engineering Chemistry	BSC	3	0	2	5	4
PRACTICALS								
7	23AD121	Python Programming Laboratory	ESC	0	0	4	4	2
8	23HS121	Communication Skill Laboratory	HSMC	0	0	2	2	1
9	23HS122	General Clubs / Technical Clubs / NCC / NSS / Extension Activities	HSMC	0	0	2	2	1*
TOTAL				**16**	**0**	**12**	**28**	**21**

SEMESTER – II

Sl. No	Course Code	Course Title	Category	Periods Per Week L	T	P	Total Contact Periods	Credits
THEORY								
1	23HS201/ 23HS202	Professional English / Foreign Language	HSMC	3	0	0	3	3
2	23MA201	Vector Calculus and Complex Functions	BSC	3	1	0	4	4
3	23PH207	Applied Physics	BSC	3	0	0	3	3
4	23AS201	Elements of Aerospace Engineering	PCC	3	0	0	3	3
5	23HS203	Tamils and Technology	HSMC	1	0	0	1	1
THEORY AND PRACTICALS								
6	23EE281	Basic Electrical and Electronics Engineering	ESC	2	0	2	4	3
7	23ME211	Engineering Graphics	ESC	3	0	2	5	4
PRACTICALS								
8	23ME221	Engineering Practices Laboratory	ESC	0	0	4	4	2
9	23AS221	Aerospace Modelling Laboratory	PCC	0	0	4	4	2
10	23ES291	Soft Skills	EEC	0	0	2	2	1*
TOTAL				**18**	**1**	**14**	**33**	**25**

SEMESTER – III

Sl. No	Course code	Course title	Category	Periods per week L	T	P	Total contact periods	Credits
THEORY								
1	23MA302	Transforms and Partial Differential Equations	BSC	3	1	0	4	4
2	23AE301	Solid Mechanics	PCC	3	0	0	3	3
3	23HS301	Universal Human Values and Ethics	HSMC	3	0	0	3	3
THEORY AND PRACTICALS								
4	23ME312	Fluid Mechanics and Hydraulic Machinery	PCC	3	0	2	5	4
5	23AE311	Aero Engineering Thermodynamics	PCC	3	0	2	5	4
PRACTICALS								
6	23AE321	Strength of Materials Laboratory	PCC	0	0	4	4	2
7	23ES391	Presentation skills	EEC	0	0	2	2	1*
TOTAL				**15**	**1**	**10**	**26**	**20**

SEMESTER – IV

Sl. No	Course code	Course title	Category	Periods per week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1	23MA403	Numerical and Statistical Methods	BSC	3	1	0	4	4
2	23AS401	Aerodynamics	PCC	3	0	0	3	3
3	23AS402	Aerospace Propulsion	PCC	3	0	0	3	3
4	23AS403	Aerospace Structural Mechanics	PCC	3	0	0	3	3
5	23AS0xx	Department Elective 1	DEC	3	0	0	3	3
6	23AS0xx	Department Elective 2	DEC	3	0	0	3	3
PRACTICALS								
7	23AS421	Low- And High- Speed Aerodynamics Laboratory	PCC	0	0	4	4	2
8	23AS422	Aerospace Structures Laboratory	PCC	0	0	4	4	2
9	23ES491	Aptitude and Logical Reasoning 1	EEC	0	0	2	2	1*
10	23AS423	Mini Project	EEC	0	0	2	2	1
TOTAL				**18**	**1**	**12**	**31**	**24**

SEMESTER – V

Sl. No	Course Code	Course Title	Category	Periods Per Week L	T	P	Total Contact Periods	Credits
THEORY								
1	23RE501	Research Methodology and Intellectual Property Rights	ESC	2	0	0	2	2
2	23AS501	Advanced Propulsion	PCC	3	0	0	3	3
3		Department Elective 3	DEC	3	0	0	3	3
4		Department Elective 4	DEC	3	0	0	3	3
5		Open Elective 1 (Emerging Technology)	OEC	3	0	0	3	3
THEORY AND PRACTICALS								
6	23AE611	Flight Dynamics and Simulation	PCC	3	0	2	5	4
PRACTICALS								
7	23AS521	Space Propulsion Laboratory	PCC	0	0	4	4	2
8	23AE522	Computational Analysis Laboratory	PCC	0	0	2	2	1
9	23AS522	Space Vehicle Design Project	EEC	0	0	4	4	2
10	23ES591	Aptitude and Logical Reasoning 2	EEC	0	0	2	2	1*
TOTAL				**17**	**0**	**14**	**31**	**23**

SEMESTER – VI

Sl. No	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1		Department Elective 5	DEC	3	0	0	3	3
2		Department Elective 6	DEC	3	0	0	3	3
3		Open Elective 2 (Management /Safety Courses)	OEC	3	0	0	3	3
4	23AS601	Space Mechanics	PCC	3	0	0	3	3
THEORY AND PRACTICALS								
5	23CE611	Environmental Science and Engineering	ESC	3	0	2	5	4
6	23AE612	Avionics	PCC	3	0	2	5	4
PRACTICALS								
7	23AS621	Project Work - Phase 1	EEC	0	0	4	4	2
8	23AS622	Technical Training	EEC	0	0	2	2	1
9	23AS623	Technical Seminar– 1	ESC	0	0	2	2	1
TOTAL				**18**	**0**	**12**	**30**	**24**

SEMESTER – VII

Sl. No	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
THEORY								
1		Open Elective 3 (Management Courses)	OEC	3	0	0	3	3
2	23AS701	Rockets and Launch Vehicles	PCC	3	0	0	3	3
3	23AE702	Finite Element Method	PCC	3	0	0	3	3
4	23AS702	Comprehension	EEC	2	0	2	2	2
5	23AE704	Total Quality and Continuing Airworthiness	PCC	3	0	0	3	3
THEORY AND PRACTICALS								
6	23AE711	Composite Materials and Structures	PCC	3	0	2	5	4
PRACTICALS								
7	23AS721	Project Work - Phase 2	EEC	0	0	6	6	3
8	23AS722	Technical Seminar – 2	ESC	0	0	4	4	2
TOTAL				**17**	**0**	**14**	**29**	**23**

SEMESTER – VIII

Sl. No	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
PRACTICALS								
1	23AS821/ 23AS622	Capstone Project / Internship cum Project	EEC	0	0	20	20	10
TOTAL				**0**	**0**	**20**	**20**	**10**

TOTAL CREDITS: 170

VERTICAL 1: SPACE TECHNOLOGY

Sl. No	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	23AS031	Cryogenics	DEC	3	0	0	3	3
2	23AS032	High Temperature Gas Dynamics	DEC	3	0	0	3	3
3	23AS033	Launch Vehicle Aerodynamics	DEC	3	0	0	3	3
4	23AS034	Orbital Mechanics	DEC	3	0	0	3	3
5	23AS035	Launch Vehicle Configuration Design	DEC	3	0	0	3	3
6	23AS036	Space Missions	DEC	3	0	0	3	3
7	23AS037	Geospatial Information Systems	DEC	3	0	0	3	3
8	23AS038	Space Exploration	DEC	3	0	0	3	3

VERTICAL 2: COMPUTATIONAL ENGINEERING

Sl. No	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	23AE039	Numerical Methods in Fluid Dynamics	DEC	3	0	0	3	3
2	23AE040	Computational Heat Transfer	DEC	3	0	0	3	3
3	23AE041	Basics of Computational Fluid Dynamics	DEC	3	0	0	3	3
4	23AE042	Computer Aided Design and Analysis	DEC	3	0	0	3	3
5	23AE043	Grid Generation Techniques	DEC	3	0	0	3	3
6	23MT041	Computer Integrated Manufacturing	DEC	3	0	0	3	3
7	23AE044	Boundary Layer Theory	DEC	3	0	0	3	3
8	23AE045	Programming Tools in Aerospace Engineering	DEC	3	0	0	3	3

VERTICAL 3: AERODYNAMICS AND PROPULSION

Sl. No	Course Code	Course Title	Catgory	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	23AE046	Experimental Aerodynamics	DEC	3	0	0	3	3
2	23AE047	High-speed Aerodynamics	DEC	3	0	0	3	3
3	23AE048	Industrial Aerodynamics	DEC	3	0	0	3	3
4	23AE049	Rocket Propulsion	DEC	3	0	0	3	3
5	23AE050	Advanced Propulsion Systems	DEC	3	0	0	3	3
6	23AE051	Hypersonic Aerodynamics	DEC	3	0	0	3	3
7	23AE052	Wind tunnel Techniques	DEC	3	0	0	3	3
8	23AE053	Fundamental of Combustion	DEC	3	0	0	3	3

VERTICAL 4: AEROSPACE STRUCTURES

Sl. No	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	23AE054	Fatigue and Fracture Mechanics	DEC	3	0	0	3	3
2	23AE055	Experimental Stress Analysis	DEC	3	0	0	3	3
3	23AE056	Vibrations and Aeroelasticity	DEC	3	0	0	3	3
4	23ME031	Additive Manufacturing	DEC	3	0	0	3	3
5	23ME036	Non-Destructive Testing and Evaluation	DEC	3	0	0	3	3
6	23AE057	Aerospace Materials	DEC	3	0	0	3	3
7	23AE058	Theory of Elasticity	DEC	3	0	0	3	3
8	23AE059	Spacecraft Structures	DEC	3	0	0	3	3

VERTICAL 5: AIRCRAFT MAINTENANCE AND PRACTICES

Sl. No	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	23AE060	Airframe Maintenance and Repair	DEC	3	0	0	3	3
2	23AE061	Aircraft General Engineering and Maintenance Practices	DEC	3	0	0	3	3
3	23AE062	Civil Aviation Regulations	DEC	3	0	0	3	3
4	23AE063	Aircraft Engine Maintenance and Repair	DEC	3	0	0	3	3
5	23AE064	Air Traffic Control	DEC	3	0	0	3	3
6	23AE065	Airport Management	DEC	3	0	0	3	3
7	23AE066	Aircraft Safety and Operations	DEC	3	0	0	3	3
8	23AE067	Crisis Management in Aircraft Industry	DEC	3	0	0	3	3

VERTICAL 6: SATELLITE TECHNOLOGY

Sl. No	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	23AS039	Spacecraft Power Systems	DEC	3	0	0	3	3
2	23AS040	Satellite Navigation and Control	DEC	3	0	0	3	3
3	23AS041	Spacecraft Sensors and Instrumentation	DEC	3	0	0	3	3
4	23AS042	Spacecraft Systems Engineering	DEC	3	0	0	3	3
5	23AS043	Satellite Architecture	DEC	3	0	0	3	3
6	23AS044	Spacecraft Dynamics	DEC	3	0	0	3	3
7	23AS045	Space Science Environment	DEC	3	0	0	3	3
8	23AS046	Fundamentals of Satellite Communication	DEC	3	0	0	3	3

VERTICAL 7: DIVERSIFIED COURSES

Sl. No	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	23AE068	Foundation of Manufacturing Technology	DEC	3	0	0	3	3
2	23AE069	Drone Technologies	DEC	3	0	0	3	3
3	23AS047	Space Weapons and Warfare	DEC	3	0	0	3	3
4	23AS048	Turbo machines	DEC	3	0	0	3	3
5	23AS049	Heat Transfer in Space Applications	DEC	3	0	0	3	3
6	23AS050	Digital Image Processing in Aerospace Applications	DEC	3	0	0	3	3
7	23AE071	Fundamentals of Machine Theory	DEC	3	0	0	3	3
8	23AE072	High Temperature Materials	DEC	3	0	0	3	3

OPEN ELECTIVE 1 – EMERGING TECHNOLOGY

Sl. No	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	23OAD971	Artificial Intelligence and Machine Learning Fundamentals	OEC	3	0	0	3	3
2	23OCE971	IoT concepts and applications	OEC	2	0	2	3	3
3	23OCS971	Augmented Reality and Virtual Reality	OEC	3	0	0	3	3
4	23OCS972	Data Science and Fundamentals	OEC	3	0	0	3	3
5	23OE990	Foundation of Big Data Analytics	OEC	3	0	0	3	3
6	23OIT971	Block Chain Technology	OEC	3	0	0	3	3
7	23OPH971	Quantum Technology	OEC	3	0	0	3	3

OPEN ELECTIVE – MANAGEMENT COURSES

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	23OMG971	Total Quality Management	OEC	3	0	0	3	3
2	23OMG972	Engineering Economics and Financial Accounting	OEC	3	0	0	3	3
3	23OMG973	Engineering Management and Law	OEC	3	0	0	3	3
4	23OMG974	Knowledge Management	OEC	3	0	0	3	3
5	23OMG975	Industrial Management	OEC	3	0	0	3	3
6	23OMG976	Entrepreneurship and Business Opportunities	OEC	3	0	0	3	3
7	23OMG977	Modern Business Administration and Financing	OEC	3	0	0	3	3
8	23OMG978	Essentials of Management	OEC	3	0	0	3	3

OPEN ELECTIVE – SAFETY RELATED COURSES

Sl. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Periods	Credits
				L	T	P		
1	23OAU981	Automotive Safety	OEC	3	0	0	3	3
2	23OCE981	Disaster Management	OEC	3	0	0	3	3
3	23OME981	Industrial Safety	OEC	3	0	0	3	3

SEMESTER-WISE CREDIT DISTRIBUTION

SEMESTER	HSMC	BSC	ESC	PCC	DEC	OEC	EEC	Total
Semester I	5	11	5					**21**
Semester II	4	7	9	5				**25**
Semester III	3	4		13				**20**
Semester IV		4		13	6		1	**24**
Semester V			2	10	6	3	2	**23**
Semester VI			5	7	6	3	3	**24**
Semester VII			2	13		3	5	**23**
Semester VIII							10	**10**
B. E. – Aerospace Engineering	**12**	**26**	**23**	**61**	**18**	**9**	**21**	**170**

SEMESTER –I

23IP101	INDUCTION PROGRAMME	L	T	P	C
		-	-	-	0

COURSE OBJECTIVES:

- This is a mandatory 2 weeks 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 objectives
- 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

- **Physical Activity**

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

- **Life skills**

Every student would choose one skill related to daily needs such as stitching, accounting, finance management, etc.,

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 dos and don'ts, 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.

Club Activity

Students will be introduced to more than 20 Clubs available in the college-both technical and non-technical. The student can choose as to which club the student will enroll in.

Value Based Communication

This module will focus on improving the communication skills of students

Lectures by Alumni

Lectures by alumni are arranged to bring in a sense of belonging to the student towards the institution and also to inspire them to perform better

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

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
Address by different heads
Heads of Placement, Training, Student affairs, counsellor, etc would be interacting with the students to introduce them to various measures taken in the institution for the betterment of students.
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

<table>
<tr><td>23HS101</td><td colspan="2">ESSENTIAL COMMUNICATION</td><td>L
3</td><td>T
0</td><td>P
0</td><td>C
3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">To help learners extract information from short and simple correspondence
To familiarize learners with different text structures by engaging them in reading, writing and grammar learning activities
To help learners write coherent, short paragraphs and essays
To enable learners to use language efficiently while expressing their opinions via various media.</td></tr>
<tr><td>UNIT I</td><td colspan="5">FORMATION OF SENTENCES</td><td>9</td></tr>
<tr><td colspan="7">Reading- Read pictures-notices- short comprehension passages and recognize main ideas and specific details. Writing- framing simple and compound sentences, completing sentences, developing hints, writing text messages. Language development- Parts of Speech, Wh- Questions, yes or no questions, direct and indirect questions. Vocabulary development– prefixes- suffixes- articles – countable and uncountable nouns</td></tr>
<tr><td>UNIT II</td><td colspan="5">NARRATION AND DESCRIPTION</td><td>9</td></tr>
<tr><td colspan="7">Reading – Read short narratives and descriptions from newspapers, dialogues and conversations. Reading strategies and practices. Language development – Tenses- simple present, present continuous, present perfect, simple past, past continuous, past perfect, simple future, future continuous, past participle, pronouns. Vocabulary development- guessing meanings of words in context. Writing – Write short narrative paragraphs, biographies of friends/relatives - writing- topic sentence- main ideas- free writing, short narrative descriptions using some suggested vocabulary and structures.</td></tr>
</table>

UNIT III	**COMPARING AND CONTRASTING**	**9**
Reading- short texts and long texts -understanding different types of text structures, -coherence-jumbled sentences. Language development- degrees of comparison, concord- Vocabulary development – single word substitutes- discourse markers- use of reference words Writing - comparative and contrast paragraphs writing- topic sentence- main idea, free writing, compare and contrast using some suggested vocabulary and structures.		
UNIT IV	**SOCIAL MEDIA COMMUNICATION**	**9**
Reading- Reading blogs, social media reviews, posts, comments, process description, Language development - relative clause, Vocabulary development- social media terms-words, abbreviations and acronyms Writing- -e-mail writing-conventions of personal email, descriptions for simple processes, critical online reviews, blog, website posts, commenting to posts.		
UNIT V	**ESSAY WRITING**	**9**
Reading- Close reading non-technical longer texts Language development - modal verbs, phrasal verbs- Vocabulary development - collocation. Writing- Writing short essays- brainstorming – developing an outline- identifying main and subordinate ideas.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Summarize simple, level-appropriate texts of around 300 words recognizing main ideas and specific details.
CO2:	Demonstrate the understanding of more complex grammatical structures and diction while reading and writing.
CO3:	Use appropriate expressions to describe, compare and

	contrast people, things, situations etc., in writing.
CO4:	Establish the ability to communicate effectively through emails.
CO5:	Determine the language use appropriate for different social media platforms.
CO6:	Use appropriate expressions for narrative descriptions and process descriptions.
TEXT BOOKS:	
1	Susan Proctor, Jack C. Richards, Jonathan Hull. Interchange Level 2. Cambridge University Press and Assessment
2	Susan Proctor, Jack C. Richards, Jonathan Hull. Interchange Level 3. Cambridge University Press and Assessment
REFERENCES:	
1	Dutt P. Kiranmai and Rajeevan Geeta. Basic Communication Skills, Foundation Books: 2013
2	Means,L. Thomas and Elaine Langlois. English & Communication for Colleges. Cengage Learning , USA: 2007

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	-	-	-	-	1	1	-	2	3	-	2	-	-	-
2	-	-	-	-	-	-	-	-	2	3	-	2	-	-	-
3	-	-	-	-	-	1	1	-	2	3	-	2	-	-	-
4	-	-	-	-	-	-	-	-	-	3	-	2	-	-	-
5	-	-	-	-	-	1	1	-	3	3	-	2	-	-	-
6	-	-	-	-	-	1	1	-	3	3	-	2	-	-	-
Overall Correlation	-	-	-	-	-	**1**	**1**	-	**3**	**3**	-	**2**	-	-	-

Recommended by Board of Studies	**02-08-2023**		
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<table>
<tr><td rowspan="2">23MA101</td><td rowspan="2">MATRICES AND CALCULUS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">
• To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
• To familiarize the students with differential calculus.
• To familiarize the student with functions of several variables. This is needed in many branches of engineering.
• To make the students understand various techniques of integration.
• To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications
</td></tr>
<tr><td>UNIT I</td><td colspan="4">MATRICES</td><td>9</td></tr>
<tr><td colspan="6">Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigenvalues and Eigenvectors – Cayley - Hamilton theorem – Diagonalization of matrices by orthogonal transformation – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms – Applications: Stretching of an elastic membrane.</td></tr>
<tr><td>UNIT II</td><td colspan="4">DIFFERENTIAL CALCULUS</td><td>9</td></tr>
<tr><td colspan="6">Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules (sum, product, quotient, chain rules) - Implicit differentiation - Logarithmic differentiation - Applications : Maxima and Minima of functions of one variable.</td></tr>
<tr><td>UNIT III</td><td colspan="4">FUNCTIONS OF SEVERAL VARIABLES</td><td>9</td></tr>
<tr><td colspan="6">Partial differentiation – Homogeneous functions and Euler‘s theorem – Total derivative – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor‘s series for functions of two variables – Applications: Maxima and minima of functions of two variables and Lagrange‘s method of undetermined multiplier.</td></tr>
<tr><td>UNIT IV</td><td colspan="4">INTEGRAL CALCULUS</td><td>9</td></tr>
<tr><td colspan="6">Definite and Indefinite integrals - Substitution rule - Techniques of</td></tr>
</table>

Integration: Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.		
UNIT V	**MULTIPLE INTEGRALS**	**9**
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.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Apply the matrix algebra techniques and applications in Engineering Problems.	
CO2:	Make use of the concept of limits and rules of differentiation to differentiate functions	
CO3:	Find the derivative of functions of several variables	
CO4:	Examine the application of partial derivatives	
CO5:	Compute integrals by different techniques of Integration.	
CO6:	Apply the concept of integration to compute multiple integrals.	
TEXT BOOKS:		
1	Kreyszig. E, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2016.	
2	James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 8th Edition, New Delhi, 2015.	
REFERENCES:		
1	Dr.P.Sivaramakrishnadas, Dr.C.Vijayakumari., ― Matrices and Calculus‖ Pearson Publications Andrews. L.C and Shivamoggi. B, "Integral Transforms for Engineers" SPIE Press, 1999.	
2	Anton. H, Bivens. I and Davis. S, " Calculus ", Wiley, 10th Edition, 2016	

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	Narayanan. S. and Manicavachagom Pillai.T. K., —Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
6	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
Overall Correlation	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-

Recommended by Board of Studies	**02-08-2023**		
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23AD101	PROGRAMMING IN PYTHON	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To know the basics of Programming.
- To convert an algorithm into a Python program.
- To construct Python programs with control structures.
- To structure a Python Program as a set of functions.
- To use Python data structures-lists, tuples, dictionaries and files.

UNIT I	COMPUTATIONAL THINKING	9

Introduction to Computing and Problem Solving: Fundamentals of Computing –Computing Devices – Identification of Computational Problems – Pseudo Code and Flowcharts – Instructions – 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).

UNIT II	INTRODUCTION TO PYTHON	9

Introduction to Python Programming: Python Interpreter and Interactive Mode– Variables and Identifiers – Arithmetic Operators – Values and Types – Statements, Reading Input, Print Output, Type Conversions, type () Function and Is Operator, Dynamic and Strongly Typed Language. Control Flow Statements: if, if…else, if…elif…else Decision Control Statements, Nested if Statement, while Loop, for Loop, continue and break Statements.

UNIT III	FUNCTIONS AND STRINGS	9

Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the Function, The return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, *args and **kwargs, Command Line Arguments. Strings: Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index

Number, String Slicing and Joining, String Methods, Formatting Strings.		
UNIT IV	**LISTS, TUPLES, DICTIONARIES AND FILES**	**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. Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages.		
UNIT V	**OBJECT-ORIENTED AND FUNCTIONAL PROGRAMMING**	**9**
Object-Oriented Programming: Classes and Objects, Creating Classes in Python,Creating Objects in Python, The Constructor Method, Classes with Multiple Objects, Class Attributes versus Data Attributes, Encapsulation, Inheritance, Polymorphism. Functional Programming: Lambda. Iterators, Generators, List Comprehensions.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Develop algorithmic solutions to simple computational problems.
CO2:	Develop and execute simple Python programs using Control Statements
CO3:	Develop simple Python programs for solving problems using Functions and Strings
CO4:	Build a Python program using lists, tuples, dictionaries and files.
CO5:	Construct a code related to Object-Oriented.
CO6:	Construct a code related to Functional Programming.
TEXT BOOKS:	
1	Allen B. Downey, ``Think Python: How to Think Like a Computer Scientist'', 2nd edition, Updated for Python 3,

	Shroff/O'Reilly Publishers, 2016 (http://greenteapress.com/wp/think- python/).
2	Karl Beecher, "Computational Thinking: A Beginner's Guide to Problem Solving and Programming", 1st Edition, BCS Learning & Development Limited, 2017.
REFERENCES:	
1	Learning To Program with Python. Richard L. Halterman. Copyright © 2011
2	Python for Everybody, Exploring Data Using Python 3. Dr. Charles R. Severance. 2016.
3	Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
4	G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
5	John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press , 2021
6	Eric Matthes, "Python Crash Course, A Hands - on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
7	https://www.python.org/
8	Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	1	-	-	-	-	1	3	1	-
2	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
3	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
4	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
5	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
6	3	2	1	1	1	-	-	1	1	1	1	1	3	1	1
Overall Correlation	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**3**	**1**	**1**

Recommended by Board of Studies	**02-08-2023**		
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23HS102	HERITAGE OF TAMILS	L	T	P	C
		1	0	0	1

COURSE OBJECTIVES:

- Explain the classical literature of Tamil and highlight notable Tamil poets.
- Explain the creation of traditional Tamil musical instruments.
- Explain the sports and games associated with Tamil heritage.
- Explore the education and literacy practices during the Sangam period.
- Explain the contributions of Tamils to the Indian freedom struggle.
- Explain the development and history of printing in Tamil Nadu.

UNIT I	LANGUAGE AND LITERATURE	3

Language Families in India – Dravidian Languages – Tamil as a Classical 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		
UNIT V	**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

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1	Explain the evolution of Tamil language and literature, focusing on its cultural, ethical, and secular themes.
CO2	Outline the making of musical instruments related to Tamil heritage.
CO3	Discuss the sports and games of Tamils
CO4	Explain the education and literacy during Sangam age.
CO5	Express the importance and contribution of Tamils to Indian Freedom Struggle
CO6	Outline the print history of books in Tamil Nadu

TEXT BOOKS:	
1	தமிழக வரலாறு-மக்களும் பண்பாடும்-கே.கேபிள்ளை (வெளியீடு: தமிழ்நாடு பாடநூல் மற்றும் கல்வியியல் பணிகள் கழகம்).
2	கணினித்தமிழ் – முனைவர் இல. சுந்தரம் (விகடன் பிரசுரம்).
REFERENCES:	
1	**கீழடி- வைகை நதிக்கரையில் சங்க கால நகர நாகரிகம்** (**தொல்லியல் துறை வெளியீடு)**
2	பொருனை- ஆற்றங்கரை **நாகரிகம்** (**தொல்லியல் துறை வெளியீடு)**

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
2	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
3	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
4	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
5	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
6	-	-	-	-	-	2	2	-	-	-	-	-	-	-	-
Overall Correlation		**-**	**-**	**-**	**-**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Recommended by Board of Studies								**02-08-2023**							
Approved								**1st ACM**		**Date**			**09-09-2023**		

<table>
<tr><td rowspan="2">23PH111</td><td rowspan="2" colspan="2">ENGINEERING PHYSICS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">

To make the students effectively achieve an understanding of mechanics.
To enable the students to gain knowledge of electromagnetic waves and its applications.
To introduce the basics of optics and lasers.
To equip the students successfully understand the importance of quantum physics.
To motivate the students towards the applications of quantum mechanics.

</td></tr>
<tr><td>UNIT I</td><td colspan="5">MECHANICS</td><td>9</td></tr>
<tr><td colspan="7">Types of stress, Stress-strain diagram and its uses- factors affecting elastic modulus- tensile strength- Bending of beams, bending moment – theory and experiment: Uniform and non-uniform bending, Center of mass (CM) – CM of continuous bodies –rod, motion of the CM. Rotation of rigid bodies: Rotational kinematics – rotational kinetic energy and moment of inertia - theorems of M .I –moment of inertia of rod, disc, solid sphere – M.I of a diatomic molecule - torque -rotational energy state of a rigid diatomic molecule – M.I of disc by torsional pendulum</td></tr>
<tr><td>UNIT II</td><td colspan="5">ELECTROMAGNETIC WAVES</td><td>9</td></tr>
<tr><td colspan="7">Concept of field-introduction to gradient, divergence and curl of field – Stokes theorem (No proof)-Gauss divergence theorem (No proof) - The Maxwell’s equations in integral form and differential form - wave equation; Plane electromagnetic waves in vacuum - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - Energy and momentum in EM waves-Poynting’s vector - Cell-phone reception.</td></tr>
<tr><td>UNIT III</td><td colspan="5">OPTICS AND LASERS</td><td>9</td></tr>
</table>

Reflection and refraction of light waves - total internal reflection – types of optical fiber, Numerical Aperture and acceptance angle - interference –Theory of air wedge and experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients(Qualitative) - population inversion - CO_2 laser, semiconductor laser (Homo junction) - Applications of lasers in industry.		
UNIT IV	**BASIC QUANTUM MECHANICS**	**9**
Photons and light waves - Electrons and matter waves –Compton effect - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization –Free particle - particle in a infinite potential well: 1D,2D and 3D Boxes- Normalization, probabilities and the correspondence principle.		
UNIT V	**ADVANCED QUANTUM MECHANICS**	**9**
The harmonic oscillator(qualitative)- Barrier penetration and quantum tunneling(qualitative)- Tunneling microscope - Resonant diode - Finite potential wells (qualitative)- Bloch's theorem for particles in a periodic potential –Basics of Kronig-Penney model and origin of energy bands.		
		TOTAL: 45 PERIODS
PRACTICAL EXERCISES: (Any Seven Experiments)		
1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of regular and irregular objects 2. Simple harmonic oscillations of cantilever 3. Non-uniform bending- Determination of Young's modulus 4. Uniform bending–Determination of Young's modulus 5. Laser-Determination of the wavelength of the laser using grating 6. Airwedge- Determination of thickness of a thinsheet /wire		

	7. a) Optical fibre-Determination of Numerical Aperture and acceptance angle b) Compact disc-Determination of width of the groove using laser. 8. Acoustic grating-Determination of velocity of ultrasonic waves in liquids. 9. Ultrasonic interferometer–determination of the velocity of sound and compressibility of liquids 10. Post office box-Determination of Band gap of a semiconductor. 11. Photoelectric effect 12. Michelson Interferometer. 13. Melde's string experiment 14. Experiment with lattice dynamics kit.
TOTAL: 30 PERIODS	
COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Determine the mechanical properties of materials.
CO2:	Apply the principles of electromagnetic waves to real world system.
CO3:	Determine the thickness of thin wire and the characteristic parameter of an optical fiber.
CO4:	Apply the principles of lasers to real world application.
CO5:	Organize the quantum mechanical properties of particles and waves.
CO6:	Utilize the quantum mechanical principles towards the formation of energy bands.
TEXT BOOKS:	
1	D.Kleppner and R.Kolenkow, "An Introduction to Mechanics", McGraw Hill Education (Indian Edition), 2017.
2	Arthur Beiser, Shobhit Mahajan, S. Rai Choudhury, "Concepts of Modern Physics", McGraw-Hill (Indian Edition), 2017.

REFERENCES:	
1	R.Wolfson," Essential University Physics", Volume 1 & 2. Pearson Education (Indian Edition), 2009.
2	Paul A. Tipler, "Physic – Volume 1 & 2", CBS, (Indian Edition), 2004.
3	K.Thyagarajan and A.Ghatak,"Lasers: Fundamentals and Applications," Laxmi Publications, (Indian Edition), 2019.
4	D.Halliday, R.Resnick and J.Walker, "Principles of Physics", Wiley (Indian Edition), 2015.
5	N.Garcia, A.Damask and S.Schwarz, "Physics for Computer Science Students",Springer Verlag, 2016.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
6	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
Overall Correlation	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-

Recommended by Board of Studies	02-08-2023		
Approved	1st ACM	Date	09-09-2023

23CY111	ENGINEERING CHEMISTRY	L	T	P	C
		3	0	1	4

COURSE OBJECTIVES:

- To inculcate sound understanding of water quality parameters and water treatment techniques.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To introduce the basic concepts and applications of phase rule and composites.
- To facilitate the understanding of different types of fuels, their preparation, properties and combustion characteristics.
- To familiarize the students with the operating principles, working processes and applications of energy conversion and storage batteries.

UNIT I	WATER AND ITS TREATMENT	9

Water: Sources and impurities, Water quality parameters: Definition and significance of-color, odour, turbidity, pH, hardness, alkalinity, TDS, COD and BOD, flouride and arsenic. Sewage treatment primary treatment and disinfection (UV, Ozonation, break-point chlorination). Hardness-Estimation of Hardness of water by EDTA-numerical Problems-Desalination of brackish water: Reverse Osmosis. Boiler troubles: Scale and sludge, Boiler corrosion, Caustic embrittlement, Priming &foaming. Treatment of boiler feed water: Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) and External treatment – Ion exchange demineralization and zeolite process

UNIT II	NANOCHEMISTRY	9

Basics: Distinction between molecules, nanomaterials and bulk materials; Size-dependent properties (optical, electrical, mechanical and magnetic); Types of nanomaterials (Metal oxide and Metal) Synthesis and Characterization of nanomaterials: sol-gel, solvothermal, laser ablation, chemical

vapour deposition, electrochemical deposition and electro spinning. Applications of nanomaterials in medicine, energy, sensor , electronics and catalysis.		
UNIT III	**PHASE RULE AND COMPOSITES**	**9**
Phase rule: Introduction, definition of terms with examples. One component system – water system; CO_2 system; Reduced phase rule; Two component system: lead-silver system – Pattinson process. Composites: Definition & Need for composites; Constitution: Matrix materials (Polymer matrix, metal matrix and ceramic matrix) and Reinforcement (fiber, particulates, flakes and whiskers). Properties and applications of: Metal matrix composites (MMC), Ceramic matrix composites and Polymer matrix composites. Hybrid composites – definition and examples.		
UNIT IV	**FUELS AND COMBUSTION**	**9**
Fuels: Fossil Fuels, Classification of fuels; 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 sequestration, Green Hydrogen.		
UNIT V	**ENERGY SOURCES AND STORAGE DEVICES**	**9**
Nuclear fission and fusion- 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 and its advanced technology, supercapacitor.	
TOTAL: 45 PERIODS	
LIST OF EXPERIMENTS **TOTAL: 30 PERIODS**	
1. Determination of hardness causing salts in water sample by EDTA method. 2. Determination of alkalinity in water sample. 3. Determination of chloride content of water sample by argentometric method. 4. Determination of strength of given Barium chloride using conductivity meter. 5. Determination of strength of Acid using pH meter. 6. Determination of strength of FAS by potentiometer 7. Determination of strength of acids in a mixture using conductivity meter. 8. Preparation of nanoparticles (TiO_2/ZnO/CuO) by Sol-Gel method. **9.** Estimation of Nickel in steel	
COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Interpret the quality of water from quality parameter data and propose suitable treatment methodologies to treat water.
CO2:	Illustrate the basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.
CO3:	Estimate the knowledge of phase rule and composites for material selection requirements
CO4:	Choose a suitable fuel for engineering processes and applications
CO5:	Relate the different forms of energy resources and apply them for suitable applications in energy sectors.
CO6:	Explain the different types of batteries, fuel cells and working principles of Electric vehicles

TEXT BOOKS:	
1	P. C. Jain and Monica Jain, “Engineering Chemistry”, 17th Edition, Dhanpat Rai 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.Grewal.B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 44^{th} Edition, 2018.
REFERENCES:	
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, 2014New Delhi, 2018.
4	ShikhaAgarwal, “Engineering Chemistry-Fundamentals and Applications”, Cambridge University Press, Delhi, Second Edition, 2019
5	O.V. Roussak and H.D. Gesser, Applied Chemistry-A Text Book for Engineers and Technologists, Springer Science Business Media, New York, 2nd Edition, 2013

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	-	2	-	-	-	-	1	2	-	-
2	2	1	-	-	-	-	2	-	-	-	-	1	2	-	-
3	2	1	-	-	-	-	2	-	-	-	-	1	2	-	-
4	3	2	1	1	-	-	3	-	-	-	-	2	3	-	-
5	3	2	1	1	-	-	3	-	-	-	-	2	3	-	-
6	2	1	-	-	-	-	2	-	-	-	-	1	2	-	-
Overall Correlation	**3**	**2**	**1**	**1**	**-**	**-**	**3**	**-**	**-**	**-**	**-**	**2**	**3**	**-**	**-**

Recommended by Board of Studies	**28-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23AD121	PYTHON PROGRAMMING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

The main objective of this laboratory is to put into practice computational thinking. The students will be expected to write, compile, run and debug Python programs to demonstrate the usage of:

- Operators and Conditional Statements
- Control Structures and Functions (both recursive and iterative) and Recursion.
- String functions
- Lists, Sets, Dictionaries, Tuples and Files.
- Object-Oriented Programming

Exercise 1	**Programs to demonstrate the usage of operators and conditional statements.**

1. Write a program that takes two integers as command line arguments and prints the sum of two integers.
2. Program to display the information:
   Your name, Full Address, Mobile Number, College Name, Course Subjects
3. Program that reads the URL of a website as input and displays contents of a webpage.

Exercise 2	**Programs to demonstrate usage of control structures.**

4. Program to find the sum of all prime numbers between 1 and 1000.
5. Program to find the product of two matrices.
6. Program to find the roots of a quadratic equation.

Exercise 3	**Programs to demonstrate the usage of Functions and Recursion**

7. Write both recursive and non-recursive functions for the following:
   a. To find GCD of two integers
   b. To find the factorial of positive integer
   c. To print Fibonacci Sequence up to given number ‗n‘

	d. To convert decimal number to Binary equivalent 8. Program with a function that accepts two arguments: a list and a number ‗n‘. It should display all the numbers in the list that are greater than the given number ‗n‘. 9. Program with a function to find how many numbers are divisible by 2, 3,4,5,6 and 7 between 1 to 1000.
Exercise 4	**Programs to demonstrate the usage of String functions.**
	10. Program that accepts two strings S1, S2, and finds whether they are equal are not. 11. Program to count the number of occurrences of characters in each string. 12. Program to find whether a given string is palindrome or not.
Exercise 5	**Programs to demonstrate the usage of lists, sets, dictionaries, tuples and files.**
	13. Simple sorting, Histogram, Students marks statement, Retail bill preparation 14. Write a program that combines lists L1 and L2 into a dictionary. 15. Program to display a list of all unique words in a text file and word count, copy file, Voter‘s age validation, Marks range validation (0-100).
Exercise 6	**Programs to demonstrate the usage of Object-Oriented Programming**
	16. Program to implement the inheritance. 17. Program to implement polymorphism
	TOTAL: 60 PERIODS
COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Develop algorithmic solutions to simple computational problems.
CO2:	Develop and execute simple Python programs.
CO3:	Construct programs in Python using conditionals and loops

	for solving problems.
CO4:	Utilize functions to decompose a Python program.
CO5:	Analyse compound data using Python data structures.
CO6:	Interpret data from/to files in Python Programs

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	1	-	-	-	-	1	3	1	-
2	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
3	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
4	3	2	1	1	1	-	-	-	-	-	-	1	3	1	-
5	3	3	2	2	1	-	-	-	-	-	-	1	3	1	-
6	2	1	-	-	1	-	-	1	1	1	1	1	3	1	1
Overall Correlation	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**3**	**1**	**1**

Recommended by Board of Studies	**02-08-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23HS121	COMMUNICATION SKILLS LABORATORY	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To enable the students to comprehend the main idea and specific information of the listening passage
- To help students express themselves clearly, and communicate effectively with others.
- To introduce authentic language use and context-specific vocabulary that might not be encountered in textbooks.

Exercise : 1	Listening to conversations set in everyday social context and complete gap-filling exercise
Exercise : 2	Listening to a monologue in everyday social context. Diagram labelling and MCQ
Exercise : 3	Listening to a group conversation in academic setting and answer MCQ
Exercise : 4	Listening to a lecture and answer MCQ or gap filling
Exercise : 5	Listening to Ted Talks, podcasts, documentaries - discussion
Exercise : 6	Listening to a lecture and reading a text on the same subject- compare and contrast
Exercise : 7	Speaking Introducing oneself
Exercise : 8	Answering questions based on the introduction
Exercise : 9	Speaking on a given prompt for 2 mins.
Exercise : 10	Answering questions based on the topic spoken
Exercise : 11	Role play- Engaging in conversation
Exercise : 12	Engaging in Podcast Discussion

TOTAL: 30 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Demonstrate fluency in speaking in variety of situations
CO2:	Express their knowledge by talking continuously for more than two minutes on a topic

CO3:	Develop active listening for more meaningful interactions and conversations
CO4:	Use a full range of structures naturally and appropriately
CO5:	Identify the specific information in conversations, interviews, talks and lectures
CO6:	Develop the ability to compare and analyse different forms of information, identifying key similarities and differences.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	-	-	-	-	1	1	-	2	3	-	2	-	-	-
2	-	-	-	-	-	-	-	-	2	3	-	2	-	-	-
3	-	-	-	-	-	1	1	-	2	3	-	2	-	-	-
4	-	-	-	-	-	-	-	-	-	3	-	2	-	-	-
5	-	-	-	-	-	1	1	-	3	3	-	2	-	-	-
6	-	-	-	-	-	1	1	-	2	3	-	-	-	-	-
Overall Correlation	-	-	-	-	-	**1**	**1**	-	**3**	**3**	-	**2**	-	-	-

Recommended by Board of Studies	**02-08-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

SEMESTER - II

23HS201	PROFESSIONAL ENGLISH	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To help learners extract information from longer, technical and scientific texts
- To familiarize learners with different text structures by engaging them in reading, writing and grammar learning activities
- To help learners write coherent, extensive reports and essays.
- To enable learners to use language efficiently while expressing their opinions in professional and business situations

UNIT I	WORKPLACE COMMUNICATION	9

Reading – Reading brochures (technical context), advertisements, telephone messages, gadget reviews social media messages, digital communication relevant to technical contexts and business. Writing – Writing emails -emails on professional contexts including introducing oneself, writing checklist, writing single sentence definition, product description- advertising or marketing slogans, Language Development– Tenses, Concord, Question types: Wh/ Yes or No/ and Tags, imperative sentences, complex sentences. Vocabulary - One-word substitutes; Abbreviations & Acronyms as used in technical contexts and social media.

UNIT II	EXPRESSING CAUSE AND EFFECT	9

Reading - Reading longer technical texts– Cause and Effect Essays, and emails of complaint. Writing - writing complaint emails (raising tickets) and responses to complaints, writing Cause and effect paragraphs and essays. Language Development– Active, Passive and Impersonal Passive Voice

transformations, Infinitive and Gerunds Vocabulary – Synonyms- contextual meaning of words, Same word acting as different parts of speech, causal expressions.		
UNIT III	**PROVIDING SOLUTIONS TO PROBLEMS**	**9**
Reading - Case Studies, editorials, news reports etc. Writing – Letter to the Editor, Writing instructions and recommendations, Problem solution essay / Argumentative Essay, Language Development – Error correction; If conditional sentences Vocabulary - Compound Words, discourse markers.		
UNIT IV	**INTERPRETATION OF GRAPHICS**	**9**
Reading - Reading newspaper articles, nonverbal communication (charts and graphs) Writing –Transferring information from nonverbal (chart, graph etc, to verbal mode) Process– description. Language development–Possessive & Relative pronouns, numerical adjectives Vocabulary Homonyms and Homophones, sequence words.		
UNIT V	**REPORT WRITING AND RESUME WRITING**	**9**
Reading – Company profiles, journal reports. Language Development– Reported Speech Vocabulary-reporting words and phrases. Writing - Writing accident report, survey report and progress report, project proposal, minutes of the meeting, writing statement of purpose, internship application and resume		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Summarize long technical and scientific text of not less than 500 words recognizing main ideas and specific details
CO2:	Demonstrate the understanding of more complex grammatical structures and diction while reading and writing
CO3:	Use appropriate expressions to describe process and product, compare and contrast data, analyze problems, provide

	solutions and prove an argument in writing
CO4:	Establish the ability to communicate effectively in professional environment through emails and reports
CO5:	Determine the language use appropriate for different social media platforms used for digital marketing
CO6:	Convert skills to assets and position themselves in job market through their own professional narratives
TEXT BOOKS:	
1	V. Chellammal, Deepa Mary Francis, K N Shoba, P R Sujatha Priyadharshini, Veena Selvam, English for Science & Technology I, Cambridge University Press and Assessment
2	V. Chellammal, Deepa Mary Francis, K N Shoba, P R Sujatha Priyadharshini, Veena Selvam, English for Science & Technology II, Cambridge University Press and Assessment
REFERENCES:	
1	Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, Tata McGraw Hill & Co. Ltd., 2001, New Delhi.
2	Developing Communication Skills by Krishna Mohan, Meera Bannerji- Macmillan India Ltd. 1990, Delhi.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	-	-	-	-	1	1	-	2	3	-	2	-	-	-
2	-	-	-	-	-	-	-	-	2	3	-	2	-	-	-
3	-	-	-	-	-	-	1	-	2	3	-	2	-	-	-
4	-	-	-	-	-	-	-	-	2	3	-	2	-	-	-
5	-	-	-	-	-	-	1	-	2	3	-	2	-	-	-
6	-	-	-	-	-	-	-	-	2	3	-	3	-	-	-
Overall Correlation	-	-	-	-	-	1	1	-	2	3	-	3	-	-	-

Recommended by Board of Studies	**02-08-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23MA201	VECTOR CALCULUS AND COMPLEX FUNCTIONS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- To acquaint the student with the concepts of vector calculus, needed for problems in all engineering disciplines. To acquaint the student with Fourier Transform techniques used in wide variety of situations.
- To develop an understanding of the standard techniques of complex functions theory so as to enable the student to apply them with confidence, in application areas. To introduce the basic concepts of probability and random variables
- To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems.
- To make the student appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.

UNIT I	VECTOR CALCULUS	9+3

Gradient and directional derivative – Divergence and curl - 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 (excluding proofs)–Verification and simple application involving cubes and rectangular parallelopipeds.

UNIT II	ANALYTIC FUNCTION	9+3

Functions of complex variable -Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties– Harmonic conjugates–Construction of analytic function- Conformal mapping– w=z+c, cz, 1/z, z2 , Bilinear Transformation

UNIT III	COMPLEX INTEGRATION	9+3
Line integral-Cauchy's integral theorem (exclude proof)– Cauchy's integral formula– Taylor's and Laurent's series - Singularities – Residues – Residue theorem (exclude proof) – Application of residue theorem for evaluation of real definite integrals as contour integrals around contour and semi circular contour (with poles NOT on real axis).		
UNIT IV	**ORDINARY DIFFERENTIAL EQUATIONS**	**9+3**
Higher order linear differential equations with constant coefficients-Method of variation of parameters – Linear Differential equations with variable coefficients - Homogenous equation of Euler's and Legendre's type – System of simultaneous linear differential equations with constant coefficients.		
UNIT V	**LAPLACE TRANSFORMS**	**9+3**
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 (exclude proof) – Transform of periodic functions – Application to solution of linear second order ordinary differential equations with constant coefficients.		
		TOTAL: 60 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Utilize the concept of Vector Calculus needed in different Engineering disciplines.
CO2:	Apply the concepts of analytic functions in solving engineering problems
CO3:	Examine the problems of conformal mappings and Bilinear Transformation
CO4:	Apply the complex integration techniques in solving engineering problems

CO5:	Solve Ordinary Differential Equations that model some Engineering Problems.
CO6:	Make use of the Laplace transform techniques in physical 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, 44th Edition, 2018.

REFERENCES:

1	P.Sivaramakrishna Das and C.Vijayakumari "Engineering Mathematics - II" - Pearson Publications
2	Narayanan. S., Manicavachagom Pillay.T.K and Ramanaiah.G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998.
3	Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
6	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
Overall Correlation	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-

Recommended by Board of Studies	**26-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23PH207	APPLIED PHYSICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To make the students understand the basics of Mechanics and using vectors to analyse them
- To make use Newton's laws of motion for simple systems
- To make students calculate orbital velocity and variation of g
- To help students gain knowledge in biomaterials
- To make students comprehend the various types of magnetic materials and superconductors
- To help the students gain knowledge in metallic glasses, shape memory alloys and nanomaterials.

UNIT I	STATICS OF PARTICLES	9

Introduction – Laws of Mechanics – Lami's theorem, Parallelogram and triangular Law of forces – Vectorial representation of forces – Vector operations of forces -additions, subtraction, dot product, cross product – Coplanar Forces – rectangular components – Equilibrium of a particle - rigid bodies in 2D - Free body diagram –Action and reaction forces –stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis

UNIT II	NEWTON'S LAWS OF MOTION	9

Centroids and centre of mass – Centroids of lines and areas - Rectangular, circular, triangular areas by integration – Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration. Newton's laws of motion- Impulse and Momentum-impact of elastic bodies- law of conservation of momentum- frictional forces-motion in an inclined plane.

UNIT III	GRAVITATION	9

Metallic glasses: types, glass forming ability of alloys, melt spinning process, applications — shape memory alloys: phases, shape memory effect, pseudoelastic effect, NiTi alloy, applications

— nanomaterials: preparation ball milling method, pulsed laser deposition, properties and applications — carbon nanotubes: types.		
UNIT IV	**MAGNETISM AND SUPERCONDUCTIVITY**	**9**
Classification of magnetic materials: diamagnetism, paramagnetism, ferromagnetism, antiferromagnetism and ferrimagnetism - Domain theory of ferro magnetism - Energies involved in the process of domain growth – M versus H behavior – soft and hard magnetic materials - Superconductivity – Zero resistance and the Meissner effect – critical current density - Type I and Type II superconductors – - BCS theory of superconductivity - High temperature superconductor ($YBa_2Cu_3O_7$), magnetic levitation.		
UNIT V	**NEW ENGINEERING MATERIALS**	**9**
Metallic glasses: types, glass forming ability of alloys, melt spinning process, applications — shape memory alloys: phases, shape memory effect, pseudoelastic effect, NiTi alloy, applications — nanomaterials: preparation ball milling method, pulsed laser deposition, properties and applications — carbon nanotubes: types.		
TOTAL: 45 PERIODS		

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply the laws of mechanics to equilibrium of particles.
CO2:	Apply the laws of motion and solve problems related to the motion of objects.
CO3:	Apply the law of gravitation to calculate escape velocity.
CO4:	Make use of the knowledge of magnetization versus magnetic field behavior to identify different magnetic materials
CO5:	Explain various types of superconductors and their applications.

CO6:	Illustrate various methods of preparing new engineering materials.
TEXT BOOKS:	
1	D.Halliday, R.Resnick and J.Walker. Principles of Physics, Wiley (Indian Edition), 2015.
2	Beer, F.P and Johnston Jr. E.R., “Vector Mechanics for Engineers (In SI Units): Statics and Dynamics”, 8th Edition, Tata McGraw-Hill Publishing company, New Delhi (2004)
3	R.Balasubramaniam, Callister’s Materials Science and Engineering. Wiley (Indian Edition), 2014
REFERENCES:	
1	Introduction to Physical Metallurgy, Sidney Avner, McGraw Hill 2017
2	Wendelin Wright and Donald Askeland, Essentials of Materials Science and Engineering, CL Engineering, 2013.
3	Ben Rogers, Jesse Adams and Sumita Pennathur, Nanotechnology: Understanding Small Systems, CRC Press, 2017.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
2	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
5	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
6	2	1	-	-	-	-	-	-	-	-	-	-	2	-	-
Overall Correlation	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**

Recommended by Board of Studies	**26-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

<table>
<tr><td rowspan="2">23AS201</td><td rowspan="2">ELEMENTS OF AEROSPACE ENGINEERING</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">• To use the standard atmosphere tables and equations.
• To find lift and drag coefficient data from NACA plots.
• To know the concept of static stability to flight vehicles.
• To learn the basics of flight propulsion system.
• To learn the basic knowledge of dynamics relevant to orbital mechanics.</td></tr>
<tr><td>UNIT I</td><td colspan="4">BASICS OF FLIGHT AND CONTROLS</td><td>9</td></tr>
<tr><td colspan="6">History of aviation – Different types of flight vehicles – standard atmosphere - pressure, temperature and density altitude- Conventional controls – Powered controls – Basic instruments for Flying-Typical systems for control actuation.</td></tr>
<tr><td>UNIT II</td><td colspan="4">AERODYNAMICS</td><td>9</td></tr>
<tr><td colspan="6">Aerodynamic forces – Lift generation Viscosity and its implications - Shear stress in a velocity profile - Lagrangian and Eulerian flow field - Concept of a streamline – Aircraft terminology and geometry - Aircraft types - Lift and drag coefficients using NACA data.</td></tr>
<tr><td>UNIT III</td><td colspan="4">PERFORMANCE AND PROPULSION</td><td>9</td></tr>
<tr><td colspan="6">Viscous and pressure drag - flow separation - aerodynamic drag - thrust calculations -Thrust /power available and thrust/power required.</td></tr>
<tr><td>UNIT IV</td><td colspan="4">AIRCRAFT STABILITY AND STRUCTURAL THEORY</td><td>9</td></tr>
<tr><td colspan="6">Degrees of freedom of aircraft motions - stable, unstable and neutral stability - concept of static stability - Hooke’s Law- brittle and ductile materials - moment of inertia – section modulus.</td></tr>
</table>

UNIT V	SPACE APPLICATIONS	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:

After completion of the course, the students will be able to:

CO1:	Develop the history of aircraft & developments over the years.
CO2:	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:	Explain various space applications.

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.

REFERENCES:

1	Sadhu Singh, “Internal Combustion Engines and Gas Turbine”, SS Kataraia & Sons, 2015.
2	Kermode, “Flight without Formulae”, Pitman; 4th revised edition 1989.
3	Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	-	-	-	-	-	-	-	-	-	2	-	-
2	3	2	1	1	2	-	-	-	-	-	1	-	2	2	-
3	2	1	1	1	2	-	-	-	-	-	1	-	2	2	-
4	3	2	1	1	2	-	-	-	-	-	1	-	2	2	-
5	3	3	2	1	2	-	-	-	-	-	1	-	2	2	-
6	2	1	1	1	2	-	-	-	-	-	1	-	2	2	-
Overall Correlation	**3**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**2**	**2**	**-**

Recommended by Board of Studies	**26-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

<table>
<tr><td rowspan="2">23HS203</td><td colspan="2" rowspan="2">TAMILS AND TECHNOLOGY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">• To summarize the weaving industry and ceramic technology during Sangam Age
• To explain the design and construction of houses during Sangam Age and the sculptures and temples of Chola,Pallava and Pandya period
• To Explain about the water bodies of Sangam age and relate it to the agricultural usage
• To Outline to students the agriculture and irrigation technology during the Chola Period
• To help students Interpret and explain the digitalization of Tamil books and development of Tamil software</td></tr>
<tr><td>UNIT I</td><td colspan="5">WEAVING AND CERAMIC TECHNOLOGY</td><td>3</td></tr>
<tr><td colspan="7">Weaving Industry during Sangam Age – Ceramic technology – Black and Red Ware Potteries (BRW) – Graffiti on Potteries.</td></tr>
<tr><td>UNIT II</td><td colspan="5">DESIGN AND CONSTRUCTION TECHNOLOGY</td><td>3</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>UNIT III</td><td colspan="5">MANUFACTURING TECHNOLOGY</td><td>3</td></tr>
<tr><td colspan="7">Art of Ship Building - Metallurgical studies - Iron industry - Iron smelting, steel -Copper and gold- Coins 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.</td></tr>
</table>

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

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Summarize the weaving industry and ceramic technology during Sangam Age
CO2:	Explain the design and construction of houses during Sangam Age
CO3:	Explain the sculptures and temples of Chola,Pallava and Pandya period.
CO4:	Explain about the water bodies of Sangam age and relate it to the agricultural usage
CO5:	Outline the agriculture and irrigation technology during the Chola Period.
CO6:	Interpret and explain the digitalization of tamil books and development of Tamil software
TEXT BOOKS:	
1	Dr.K.K.Pillay ,"Social Life of Tamils", A joint publication of TNTB & ESC and RMRL

REFERENCES:	
1	Dr.S.Singaravelu ,"Social Life of the Tamils - The Classical Period", Published by: International Institute of Tamil Studies.
2	Dr.S.V.Subatamanian , Dr.K.D. Thirunavukkarasu, "Historical Heritage of the Tamils", Published by: International Institute of Tamil Studies

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
2	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
3	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
4	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
5	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
6	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-
Overall Correlation	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-

Recommended by Board of Studies	26-07-2023		
Approved	1st ACM	Date	09-09-2023

23EE281	BASIC ELECTRICAL AND ELECTRONICS ENGINEERING	L	T	P	C
		2	0	2	3

COURSE OBJECTIVES:

- To introduce the basics of electric circuits and analysis
- To impart knowledge in the basics of working principles and application of electrical machines
- To introduce analog devices and their characteristics
- To educate on the fundamental concepts of digital electronics, functional elements and working of measuring instruments
- To demonstrate the load test on DC machines, working of PN Junction diodes, Zener diodes and rectifiers.

UNIT I	ELECTRICAL CIRCUITS	6

DC Circuits: Circuit Components: Conductor, Resistor, Inductor, Capacitor– Ohm 's Law-Kirchhoff's Laws -Nodal Analysis, Mesh analysis with independent sources only (Steady State)-Introduction to AC Circuits –Steady state analysis of RL, RC, and RLC circuits (Simple problems only).

UNIT II	ELECTRICAL MACHINES	6

Construction and Working principle of DC Generators, EMF equation, Types and Applications- Working Principle of DC motors, Torque Equation, Types and Applications. - Construction, Working principle and Applications of Single-Phase Transformer.

UNIT III	ANALOG ELECTRONICS	6

PN Junction Diodes, Zener Diode–Characteristics & Applications–Bipolar Junction Transistor, JFET, SCR, MOSFET, – Types, I-V Characteristics and Applications – Rectifier.

UNIT IV	DIGITAL ELECTRONICS	6

Review of number systems, Combinational logic (adder and subtractor) – representation of logic functions-SOP and POS forms, K-map representations and minimization using K-maps (up to 3 variables).

UNIT V	MEASUREMENTS AND INSTRUMENTATION	6
Functional elements of an instrument, Standards and calibration, Operating Principle, types- Moving Coil and Moving Iron meters, Instrument Transformers- CT and PT, DSO-Block Diagram		
		Total : 30 PERIODS

LAB COMPONENT

1. Verification of Ohms and Kirchhoff's Laws.
2. Load test on DC Shunt Motor.
3. Characteristics of PN and Zener Diodes
4. Design and analysis of Half wave and Full Wave rectifiers
5. Implementation of Binary Adder and Subtractor
6. Study of DSO

Total : 30 + 30 = 60 Periods

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Apply fundamental laws to DC electric circuits and demonstrate it experimentally.
CO2:	Explain the steady state AC circuits with RL, RC, and RLC circuits
CO3:	Identify the working principle and applications of electrical machines with experimental results
CO4:	Demonstrate the characteristics of various analog electronic devices
CO5:	Experiment with the basic concepts of digital electronics and demonstrate the implementation of Binary Adder and Subtractor
CO6:	Illustrate the operating principles of measuring instruments and demonstrate DSO for the basic measurements.

TEXT BOOKS:

1	Kothari D P and I.J Nagrath,―Basic Electrical and Electronics Engineering‖ , Second Edition, McGraw Hill Education,2020

2	Sedha R. S.,―A textbook book of Applied Electronics‖, S. Chand & Co.,2008
3	A.K. Sawhney, Puneet Sawhney ‗A Course in Electrical & Electronic Measurements & Instrumentation', Dhanpat Rai and Co, 2015.
REFERENCES:	
1	Kothari D P and I.J Nagrath, ―Basic Electrical Engineering‖, Fourth Edition, Mc Graw Hill Education, 2019.
2	S.K. Bhattacharya ―Basic Electrical and Electronics Engineering‖, Pearson Education, Second Edition, 2017.
3	Thomas L. Floyd, 'Digital Fundamentals', 11th Edition, Pearson Education,2017.
4	Albert Malvino, David Bates, ‗Electronic Principles, McGraw Hill Education; 7th edition, 2017.
5	Mahmood Nahvi and Joseph A. Edminister, ―Electric Circuits‖, 86 Schaum 'Outline Series, McGraw Hill, 2002.
6	H.S. Kalsi, ‗Electronic Instrumentation' , Tata McGraw-Hill, New Delhi, 2010
7	James A. Svoboda, Richard C. Dorf,― Dorf's Introduction to Electric Circuits‖, Wiley, 2018.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	1	1	1	-	1	3	-	1
2	2	1	-	-	-	-	-	1	1	1	-	1	2	-	1
3	3	2	1	1	-	1	1	1	1	1	-	1	3	-	1
4	2	1	-	-	-	1	1	1	1	1	-	1	2	-	1
5	3	2	1	1	-	-	-	1	1	1	-	1	3	-	1
6	2	1	-	-	-	-	-	1	-	-	-	-	3	-	1
Overall Correlation	**3**	**2**	**1**	**1**	**-**	1	1	1	1	1	-	1	**3**	**-**	1

Recommended by Board of Studies	**26-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23ME211	ENGINEERING GRAPHICS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- Gain a solid foundation in the fundamental principles and concepts of engineering graphics, including conic sections, orthographic projection, isometric projection, section views and development of surfaces, perspective projection, and dimensioning.
- Develop graphic skills for communication of concepts, ideas and design of engineering products.
- Gain knowledge on drafting software to construct part models.
- Familiarize with existing national standard practices and conventions related to technical drawings.
- Enhance the ability to visualize objects in three dimensions and translate them into 2D representations.

UNIT I	PLANE CURVES	9+6

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.

LIST OF EXERCISES:

1. Drawing of a title block with necessary text, projection symbol and lettering using drafting software
2. Drafting of Conic curves - Ellipse, Parabola and Hyperbola

UNIT II	PROJECTION OF POINTS, LINES AND PLANE SURFACE	9+6

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. Projection of planes (hexagonal and pentagonal planes only) inclined to both the principal planes by rotating object method.

<table>
<tr><td colspan="3">LIST OF EXERCISES:
1. Draw the projection of points when it is placed in different quadrants
2. Draw the projection of lines when it is placed in first quadrant
3. Draw the planes when it is placed in first quadrant.</td></tr>
<tr><td>UNIT III</td><td>PROJECTION OF SOLIDS AND FREE HAND SKETCHING</td><td>9+6</td></tr>
<tr><td colspan="3">Projection of simple solids - hexagonal prism, pentagonal pyramid and cone inclined to the horizontal plane by rotating object method. Free Hand sketching: Visualization principles - Representation of Three Dimensional objects - Layout of views - Free hand sketching of multiple views from pictorial views of objects
LIST OF EXERCISES:
1. Practicing three dimensional modelling of simple objects.
2. Drawing of orthographic views from the given pictorial diagram</td></tr>
<tr><td>UNIT IV</td><td>PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES</td><td>9+6</td></tr>
<tr><td colspan="3">Sectioning of hexagonal prism, pentagonal pyramid and cone when the cutting plane is inclined to the horizontal plane, Development of lateral surfaces of simple and sectioned solids – hexagonal prism and cone cut by a plane inclined to horizontal plane only.
LIST OF EXERCISES:
1. Draw the sectioned views of prisms and pyramids
2. Draw the development of hexagonal prism cut by a section plane inclined to the horizontal plane</td></tr>
<tr><td>UNIT V</td><td>ISOMETRIC PROJECTION</td><td>9+6</td></tr>
<tr><td colspan="3">Principles of isometric projection - Isometric scale – Isometric view - Isometric projections of simple solids and truncated solids - Prisms, pyramids, cylinders, cones- combination of two solid objects in simple vertical positions.</td></tr>
</table>

LIST OF EXERCISES: 1. Drawing Isometric view and projection of simple solids. 2. Drawing three dimensional modeling of isometric projection of combination of solids.	
TOTAL: 75 PERIODS	
COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Construct the conic curves, involutes and cycloids.
CO2:	Develop and Sketch the orthographic projections of points, lines and plane surfaces.
CO3:	Develop and Sketch the orthographic projections of simple solids.
CO4:	Construct the projections of sectioned solids and development of the lateral surfaces of solids.
CO5:	Develop and Sketch the isometric sections of solids.
CO6:	Develop and Sketch the orthographic projection 2D and 3D objects using Auto CAD.
TEXT BOOKS:	
1	Bhatt N.D. and Panchal V.M., —Engineering Drawing‖, Charotar Publishing House, 53rd Edition, 2019.
2	Basant Agarwal and Agarwal C.M.,—Engineering Drawing‖, McGraw Hill, 2nd Edition, 2019
REFERENCES:	
1	Natrajan K.V., —A Text Book of Engineering Graphics‖, Dhanalakshmi Publishers, Chennai, 2018.
2	Gopalakrishna K.R., —Engineering Drawing‖ (Vol. I and II combined), Subhas Publications, Bangalore, 27th Edition, 2017.
3	Luzzader, Warren.J. and Duff, 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.

4	Parthasarathy N. S. and Vela Murali, ―Engineering Graphics‖, Oxford University, Press, New Delhi, 2015. 5. Shah M.B., and Rana B.C., ―Engineering Drawing‖, Pearson Education India, 2nd Edition, 2009.
5	Venugopal K. and Prabhu Raja V., ―Engineering Graphics", New Age International (P) Limited, 2008.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-
2	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-
3	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-
4	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-
5	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-
6	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-
Overall Correlation	3	2	1	1	2	-	-	1	-	3	2	2	2	2	-

Recommended by Board of Studies	**26-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23ME221	ENGINEERING PRACTICES LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- Familiarize students with basic engineering tools and equipment.
- Educate students on the importance of safety practices, including proper handling of equipment, adherence to safety protocols, and understanding potential hazards in the laboratory environment. Develop basic manufacturing and fabrication skills.
- Provide hands on training to the students in plumbing and woodworking.
- Provide hands on training to the students in welding various joints in steel plates using arc welding work; Machining various simple processes like turning, drilling, tapping in parts; Assembling simple mechanical assembly of common household equipment; Making a tray out of metal sheet using sheet metal work.
- Demonstrate the wiring and measurement methods in common household electrical applications.
- Study the basic electronic components, gates and provide hands on training in soldering.

GROUP A (CIVIL and MECHANICAL)

PART I	CIVIL ENGINEERING PRACTICES	15

PLUMBING WORK

a) Connecting various basic pipe fittings like valves, taps, coupling, unions, reducers, elbows and other components which are commonly used in households.
b) Preparation of 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.

WOOD WORK

a) Sawing
b) Planning
c) Making of T-Joint, Mortise joint and Tenon joint and Dovetail joint.

WOOD WORK STUDY

a) Study of joints in door panels and wooden furniture
b) Study of common industrial trusses using models.

PART II	**MECHANICAL ENGINEERING PRACTICES**	**15**

WELDING WORK

a) Study of Welding and its tools.
b) Welding of Butt Joints, Lap Joints and Tee Joints by metal arc welding.
c) Study of Gas Welding.

BASIC MACHINING PRACTICE

a) Facing and Plain Turning
b) Taper Turning
c) Drilling and Tapping

SHEET METAL WORK

a) Forming and Bending
b) Making of a square Tray

MACHINE ASSEMBLY WORK

a) Study of Centrifugal Pump
b) Study of Air Conditioner

FOUNDRY PRACTICE

Demonstration on Foundry operations like mould preparation.

TOTAL: 30 PERIODS

GROUP B (ELECTRICAL & ELECTRONICS)		
PART III	**ELECTRICAL ENGINEERING PRACTICES**	**15**
1. Residential House wiring using Switches, Fuse, Indicators, Lamp and Energy Meter. 2. Staircase Wiring. 3. Fluorescent Lamp Wiring with Introduction to CFL and LED Types. 4. Measurement of Energy using Single Phase Energy Meter. 5. Study of Iron Box Wiring and Assembly **6.** Study of Fan Regulator – Electronic Type		
PART IV	**ELECTRONICS ENGINEERING PRACTICES**	**15**
1. Study of Electronic components and equipment – Resistors, Colour coding measurement of AC signal parameter (peak-peak, RMS period, frequency) using CRO. 2. Study of logic gates AND, OR, EX-OR and NOT. 3. Generation of Clock Signal. 4. Soldering simple electronic circuits and checking continuity. 5. Study the elements of smart phone 6. Study of LED TV (Block diagram		
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Plan the pipeline layout for common household plumbing work.	
CO2:	Make use of welding equipment and carpentry tool for making joints.	
CO3:	Demonstrate on centrifugal pump, air conditioner and foundry operations.	
CO4:	Demonstrate the electrical wiring connections for household applications and study the working of iron box and fan regulator.	

CO5:	Identify the basic electronic components and explain the gates and soldering methods.
CO6:	Examine the performance and operation of CRO, LED TV and Smart phone.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	1	-	-	2	2	2	2	1	-
2	3	2	1	1	1	1	1	-	-	2	2	2	2	1	-
3	3	2	1	1	1	1	1	-	-	2	2	2	2	1	-
4	3	2	1	1	1	1	1	-	-	2	2	2	2	1	-
5	3	2	1	1	1	1	1	-	-	2	2	2	2	1	-
6	3	2	1	1	1	1	1	-	-	2	2	2	2	1	-
Overall Correlation	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**-**	**-**	**2**	**2**	**2**	**2**	**1**	**-**

Recommended by Board of Studies	**26-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23AS221	AEROSPACE MODELLING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To learn the theories behind flight.
- To learn the art of making model airplanes.
- To learn problem solving skills related to flight principles and interpretation of experimental data.
- To determine error in experimental measurements and techniques used to minimize such error.
- To make the student as an active participant in each part of all lab exercises.

LIST OF EXPERIMENTS:

1. Introduction to wing plan forms and Aerofoil
2. Introduction to Gliders & its Design calculation.
3. Fabrication of Un-powered Gliders.
4. Flight Simulation of RC plane using simulators
5. Fabrication of aerofoil
6. Connection test on RC Plane electronics
7. Design calculation of RC plane
8. Design and Fabrication of CUBE SAT.
9. Design and Fabrication of CAN SAT.
10. Design and Fabrication of NANO SAT.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Explain the principles of flight.
CO2:	Inspect the importance of c.g location in an aircraft.
CO3:	Design airplane models.

CO4:	Evaluate airplane models.
CO5:	Survey the flying of model airplanes.
CO6:	Examine the importance of flight control systems.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	1	-	-	2	-	1	3	1	-
2	3	2	1	1	1	1	1	1	-	2	-	2	3	1	1
3	3	3	3	3	1	2	-	-	-	1	-	1	3	1	-
4	3	3	3	2	1	-	1	-	-	2	-	1	3	1	-
5	3	2	1	1	1	1	1	1	-	2	-	2	3	1	1
6	3	2	1	1	1	2	-	-	-	1	-	1	3	1	-
Overall Correlation	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**-**	**2**	**-**	**2**	**3**	**1**	**1**

Recommended by Board of Studies	**26-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

23ES291	SOFT SKILLS	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To help learners improve their interpersonal skills and critical thinking
- To familiarize learners with the attributes of a leader to enhance team performance
- To prepare students to face job interviews
- To help learners to know the importance of ethics in work place

UNIT I	INTERPERSONAL COMMUNICATION	

Basic communication- verbal and non-verbal communication; passive, assertive and aggressive communication; presentation skills; giving feedback and responding to feedback.

UNIT II	TEAM WORK AND LEADERSHIP	

Vision- setting realistic goals and objectives, collaboration, cooperation, dependability, empathy, sympathy, motivation, delegation of responsibilities, open mindedness, creativity, flexibility, adaptability, cross cultural communication and group dynamics.

UNIT III	TIME MANAGEMENT AND STRESS MANAGEMENT	

Effective Planning, Planning activities at macro and micro levels, setting practical deadlines and realistic limits/targets, punctuality, prioritizing activities, spending the right time on the right activity, positive attitude, emotional intelligence, self-awareness and regulation.

UNIT IV	CRITICAL THINKING AND WORK ETHICS	

Questioning, analysing, inferencing, interpreting, evaluating, solving problems, explaining, self-regulation, open-mindedness, conflict management- ethical dilemmas, appearance, attendance, attitude, character, organizational skills, productivity, respect.

UNIT V	INTERVIEW SKILLS AND RESUME BUILDING TECHNIQUES	
Telephonic interview, online interviews, f2f interviews, FAQ soft skills interview questions, drafting error-free CVs/ Resumes and Cover Letters, selecting the ideal format for resume, content drafting along with sequencing, art of representing one's qualifications and most relevant work history, video resume, website resume.		
		TOTAL: PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Express their thoughts, opinions and ideas confidently to one or more people in spoken form
CO2:	Develop evolving competences required for professional success
CO3:	Demonstrate knowledge and skills in a group as team player and leader
CO4:	Compose a comprehensive resume reflecting qualifications, exposure and achievements
CO5:	Exhibit knowledge and skills confidently during job interviews
CO6:	Demonstrate ethical and professional behaviour at workplace in all situations
TEXT BOOKS:	
1	Soft Skills: Key to Success in Workplace and Life by Meenakshi Raman & Shalini Upadhyay. Cengage
REFERENCES:	
1	English for Job Seekers (Language and Soft Skills for the Aspiring) by Geetha Rajeevan, C.L.N. Prakash) Cambridge University Press pvt, Ltd.

2	Business Benchmark by Norman Whitby. Cambridge University Press pvt, Ltd

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	-	-	-	-	-	-	-	2	2	-	-	-	-	-
2	-	-	-	-	-	2	2	2	3	3	2	2	-	-	2
3	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
4	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
5	-	-	-	-	-	-	-	-	3	3	-	-	-	-	-
6	-	-	-	-	-	-	-	3	3	3	-	-	-	-	3
Overall Correlation	-	-	-	-	-	2	2	2	3	3	2	2	-	-	**2**

Recommended by Board of Studies	**26-07-2023**		
Approved	**1st ACM**	**Date**	**09-09-2023**

SEMESTER –III

23MA302	TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- To introduce the basic concepts of PDE for solving standard partial differential equations.
- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems.
- To acquaint the student with Fourier series techniques in solving heat flow problems used in various situations.
- To acquaint the student with Fourier transform techniques used in wide variety of situations.
- To introduce the effective mathematical tools for the solutions of partial differential equations that model several physical processes and to develop Z transform techniques for discrete time systems

UNIT I	PARTIAL DIFFERENTIAL EQUATIONS	9+3

Formation of partial differential equations –Solutions of standard types of first order partial differential equations - Lagrange's linear equation - Linear partial differential equations of second and higher order with constant coefficients of both homogeneous and non-homogeneous types.

UNIT II	FOURIER SERIES	9+3

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

UNIT III	APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS	9+3

Classification of second order Quasi Linear 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 (Infinite) (Cartesian coordinates only)		
UNIT IV	**FOURIER TRANSFORMS**	**9+3**
Statement of Fourier integral theorem– Fourier transform pair – Fourier sine and cosine transforms – Properties – Transforms of simple functions – Convolution theorem (Without proof) – Parseval's identity.		
UNIT V	**Z-TRANSFORMS AND DIFFERENCE EQUATIONS**	**9+3**
Z-transforms - Elementary properties – Convergence of Z-transforms – Initial and final value theorems - Inverse Z-transform using partial fraction and convolution theorem - Formation of difference equations – Solution of difference equations using Z - transforms.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Solve the given standard partial differential equations.
CO2:	Compute the general Fourier series which plays a vital role in engineering applications.
CO3:	Examine the half range Fourier series and harmonic analysis
CO4:	Find the physical significance of Fourier series techniques in solving one and two dimensional heat flow problems, one dimensional wave equations.
CO5:	Apply the mathematical principles on Fourier transforms to solve some of the physical problems of engineering.
CO6:	Apply the effective mathematical tools for the solutions of difference equations by using Z transform techniques for discrete time systems.
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, 44th Edition, 2018.
3	P.Sivaramakrishna Das and C.Vijayakumari "A Text Book on TPDE" Pearson Publications

REFERENCES:

1	Narayanan. S., Manicavachagom Pillay. T.K. and Ramanaiah. G "Advanced Mathematics for Engineering Students", Vol. II & III, S.Viswanathan Publishers Pvt. Ltd, Chennai, 1998
2	Ramana. B.V., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2018.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
6	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
Overall Correlation	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-

Recommended by Board of Studies	**08-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

23AE301	SOLID MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To think, Analyse and solve Engineering Problems expected from the course
- To understand stress and strain concepts related to deformable bodies
- 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
- To familiarize with the different methods used for beam deflection analysis
- 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 distributedinternally

UNIT I	SIMPLE STRESS AND STRAIN	9

Mechanical properties of materials; Stresses and strains; Hooke's law, elastic constant, relation between moduli, working stress, factor of safety, poisons ratio ; bars of varying cross section; Thermal stresses.

UNIT II	TRANSFORMATION OF STRESS AND STRAIN	9

Plane stress and strain, Principal stresses, Mohr's circle and Hooke's law for plane stresses. Application of plane stress: Spherical and Cylindrical pressure vessel

UNIT III	SHEAR FORCE AND BENDING MOMENT	9

Types of loads- Types of Supports, Shear force and bending moment diagrams for simply supported and cantilever beams with concentrated, uniformly distributed and variable loads. Relation between load, shear force and bending moment.

UNIT IV	STRESSES IN BEAMS	9
Theory of Simple Bending, Section modulus, Distribution of Bending stresses and Shear stress variation in beams of symmetric and unsymmetric sections; Beams of uniform strength; Flexural stresses: Bending equations, calculation of bending stresses for different sections of beams like I, L, T, C, angle section.		
UNIT V	**TORSION**	**9**
Torsional shear stress in solid, hollow and stepped circular shafts, angular deflection and power transmission capacity, Strain energy in torsion, Stresses in members subjected to combined axial, bending and torsional loads.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Determine the stress and strain for deformable bodies
CO2:	Calculate stresses developed internally in the bodies due various loading conditions
CO3:	Evaluate the behaviour of beams under different loading conditions
CO4:	Apply the suitable method to identify the stress in the body
CO5:	Evaluate the shear force and bending moment for the beams
CO6:	Estimate the stresses in shafts due to torsion.

TEXT BOOKS:	
1	Beer Jr FP. E. Russell Johnston, John T. Dewolf, and David F. Mazurek. Mechanics of Materials. McGraw-Hill, New York. 2020.
2	Hibbeler RC. Statics and Mechanics of Materials in SI Units. Pearson Higher Ed; 2018.

REFERENCES:	
1	Egor P Popov, Mechanics of Materials, Pearson, 2015
2	James M. Gere, Mechanics of Materials, Sixth Edition, Thomson Learning, 2004.
3	William F. Riley, Leroy D. Sturges, Don H. Morris, Mechanics of Materials, John Wiley & Sons, 2006.
4	Arthur P. Boresi, Richard J. Schmidt, Advanced Mechanics of Materials, 6th Edition, Wiley India Pvt. Limited.2002.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
2	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
5	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
6	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
Overall Correlation	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

23HS301	UNIVERSAL HUMAN VALUES AND ETHICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To develop a holistic perspective based on self-exploration about themselves (human being), family, society and nature/existence.
- To understand (or developing clarity) the harmony in the human being, family, society and nature/existence.
- To strengthen the self-reflection.
- To develop commitment and courage to act.

UNIT I	COURSE INTRODUCTION	9

Need, Basic Guidelines, Content and Process for Value Education - Understanding the need, basic guidelines, content and process for Value Education -Self Exploration–what is it? - its content and process; 'Natural Acceptance' and Experiential Validation- as the mechanism for self exploration - Continuous Happiness and Prosperity- A look at basic Human Aspirations -Right understanding, Relationship and Physical Facilities- the basic requirements for fulfilment of aspirations of every human being with their correct priority -Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario - Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

UNIT II	UNDERSTANDING HARMONY IN THE HUMAN BEING	9

Harmony in Myself- Understanding human being as a co-existence of the sentient 'I' and the material 'Body' - Understanding the needs of Self ('I') and 'Body' - Sukh and Suvidha- Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) -Understanding the characteristics and activities of 'I' and harmony in 'I' -Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity.

UNIT III	**UNDERSTANDING HARMONY IN THE FAMILY AND SOCIETY**	**9**
Harmony in Human-Human Relationship -Understanding Harmony in the family – the basic unit of human interaction -Understanding values in human-human relationship; meaning of Nyaya and program for its fulfilment to ensure satisfaction; Trust(Vishwas) and Respect as the foundational values of relationship -Understanding the meaning of Vishwas; Difference between intention and competence -Understanding the meaning of Samman, Difference between respect and differentiation; the other salient values in relationship -Understanding the harmony in the society (society being an extension of family)-Visualizing a universal harmonious order in society- Undivided Society (Akhand Samaj), Universal Order- from family to world family.		
UNIT IV	**ENGINEERING ETHICS**	**9**
Senses of ‗Engineering Ethics‖ – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Models of professional roles - Theories about right action – Self-interest – Customs and Religion – Uses of Ethical Theories.		
UNIT V	**SAFETY, RESPONSIBILITY AND RIGHTS**	**9**
Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis and Reducing Risk - Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) – Discrimination-Moral Leadership –Code of Conduct – Corporate Social Responsibility.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Explain the need of value education.	
CO2:	Interpret the difference between self and body.	

CO3:	Demonstrate the need to exist as a unit of Family and society.
CO4:	Classify Harmony at all levels.
CO5:	Apply the values acquired in the professional front.
CO6:	Identify appropriate technologies for ecofriendly production systems.
TEXT BOOKS:	
1	R R Gaur, R Sangal, G P Bagaria,Human Values and Professional Ethics, Excel Books, New Delhi, 2010 3.
2	Mike W. Martin and Roland Schinzinger, ―Ethics in Engineering‖, Tata McGraw Hill, New Delhi, 2003.
3	Govindarajan M, Natarajan S, Senthil Kumar V. S, ―Engineering Ethics‖, Prentice Hall of India, New Delhi, 2004
REFERENCES:	
1	Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3	The Story of Stuff (Book).
4	The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi AICTE Model Curriculum in Humanities, Social Science and Management Courses (UG Engineering & Technology) 169 | Page .
5	Small is Beautiful - E. F Schumacher.
6	Slow is Beautiful - Cecile Andrews.
7	Economy of Permanence - J C Kumarappa 8. Bharat Mein Angreji Raj – Pandit Sunderlal.
8	Rediscovering India - by Dharampal.
9	Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi.
10	India Wins Freedom - Maulana Abdul Kalam Azad.

11	Vivekananda - Romain Rolland (English) 13. Gandhi - Romain Rolland (English).
12	Charles B. Fleddermann, ―Engineering Ethics‖, Pearson Prentice Hall, New Jersey, 2004.
13	Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, ―Engineering Ethics – Concepts and Cases‖, Cengage Learning, 2009.
WEB SOURCES:	
1	www.onlineethics.org
2	www.nspe.org
3	www.globalethics.org

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
2	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
3	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
4	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
5	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
6	-	-	-	-	-	3	3	3	3	3	-	-	-	-	3
Overall Correlation	**-**	**-**	**-**	**-**	**-**	**3**	**3**	**3**	**3**	**3**	**-**	**-**	**-**	**-**	**3**

Recommended by Board of Studies	**08-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

23ME312	FLUID MECHANICS AND HYDRAULIC MACHINERY	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- Study about the properties of the fluids and behavior of fluids under static conditions.
- Gain basic knowledge of the dynamics of fluids and boundary layer concepts.
- Study the applications of the conservation laws to flow measurements, flow through pipes and forces on pipe bends.
- Learn the significance of boundary layer theory and its thicknesses.
- Study the basic principles of working and design of Pelton wheel, Francis and Kaplan turbine.

Acquire knowledge on working principles of centrifugal, reciprocating and rotary pumps.

UNIT I	FLUID PROPERTIES AND FLOW CHARACTERISTICS	9+3

Fluid Definition and Classification – Properties of fluids, Fluid statics - Pressure Measurements - Buoyancy and floatation - forces on submerged bodies, stability of floating bodies, Flow characteristics - Concept of control volume and system – Velocity potential and stream functions, Continuity equation, energy equation and momentum equation - Applications.

UNIT II	FLOW THROUGH PIPES AND BOUNDARY LAYER	9+3

Reynold's Experiment - Laminar flow through circular conduits - Darcy Weisbach equation - friction factor - Moody diagram - Major and minor losses - Hydraulic and energy gradient lines - Pipes in series and parallel - Boundary layer concepts - Types of boundary layer thickness.

UNIT III	DIMENSIONAL ANALYSIS AND MODEL STUDIES	9+3
Fundamental dimensions - Dimensional homogeneity - Rayleigh's method and Buckingham Pi theorem - Dimensionless parameters - Similitude and model studies - Distorted and undistorted models.		
UNIT IV	**TURBINES**	**9+3**
Impact of jets - Velocity triangles - Theory of rotodynamic machines - Classification of turbines - Working principles - Pelton wheel - Modern Francis turbine - Kaplan turbine - Work done - Efficiencies - Draft tube - Specific speed - Performance curves for turbines - Governing of turbines.		
UNIT V	**PUMPS**	**9+3**
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.		
LIST OF EXPERIMENTS: 1. Determination of coefficient of discharge of a venture meter. 2. Determination of coefficient of discharge of an orifice meter. 3. Determination of friction factor for flow through pipes. 4. Determination of metacentric height. 5. Characteristics of centrifugal pumps. 6. Characteristics of reciprocating pump. 7. Characteristics of gear pump. 8. Characteristics of Pelton wheel turbine. 9. Flow measurement using Rotameter 10. Characteristics of Francis turbine.		
TOTAL: 45 +15 PERIODS		

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply the conservation laws applicable to fluids and its application through fluid kinematics and dynamics and also to understand the properties and behavior of fluids in static conditions.
CO2:	Estimate the losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel.
CO3:	Apply the concept of boundary layer and its thickness on the flat solid surface.
CO4:	Formulate the relationship among the parameters involved in the given fluid phenomenon and to predict the performances of prototype by model studies.
CO5:	Calculate the power developed by the turbines.
CO6:	Calculate the efficiency of the different pumps.
TEXT BOOKS:	
1	Modi P.N. and Seth, S.M. Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, 22nd edition (2019)
2	R K Bansal, A Text Book of Fluid Mechanics and Hydraulic Machines, Laxmi Publications, New Delhi.
3	Kumar K. L., Engineering Fluid Mechanics, Eurasia Publishing House (p) Ltd. New Delhi, 2016.
REFERENCES:	
1	Streeter, V. L. and Wylie E. B., Fluid Mechanics, McGraw Hill Publishing Co., 2010.

2	Cengel Y A and Cimbala J M, Fluid Mechanics, McGraw Hill Education Pvt. Ltd., 2014.
3	S K Som; Gautam Biswas and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill Education Pvt. Ltd., 2012.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	2	2	1	-	2	2	2	1	1	1
2	3	3	3	3	1	2	2	1	-	2	2	2	1	1	1
3	3	2	1	1	1	2	2	1	-	2	2	2	1	1	1
4	3	3	3	3	1	1	2	1	-	2	2	2	1	1	1
5	3	2	1	1	1	1	2	1	-	2	2	2	1	1	1
6	3	2	1	1	1	1	2	1	-	2	2	2	1	1	1
Overall Correlation	3	3	3	3	1	1	2	1	-	2	2	2	1	1	1

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

23AE311	AERO ENGINEERING THERMODYNAMICS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To understand the basic concepts of thermodynamics systems and the application of first law of thermodynamics to open and closed systems.
- To understand the concept of second law of thermodynamics and entropy.
- To derive fundamental relations between thermodynamic properties.
- To comprehend the operational principles of piston engines and jet engines, as well as their air standard cycles.
- To understand the behavior of pure substances and its application to produce power.
- To understand the basic of heat transfer and the application on real time problem.

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, Zeroth law of thermodynamics, First law of thermodynamics, relation between pressure, volume and temperature for various processes, SFEE, application of SFEE to jet engine components

UNIT II	SECOND - LAW AND ENTROPY	9

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

UNIT III	AIR STANDARD CYCLES	9

Otto, Diesel, Dual 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 - standard Rankine cycle, Reheat and Regeneration cycle. Heat rate, Specific steam consumption, Tonne of refrigeration.		
UNIT V	**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, conduction in parallel, radial and composite wall, Basics of convective and radiation heat transfer.		
		TOTAL: 45 PERIODS

LIST OF EXPERIMENTS:

1. Draw the Valve timing diagram of 4-Stroke engine and the Port timing diagram of 2-Stroke engine.
2. Performance test on a 4-Stroke diesel engine.
3. Determination of specific heat of solid by Bomb calorimeter.
4. Determine the COP of a Refrigeration System.
5. Determine the COP of an Air-conditioning System.
6. Determination of effectiveness of a parallel flow and counter flow heat exchanger and calculate the overall heat transfer coefficient (u) in the parallel flow heat exchanger.
7. Determination of effectiveness of a counter flow heat exchanger and calculate the overall heat transfer coefficient (u) in the counter flow heat exchanger.
8. Determination of convective heat transfer coefficient during free and forcedconvection.
9. Determination of thermal conductivity of a metal.
10. Determination of thermal conductivity of a composite wall.

TOTAL: 30 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply first law of thermodynamics to solve problems related to open and closed systems
CO2:	Apply the second law of thermodynamics to Engineering devices.
CO3:	Identify the efficiency and performance of various air standard cycles
CO4:	Identify efficiency and performance of vapor power cycle.
CO5:	Solve thermodynamics problems related to conduction, convection and radiation
CO6:	Identify the jet engine performance by applying thermodynamics properties.
TEXT BOOKS:	
1	Nag. P. K., "Engineering Thermodynamics", 6th Edition, Tata McGraw-Hill,New Delhi, 2017.
2	Cengel, Y, M. Boles and M. Kanoğlu, Thermodynamics - An EngineeringApproach, Tata McGraw Hill,8thEdition, 2015.
3	Holman.J.P., "Thermodynamics", 3rd Edition, McGraw-Hill, 2007.
REFERENCES:	
1	Rathakrishnan E., "Fundamentals of Engineering Thermodynamics", 2nd Edition, Prentice-Hall India, 2011.
2	Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2017.
3	R.K.Rajput, "A text book of Engineering Thermodynamics", Fifth Edition, Lakshmi Publications, New Delhi, 2016.
4	Merala C, Pother, Craig W, Somerton, "Thermodynamics for Engineers", Schaum Outline Series,Tata McGraw-Hill, New Delhi, 2004.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	1	1	-	1	-	-	-	1	2	3	1	-
2	3	2	2	1	1	1	1	-	-	-	1		3	1	-
3	3	2	2	1	1	1	1	1	-	1	-	2	3	1	1
4	3	2	2	1	1	-	-	-	-	-	1	1	3	1	-
5	3	2	2	1	2	-	1	-	-	-	1	2	3	2	-
6	3	2	2	1	1	1	1	-	-	1	1	2	3	1	-
Overall Correlation	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**-**	**1**	**1**	**2**	**3**	**2**	**1**

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

23AE321	STRENGTH OF MATERIALS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To determine experimental data, include universal testing machines and torsionequipment.
- To understand experimental data for spring testing machine, compression testing machine, impact tester, hardness tester.
- To study stress analysis and design of beams subjected to bending and shearing loadsusing several methods.
- To make use of Flexural strength of a beam.
- To understand experimental stress with compression tests.

LIST OF EXPERIMENTS:

1. Tension test on a mild steel rod & Plastics.
2. Compression on UTM.
3. Double shear test
    - Mild steel rods
    - Aluminum rods.
4. Torsion test on mild steel rod.
5. Impact test on metal & Composite specimen.
    - Charpy Test
    - Izod Test
6. Hardness test on metals
    - Brinell Hardness Number.
    - Rockwell Hardness Number.
7. Deflection test on beams
    - Cantilever Hardness Number.
    - Simply supported beams.
8. Compression test on helical springs.
    - Open coil Spring
    - Closed coil spring

9. Effect of hardening- Improvement in hardness
10. Microscopic Examination of Hardened samples and Tempered samples

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Analyse and design structural members subjected to tension, compression, torsion, bending and combined stresses using the fundamental concepts of stress, strain and elastic behaviour of materials.
CO2:	Examine the basic concepts of stress, strain, deformation, and material behaviour under different types of loading (axial, torsion, bending).
CO3:	Examine stress analysis, design of beams subjected to bending and shearing loads using several methods.
CO4:	Examine the stresses and strains in axially loaded members subject to flexural loadings.
CO5:	Inspect the compression strength of the cast iron and steel.
CO6:	Analyse the changes that occur during the hardening of the material

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	1	2	2	2	2	3	1	-	1	2	2	2
2	3	3	2	1	2	2	2	2	3	1	-	1	3	2	2
3	3	3	2	1	2	2	2	2	3	1	-	1	3	2	2
4	3	3	2	1	2	2	2	2	3	1	-	1	3	2	2
5	3	3	2	1	2	2	2	2	3	1	-	1	3	2	2
6	3	3	2	1	2	2	2	2	3	1	-	1	3	2	2
Overall Correlation	**3**	**3**	**2**	**1**	**2**	**2**	**2**	**2**	**3**	**1**	**-**	**1**	**3**	**2**	**2**

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

23ES391	PRESENTATION SKILLS	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To help learners use brainstorming techniques for generating, organizing and outlining ideas.
- To familiarize learners with different speech structures by engaging them in watching speeches with great opening and closing
- To give practice on voice modulation and use of body language and eye contact for making captivating presentations
- To give hands on training on preparing presentation slides and using remote presentation tools
- To train students on responding to questions and feedback with confidence.

Exercise 1 | Introducing Oneself

Prepare a script about oneself on parameters including

1. Name
2. Educational Background
3. Personal and Professional Interests,
4. Short-term and Long-term Goals
5. Strengths and Weaknesses
6. Skills
7. Achievements
8. Hobbies, etc.

Exercise 2 | Presentation on topic of choice

1. Generate ideas based on the existing knowledge about the topic
2. Add more ideas to the topic by referring to books/ online articles or using AI tools
3. Organize the ideas collected and decide on 3 key ideas
4. Structure the presentation by crafting, stating the objective, and elaborating on each key idea with examples/ data/anecdotes/ reasons.
5. Present with eloquence using appropriate vocal variety and body language, respond to questions and feedback

Exercise 3	Presentation on the given topic
	1. Generate ideas based on the existing knowledge about the topic 2. Add more ideas to the topic by referring to books/ online articles or using AI tools 3. Organize the ideas collected and decide on 3 key ideas 4. Structure the presentation by crafting, stating the objective, and elaborating on each key idea with examples/ data/anecdotes/ reasons. 5. Present with eloquence using appropriate vocal variety and body language, respond to questions and feedback
Exercise 4	**Presentation on a technical topic using technological aids**
	1. Generate ideas based on the existing knowledge about the topic 2. Add more ideas to the topic by referring to books/ online articles or using AI tools 3. Organize the ideas collected and decide on 3 key ideas 4. Structure the presentation by crafting, stating the objective, and elaborating on each key idea with examples/ data/anecdotes/ reasons. 5. Prepare a PowerPoint Presentation with less verbal content and more relevant images 6. Present with eloquence using appropriate vocal variety and body language, respond to questions and feedback
	TOTAL : 60 PERIODS
COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Construct ideas for presentation through mind mapping techniques

CO2:	Organize ideas and structure the presentation with captivating introduction, body paragraphs illustrated with examples and reasons and compelling conclusion
CO3:	Apply vocal variety and body language techniques to enhance delivery
CO4:	Prepare engaging presentations by integrating multimedia elements
CO5:	Demonstrate proficiency in delivering presentations in remote platforms utilizing various technological tools and strategies to engage audience in virtual environments
CO6:	Exhibit active listening skills by responding to questions with clarity and confidence and incorporating constructive feedback for professional development

TEXT BOOKS:

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	-	-	-	-	-	1	1	-	2	3	-	2	-	-	-
2	-	-	-	-	-	1	1	-	2	3	-	2	-	-	-
3	-	-	-	-	-	-	-	-	2	3	-	2	-	-	-
4	-	-	-	-	3	-	-	-	-	3	-	2	-	-	-
5	-	-	-	-	3	-	-	-	3	3	-	2	-	-	-
6	-	-	-	-	-	-		-	-	3	-	-	-	-	-
Overall Correlation	-	-	-	-	3	1	1	-	3	3	-	2	-	-	-

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

SEMESTER –IV

23MA403	NUMERICAL AND STATISTICAL METHODS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals and numerical techniques of differentiation and integration which plays an important role in engineering and technology
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems
- To provide the necessary basic concepts of a few statistical and numerical methods and give procedures for solving numerically different kinds of problems occurring in engineering and technology.

UNIT I	SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS	9+3

Solution of algebraic and transcendental equations - Fixed point iteration method – Newton Raphson method- Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Iterative methods of Gauss Jacobi and Gauss Seidel - Eigenvalues of a square matrix by Power method

UNIT II	INTERPOLATION, NUMERICAL DIFFERENTIATION AND NUMERICAL INTEGRATION	9+3

Interpolation - Newton's forward and backward difference interpolation -Lagrange's and Newton's divided difference interpolations –– Approximation of derivative using

interpolation polynomials – Numerical single integration and doubleintegrations using Trapezoidal and Simpson's 1/3rules.		
UNIT III	**NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS**	**9+3**
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 Adam's Bashforth method.		
UNIT IV	**TESTING OF HYPOTHESIS**	**9+3**
Sampling distributions – Standard error - Large sample test for single mean, proportion, difference of means – Small sample Tests– t Test for single mean and difference of means - F test for equality of variance – Chi square test for single variance-Independence of attribute-Goodness of fit (Binomial Distribution, Poisson Distribution).		
UNIT V	**DESIGN OF EXPERIMENTS**	**9+3**
One way and two way classifications - Completely randomized design – Randomized block design – Latin square design		
		TOTAL: 60 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Find numerical solutions for nonlinear (algebraic or transcendental) equations, large system of linear equations and Eigen value problem of a matrix, when analytical methods fail to give solution.
CO2:	Determine the intermediate values of the experimental data using Newton's forward, backward, divided difference and Lagrange's method.
CO3:	Find the solution of the problems using numerical differentiation and integration.
CO4:	Solve numerically, ordinary differential equations which is used to solve different kinds of problems occurring in engineering and technology.
CO5:	Examine the given data for large and small samples.

CO6:	Examine the problems involving design of experiments.

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 andStatistics for Engineers", Pearson Education, Asia, 8th Edition,2015.

REFERENCES:

1	Dr.P. Sivaramakrishnadas, Dr. C. Vijayakumari, ―Statistics and Numerical Methods‖ Pearson Publications.
2	Burden, R.L and Faires, J.D, "Numerical Analysis‖, 9th Edition, Cengage Learning,2016.
3	Devore.J.L.‖ Probability and Statistics for Engineering and the Sciences‖, Cengage Learning, New Delhi, 8th Edition,2014.
4	Gerald. C.F. and Wheatley. P.O. "Applied Numerical Analysis‖ Pearson Education, Asia, New Delhi, 7th Edition, 2007.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
2	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
5	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
6	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-
Overall Correlation	3	2	1	1	-	-	-	-	-	-	-	1	3	-	-

Recommended by Board of Studies	**08-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

23AS401	AERODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To recall the governing equations of fluid mechanics.
- To familiarize the behaviour of airflow over bodies with particular emphasis on aerofoil sections in the incompressible and compressible flow regime.
- To develop the Navier- Stoke equations and its application
- To make the student understand the concept of vorticity, irrotationality, theory of airfoil and wing sections.
- To illustrate the conformal transformation and to extend the wing theory.
- To compare the interactions of shocks and expansion waves in fluid flow.

UNIT I	INTRODUCTION TO LOW-SPEED FLOW	9

Incompressible Bernoulli's equation – circulation and vorticity – Green's lemma and Stoke's theorem – barotropic flow – Kelvin's theorem.

UNIT II	TWO-DIMENSIONAL FLOWS	9

Basic flows – Source, Sink, Free and Forced Vortex, Uniform, and Parallel Flow and their combinations – Pressure and velocity distributions on bodies with and without circulation in ideal and real fluid flows.

UNIT III	CONFORMAL TRANSFORMATION	9

Kutta Joukowski's theorem – Joukowski transformation and its application to fluid flow problems – Schwartz-Christoffer transformation – Kutta condition – Blasius theorem.

UNIT IV	AIRFOIL AND WING THEORY	9
Joukowski, Karman – Trefftz, Profiles – Thin aerofoil theory and its applications – Vortex line – Horse shoe vortex – Biot and Savart law – Lifting line theory and its limitations.		
UNIT V	**SHOCKS AND EXPANSION WAVES**	**9**
Mach number and its importance in compressible flows – Equation of motion for compressible flow in 1D – Normal shock – Rankine - Hugoniot relations – oblique shock relations – strong, weak and detached shocks – isentropic flows – Prandtl - Meyer expansion and expansion fans.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will 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:	Identify Normal , Oblique shock waves.
CO6:	Solve the isentropic flow problems using Prandtl - Meyer expansion wave theory.

TEXT BOOKS:

1	Anderson J. D., “Fundamentals of Aerodynamics”, 5th Ed., McGraw-Hill, 2010.
2	Anderson J. D., “Modern Compressible Flow with Historical Perspective”, TMH,3rd Ed., 2012.
3	Clancy L. J., “Aerodynamics”, Reprint Ed., Himalayan Books, 2006.
4	E Rathakrishnan, “Theoretical Aerodynamics”, John Wiley, NJ, 2013.

REFERENCES:

1	Bertin, J. J. and Cummings, R. M., “Aerodynamics for Engineers”, 6th Ed., Prentice Hall, 2013.
2	Drela, M., “Flight Vehicle Aerodynamics”, MIT Press, 2014.
3	Houghton, E. L., Carpenter, P. W., Collicott, S. H., and Valentine, D. T.,“Aerodynamics for Engineering Students”, 6th Ed., Butterworth-Heinemann, 2012.
4	Kuethe, A. M. and Chow, C. Y., “Foundations of Aerodynamics”, 5th Ed., John Wiley, 1998.
5	Milne Thomson, L.H., “Theoretical aerodynamics”, Dover Publications, 2011.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	-	-	-	1	1	1	3	1	-
2	3	2	1	1	2	-	-	-	-	1	1	1	3	2	-
3	3	2	1	1	2	-	-	-	-	1	1	2	3	2	-
4	3	2	1	1	2	-	-	-	-	1	1	1	3	2	-
5	3	3	2	1	2	-	-	-	-	1	1	1	3	2	-
6	3	3	2	1	2	1	1	2	-	1	1	2	1	2	2
Overall Correlation	**3**	**3**	**2**	**1**	**2**	**1**	**1**	**2**	**-**	**1**	**1**	**2**	**3**	**2**	**2**

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**05-05-2024**

23AS402	AEROSPACE PROPULSION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the principles of operation of aircraft propulsion systems.
- To extend the performances of aircraft propulsion systems.
- To introduce the working of different types of compressors and solve complexproblems.
- To introduce the working of different types of turbines and solve complexproblems.
- To understand the combustion process in Jet Engines.
- To understand the basics of integral ram-rocket and its performance.

UNIT I	SUBSONIC AND SUPERSONIC INTAKES	9

T-S diagram of turbojet engine-Performance of subsonic and supersonic intakes – Performance parameters – Sources of losses –Starting problem in supersonic intakes – Modes of operation of an external compression intake.

UNIT II	CENTRIFUGAL AND AXIAL FLOW COMPRESSORS	9

Principle of operation – Work done and pressure rise – diffuser – Compressibility effects – non-dimensional quantities for plotting compressor characteristics – Centrifugal compressor characteristics. Basic operation – Elementary theory – Factors affecting stage pressure ratio – Blockage in the compressor annulus – Degree of reaction – Three-dimensional flow – Calculation of stage performance – Compressibility effects – Axial compressor characteristics.

UNIT III	AXIAL AND RADIAL FLOW TURBINES	9

Elementary theory of axial flow turbine – Vortex theory – Choice of blade profile, pitch and chord – Estimation of stage performance – Overall turbine performance – Turbine Blade Cooling– Radial flow turbine – Operating Principle – Velocity Diagram and Applications.

UNIT IV	COMBUSTION CHAMBERS AND NOZZLES	9
Operational requirements – Types of combustion system – Gasturbine Combustors – Afterburners – Fuel injection in combustion chamber – Important factors combustor design – Combustion chamber performance – Aircraft fuels – Sustainable aviation and zero emission fuels- Exhaust Nozzles – Fixed and variable geometry nozzles – Functions of nozzles – Thrust vector control – Thrust reversal.		
UNIT V	**RAMJET PROPULSION**	**9**
Thermodynamic cycle – performance parameters – Performance variation – Components – combustors – Solid and liquid ramjets – Design of a Ramjet – basics of integral ram-rocket and its performance.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Utilize the working operation and effective application with the knowledge of performance and losses found in Inlets
CO2:	Solve complex problems in compressors used in aircraft.
CO3:	Solve complex problems in turbines used in aircraft engine
CO4:	Explain the combustion chamber working and performance
CO5:	Outline the various functions of nozzle
CO6:	Identify the thermodynamic cycle of Ramjet propulsion systems and its applications
TEXT BOOKS:	
1	Farokhi, S., "Air Craft Propulsion", Wiley, 2nd Ed., 2014.
2	Hill P. G., and Peterson C. R., "Mechanics and Thermodynamics of Propulsion", Pearson Education, 2nd Ed., 2009

REFERENCES:	
1	Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”,Standard Publishers & Distributors, Delhi, 2nd Ed., 2014.
2	Oates G. C., “Aerothermodynamics of Aircraft Engine Components”, AIAA Education Series, 1985.
3	Rolls Royce, “The Jet Engine”, Hand Book, Wiley – 5th Ed., 2015.
4	Saravanamuttoo, H.I.H., Rogers, and G.F.C., Cohen, H., “Gas Turbine Theory”, Pearson, 7th Ed., 2017.
5	Rathakrishanan E “Applied Gas Dynamics” Wiley – 2nd Ed,2019.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	-	-	-	-	-	-	-	-	2	-	-
2	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
3	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
4	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
5	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
6	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
Overall Correlation	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**-**	**-**

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**05-05-2024**

23AS403	AEROSPACE STRUCTURAL MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT I	UNSYMMETRICAL BENDING	9

Bending stresses in beams of unsymmetrical sections (K-method, Neutral axis method and Principal axis Method) – Bending of symmetric sections with skew loads.

UNIT II	STATICALLY DETERMINATE & INDETERMINATE STRUCTURE	9

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

UNIT III	ENERGY METHODS	9

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

UNIT IV	SHEAR FLOW IN OPEN & CLOSED SECTIONS	9
Thin-walled beams, Concept of shear flow, Shear center, Elastic axis, with one axis of symmetry with effective and ineffective wall in bending, Bredt-Batho formula, Shear flow in single and multi -cell structures under torsion and bending with effective and ineffective wall, Box Beams.		
UNIT V	**BUCKLING OF COLUMNS, PLATES & THIN-WALLED BEAMS**	**9**
Euler's column curve – inelastic buckling – effect of initial curvature – Southwell plot – columns with eccentricity - Buckling of thin plates, Inelastic buckling of plates, Local instability, Instability of stiffened panels, Failure stress in plates and stiffened panels, Crippling stresses by Needham's and Gerard's methods.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Analyse and investigate the normal stress variation on unsymmetrical sections, subjected to bending moments
CO2:	Analyse the determinate aircraft structural components using linear static analysis.
CO3:	Analyse the indeterminate structural methods using 3 moment equation and Moment distribution method
CO4:	Apply the energy methods to determine the reactions of structure
CO5:	Construct the shear flow variation in thin-walled open and closed sections with skin effective and ineffective in bending
CO6:	Calculate the crippling stress and buckling load for column and plates under various loading conditions

TEXT BOOKS:

1	James M. Gere & Barry J Goodno, " Mechanics of Materials ", Cengage Learning Custom Publishing; 8th edition, 2012.
2	Megson T M G, `Aircraft Structures for Engineering students’ Butterworth- Heinemann publisher, 5th edition.

REFERENCES:

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.
4	N.C. Pandya, C.S. Shah, “Elements of Machine Design”, Charotar Publishing House, 15th edition, 2009.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	2	1	-	-	-	-	-	-	-	3	1	-
2	3	3	2	2	1	-	-	-	-	-	-	-	3	1	-
3	3	3	2	2	1	-	-	1	-	-	-	-	3	1	1
4	3	2	1	1	1	-	-	1	-	-	-	-	3	1	1
5	3	2	1	1	1	-	-	-	-	-	-	-	3	1	-
6	3	2	1	1	1	-	-	-	-	-	-	-	3	1	-
Overall Correlation	**3**	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**-**	**3**	**1**	**1**

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**05-05-2024**

23AS421	LOW- AND HIGH-SPEED AERODYNAMICS LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To study experimentally the aerodynamic forces on different bodies atlow - and high- speeds.
- To predict different aerodynamic used in aero application.
- To study airfoil and wing characteristics.

LIST OF EXPERIMENTS:

1. Calibration of subsonic wind tunnel.
2. Illustrate the Pressure distribution over smooth and rough cylinder.
3. Illustrate the Pressure distribution over symmetric airfoils.
4. Illustrate the Pressure distribution over cambered airfoils & thin airfoils.
5. Measure the forces acting on a model using wind tunnel balance.
6. Force measurement and flow visualization of VTOL model at low speeds.
7. Demonstrate the flow over a flat plate at different angles of incidence.
8. Show the flow visualization studies in low speed flows over cylinders.
9. Show the flow visualization studies in low speed flows over airfoil withdifferent angle of incidence.
10. Calibration of supersonic wind tunnel.
11. Show the Supersonic flow visualization with Schlieren system.

TOTAL: 60 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Experiment with the wind tunnel for wall effect, blockage and support interference on the measurements as well as determining the uncertainty in the measurement technique.
CO2:	Determine the pressure distribution and forces acting over aerodynamical models.
CO3:	Explain flow over the aerodynamical model through flow visualization.
CO4:	Illustrate the limits and usefulness of the experimental approach.
CO5:	Demonstrate the experimental findings in clear oral and concise report.
CO6:	Illustrate the limits and usefulness of the experimental approach on comparing with theoretical approach.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	1	2	1	1	2	3	3	2	2	3	2	2
2	3	3	3	2	2	1	1	2	3	3	2	2	3	2	2
3	3	3	3	2	2	1	1	1	3	3	1	1	3	2	2
4	3	2	2	1	1	1	2	2	3	3	2	1	3	2	2
5	3	3	2	1	1	1	1	2	2	2	2	2	3	1	2
6	3	2	2	1	1	1	1	2	2	2	2	2	3	1	2
Overall Correlation	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**2**

Recommended by Board of Studies	01-04-2024		
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23AS422	AEROSPACE STRUCTURES LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To experimentally study the unsymmetrical bending of beams.
- To find the location of shear centre.
- To obtain the stresses in circular discs and beams using photo elastic techniques.
- To 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. Beam with combined loading.
7. Calibration of Photo-elastic materials.
8. Stresses in circular discs and beams using photo-elastic techniques.
9. Vibrations of beams.
10. Experiment with the Wagner beam – Tension field beam.
11. Buckling load for column- Various end conditions.

TOTAL: 60 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Evaluate the effects of bending in the aerospace structures.
CO2:	Explain the shear centre of the aerospace structures.
CO3:	Compare the photo-elastic techniques on the aerospace structures.
CO4:	Justify the experimental findings in clear oral and concise report.
CO5:	Analyze the columns at various end conditions.
CO6:	Analyze the vibrations of cantilever beam.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	2	1	-	-	-	-	-	-	-	2	1	-
2	3	3	3	2	1	-	-	-	-	-	-	-	3	1	-
3	3	3	3	2	2	-	-	-	-	-	-	-	3	2	-
4	3	3	3	2	1	-	-	-	-	-	-	-	2	1	-
5	3	3	3	2	1	-	-	-	-	-	-	-	3	1	-
6	3	3	3	2	2	-	-	-	-	-	-	-	3	2	-
Overall Correlation	**3**	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**-**

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**05-05-2024**

23ES491	APTITUDE AND LOGICAL REASONING –1	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To improve the problem solving and logical thinking ability of the students.
- To acquaint student with frequently asked questions and patterns in quantitative aptitude and logical reasoning.

UNIT I		4

Numbers, LCM, HCF, Averages, Ratio & Proportion, Mixtures & Allegation.

UNIT II		4

Percentages, Time and work, Pipes and Cistern, coding and decoding.

UNIT III		4

Time Speed Distance, Train, Boats and Streams, Analogy.

UNIT IV		4

Data Interpretation (BAR,PIE,LINE), Seating arrangement.

UNIT V		4

Simple Interest and Compound Interest, Profit loss and Discount, Partnership.

TOTAL: 20 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Analyse and solve complex problems, and foster critical thinking and logical reasoning skills.
CO2:	Solve fundamental mathematical problems, and enhance their computational skills and numerical ability.
CO3:	Develop strategies for tackling a variety of problem types, and encourage the use of multiple approaches to solve problems efficiently.
CO4:	Analyse and solve different data analysis problems for time and distance, and interpret data analysis for a case study.
CO5:	Derive information from graphs, and solve questions based on mathematical operations such as ratios, proportions, basic algebra, and statistical estimation.
CO6:	Solve questions in a fraction of a minute using shortcut methods

TEXT BOOK:	
1	Smith, John. "APTIPEDIA." 2nd ed., Wiley Publishers, 2020.
2	Agarwal, R.S. "Quantitative Aptitude." 2nd ed., S. Chand Publishing.
REFERENCES:	
1	Agarwal, R.S. "A Modern Approach to Verbal & Non-Verbal Reasoning." 2nd ed., S. Chand Publishing

Cos	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	-	-	2	1	1	2	1	2	3	1	-	3
2	2	3	3	-	-	2	-	1	3	2	2	3	2	1	3
3	3	3	3	-	-	2	-	1	2	2	2	3	2	-	3
4	2	3	2	3	-	2	1	2	3	3	2	3	1	2	3
5	3	2	2	-	1	3	-	2	2	3	3	3	3	1	3
6	3	3	3	3	2	3	1	3	3	2	3	3	3	1	3
Overall Correlation	3	3	3	1	1	3	1	2	3	3	3	3	2	1	3

Recommended by Board of Studies	**08-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

23AS423	MINI PROJECT	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- Encourage students to apply foundational theoretical knowledge to practical engineering problems.
- Develop collaborative and project management skills through teamwork and effective communication.
- Train students in basic research methodology, technical documentation, and presentation techniques to articulate project outcomes clearly.
- Enhance students' ability to systematically design, analyze, and evaluate simple prototypes or models.
- Prepare students for real-world engineering challenges and lay the foundation for multidisciplinary teamwork and problem-solving in advanced projects.

COURSE DESCRIPTION:

This course serves as an introductory platform for students to apply the foundational knowledge acquired from their core and interdisciplinary subjects in a practical setting. This course enables students to work on small-scale, department-relevant projects that focus on problem identification, basic design, and preliminary prototype development. With limited prior expertise, students will explore the process of translating theoretical concepts into tangible solutions, fostering creativity, teamwork, and critical thinking. The course emphasizes hands-on learning, communication, and project documentation, laying a strong foundation for advanced projects and professional challenges in later semesters.

PROJECT OUTLINE:

Week 1	Course Orientation and Topic Selection
Week 2	Problem Definition and Objective Setting
Week 3	Literature Review and Research
Week 4	First Review and Feedback
Week 5	Problem Refinement and Research Gap Identification
Week 6	Conceptual Design and Initial Approach

Week 7	Methodology and Project Planning
Week 8	Second Review and Project Evaluation
Week 9	Design Refinement and Testing
Week 10	Resource Identification and Budget Estimation
Week 11	Report Writing and Presentation Preparation
Week 12	Third Review Presentation and Submission of Thesis
EVALUATION:	
• The progress of the mini project will be evaluated through three reviews, conducted by a committee appointed by the Head of the Department. A final project report must be submitted at the end of the semester. Evaluation will be based on oral presentation and the written report, assessed by internal examiners designated by the Head of the Department. • The project should focus on topics from first three or four semester (whichever is applicable) subjects / industry demand topics, or futuristic technologies. It is recommended for Faculty of Aeronautical Engineering, Civil Engineering, and Mechanical Engineering students, the project should demonstrate an understanding of first principles of engineering. • Similarly for students of Faculty of Computer Science Engineering, the project may involve programming using Python or C language. For Faculty of Electronics and Communication Engineering, the student project shall incorporate appropriate techniques and systems relevant to the field. For the students of Faculty of Fashion Technology, the project based on material innovations, or technology in fashion is recommended. • The evaluation will focus on how well the project is structured, including clarity and logical flow in both oral presentations and written texts. • The relevance and innovation of the project will be assessed, particularly its potential to contribute to sustainability, innovation, and SDG-aligned goals. • The accuracy of English usage, including grammar, clarity, and coherence, will be reviewed in both oral and written communication to ensure effective delivery of technical content.	
	TOTAL: 30 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply basic engineering principles to solve simple problems.
CO2:	Choose relevant sources to understand the current knowledge and identify areas to improve.
CO3:	Utilise basic tools and techniques to test simple solutions.
CO4:	Interpret the impact of engineering solutions on society and the environment.
CO5:	Combine in teams to plan and complete projects within given constraints.
CO6:	Develop comprehensive technical reports and deliver structured presentations to effectively convey project outcomes.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
2	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
3	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
4	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
5	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
6	3	2	1	1	1	1	1	3	2	2	2	1	3	1	3
Overall Correlation	3	2	**1**	**1**	**1**	**1**	**1**	**3**	**2**	**2**	**2**	**1**	**3**	**1**	**3**

Recommended by Board of Studies	**01-04-2024**		
Approved	**2nd ACM**	**Date**	**25-05-2024**

SEMESTER -V

23RE501	RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS	L	T	P	C
		2	0	0	2

COURSE OBJECTIVES:

- To provide an overview on selection of research problem based on the Literature review
- To enhance knowledge on the Data collection and Analysis
- To outline the importance of ethical principles to be followed in Research work and IPR

UNIT I	INTRODUCTION TO RESEARCH FORMULATION	6

Meaning of research problem, Sources of research problem, Criteria- good research problem, and selecting a research problem, Scope and objectives of research problem. Defining and formulating the research problem - Necessity of defining the problem - Importance of literature review in defining a problem

UNIT II	LITERATURE REVIEW	6

Literature review – Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis

UNIT III	DATA ANALYSIS	6

Execution of the research - Data Processing and Analysis strategies - Data Analysis with Statistical Packages - Generalization and Interpretation

UNIT IV	REPORT, THESIS PAPER, AND RESEARCH PROPASAL WRITING	6

Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables - Bibliography, types of referencing, citations- index and footnotes, how to write report- Paper Developing,- Plagiarism- Research Proposal- Format of research proposal- a presentation - assessment by a review committee

UNIT V	INTELLECTUAL PROPERTY AND PATENT RIGHTS	6
Ethical principles- Plagiarism, Nature of Intellectual Property - Patents, Designs, Trade and Copyright- patent search, Process of Patenting and Development: technological research, innovation, patenting, and development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of Patent Rights – Scope of Patent Rights, Geographical Indications		
		TOTAL: 30 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Analyze the literature to identify the research gap in the given area of research.
CO2:	Identify and formulate the research Problem
CO3:	Analyze and synthesize the data using research methods and knowledge to provide scientific interpretation and conclusion.
CO4:	Prepare research reports and proposals by properly synthesizing, arranging the research documents to provide comprehensive technical and scientific report
CO5:	Conduct patent database search in various countries for the research problem identified.
CO6:	Apply ethical principles in research and reporting to promote healthy scientific practice

TEXT BOOKS:	
1	Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An Introduction to Research Methodology, RBSA Publishers.
2	Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
3	Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.

4	Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
5	Wadehra, B.L. 2000. Law relating to patents, Trade Marks, Copy right designs and Geographical indications. Universal Law Publishing

REFERENCES:

1	Anthony, M., Graziano, A.M. and Raulin, M.L., 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
2	Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
3	Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
4	Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
5	Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
6	Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.
7	Satarkar, S.V., 2000. Intellectual property rights and copy right. ESS Publications.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	-	1	1	2	-	1	3	2	1
2	3	2	1	1	1	-	-	1	1	2	-	1	3	2	1
3	3	2	1	1	1	-	-	1	1	2	-	1	3	2	1
4	3	2	1	1	1	-	-	1	1	2	-	1	3	2	1
5	3	2	1	1	1	-	-	1	1	2	-	1	3	2	1
6	2	2	1	1	1	-	-	1	1	2	-	1	3	2	1
Overall Correlation	3	2	**1**	**1**	**1**	**-**	**-**	**1**	**1**	2	**-**	**1**	**3**	**2**	**1**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23AS501	ADVANCED PROPULSION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the principles of operation and design of spacecraft power plants.
- To explain the basics of hypersonic propulsion.
- To compare the solid and liquid rocket propulsion.
- To show the advantages and applications of electrical rocket propulsion.
- To learn the concepts of hybrid rocket propulsion.
- To apply propulsion knowledge to various rocket systems.

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 Motors –Plume, Signal Interference and Plume Signature – Structural Analysis of Propellant Grains –Safety Characteristics of Solid Propellants and Hazards of Solid Rocket Motors.

UNIT III	LIQUID ROCKET PROPULSION	9

Types of Propellants – Propellant Tanks – Propellant Feed Systems – Gas Pressure Feed Systems – Tank Pressurization – Turbo pump Feed Systems and Engine Cycles – Injector-Rocket Engines for Manoeuvring, Orbit Adjustments, Attitude Control – Engine Families – Valves and Pipelines – Engine Support Structure.

UNIT IV	**HYBRID ROCKET PROPULSION**	**9**
Conventional bi-propellant systems – High regression rate fuels – O/F shift – Scale-up tests -Regression rate analysis – Review of Solid-Fuel Regression Rate Behaviour in Classical and Nonclassical Hybrid Rocket Motors – Mechanisms and Measurement Techniques of Solid-Fuel Pyrolysis Phenomena and Regression– High-Speed Flow Effects – Combustion Instability and Transient Behaviour – Similarity and Scaling Effects.		
UNIT V	**ELECTRICAL ROCKET PROPULSION**	**9**
Introduction – Electrostatic Propellant Acceleration – Bombardment Ionization –Electrostatic Thruster Performance – Arc jet – Pulsed-Magneto plasma Accelerators – Laser Propulsion-Different Types, Advantages and Applications-Solar electric propulsion.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Apply the basic principles to design a hypersonic propulsion system.
CO2:	Explain hypersonic propulsion systems and their application to aerospace vehicles.
CO3:	Explain the working principle of solid propellant rocket and its design aspect of propellant grain.
CO4:	Develop the liquid rocket engine Working and its maneuvering and control system.
CO5:	Compare the combustion mechanism solid rocket and hybrid rocket.
CO6:	Develop the principles of various Electric propulsion technologies and laser propulsion systems.

TEXT BOOKS:	
1	John T. Bertin, “Hypersonic Aerothermodynamics”, AIAA Inc., Washington DC, 1994.
2	Sutton, G.P., “Rocket Propulsion Elements”, Wiley, New York, 9th Ed., 2017.
REFERENCES:	
1	Heiser, W. H. and Pratt, D. T., “Hypersonic Air Breathing Propulsion”, AIAA, 1994.
2	Hill P. G., and Peterson C. R., “Mechanics and Thermodynamics of Propulsion”, Pearson Education, 2nd Ed., 2009.
3	Oates G. C., “Aerothermodynamics of Aircraft Engine Components”, AIAA Education Series, 1985.
4	H. S. Mukunda "Understanding Aerospace Chemical Propulsion", Krishan Makhijani Publishers Pvt. Ltd, 2017.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	1	1	-	-	-	1	1	1	-	3	1	-
2	2	1	1	1	1	-	-	-	1	1	1	-	3	1	-
3	2	1	1	1	-	1	-	-	1	1	-	-	3	-	-
4	3	2	1	1	-	-	-	-	1	1	-	-	3	-	-
5	3	3	2	1	1	-	1	-	1	1	1	-	3	1	-
6	3	2	1	1	-	-	-	-	-	-	1	-	1	-	-
Overall Correlation	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**-**	**1**	**1**	**1**	**-**	**3**	**1**	**-**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

<table>
<tr><td rowspan="2">23AE611</td><td rowspan="2">FLIGHT DYNAMICS AND SIMULATION</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">• To know about the forces and moments acting on aircraft, the different types of drag, drag polar, ISA, variation of thrust, power, SFC with velocity and altitude.
• To have understanding about performance in level flight, minimum drag and power required, climbing, gliding and turning flight, v-n diagram and load factor.
• To knowledge about degrees of stability, stick fixed and stick free stability, stability criteria, effect of fuselage and CG location, stick forces, aerodynamic balancing.
• To understanding about lateral control, rolling and yawing moments, static directional stability, rudder and aileron control requirements and rudder lock.
• To understanding about dynamic longitudinal stability, stability derivatives, modes and stability criterion, lateral and directional dynamic stability.</td></tr>
<tr><td>UNIT I</td><td colspan="4">CRUISING FLIGHT PERFORMANCE</td><td>9</td></tr>
<tr><td colspan="6">Forces and moments acting on a flight vehicle - Equation of motion of a rigid flight vehicle - Different types of drag – estimation of parasite drag co-efficient by proper area method- Drag polar of vehicles from low speed to high speeds - Variation of thrust, power with velocity and altitudes for air breathing engines. Performance of airplane in level flight - Power available and power required curves. Maximum speed in level flight - Conditions for minimum drag and minimum power required</td></tr>
<tr><td>UNIT II</td><td colspan="4">MANEUVERING FLIGHT PERFORMANCE</td><td>9</td></tr>
<tr><td colspan="6">Range and endurance - Climbing and gliding flight -Maximum rate of climb and steepest angle of climb, minimum rate of sink and shallowest angle of glide -Turning performance -Turning rate turn radius. Bank angle and load factor – limitations on turn - V-n diagram and load factor.</td></tr>
</table>

UNIT III	STATIC LONGITUDINAL STABILITY	9
Degree of freedom of rigid bodies in space - Static and dynamic stability - Purpose of controls in airplanes - Inherently stable and marginal stable airplanes – Static, Longitudinal stability – Stick-fixed stability – Basic equilibrium equation - Stability criterion - Effects of fuselage and nacelle - Influence of CG location – Power effects – Stick-fixed neutral point – Stick-free stability-Hinge moment coefficient – Stick-free neutral points Symmetric maneuvers - Stick force gradients - Stick force per 'g' - Aerodynamic balancing.		
UNIT IV	**LATERAL AND DIRECTIONAL STABILITY**	**9**
Dihedral effect - Lateral control - Coupling between rolling and yawing moments - Adverse yaw effects - Aileron reversal - Static directional stability - Weather cocking effect - Rudder requirements - One engine inoperative condition - Rudder lock.		
UNIT V	**DYNAMIC STABILITY**	**9**
Introduction to dynamic longitudinal stability: - Modes of stability, effect of freeing the stick – Brief description of lateral and directional. dynamic stability - Spiral, divergence, Dutch roll, auto rotation and spin		
		TOTAL: 45 PERIODS

LIST OF EXPERIMENTS:

1. C.G. determination.
2. Calibration of ASI and Altimeter.
3. Calibration of special instruments.
4. Cruise and climb performance.
5. Determination of stick fixed and stick free neutral points.
6. Determination of stick fixed and stick free maneuver points.
7. Verification of Lateral-directional equations of motion for a steady state side slip maneuver.
8. Verification of Lateral-directional equations of motion for a steady state coordinated turn.
9. Flight determination of drag polar of a glider.
10. Demonstration of stall, Phugoid motion and Dutch roll.

TOTAL: 30 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Examine the forces & moments of an aircraft, types of drag, drag polar, and performance in level flight.
CO2:	Develop an understanding about basic maneuvering performance (range, endurance, climbing, gliding & turning flight), v-n diagram and load factor.
CO3:	Make use of degrees of stability, stick fixed & stick free stability, stability criteria, effect of fuselage & CG location, stick forces, aerodynamic balancing.
CO4:	Apply the lateral control, rolling & yawing moments, static directional stability, rudder & aileron control requirements and rudder lock.
CO5:	Make use of dynamic longitudinal stability, stability derivatives, modes & stability criterion, lateral and directional dynamic stability to determine the stability of the aircraft.
CO6:	Apply practical experience on the dynamics of the aircraft.
TEXT BOOKS:	
1	McCormick, Barnes W. "Aerodynamics, Aeronautics, and Flight Mechanics". 2nd ed. New York: John Wiley & Sons, 1994.
2	Nelson, Robert C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 2004.
REFERENCES:	
1	Babister, A.W. "Aircraft Dynamic Stability and Response" Pergamon International Library of Science, Technology, Engineering, and Social Studies. Oxford: Pergamon Press, 1980.

2	Dommasch, Daniel O., Sydney S. Sherby, and Thomas F. Connolly. “Aeroplane Aerodynamics” 3rd ed. London: Isaac Pitman, 1981.
3	Etkin, Bernard, and Lloyd Duff Reid. “Dynamics of Flight: Stability and Control”. 3rd ed. New York: John Wiley & Sons, 1995.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	2	1	1	1	-	1	1	-	3	2	1
2	3	2	1	1	2	1	1	1	-	1	1	-	3	2	1
3	3	2	1	1	2	1	1	1	-	1	1	-	3	2	1
4	3	2	1	1	2	1	1	1	-	1	1	-	3	2	1
5	3	2	1	1	2	1	1	1	-	1	1	-	3	2	1
6	3	2	1	1	2	1	1	1	-	1	1	-	3	2	1
Overall Correlation	**3**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**-**	**1**	**1**	**-**	**3**	**2**	**1**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23AS521	SPACE PROPULSION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To understand the basic concepts of aerodynamic and thermodynamic characteristics of major engine components
- To study the performance of supersonic nozzles at different Mach numbers
- To explore the practical components of aircraft piston and gas turbine engines and their working principles.
- To understand the formation of shock waves
- To impart practical knowledge of the flow phenomenon of subsonic and supersonic jets.
- To determine the practical thrust developed by rocket propellants

LIST OF EXPERIMENTS:

1. Propeller Performance test.
2. Measurement of the wall pressure distribution in a subsonic diffuser.
3. Measurement of the wall pressure distribution in a supersonic nozzle.
4. Wall pressure measurement of Single Expansion Ramp Nozzle (SERN).
5. Optical Flow visualization of shock waves at the lip of supersonic intake.
6. Optical Flow visualization of secondary injection in a supersonic flow.
7. Experimental study of the supersonic free jet.
8. Experimental study of supersonic wall jet.
9. Cold flow studies in a Ramjet duct.
10. Cascade Testing of turbine blades.
11. Orsat Apparatus – Combustion studies
12. Experiment on Plasma thruster under vacuum conditions.
13. Micro Gas Turbine test

TOTAL: 60 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Identify components and information of the gas turbine engine.
CO2:	Analyze the behaviour of flow through ducts and jet engine components
CO3:	Examine the flow phenomenon in supersonic flow using the visualization technique.
CO4:	Compare the flow characteristics of subsonic and supersonic flow.
CO5:	Dissect the operation of equipment like a highly sensitive pressure scanner.
CO6:	Analyze the physical properties of shockwaves.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	1	1	-	1	1	-	1	1	2	1	1
2	3	3	2	2	1	1	-	1	1	-	1	1	2	1	1
3	3	3	2	2	1	1	-	1	1	-	1	1	2	1	1
4	3	3	2	1	1	1	-	1	1	-	1	1	2	1	1
5	3	3	2	1	1	1	-	1	1	-	1	1	2	1	1
6	3	3	2	2	1	1	-	1	1	-	1	1	2	1	1
Overall Correlation	**3**	**3**	**2**	**2**	**1**	**1**	**-**	**1**	**1**	**-**	**1**	**1**	**2**	**1**	**1**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23AE522	COMPUTATIONAL ANALYSIS LABORATORY	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To acquaint with the stress distribution.
- To gain experience with meshing of various geometries.
- To understand the variation of mechanical properties under different load conditions.
- To explore flow analysis.
- To study thermal analysis.

LIST OF EXPERIMENTS:

1. Grid independence study and convergence test using any simple case like cylinder.
2. Simulation of flow over backward facing step.
3. Simulation of Karman vortex trail (vortex shedding) using circular cylinder.
4. External flow simulation of aerofoil at subsonic & supersonic speeds.
5. Internal flow simulation of subsonic, sonic and supersonic flow through a CD nozzle.
6. Structural analysis of bar and beam.
7. Structural analysis of truss.
8. Structural analysis of tapered wing.
9. Analysis of composite laminate structures.
10. Heat transfer analysis of structures.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Make use of solid modelling and simulation tools for solving CFD and Structural problems.
CO2:	Develop the ideal grid generation techniques.

CO3:	Apply the analysis type for CFD and Structural Analysis.
CO4:	Analyse the aerofoil and fluid dynamics problems.
CO5:	Analyse and validate the computational results.
CO6:	Analyse structural and CFD problems related to the Aerospace industry

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	2	2	2	2	3	1	-	1	2	2	2
2	3	2	1	1	2	2	2	2	3	1	-	1	3	2	2
3	3	2	1	1	2	2	2	2	3	1	-	1	3	2	2
4	3	3	2	2	2	2	2	2	3	1	-	1	3	2	2
5	3	3	2	2	2	2	2	2	3	1	-	1	3	2	2
6	3	3	2	2	2	2	2	2	3	1	-	1	3	2	2
Overall Correlation	**3**	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**3**	**1**	**-**	**1**	**3**	**2**	**2**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23AS522	SPACE VEHICLE DESIGN PROJECT	L	T	P	C
		0	0	4	2

COURSE OBJECTIVES:

- To make the student work in groups and effectively improve their team work.
- To understand the concepts involved in designing the space launch vehicle.
- To learn the conceptual stage of a spacecraft design in respect of its stability.
- To understand the necessary phases in the design process and produce the required outcomes of each phase.
- To understand the staging of rockets.
- To understand different loads acting on space vehicles.

LIST OF EXPERIMENTS :

1. Study on classification of rockets & launch vehicles.
2. Study on Current & future launch vehicles, Orbit/trajectory requirements and missions.
3. Study on the generation of thrust, the rocket equation, specific impulse, types of engines, Launch vehicle parameters and performance.
4. Perform Staging, Structure and propulsion design trades.
5. Study on Powered flight, Gravity loss, Ascent through the atmosphere, drag loss, Vehicle coordinates, moving coordinate systems, The local horizon frames. Motion of the launch site, Ascent trajectories, The gravity-turn trajectory, Numerical calculation of trajectories.
6. Application of software in trajectory calculation, Optimization principles, Introduction to GPOPS2 program & application to launch optimization, Structures: tanks, inter-tank & inter- stage structure, thrust structure, separation systems.
7. Estimate Δv , initial sizing, inboard profile & layout, Engine selection, Preliminary mass parameters.
8. Calculation of loads from ground winds, loads during flight: thrust, aero, and inertial forces, Trimmed flight, Max-q, Calculation of internal forces, moments, shears.

9. Calculation of stresses due to external loads, internal pressurization, Tank and interstage structural design, Vibration, shock, acoustic, and thermal effects.
10. Determine VS&A, thermal, concluded Guidance, stability and control.
11. Structural flexibility effects, Instabilities, Manufacturing, Launch pad and facilities.
12. Ground testing, Safety and flight termination systems

TOTAL: 60 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Design aerospace system using CAD drawings.
CO2:	Evaluate design concepts for aerospace systems using analysis, experiment or simulation methods.
CO3:	Develop a number of standard methods to various phases of the design process.
CO4:	Evaluate different space vehicle design phases.
CO5:	Analyze different staging of rockets
CO6:	Analyze the loads acting on space vehicles

Cos	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	1		1	-	-	1	-	1	3	1	-
2	3	3	2	2	1	1	1	1	-	1	-	-	3	1	1
3	3	2	1	1	-	-	-	-	-	1	-	1	3	-	-
4	3	3	2	2	1		1	-	-	1	-	1	3	1	-
5	3	3	2	1	1	1	1	1	-	1	-	-	3	1	1
6	3	3	21	1	-	-	-	-	-	1	-	1	3	-	-
Overall Correlation	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**1**		**1**		**1**	**3**	**1**	**1**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23ES591	APTITUDE AND LOGICAL REASONING –2	L	T	P	C
		0	0	2	1

COURSE OBJECTIVES:

- To improve the problem solving and logical thinking ability of the students.
- To acquaint the student with frequently asked patterns in quantitative aptitude and logical reasoning during various examinations and campus interviews

UNIT I		4
Probability, Permutation & Combination, Algebra, Problems on ages		
UNIT II		**4**
Mensuration, Logarithms, inequalities and modulus, Syllogism		
UNIT III		**4**
Directions, logical sequence words, number series, Analytical Reasoning		
UNIT IV		**4**
Blood relation, Clock and Calendar, Picture puzzles		
UNIT V		**4**
Data sufficiency, cube and cuboids, odd man out		
		TOTAL: 20 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Apply concepts of probability, permutation, and combination to solve real-world problems.
CO2:	Solve algebraic problems and age-related problems using logical approaches and techniques.
CO3:	Analyze and solve problems in mensuration, logarithms, and inequalities.
CO4:	Interpret and solve problems related to directions, logical sequence, and number series.
CO5:	Identify and solve problems in logical reasoning such as syllogism, blood relations, clock and calendar.
CO6:	Identify and solve problems in logical reasoning such as syllogism, blood relations, clock and calendar.

TEXT BOOK:	
1	Smith, John. "APTIPEDIA." 2nd ed., Wiley Publishers, 2020.
2	Agarwal, R.S. "Quantitative Aptitude." 2nd ed., S. Chand Publishing.
REFERENCES:	
1	Agarwal, R.S. "A Modern Approach to Verbal & Non-Verbal Reasoning." 2nd ed., S. Chand Publishing.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	1	3	2	2	2	1	3	1	2	3	2	2
2	3	2	2	2	3	2	3	2	1	2	1	2	3	2	3
3	3	3	2	2	2	2	2	2	1	3	1	2	3	3	2
4	2	3	2	1	2	3	1	2	3	3	2	3	2	2	3
5	2	3	3	2	2	2	2	3	2	2	2	3	3	3	3
6	3	3	2	2	3	2	3	3	2	2	1	2	3	3	2
Overall Correlation	3	3	3	2	3	3	3	3	2	3	2	3	3	3	3

Recommended by Board of Studies	**13-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

SEMESTER –VI

23AS601	SPACE MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Understand the space environment, its effects on spacecraft and astronauts, and strategies for managing space debris.
- Learn orbital mechanics concepts, including Kepler's laws, two-body problems, and celestial coordinate systems.
- Analyze interplanetary missions, focusing on orbits, trajectories, and mission planning techniques.
- Explore the design and optimization of space launch vehicles, including propulsion, thermal, and communication systems.
- Study astrophysics concepts, astronomical observations, and the structure of the galaxy using modern techniques.

UNIT I	SPACE ENVIRONMENT	9

Peculiarities of space environment and its description– Effect of space environment on materials of spacecraft structure and astronauts- Manned space missions – Effect on satellite life time- Space debris Management.

UNIT II	ORBITAL MECHANICS	9

The solar system – Reference frames and coordinate systems – Terminology related to the celestial sphere and its associated concepts – Kepler's laws of planetary motion and proof of the laws – Newton's universal law of gravitation - The many body problem - Lagrange-Jacobi identity – The circular restricted three body problem – Liberation points – The general N-body problem – Two body problem – Relations between position and time.

UNIT III	INTERPLANATERY MISSION	9

Orbits and trajectories- Effect of injection condition- Effect of earth's rotation, perturbation analysis-Parking orbit- Transfer trajectory- Impulsive shot; rendezvous- recent interplanetary missions

UNIT IV	**SPACE LAUNCH VEHICLE**	**9**
Space Vehicle Design: requirements, Specifications and design process – Rocket equation – Velocity budget, Staging, Launch vehicle sizing, Launch into an orbit, range safety – Rocket propulsion options – Configuration and structural design – NGC systems – Thermal control – Power systems – Communication systems – Design for reentry – Vehicle integration.		
UNIT V	**ASTROPHYSICS**	**9**
Mass, Length and Time Scales in Astrophysics - The Emergence of Modern Astrophysics - Application of Physics to Astrophysics. - Relevance of General Relativity - Sources of Astronomical Information - Astronomy in Different Bands Of Electromagnetic Radiation - Optical Astronomy - Radio Astronomy - X-Ray Astronomy Other New Astronomies - Astronomical Nomenclature- Our Galaxy And Its Interstellar Matter - The Shape And Size Of Our Galaxy - Some Basics Of Star Count Analysis.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Make use of the satellite injection, satellite perturbations and trajectory control
CO2:	Apply orbital mechanics for space application
CO3:	Examine the trajectory/orbit of a space vehicle or a satellite in a suitable coordinate system.
CO4:	Analyze the delta-v required for transferring a spacecraft from one orbit to another.
CO5:	Explain astrophysics in the space application.
CO6:	Summarize the space launch vehicle and its uses.

TEXT BOOKS:

1	Choudhuri, Arnab Rai. “Astrophysics for physicists”, Cambridge University Press The Edinburgh Building, Cambridge CB2 8RU, UK, 2010.
2	Griffin, Michael D., and J. R. French. "Space Vehicle Design AIAA Education Series." , JR French–Reston VA: AIAA ,2004.

REFERENCES:

1	E. Stuhlinger and G. Mesmer. “Space Science and Engineering”. 1st Edition, McGraw-Hill, New York ,1965.
2	W.N. Hess. “Space Science”. 1st Edition, Blackie and Son,1965.
3	Howard Curtis, “Orbital Mechanics for Engineers and Scientists”, 3rd edition, Elsevier, 2010.
4	Marcel J. Sidi, “Spacecraft Dynamics and Control: A Practical Engineering Approach”, Cambridge University Press, 1997.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	1	1	1	1	1	1	2	1	1
2	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1
3	3	3	2	1	1	1	1	1	1	1	1	1	3	1	1
4	3	3	2	2	1	1	1	1	1	1	1	1	3	1	1
5	2	1	1	1	1	1	1	1	1	1	1	1	3	1	1
6	2	1	1	1	1	1	1	1	1	1	1	1	3	1	1
Overall Correlation	**3**	**2**	**1**	**1**	**1**	**1**	1	1	1	1	1	1	1	**1**	1

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

<table>
<tr><td rowspan="2">23CE611</td><td colspan="2" rowspan="2">ENVIRONMENTAL SCIENCE AND ENGINEERING</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">
• To provide basic knowledge on environment impact assessment
• To create an awareness on the pollutants in the environment
• To familiarize the student with the technology for restoring the environment.
• Applying the technology for producing ECO safe products
• To develop simple climate models and evaluate climate changes using models
</td></tr>
<tr><td>UNIT I</td><td colspan="5">INTRODUCTION TO ENVIRONMENT IMPACT ASSESSMENT</td><td>9+3</td></tr>
<tr><td colspan="7">Impacts of Development on Environment – Rio Principles of Sustainable Development- Environmental Impact Assessment (EIA) – Objectives – Historical development – EIA Types – EIA in project cycle –EIA Notification and Legal Framework</td></tr>
<tr><td>UNIT II</td><td colspan="5">MOVEMENT OF POLLUTANTS IN ENVIRONMENT</td><td>9+3</td></tr>
<tr><td colspan="7">Concepts of diffusion and dispersion, point and area source pollutants, pollutant dispersal; Gaussian plume model, hydraulic potential, Darcy’s equation, types of flow, turbulence. Concept of heat transfer, conduction, convection; concept of temperature, lapse rate (dry and moist adiabatic); mixing heights, laws of thermodynamics; concept of heat and work, Carnot engine, transmission of electrical power, efficiency of turbines, wind mills and hydroelectric power plants.</td></tr>
<tr><td>UNIT III</td><td colspan="5">ECOLOGICAL RESTORATION</td><td>9+3</td></tr>
<tr><td colspan="7">Wastewater treatment: anaerobic, aerobic process, methanogenesis, treatment schemes for waste water: dairy, distillery, tannery, sugar, antibiotic industries; solid waste treatment: sources and management (composting, vermiculture</td></tr>
</table>

and methane production, landfill. hazardous waste treatment).		
UNIT IV	**ECOLOGICALLY SAFE PRODUCTS AND PROCESSES**	**9+3**
Biofertilizers, microbial insecticides and pesticides, bio-control of plant pathogen, Integrated pest management; development of stress tolerant plants, biofuel; mining and metal biotechnology: microbial transformation		
UNIT V	**CLIMATE CHANGE MODELS**	**9+3**
Constructing a climate model – climate system modeling – climate simulation and drift – Evaluation of climate model simulation – regional (RCM) – global (GCM) – Global average response to warming –climate change observed to date		
		TOTAL: 60 PERIODS

LIST OF EXPERIMENTS

1. Determination of Bio fuel parameters such as flash point and fire point.
2. Determination of density of biofuels.
3. Determination of BOD/COD in water.
4. Simulating the RCM and GCM model for different geographic conditions.
5. Measurement of Pollutant in environment by Gaussian Plume model.

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Explain the importance of the process of Environmental impact assessment and its types.
CO2:	Illustrate the chemical processes and pollutant chemistry
CO3:	Identify the methods to solve environmental problems
CO4:	Apply the knowledge to develop ecofriendly products.
CO5:	Construct the various simple climate models for simulation
CO6:	Apply the climate model simulation to monitor climate change

TEXT BOOKS:	
1	David .E Neelin "Climate Change and Modelling", Cambridge University Press, California 2012.
2	Evans, G.G. & Furlong, J. 2010. Environmental Biotechnology: Theory and Application (2nd edition). Wiley-Blackwell Publications.
3	Pani, B. 2007. Textbook of Environmental Chemistry. IK international Publishing House
4	N.S. Raman , A.R. Gajbhiye & S.R. Khandeshwar, Environmental Impact Assessment, 2014,IK International Pvt Ltd.
REFERENCES:	
1	Carson (1907-1964). Environment Conservation-book
2	Encyclopaedia of Environmental Issues by Craig W. Allin &Probe.
3	Encyclopaedia of Environmental studies by William Ashworth.
4	Climate Change and Climate Modeling- Kindle Edition.
5	Environmentally- Friendly Product development -Eberhand Abile ,Reiner Anderl,2005

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	-	2	1	-	-	-	-	-	2	-	-
2	3	2	1	1	-	3	2	-	-	-	-	1	3	-	-
3	3	2	1	1	-	3	2	-	-	-	-	1	3	-	-
4	3	2	1	1	-	3	2	-	-	-	-	1	3	-	-
5	3	2	1	1	-	3	2	-	-	-	-	1	3	-	-
6	3	2	1	1	-	3	2	-	-	-	-	1	3	-	-
Overall Correlation	**3**	**2**	**1**	**1**	**-**	**3**	**2**	**-**	**-**	**-**	**-**	**1**	**3**	**-**	**-**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23AE612	AVIONICS	L	T	P	C
		3	0	2	4

COURSE OBJECTIVES:

- To introduce the basics of avionics and its need for civil and military aircraft.
- To impart knowledge about the avionic architecture and various avionics data buses.
- To gain more knowledge on various avionics subsystems.
- To study the concepts of navigation systems.
- To introduce the basics of the autopilot system.
- To introduce the basics of Airdata systems.

UNIT I	INTRODUCTION TO AVIONICS	9

Need for avionics in civil and military aircraft and space systems – Integrated avionics 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 – 429 – 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, ILS, MLS – Inertial Navigation Systems (INS) – Inertial sensors, INS block diagram – Satellite navigation systems – GPS.

UNIT V	AIR DATA SYSTEMS AND AUTOPILOT	9

Air data quantities – Altitude, Airspeed, Vertical speed, Mach Number, Mach warning, Altitude warning – Auto pilot – Basic principles, Longitudinal and Lateral autopilot.

TOTAL: 45 PERIODS

LIST OF EXPERIMENTS:	
	1. 8-bit Addition/ subtraction using 8085 microprocessor kit. 2. 16-bit Addition/ subtraction using 8085 microprocessor kit. 3. Sum of a given series with and without carry using 8085 microprocessor kit. 4. Design PID controller using MATLAB. 5. Compute Arithmetic and logical operations using MATLAB. 6. Compute Arithmetic operations on matrices using MATLAB. 7. Check the response of the control system by applying different types of input signals. 8. Design of the PID controller using MATLAB. 9. Stability Analysis by using ROOT LOCUS techniques. 10. Stability Analysis by using BODE PLOT techniques.
	TOTAL: 30 PERIODS
COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Design and study various Avionic systems present in the aircraft.
CO2:	Build the Digital avionics architecture and integrate the avionics systems using data buses.
CO3:	Analyze the performance of various cockpit display technologies.
CO4:	Design the Navigation system and find out the position.
CO5:	Design autopilot and study various air data systems.
CO6:	Apply integration to the systems present in the aircraft.
TEXT BOOKS:	
1	Helmreich, Albert D. "Principles of Avionics". 7th ed. Leesburg, Avionics Communications, 2018.
2	Collinson, R. P. G. *"Introduction to Avionics"*. 4th ed. London: Chapman and Hall, 2023.

REFERENCES:

1. Middleton, D. H., ed. "Avionic Systems". Longman Scientific and Technical. England: Longman Group UK Ltd., 1989.
2. Pallett, E.H.J. "Aircraft Instruments and Integrated Systems ", Pearsons, Indian edition 2011.
3. Spitzer, Cary R., Uma Ferrell, and Thomas Ferrell, eds. "*Digital Avionics Handbook*". 3rd ed. Boca Raton, FL: CRC Press, 2014.
4. Spitzer, Cary R., ed. "*The Avionics Handbook*". Boca Raton, FL: CRC Press, 2000.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	2	-	-	-	-	-	-	-	2	2	-
2	3	3	3	3	2	-	-	-	-	-	-	-	3	2	-
3	3	3	2	1	1	-	-	-	-	-	-	-	3	1	-
4	3	3	3	3	2	-	-	-	-	-	-	-	3	2	-
5	3	3	3	3	2	-	-	-	-	-	-	-	3	2	-
6	3	2	1	1	1	-	-	-	-	-	-	-	3	1	-
Overall Correlation	**3**	**3**	**3**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**1**	**-**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

23AS621	PROJECT WORK PHASE-1	L	T	P	C
		0	0	4	2

COURSE DESCRIPTION:

This course provides an opportunity for students to apply their engineering knowledge to solve real-world problems through project-based learning. Students, working in groups with maximum of 4 under faculty supervision, undertake a comprehensive project addressing an approved topic. The course focuses on fostering collaboration, research, and practical skills, culminating in a detailed Phase 1 project report and oral presentations. Regular reviews ensure consistent progress and adherence to academic standards.

COURSE OBJECTIVES:

- Encourage students to apply theoretical knowledge to practical engineering problems.
- Develop collaborative and project management skills through teamwork.
- Train students in research methodology, technical documentation, and presentation skills.
- Enhance students' ability to design, analyze, and evaluate solutions systematically.
- Prepare students for real-world engineering challenges and multidisciplinary teamwork

PROJECT OUTLINE:

Week 1	Orientation and course overview. Formation of project teams and approval of topics by HoD.
Week 2	Initial meeting with supervisors. Define problem statement and objectives
Week 3	Literature review: Research methodologies and topic-specific studies.
Week 4	Zeroth Review.
Week 5	Refinement of literature review and identification of research gaps.

Week 6	Identification of Base Paper.
Week 7	First Review.
Week 8	Conceptual design discussions and brainstorming solutions.
Week 9	Narrowing done on the exact work.
Week 10	Completion of first stage of the Project.
Week 11	Development of detailed conceptual design and methodology.
Week 12	Incorporation of feedback and refinement of design and methodology.
Week 13	Second Review.
Week 14	Compilation of Phase 1 results, report writing, and presentation preparation.
Week 15	Final Viva Voce Presentations.
Individual meetings will be set up on a need's basis in conjunction with developing work	
EVALUATION:	
• The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A phase 1 project report is required to be submitted at the end of the semester. Evaluation is based on oral presentation and the phase 1 project report jointly by internal examiners constituted by the Head of the Department. • Evaluate how effectively the project is structured and communicated in both oral presentations and written texts, emphasizing logical flow and coherence. • Evaluate the relevance and innovation of practical resources or prototypes developed, focusing on their potential to support sustainability, innovation, and SDG-aligned goals. • Review the accuracy of English usage, including grammar, clarity, and coherence in oral and written communication, ensuring effective delivery of technical content.	

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Develop feasible solutions by analyzing complex engineering problems using foundational knowledge, mathematics, and science.
CO2:	Survey literatures to identify gaps, define research questions, and propose designs and methods for solving engineering problems.
CO3:	Make use of modern tools to check the feasibility of the solutions effectively.
CO4:	Evaluate societal and environmental impacts of solutions while incorporating sustainability and ethical practices.
CO5:	Combine in teams to plan, manage, and lead projects within professional and economic constraints.
CO6:	Formulate technical reports, deliver presentations, and engage in lifelong learning to adapt to new technologies.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
2	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
3	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
4	3	2	2	2	1	1	2	3	3	3	3	3	3	1	3
5	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
6	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
Overall Correlation	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**3**

Recommended by Board of Studies	**07-11-2024**		
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23AS622	TECHNICAL TRAINING	L	T	P	C
		0	0	2	1

PREAMBLE:

The course 'Technical Training' is intended to enable a B.E./B.Tech. graduate to practice, learn, apply and prepare report about the training undergone. The learner shall be trained in the latest technology in relevant Industry preferably in computer-oriented platform. This course can help the learner to experience training and learn practical skills for the relevant domain. Learner should also be able to present his learning through PPT and report articulating his level of learning about the specific training.

COURSE OBJECTIVES:

- To equip students with practical skills and real-world experience in technical domains, enabling them to effectively apply theoretical knowledge to hands-on applications.
- To develop competencies in working with industry-relevant tools and software technologies.
- To foster teamwork, problem-solving, and technical skills through innovative technologies

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Identify specific domain from the enrolled branch and to get training preferable in computer-oriented platform.
CO2:	Survey and apprehend the learning modules in the training program and to become expert in the specific domain.
CO3:	Apply theoretical learning in the practical environment and enhance the skillset of learner.
CO4:	Estimate the learning using available data.

CO5:	Defend a presentation about the learning done in the specified skillset.
CO6:	Construct a technical report about the training.

GUIDELINES:

- More than one training program may be given depending on availability and interest of the students. One training coordinator may be appointed for the same.
- Training coordinator shall provide required input to their students regarding the selection of training topic.
- Choosing a Training topic: The topic for a Technical Training should be current and broad based rather than very specific area of interest. It should also be outside the present syllabus. It's advisable to choose a training topic to be computer oriented as the resources for the same may be readily available. Every student of the program should be involved and assessed.
- Head of Department shall approve the selected training topic by the second week of the semester. Training may be assessed based on the ability to apply the skillset in a practical domain.

EVALUATION PATTERN:

Training Coordinator:

50 marks (Training Manual – 40 (Each student shall maintain a Training Manual and the Coordinator shall monitor the progress of the training work on a weekly basis and shall approve the entries in the Training Manual during the weekly meeting with the student), Attendance – 10,).

Presentation of Application:

Candidate should apply the skillset attained in training. 20 marks to be awarded by the Examiners (Clarity of presentation – 5, Interactions – 10, Quality of the slides – 5).

Report about Application:

30 marks to be awarded by the Examiners (check for technical content, overall quality, templates followed, adequacy of application of the skillset etc.).

Training duration – 30 Hours															
COs	**POs**											**PSOs**			
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	2	1	-	-	-	-	3	3	-	-
2	3	3	2	1	-	2	1	-	-	-	-	3	3	-	-
3	3	3	3	3	3	-	-	1	-	2	-	3	3	3	1
4	3	3	3	2	2	-	-	1	-	3	-	3	3	2	1
5	3	3	3	2	1	2	-	2	-	2	-	2	3	1	2
6	3	3	3	3	2	2	-	2	-	3	-	3	3	2	2
Overall Correlation	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**-**	**3**	**-**	**3**	**3**	**2**	**2**

Recommended by Board of Studies	**07-11-2024**		
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23AS623	TECHNICAL SEMINAR – 1	L	T	P	C
		0	0	2	1

PREAMBLE:

The course 'Technical Seminar' is intended to enable a B.E./B. Tech graduate to read, understand, present and prepare report about an academic document. The learner shall search in the literature including peer reviewed journals, conference, books, project reports etc., and identify an appropriate paper/thesis/report in her/his area of interest, in consultation with her/his seminar coordinator. This course can help the learner to experience how a presentation can be made about a selected academic document and empower her/him to prepare a technical report.

COURSE OBJECTIVES:

- To do Literature surveys in a selected area of study
- To understand an academic document from the literature and to give a presentation about it
- To prepare a technical report.

GUIDELINES:

- The Department shall form an Internal Assessment Committee (IAC) for the seminar with academic coordinator for that program as the Chairperson and seminar coordinator as member. During the seminar presentation of a student, all members of IAC shall be present.
- Formation of IAC shall be completed within a week after the End Semester Examination (or last working day) of the previous semester.
- Seminar Coordinator shall provide required input to their students regarding the selection of topic/ paper.

- Choosing a seminar topic: The topic for a UG seminar should be current and broad based rather than very specific research work, beyond the syllabus. Every member of the project team could choose or be assigned Seminar topics that covers various aspects linked to the Project area.
- A topic/paper relevant to the discipline shall be selected by the student during the semester break.
- Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IAC. The IAC shall approve the selected topic/paper by the second week of the semester.
- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

EVALUATION PATTERN

Seminar Coordinator:

40 marks (Background Knowledge – 10 (The coordinator shall give deserving marks for a candidate based on the candidate's background knowledge about the topic selected), Relevance of the paper/topic selected – 10).

(Seminar Diary – 10 (Each student shall maintain a seminar diary and the coordinator shall monitor the progress of the seminar work on a weekly basis and shall approve the entries in the seminar diary during the weekly meeting with the student), Attendance – 10).

Presentation:

40 marks to be awarded by the IAC (Clarity of presentation – 10, Interactions – 10 (to be based on the candidate's ability to answer questions during the interactive session of her/his presentation), Overall participation – 10 (to be given based on her/his involvement during interactive sessions of presentations by other students), Quality of the slides – 10).

Report:

20 marks to be awarded by the IAC (check for technical content, overall quality, templates followed, adequacy of references etc.).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Identify academic documents from the literature which are related to her/his areas of interest.
CO2:	Survey and apprehend an academic document from the literature which is related to her/ his areas of interest.
CO3:	Compile a presentation about an academic document.
CO4:	Estimate the Contents using available literature.
CO5:	Defend a presentation about an academic document.
CO6:	Construct a technical report.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	2	2	1	1	2	3	3	2	2	3	2	2
2	3	3	3	1	2	1	1	2	3	3	2	2	3	2	2
3	3	3	2	2	2	1	1	1	3	3	1	1	3	2	2
4	3	3	2	1	1	1	2	2	3	3	2	1	3	2	2
5	3	3	2	1	1	1	1	2	2	2	2	2	3	1	2
6	3	3	2	1	1	1	1	2	2	2	2	2	3	1	2
Overall Correlation	**3**	**3**	**2**	**1**	**1**	**1**	**1**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**2**

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SEMESTER – VII

23AS701	ROCKETS AND LAUNCH VEHICLES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To compute and analyse the various forces and moments acting on a rocket.
- To formulate the equations of motions for flight and separation phases.
- To understand the combustion and propulsion systems in rocket.
- To select suitable materials for the rockets and launch vehicles.
- To understand the design, performance and testing aspects.
- To comprehend the stage separation of multistage rockets.

UNIT I	ROCKET DYNAMICS	9

Peculiarities of space environment and its description– Effect of space environment on materials of spacecraft structure and astronauts- Manned space missions – Effect on satellite life time- Space debris Management.

UNIT II	SOLID PROPULSION AND PYROTECHNICS	9

Solid propellant rockets – Classification – Components and their design considerations – Propellant grain design – grain mechanical properties – Ballistics and burn rate design issues – Igniter design – Pyrotechnic devices and systems – Classification – Mechanisms and application of pyrotechnic devices in rockets and launch vehicles – Design problems in rocket systems.

UNIT III	LIQUID PROPULSION AND CONTROL SYSTEMS	9

Liquid propellant rockets – Classification and components – Thrust chamber, feed systems, propellant tanks, turbo-pumps, types of valves and applications – Their design considerations – Different bipropellant systems like cryogenics and their characteristics – Pogo and slosh engine gimbal systems and thrusters for control – Thrust control systems – Design problems.

UNIT IV	**MULTI-STAGING OF ROCKET AND SEPARATION DYNAMIC**	**9**
Navigation and guidance systems in rockets and launch vehicles – Aerodynamic control systems of launch vehicles – Multi-staging of rockets – Vehicle optimization techniques – Stage separation system – Dynamics, separation techniques – Rocket flight dispersion, numerical problems.		
UNIT V	**ASTROPHYSICS**	**9**
Design requirements and selection – Performance evaluation and assessment – Space environment on the selection of materials for rockets and spacecraft – Material selection for specific requirements – Advance materials-super alloys and composite materials – Qualification of rocket and missile systems – types of testing and evaluation of design and function.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Identify various rocket and launch vehicle systems, derive motion equations, and explore advanced rockets for future missions.	
CO2:	Organize design concepts and operational principles of solid propellant propulsion and pyrotechnic systems.	
CO3:	Apply functionality and design principles of liquid propellant propulsion and control systems.	
CO4:	Analyze motion equations, dynamics of stage separation, navigation, guidance, and control systems, and multistage rocket design.	
CO5:	Plan system design, construction, functionality, performance, testing, and material selection for rocket systems.	
CO6:	Classify the guidance and navigation system of the rocket.	

TEXT BOOKS:	
1	Cornelisse, J. W., “Rocket Propulsion and Spaceflight Dynamics”, Pitman, London, 1982.
2	Ramamurthi K., “Rocket Propulsion”, Macmillan Publishers India first Ed., 2010.

REFERENCES:	
1	Sutton, G.P., “Rocket Propulsion Elements”, Wiley, New York, 9th Ed., 2017.
2	Joseph Jimmerson, “The Rocket Files”, Lulu.com, 2nd Ed., 2013.
3	George M. Siouris, “Missile Guidance and Control Systems”, Springer-Verlag New York, 2004.
4	Ronald Humble, Henry and Larson, “Space Propulsion Analysis and Design”, McGraw-Hill. 1995.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	1	-	-	1	-	-	1	-	2	1	1
2	3	2	1	1	1	-	-	-	1	1	1	1	2	1	-
3	3	2	1	1	1	-	-	1	1	1	1	1	3	1	1
4	3	3	2	2	1	-	-	-	1	1	1	1	3	1	-
5	3	2	1	1	1	-	-	1	1	1	1	1	3	1	1
6	2	1	1	1-	1	1	1	1	1	1	1	1	2	1	1
Overall Correlation	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**3**	**1**	**1**

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23AE702	FINITE ELEMENT METHOD	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

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

UNIT I	INTRODUCTION	9

Review of various approximate methods – Variational approach and Weighted residual approach application to structural mechanic's 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. Higher order elements for bar problem.

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. Force matrix for CST and LST element under uniform and varying loads.

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:	
	After completion of the course, the students will be able to:
CO1:	Construct the flow chart of finite element steps and understand the convergence of the problem.
CO2:	Solve stiffness matrix for bar, beam and frame problems using suitable boundary condition.
CO3:	Analyze 2d structures using Plane stress and plane strain conditions.
CO4:	Solve 2d and 3d structures using isoparametric elements.
CO5:	Apply the concepts of Numerical integration and finite element methods to solve fluid flow and heat transfer problems.
CO6:	Test for autonomous navigation in UAV Analyze structures using the software packages and analytical techniques.

TEXT BOOKS:	
1	Reddy J.N., "An Introduction to Finite Element Method", McGraw Hill, fourth edition, 2020.
2	Tirupathi. R. Chandrapatha and Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", Prentice Hall India, Fifth edition, 2021.

REFERENCES:	
1	P. Seshu "Finite Element Analysis", PHI Learning Pvt Ltd., 2012.
2	Bathe, K.J. and Wilson, E.L., "Numerical Methods in Finite Elements Analysis", Prentice Hall of India, 1985.
3	Krishnamurthy, C.S., "Finite Element Analysis", Tata McGraw Hill, 2000.
4	Rao. S.S., "Finite Element Methods in Engineering," Butterworth and Heinemann, 2001.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	1	-	-	1	0	0	1	1	2	2	1
2	3	2	1	1	2	-	-	1	1	1	1	1	2	2	1
3	3	3	2	2	2	-	-	1	1	1	1	1	3	2	1
4	3	2	1	1	2	-	-	1	1	1	1	1	3	2	1
5	3	2	1	0	2	-	-	1	1	1	1	1	3	2	1
6	3	3	2	2	2	1	1	2	1	1	1	2	3	3	2
Overall Correlation	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**3**	**3**	**2**

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23AS702	COMPREHENSION	L	T	P	C
		2	0	0	2

PURPOSE:

To provide a complete review of the topics covered in the previous semesters, to ensure that a comprehensive understanding of the subjects is achieved. The student will be tested as per the guidelines given by national level examinations like GATE, TANCET etc. It will also help students to face job interviews and competitive examinations.

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Analyse the phenomena involved in the concerned problem and solve them.
CO2:	Apply principles to new and unique circumstances.
CO3:	Estimate concepts and principles of concerned branch of engineering.
CO4:	Distinguish between facts and opinion in the engineering field.
CO5:	Deduct cause-and-effect relationships of any relationship.
CO6:	Interpret data from charts and graphs and judge the relevance of information.

GUIDELINES:

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	3	2	1	-	2	1	-	-	-	-	1	3	-	-
2	3	2	1	1	-	1	1	-	-	-	-	1	3	-	-
3	3	3	3	3	3	-	-	3	-	3	-	3	3	3	3
4	3	2	1	1	2	-	-	1	-	3	-	3	3	2	1
5	3	3	3	2	1	2	-	2	-	2	-	2	3	1	2
6	3	3	3	2	1	2	-	2	-	2	-	2	3	1	2
Overall Correlation	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**2**	**-**	**3**	**-**	**3**	**3**	**3**	**2**

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23AE704	TOTAL QUALITY AND CONTINUING AIRWORTHINESS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the principles, historical evolution, and key concepts of Total Quality Management (TQM) in the aviation industry.
- To explore international aviation regulations, certification processes, and the role of regulatory authorities in ensuring airworthiness.
- To study Quality Management Systems (QMS) and continuing airworthiness management, including maintenance planning and regulatory compliance.
- To learn the procedures outlined in CAR-M and CAR-66 for AME licensing, mandatory inspections, and modifications.
- To examine CAR Series T and X, covering flight testing, weight and balance, aircraft documentation, and type approval processes.

UNIT I	INTRODUCTION	8

Definition - principles of Total Quality Management-Historical development and evolution of TQM in the aviation industry-Importance of TQM in ensuring airworthiness-Key concepts: customer focus, continuous improvement, employee involvement.

UNIT II	REGULATORY FRAMEWORK FOR AIRWORTHINESS	11

Overview of international aviation regulations (e.g., FAA, DGCA, EASA, ICAO)-Regulatory requirements for maintaining airworthiness-Certification and Compliance processes-Role of regulatory authorities in ensuring quality and Airworthiness.

UNIT III	**QUALITY MANAGEMENT SYSTEMS (QMS) AND CONTINUING AIRWORTHINESS MANAGEMENT**	**8**
Introduction to Quality Management Systems (ISO 9001, AS9100)-Implementation of QMS in aviation organizations-Auditing and assessment of QMS-Case studies on successful QMS implementations in aviation-Definition and importance of continuing airworthiness-Components of a continuing airworthiness management system-Maintenance planning and execution-Airworthiness directives, service bulletins, and regulatory compliance.		
UNIT IV	**CAR – M and CAR - 66**	**9**
Procedure and Issue of AME License - classification and experience requirements, Mandatory Modifications /Inspections.		
UNIT V	**CAR SERIES T and X**	**9**
Flight testing of aircraft for issue of C of A - Registration Markings of aircraft -Weight and balance control of an aircraft - Provision of first aid kits and Physician's kit in an aircraft - Aircraft furnishing practices - Aircraft log books -Document to be carried on board on Indian registered aircraft - Procedure for issue of tax permit - Procedure for issue of type approval of aircraft components and equipment including instruments.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the Foundations of Total Quality Management (TQM) in Aviation.
CO2:	Explain Proficiency in Regulatory Compliance for Airworthiness.
CO3:	Summarize Quality Management Systems (QMS) in Aviation.
CO4:	Outline the Competence in Continuing Airworthiness Management.
CO5:	Interpret on CAR – M & CAR -66 Type certificate and Noise certificate.

CO6:	Explain on CAR series F airworthiness and continued airworthiness.
TEXT BOOKS:	
1	Bijan Vasigh, Ken Fleming, Thomas Tacker, "Introduction to Air Transport Economics: From Theory to Applications", Third Edition, New Delhi, 2018.
2	Airworthiness Advisory Circulars from DGCA 2003 & 2015.
REFERENCES:	
1	"Aeronautical Information Circulars (relating to Airworthiness) from DGCA 7 AAI", 2000 and 2006.
2	Civil aviation requirements with latest amendment (section 2 airworthiness) – published by DGCA, the English book store, 17-l, Connaught circus, New Delhi.
3	Aeronautical information circulars (relating to airworthiness) from DGCA.
4	Aircraft manual (India) volume – latest edition, the English book store, 17-l, Connaught circus New Delhi.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	1	-	-	-	-	-	-	-	1	2	-	-
2	2	1	-	-	-	1	-	-	-	-	-	1	2	-	-
3	2	1	1	-	-	-	-	-	-	-	-	-	2	-	-
4	2	1	1	-	-	-	-	-	-	-	-	-	2	-	-
5	2	1	1	-	-	1	1	1	1	-	-	1	2	-	1
6	2	1	1	-	-	1	1	1	-	-	-	1	2	-	1
Overall Correlation	**2**	**1**	**1**	**1**	**-**	**1**	**1**	**1**	**1**	**-**	**-**	**1**	**2**	**-**	**1**

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<table>
<tr><td rowspan="2">23AE711</td><td rowspan="2">COMPOSITE MATERIALS AND STRUCTURES</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>2</td><td>4</td></tr>
</table>

COURSE OBJECTIVES:

- To provide the students an understanding on classification and applications of composite materials and its micromechanical study.
- To provide the students an understanding on Macromechanics and engineering constants required to relate stress and strain.
- To make the students to learn about laminate coding and its governing equations.
- To familiarize the students with the various methods of composite materials fabrication.
- To explore the knowledge about the sandwich construction and failures.

UNIT I	**MICROMECHANICS**	**10**

Introduction - Advantages and application of composite materials – Types of reinforcements and matrices - Micro mechanics – Mechanics of materials approach, elasticity approach- Bounding techniques – Fiber volume ratio – Mass fraction – Density of composites- Effect of voids in composites.

UNIT II	**MACROMECHANICS**	**10**

Generalized Hooke's Law - Elastic constants for Anisotropic, Orthotropic and Isotropic materials - macro mechanics – Stress-Strain relations with respect to natural axis, arbitrary axis – Determination of in plane strengths of a lamina - Experimental characterization of lamina. Failure theories of a lamina. Hygrothermal effects on lamina.

UNIT III	**LAMINATED PLATE THEORY**	**10**

Governing differential equation for a laminate- Stress – Strain relations for a Laminate. Different types of laminates in plane and flexural constants of a laminate- Hygrothermal stresses and Strains in a laminate. Failure analysis of a laminate- Impact resistance and Interlaminar stresses-Netting analysis.

UNIT IV	FABRICATION PROCESS AND REPAIR METHODS	8
Various open and closed mould processes, Manufacture of fibers, Importance of repair and Different types of repair techniques in composites – Autoclave and Non-autoclave methods.		
UNIT V	**SANDWICH CONSTRUCTIONS**	**7**
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

LIST OF EXPERIMENTS:

1. Tensile testing of composite specimens.
2. Compression testing of composite specimens.
3. Impact testing of composite specimens.
4. Flexure Tests of Composite Specimens.
5. Acoustic and Ultrasonic Testing of Composites.
6. Fatigue testing of Composite specimens.
7. Shear testing of composite specimens.
8. Fracture toughness testing of composite specimens.
9. Bearing and pull-out testing of composite specimens.
10. Peel test of composite specimens

TOTAL: 30 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Apply the micromechanics for the analysis of composite materials.
CO2:	Apply the macromechanics for the analysis of composite materials.
CO3:	Identify the governing equation of composite laminate.
CO4:	Demonstrate the manufacturing of composites.
CO5:	Explain the applications and uses of composites in various fields.
CO6:	Test for composite under different loading conditions.

TEXT BOOKS:

1	Autar K Kaw, “Mechanics of Composite Materials”, CRC Press, 2nd edition, 2005.
2	Jones, Robert M. “Mechanics of composite materials”. CRC press, 2018..
3	Madhujit Mukhopadhyay, “Mechanics of Composite Materials and Structures”, University Press, 2004.

REFERENCES:

1	Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites," John Wiley & Sons, 3rd edition, July 2006.
2	Allen Baker, “Composite Materials for Aircraft Structures”, AIAA Series, 2nd Edition, 2004.
3	Calcote, L R. “The Analysis of laminated Composite Structures”, Von – Nostrand Reinhold Company, New York 1998.
4	Lubing, Handbook on Advanced Plastics and Fibre Glass, Von Nostran Reinhold Co., NewYork, 1989

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	2	1	1	2	2	2	2	2	3	2	2
2	3	2	1	1	2	1	1	2	2	2	2	2	3	2	2
3	3	2	1	1	2	1	1	2	3	2	2	2	3	2	2
4	2	2	-	-	2	1	1	2	3	2	2	2	3	2	2
5	2	1	-	-	2	1	1	2	3	1	1	2	3	2	2
6	3	3	2	1	2	1	1	2	3	2	2	2	3	2	2
Overall Correlation	**3**	**2**	**1**	**1**	**2**	**1**	**1**	**2**	**3**	**2**	**2**	**2**	**3**	**1**	**2**

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23AS721	PROJECT WORK - PHASE 2	L	T	P	C
		0	0	6	3

COURSE DESCRIPTION:

Project Phase 2 is a continuation of Project Phase 1, focusing on implementing the proposed methodology through fabrication, simulation, or experimental validation. Students will refine their designs, validate test problems, and commission setups for final testing. This phase emphasizes hands-on application, calibration, and demonstration of results, culminating in a final presentation and report submission.

COURSE OBJECTIVES:

- Implement the proposed methodology to address engineering problems identified in Phase 1.
- Develop and fabricate prototypes or simulate solutions for the selected project integrating theoretical knowledge with practical application across hardware and software systems.
- Validate solutions through testing ensuring reliability and performance in both physical and virtual environments.
- Enhance problem-solving and critical thinking skills by troubleshooting and optimizing either experiment setups or software code to improve results.
- Prepare a research manuscript or applying for patent grant either for design or research.

PROJECT OUTLINE:

Week 1	Review of Phase 1 outcomes and refinement of proposed methodology.
Week 2	Material procurement/ software setup for simulation, and initiation of fabrication/simulation work.
Week 3	Intermediate fabrication/simulation work and initial testing or calibration, troubleshooting challenges.

Week 4	Second Review.
Week 5	Validation of test problem or refinement of prototype/simulation
Week 6	Optimisation of the test setup or solution trials, Data curation / uncertainty analysis
Week 7	Final testing of setup or simulation outcomes, Validation of Data .
Week 8	Third Review
Week 9	Demonstration of the solution with high level of data accuracy and precision.
Week 10	Compilation of Phase 2 results, report writing, and presentation preparation.
Week 11	Preparing or publishing of research article/ Filing or Grant of Patent
Week 12	Final Viva Voce Presentations.
Individual meetings will be set up on a need's basis in conjunction with developing work	
EVALUATION:	

- The progress of the project is evaluated based on a minimum of two reviews. The review committee may be constituted by the Head of the Department. A project report is required at the end of the semester. The project work is evaluated based on oral presentation and the project report jointly by external and internal examiners constituted by the Head of the Department.
- Assess the depth of understanding demonstrated in the project's conceptualization and the ability to answer questions during public presentations.
- Publication of Research article in indexed journal or Patent award is necessary at the end of completion of the project.

TOTAL: 90 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply appropriate methodologies to implement solutions for complex engineering problems identified in phase -1 using hardware / software or both systems.
CO2:	Develop existing functional prototypes or simulations models by integrating theoretical and practical knowledge.
CO3:	Evaluate solutions ensuring compliance with design specifications.
CO4:	Appraise the performance of solutions by refining designs or improving algorithms for enhanced outcomes.
CO5:	Collaborate effectively with team members to plan, manage, and execute engineering projects adhering to ethical principles and professional standards.
CO6:	Prepare technical reports, impactful presentations that communicate solutions effectively.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
2	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
3	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
4	3	2	2	2	1	1	2	3	3	3	3	3	3	1	3
5	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
6	3	2	2	2	1	2	2	3	3	3	3	3	3	1	3
Overall Correlation	**3**	**2**	**2**	**2**	**1**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**3**

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23AS722	TECHNICAL SEMINAR – 2	L	T	P	C
		0	0	4	2

PREAMBLE:

The course 'Technical Seminar 2' is intended to be continuation of Technical Seminar 1. It enables a B.E./B. Tech graduate to read, understand, present and prepare report about higher level academic document. The selected topic should be outside the given syllabus. The learner shall search in the literature / current affairs including mass media, print media, peer reviewed journals, conference, books, project reports etc., and identify an appropriate topic/paper/thesis/report in her/his area of interest, in consultation with her/his seminar coordinator. This course can help the learner to experience how a higher-level presentation can be made about a selected academic document and empower her/him to prepare a technical report.

COURSE OBJECTIVES:

- To do Literature surveys in a selected area of study
- To understand an academic document from the literature and to give a presentation about it
- To prepare a technical report.

GUIDELINES:

- The Department shall form an Internal Assessment Committee (IAC) for the seminar with academic coordinator for that program as the Chairperson and seminar coordinator as member. During the seminar presentation of a student, all members of IAC shall be present.
- Formation of IAC shall be completed within a week after the End Semester Examination (or last working day) of the previous semester.
- Seminar Coordinator shall provide required input to their students regarding the selection of topic/ paper.

- Choosing a seminar topic: The topic for a UG seminar should be current and broad based rather than very specific research work, beyond the syllabus. Every member of the project team could choose or be assigned Seminar topics that covers various aspects linked to the Project area.
- A topic/paper relevant to the discipline shall be selected by the student during the semester break.
- Topic/Paper shall be finalized in the first week of the semester and shall be submitted to the IAC. The IAC shall approve the selected topic/paper by the second week of the semester.
- Accurate references from genuine peer reviewed published material to be given in the report and to be verified.

EVALUATION PATTERN

Seminar Coordinator:

40 marks (Background Knowledge – 10 (The coordinator shall give deserving marks for a candidate based on the candidate's background knowledge about the topic selected), Relevance of the paper/topic selected – 10).

(Seminar Diary – 10 (Each student shall maintain a seminar diary and the coordinator shall monitor the progress of the seminar work on a weekly basis and shall approve the entries in the seminar diary during the weekly meeting with the student), Attendance – 10).

Presentation:

40 marks to be awarded by the IAC (Clarity of presentation – 10, Interactions – 10 (to be based on the candidate's ability to answer questions during the interactive session of her/his presentation), Overall participation – 10 (to be given based on her/his involvement during interactive sessions of presentations by other students), Quality of the slides – 10).

Report:

20 marks to be awarded by the IAC (check for technical content, overall quality, templates followed, adequacy of references etc.).

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Identify academic documents from the literature which are related to her/his areas of interest.
CO2:	Survey and apprehend an academic document from the literature which is related to her/ his areas of interest.
CO3:	Compile a presentation about an academic document.
CO4:	Estimate the Contents using available literature.
CO5:	Defend a presentation about an academic document.
CO6:	Construct a technical report.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	2	2	1	1	2	3	3	2	2	3	2	2
2	3	3	3	1	2	1	1	2	3	3	2	2	3	2	2
3	3	3	2	2	2	1	1	1	3	3	1	1	3	2	2
4	3	3	2	1	1	1	2	2	3	3	2	1	3	2	2
5	3	3	2	1	1	1	1	2	2	2	2	2	3	1	2
6	3	3	2	1	1	1	1	2	2	2	2	2	3	1	2
Overall Correlation	**3**	**3**	**2**	**1**	**1**	**1**	**1**	**2**	**3**	**3**	**2**	**2**	**3**	**2**	**2**

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

SEMESTER -VIII

23AS821	CAPSTONE PROJECT	L	T	P	C
		0	0	20	10

COURSE DESCRIPTION:

Prerequisites:

i) Team segregation.

ii) Identification of Project Guide.

iii) Identification of Area of Interest.

iv) Literature Review on the chosen area of interest.

Zeroth Review needs to be completed in the previous semester by the project coordinator

The *Capstone Project* ***(CP)*** provides an opportunity for students to engage in high-level inquiry focusing on an area of specialization within the engineering field. Capstone projects will be investigative, practice-centered. All capstones aim to bridge theory and practice and are aimed to have an impact on the professional life of students

The aim of the course is to facilitate the development of your *Capstone Projects.* Students are encouraged to apply and expend knowledge gained on teaching and learning throughout the Bachelor of Engineering Education program as part of this process

COURSE OBJECTIVES:

The Capstone Project should demonstrate the depth and extent of knowledge of students

During this course, students will

- Investigate and evaluate prominent literature connected to your CP.
- Present a clearly articulated investigative framework, while situating projects within established academic practices and/ or ideas.

• Develop and create practical resources (either computational or experimental) for the concerned area of interest in engineering field. • Offer inquiry-based argumentation for development in the concerned area within engineering field. • Summarize the findings in the form of report, documentation and presentation

PROJECT OUTLINE:	
Week 1	Identification problem.
Week 2	Literature review.
Week 3	Preliminary work.
Week 4	First review.
Week 5	Completion of first stage of the Project methodology.
Week 6	Development.
Week 7	Testing & Validation.
Week 8	Second review.
Week 9	Repeatability.
Week 10	Report correction and Documentation
Week 11	Third review-Submission of paper for conference/journal
Week 12	Thesis Correction and Submission
Individual meetings will be set up on a need's basis in conjunction with developing work	

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Take part in challenging practical problems and find solutions by formulating proper methodology.
CO2:	Plan research methodology to tackle a specific problem.
CO3:	Construct extensive study on particular research projects.

CO4:	Develop experimental and computational studies on innovative research projects.
CO5:	Estimate incremental study on existing research projects.
CO6:	Take part in real life engineering challenges and propose appropriate solutions.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
2	3	2	3	3	2	3	2	3	2	3	2	3	3	2	3
3	2	3	3	3	3	3	3	3	3	3	3	3	2	3	3
4	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
5	2	3	3	3	3	3	3	3	3	3	3	3	2	3	3
6	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Overall Correlation	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3

Recommended by Board of Studies	**07-11-2024**		
Approved	**3rd ACM**	**Date**	**30-11-2024**

VERTICAL -1 - SPACE TECHNOLOGY

23AS031	CRYOGENICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Learn the historical background and properties of cryogenic propellants like liquid hydrogen, helium, nitrogen, and oxygen.
- Understand the principles of low-temperature production, including expansion engines, Joule-Thompson effect, and magnetic cooling.
- Analyse the efficiency of cryogenic systems by studying losses, cooling performance, and thermodynamic methods.
- Explore cryogenic cycles, including throttle expansion and expander cycles, through thermodynamic analysis and numerical problems.
- Examine the use of cryogenics in aerospace, focusing on storage, loading, and zero-gravity challenges of cryogenic propellants.

UNIT I	INTRODUCTION	9

Historical Background - Introduction to cryogenic propellants - Liquid hydrogen, liquid helium, liquid nitrogen and liquid oxygen and their properties.

UNIT II	PRODUCTION OF LOW TEMPERATURE	9

Theory behind the production of low temperature - Expansion engine heat exchangers – Cascade Process Joule Thompson Effect - Magnetic effect - Ortho and H2 - Helium4 and Helium3.

UNIT III	EFFICIENCY OF CRYOGENIC SYSTEMS	9

Types of losses and efficiency of cycles - specific amount of cooling - The fraction liquified Cooling coefficient of performance - Thermodynamic efficiency – energy balance Method.

UNIT IV	CYCLES OF CRYOGENIC PLANTS	9
Classification of cryogenic cycles - Structure of cycles - Throttle expansion cycles – Expander cycles - Thermodynamic analysis - Numerical problems.		
UNIT V	**CRYOGENICS IN AEROSPACE APPLICATIONS**	**9**
Cryogenic liquids in Rocket launching and space simulation Storage of cryogenic liquids - Effect of cryogenic liquids on properties of aerospace materials – Cryogenic loading problems - Zero gravity problems associated with cryogenic propellants - Phenomenon of tank collapse - Elimination of Geysering effect in missiles.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Identify and describe the properties of liquid hydrogen, liquid helium, liquid nitrogen, and liquid oxygen.
CO2:	Apply principles of cryogenic liquid storage and handling in rocket launching and space simulation, evaluating the effects of cryogenic liquids on aerospace materials.
CO3:	Select appropriate cooling requirements and cooling coefficient of performance.
CO4:	Make use of thermodynamic analyses related to cryogenic cycles..
CO5:	Analyze cryogenic loading challenges and zero-gravity issues, focusing on tank collapse prevention and mitigation of the geysering effect in missiles.
CO6:	Evaluate cryogenic loading and zero-gravity issues associated with cryogenic propellants.

TEXT BOOKS:	
1	Barron, R. F. "Advances in cryogenic principles", pp. 105-119. New York, NY: Springer New York, 2007.
2	Hutzler, A. Scott. "Engineering Sciences of Aerospace Fuels." ASME Digital Collections, 2019.
REFERENCES:	
1	Sarner, S. F., "Propellant Chemistry", Reinhold Publishing Corp., New York 1985.
2	Weisend, J. G., "The Handbook of Cryogenic Engineering", Taylor & Francis, 1998.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	-	-	-	1	1	1	2	1	-
2	3	2	1	1	1	-	-	-	-	1	1	1	2	1	-
3	3	2	1	1	1	-	-	-	-	1	1	1	2	1	-
4	3	2	1	1	1	-	-	-	-	1	1	1	2	1	-
5	3	3	2	2	1	-	-	-	-	1	1	1	2	1	-
6	3	3	3	2	1	-	-	-	-	1	1	1	2	1	-
Overall Correlation	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**1**	**1**	**1**	**3**	**1**	**-**

23AS032	HIGH TEMPERATURE GAS DYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the theory of high temperature flows.
- To make the students learn the kinetic theory of hypersonic flows.
- To make the students learn the kinetic theory of statistical thermodynamic aspects of flows at very high temperatures.
- To make them familiarize the calculations transport properties of gases high temperature.
- To learn the concepts of inviscid high temperature flows.

UNIT I	INTRODUCTION	9

Nature of high temperature flows – Chemical effects in air – Real perfect gases – Gibb's free energy and entropy by chemical and non equilibrium – Chemically reacting mixtures and boundary layers.

UNIT II	STATISTICAL THERMODYNAMICS	9

Introduction to statistical thermodynamics – Relevance to hypersonic flow - microscopic description of gases – Boltzman distribution – Cartesian function.

UNIT III	KINETIC THEORY AND HYPERSONIC FLOWS	9

Chemical equilibrium calculation of equilibrium composition of high temperature air – equilibrium properties of high temperature air – Collision frequency and mean free path – Velocity and Speed distribution functions.

UNIT IV	INVISCID HIGH TEMPERATURE FLOWS	9

Equilibrium and non – Equilibrium flows – Governing equations for inviscid high temperature equilibrium flows – Equilibrium normal and oblique shock wave flows – Frozen and Equilibrium flows – Equilibrium conical and blunt body flows – Governing equations for non equilibrium inviscid flows.

UNIT V	TRANSPORT PROPERTIES IN HIGH TEMPERATURE GASES	9
Transport coefficients – Mechanisms of diffusion – Total thermal conductivity – Transport characteristics for high temperature air – Radiative transparent gases – radiative transfer equation for transport, absorbing and emitting and absorbing gases.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the theory of high temperature flows.
CO2:	Explain the kinetic theory of hypersonic flows.
CO3:	Analyze the kinetic theory of statistical thermodynamic aspects of flows at very high temperatures.
CO4:	Summarize the inviscid high temperature flows.
CO5:	Solve the calculations transport properties of gases high temperature.
CO6:	Inspect high temperature gas properties.
TEXT BOOKS:	
1	E Rathakrishnan, "High Enthalpy Gas Dynamics", John Wiley, NJ, 2015.
2	William H. Heiser and David T. Pratt, "Hypersonic Air breathing propulsion", AIAA Education Series,1994.
REFERENCES:	
1	John D. Anderson, Jr., "Hypersonic and High Temperature Gas Dynamics", McGraw-Hill Series, New York, 1996.
2	John D. Anderson, Jr., "Modern Compressible Flow with Historical perspective", McGraw-Hill Series, New York, 1996.
3	John T. Bertin, "Hypersonic Aerothermodynamics publishers" - AIAA Inc., Washington, D.C.,1994.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	1	2	-	-	-	-	-	-	-	-	2	-
2	2	1	1	1	1	-	-	-	-	-	1	-	3	1	-
3	3	3	2	1	1	-	-	-	-	-	1	-	3	1	-
4	2	2	1	1	1	-	-	-	-	-	-	-	-	1	-
5	3	2	2	2	1	-	-	-	-	-	1	-	3	1	-
6	3	3	2	2	1	-	-	-	-	-	1	-	3	1	-
Overall Correlation	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**1**	**-**	**3**	**2**	**-**

23AS033	LAUNCH VEHICLE AERODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the concept of high-speed aerodynamics and configurations of launch vehicles.
- To make familiar with the understanding of aerodynamics in competitive design.
- To make acquaint with the testing and analysis methods in different speed regimes.
- To Design trade-offs between aerodynamics and other considerations.
- To learn the concepts of boundary layer effects.

UNIT I	BASICS OF HIGH-SPEED AERODYNAMICS	9

Compressible flows-Isentropic relations-Mathematical relations of flow properties across shock and expansion waves-Fundamentals of Hypersonic Aerodynamics.

UNIT II	BOUNDARY LAYER EFFECTS	9

Basics of boundary layer theory-Compressible boundary layer-Shock shear layer interaction-Aerodynamic heating-Heat transfer effects on launch vehicle.

UNIT III	LAUNCH VEHICLE CONFIGURATIONS AND DRAG ESTIMATION	9

Types of Rockets and missiles-Various configurations-Components-Forces on the vehicle during atmospheric flight-Nose cone design and drag estimation.

UNIT IV	AERODYNAMICS OF SLENDER AND BLUNT BODIES	9

Aerodynamics of slender and blunt bodies, Wing-body interference effects-Asymmetric flow separation and vortex shedding-Unsteady flow characteristics of launch vehicles-determination of aero elastic effects.

UNIT V	AERODYNAMIC ASPECTS OF LAUNCHING PHASE	9
Booster separation-Cross wind effects-Specific considerations in missile launching -Missile integration and separation-Methods of evaluation and determination- Stability and Control Characteristics of Launch Vehicle Configuration- Wind tunnel tests – Comparison with CFD Analysis.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Explain the concept of high-speed aerodynamics and configurations of launch vehicles.
CO2:	Explain the effects of boundary layer while launching.
CO3:	Interpret the forces on the vehicle during atmospheric flight.
CO4:	Explain the flow characteristics of launch vehicles.
CO5:	Apply the aerodynamic aspects of launching phase.
CO6:	Develop knowledge in Aerodynamics of Launch Vehicle Technology.

TEXT BOOKS:

1	Anderson J. D., "Fundamentals of Aerodynamics", 5th Ed., McGraw-Hill, 2010.
2	Chin SS, "Missile Configuration Design", Mc Graw Hill, New York, 1961.

REFERENCES:

1	Anderson J. D., "Hypersonic and High Temperature Gas Dynamics", AIAA Education Series, 2nd Ed., 2006.
2	Nielson, Jack N, Stever, Gutford, "Missile Aerodynamics", AIAA, 1988.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	1	2	-	1	-	-	1	1	1	3	2	-
2	2	1	1	1	2	-	2	-	-	1	1	1	3	2	-
3	2	1	1	1	2	-	1	-	-	1	1	1	3	2	-
4	2	1	1	1	1	-	1	-	-	1	1	1	3	1	-
5	3	2	1	1	2	-	-	-	-	1	1	1	3	2	-
6	3	2	1	1	1	-	1	-	-	1	1	1	3	1	-
Overall Correlation	**3**	**2**	**1**	**1**	**2**	**-**	**1**	**-**	**-**	**1**	**1**	**1**	**3**	**2**	**-**

23AS034	**ORBITAL MECHANICS**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OBJECTIVES:

- To understand the dynamics of particles, including reference frames, gravitational laws, rotations, and relative motions.
- To analyze two-body and restricted three-body problems, orbit types, Lagrange points, and energy laws.
- To learn orbital mechanics, state vectors, coordinate transformations, and the effects of Earth's oblateness.
- To explore interplanetary trajectories, including Hohmann transfers, rendezvous, planetary flybys, and ephemeris calculations.
- To study orbital maneuvers, including impulsive maneuvers, plane changes, and advanced transfer techniques.

UNIT I	**DYNAMICS OF POINT MASSES**	**9**

Dynamics of Particles: reference Frames, Kinematics, Gravitational laws and rotations – Energy, Angular momentum-Time derivatives of moving vectors – Relative motions.

UNIT II	**TWO BODY PROBLEM**	**9**

Equations of motion in an inertial frame - Equations of relative motion 37- Angular momentum and the orbit formulas -The energy law - Circular orbits ($e = 0$) - Elliptical Orbits ($0 < e < 1$) - Parabolic trajectories ($e = 1$) - Hyperbolic trajectories ($e > 1$) - Perifocal frame - The Lagrange coefficients - Restricted three-body problem- Lagrange points- Jacobi constant.

UNIT III	**ORBITAL MECHANICS**	**9**

Geocentric right ascension–declination frame - State vector and the geocentric equatorial frame - Orbital elements and the state vector - Coordinate transformation - Transformation between geocentric equatorial and perifocal frames -Effects of the earth's oblateness - Problems.

UNIT IV	INTERPLANETARY TRAJECTORIES	9
Interplanetary Hohmann transfers - Rendezvous opportunities - Sphere of influence - Method of patched conics - Planetary departure - Sensitivity analysis - Planetary rendezvous - Planetary fly by - Planetary ephemeris - non-Hohmann interplanetary trajectories - Problems.		
UNIT V	**ORBITAL MANEUVERS**	**9**
Impulsive maneuvers - Hohmann transfer - Bi-elliptic Hohmann transfer - Phasing maneuvers - non-Hohmann transfers with a common apse line - Apse line rotation - Chase maneuvers- Plane change maneuvers - Problems.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply orbit perturbations, trajectories, and maneuver strategies to guide mission planners in selecting optimal orbit maintenance, rendezvous, and transfers to achieve mission objectives.
CO2:	Make use of the basic principles of orbital mechanics, including the effects of forces on orbiting objects and methods for changing orbits.
CO3:	Explain spacecraft design and subsystems to ensure alignment with mission requirements and objectives.
CO4:	Analyze orbital challenges and problems satellites may encounter during their launch phase.
CO5:	Discuss processes for orbital mechanics, including tracking, orbit determination, and implementing orbit corrections.
CO6:	Apply foundational principles of algebra, geometry, and physics to describe the motion of objects in space-related scenarios.

TEXT BOOKS:	
1	Curtis, H. D., “Orbital Mechanics for Engineering Students“, 2 nd ed., Elsevier, 2014.
2	Chobotov, V. A., “Orbital Mechanics” , 3rd ed., AIAA Edu. Series , 2002.
REFERENCES:	
1	Wiesel, W. E., “Spaceflight Dynamics” , 3rd ed., McGraw-Hill , 2010.
2	Brown, C. D., “Spacecraft Mission Design” , 2 nd ed., AIAA Edu. Series , 1998.
3	Escobal, P. R., “Methods of Orbit Determination” , 2 nd ed., Krieger Pub. Co. , 1976.
4	Tewari, A., “Atmospheric and Space Flight Dynamics: Modeling and Simulation with MAT- LAB and Simulink” , Birkhuser , 2007.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	1	1	1	1	1	1	2	1	1
2	3	2	1	1	1	1	1	1	1	1	1	1	3	1	2
3	3	3	3	2	1	1	1	1	1	1	1	1	3	1	2
4	3	3	2	2	1	1	1	1	1	1	1	1	3	1	1
5	3	3	3	3	1	1	1	1	1	1	1	1	3	1	1
6	3	2	2	1	1	1	1	1	1	1	1	1	3	1	1
Overall Correlation	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**3**	**1**	**1**

23AS035	LAUNCH VEHICLE CONFIGURATION DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To interpret the missile space stations, space vs earth environment.
- To explain the life support systems, mission logistics and planning.
- To deploy the skills effectively in the understanding of launch vehicle configuration design.
- To explain Engine system and support of launch vehicle.
- To interpret nose cone configuration of launch vehicle.

UNIT I	FUNDAMENTAL ASPECTS	9

Energy and Efficiencies of power plants for launch vehicles – Typical Performance Values – Mission design – Structural design aspects during launch - Role of launch environment on launch vehicle integrity.

UNIT II	SELECTION OF ROCKET PROPULSION SYSTEMS	9

Ascent flight mechanics – Launch vehicle selection process – Criteria for Selection for different missions – Selection of subsystems – Types of staging – Interfaces – Selection and criteria for stages and their role in launch vehicle configuration design.

UNIT III	ENGINE SYSTEMS, CONTROLS, AND INTEGRATION	9

Propellant Budget – Performance of Complete or Multiple Rocket Propulsion Systems – Engine Design – Engine Controls – Engine System Calibration – System Integration and Engine Optimization.

UNIT IV	THRUST VECTOR CONTROL	9

TVC Mechanisms with a Single Nozzle – TVC with Multiple Thrust Chambers or Nozzles – Testing – Integration with Vehicle – SITVC method – Other jet control methods - Exhaust plume problems in space environment.

UNIT V	NOSE CONE CONFIGURATION	9
Aerodynamic aspects on the selection of nose shape of a launch vehicle - Design factors in the finalization of nose configuration with respect to payload - Nose cone thermal protection system - Separation of fairings - Payload injection mechanism.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Explain the exotic space propulsion concepts, such as nuclear, solar sail, and antimatter.
CO2:	Select the appropriate rocket propulsion systems.
CO3:	Interpret the air-breathing propulsion suitable for initial stages and fly-back boosters.
CO4:	Explain the thrust vectoring control and various techniques.
CO5:	Explain the aerodynamics aspect, including boost-phase lift and drag, hypersonic, and re-entry.
CO6:	Develop the aircraft engineers moving into launch vehicle, spacecraft, and hypersonic vehicle design.

TEXT BOOKS:

1	Michael D. Griffin, James R. French, "Space Vehicle Design", AIAA, 2nd Ed., 2004.
2	Karl Dawson Wood, "Aerospace Vehicle Design: Spacecraft Design", Johnson Publishing Company, 1964.

REFERENCES:

1	Bong Wie, "Space Vehicle Dynamics and Control", AIAA, 1998.
2	Anton H. de Ruiter, Christopher Damaren, James R. Forbes, "Spacecraft Dynamics and Control: An Introduction", John Wiley & Sons, 2013.
3	Marcel J. Sidi, "Spacecraft Dynamics and Control: A Practical Engineering Approach", Cambridge University Press, 2000.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	1	-	-	-	-	-	-	-	-	2	-	-
2	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
3	2	2	1	1	-	-	-	-	-	-	-	-	2	-	-
4	2	2	1	1	-	-	-	-	-	-	-	-	2	-	-
5	2	2	1	1	-	-	-	-	-	-	-	-	2	-	-
6	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
Overall Correlation	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**

23AS036	SPACE MISSIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the physics of space, key missions, engineering challenges, and scientific gains of space programs.
- To learn the differences between space and Earth environments, focusing on radiation, microgravity, and their effects on humans.
- To explore life support systems, countermeasures, and rocket engine technologies for space maneuvers and control.
- To study mission logistics and planning, including orbital selection, spacecraft design, and surface mission integration.
- To examine allied topics such as spacecraft operations, attitude control, EVA systems, robotics, and communication architectures.

UNIT I	INTRODUCTION	8

The physics of space - Current missions: space station, Moon mission, and Mars missions - Engineering challenges on Manned vs. Unmanned missions - Scientific and technological gains from space programs - Salient features of Apollo and Space station missions – space shuttle mission.

UNIT II	SPACE VS EARTH ENVIRONMENT	10

Atmosphere: Structure and Composition - Air Pressure, Temperature, and Density - Meteoroid, Orbital Debris & Radiation Protection - Human Factors of Crewed Spaceflight, Safety of Crewed Spaceflight - Magnetosphere - Radiation Environment: Galactic Cosmic Radiation (GCR), Solar Particle Events (SPE) - Radiation and the Human Body – Impact of microgravity and g forces on humans – Space adaptation syndrome.

UNIT III	**LIFE SUPPORT SYSTEMS AND COUNTER MEASURES**	**8**
Types of Propellants – Propellant Tanks – Propellant Feed Systems – Gas Pressure Feed Systems – Tank Pressurization – Turbo pump Feed Systems and Engine Cycles – Injector-Rocket Engines for Maneuvering, Orbit Adjustments, Attitude Control – Engine Families – Valves and Pipelines – Engine Support Structure.		
UNIT IV	**MISSION LOGISTICS AND PLANNING**	**10**
Group Dynamics: Ground Communication and Support - Space Resources and Mission Planning - Space Mission Design: Rockets and Launch Vehicles - Orbital Selection and Astrodynamics, Entry, Descent, Landing, and Ascent, Designing and Sizing Space elements, Transfer, Entry, Landing, and Ascent Vehicles, Designing, Sizing, and Integrating a Surface Base, Planetary Surface Vehicles.		
UNIT V	**ALLIED TOPICS**	**9**
Spacecraft: Space Operations - Space Architecture, Attitude Determination and Control - Designing Power Systems - Extravehicular Activity (EVA) Systems - Space Robotics - Mission Operations for Crewed Spaceflight - Command, Control, Communications Architecture and AI.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Interpret the concept of space environment.
CO2:	Make use of the support systems available for space application for human and other missions.
CO3:	Utilize the various topics such as space mission and its logistical operation.
CO4:	Survey skills for necessary protection again the space environment.

CO5:	Evaluate knowledge in space operations, control and communications of space missions.
CO6:	Elaborate use of the knowledge of robotics and AI in space application.

TEXT BOOKS:

1	Larson, W. J. and Pranke, L. K., "Human Spaceflight: Mission Analysis and Design", McGraw- Hill Higher Education, Washington, DC, 1999.
2	McNamara, Bernard, "Into the Final Frontier: The Human Exploration of Space", Brooks Cole Publishing, 2000.

REFERENCES:

1	Connors, M.M., Harrison, A.A., and Akins, F.R., "Living Aloft: Human Requirements for Extended Spaceflight", University Press of Pacific, Honolulu, Hawaii, 2005.
2	Eckart, P., "Spaceflight Life Support and Biospherics", 1996.
3	Charles D. Brown, "Elements of Spacecraft Design", First Edition, AIAA Education Series, 2002.
4	Roger R.Bate, Donald D.Mueller, and Jerry E.White, "Fundamentals of Astrodynamics", Dover Publications Inc., 1971.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	-	1	1	1	1	1	1	1	1	2	1	1
2	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1
3	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1
4	3	3	2	2	1	1	1	1	1	1	1	1	3	1	1
5	3	3	3	2	1	1	1	1	1	1	1	1	3	1	1
6	3	3	3	3	1	1	1	1	1	1	1	1	3	1	1
Overall Correlation	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**3**	**1**	**1**

<table>
<tr><td rowspan="2">23AS037</td><td rowspan="2" colspan="2">GEOSPATIAL INFORMATION SYSTEMS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">

To interpret the missile space stations, space vs earth environment.
To explain the life support systems, mission logistics and planning.
To deploy the skills effectively in the understanding of launch vehicle configuration design.
To show the advantages and applications of electrical rocket propulsion.
To explain Engine system and support of launch vehicle.
To interpret nose cone configuration of launch vehicle.

</td></tr>
<tr><td>UNIT I</td><td colspan="5">ANALYSIS OF SPATIAL DISTRIBUTIONS</td><td>9</td></tr>
<tr><td colspan="7">Introduction spatial measurements and statistics - Geographic analysis with statistics Understanding spatial data distributions - Measuring geographic distributions - Finding the center - Measuring the compactness of the distribution - Measuring orientation and direction - Testing statistical significance – Case Studies.</td></tr>
<tr><td>UNIT II</td><td colspan="5">ANALYSIS OF SPATIAL PATTERNS</td><td>9</td></tr>
<tr><td colspan="7">Identifying spatial patterns - Statistical parameters to characterize patterns - Measuring the pattern of feature locations - Measuring the spatial pattern of feature values - Defining spatial neighborhoods and weights - Identifying clusters - Parameters for identification of clusters- Analysis of features clusters - clusters of similar values – Case Studies.</td></tr>
<tr><td>UNIT III</td><td colspan="5">UNDERSTANDING SPATIAL AND TEMPORAL RELATIONSHIPS</td><td>9</td></tr>
<tr><td colspan="7">Propellant Budget – Performance of Complete or Multiple Rocket Propulsion Systems – Engine Design – Engine Controls – Engine System Calibration – System Integration and Engine Optimization.</td></tr>
</table>

UNIT IV	GIS MODELLING	9
Introduction – GIS Modelling Process - Suitability Analysis – Design of Boolean Suitability Model - Finding Suitable Locations by Selection, Overlay – Rating of Suitable Locations – Weighted Overlay, Fuzzy Overlay – Use of Artificial Intelligence – Case Studies.		
UNIT V	**NETWORK MODELLING**	**9**
Designing a Path Model – Modelling path in networks – Modelling overland path – Flow Modelling – Modelling accumulation over surface – Tracing Flow over Network – Designing Interaction Models – Allocation of Demand to facilities – Modelling Travel to facilities – Case Studies.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Explain the Computer systems and data formats.
CO2:	Explain the basics of Geoinformation.
CO3:	Summarize the role of complex network systems that handles Geo-information.
CO4:	Summarize the scripting languages and database.
CO5:	Explain the concepts of spatial data modeling.
CO6:	Analyze the real time flow networks and its implementation.

TEXT BOOKS:

1	Andy Mitchell , "The Esri Guide to GIS Analysis, Volume 3: Modeling Suitability, Movement, and Interaction", ESRI Press,2012.
2	DeMers, Michael N. "Fundamentals of geographic information systems" John Wiley & Sons, 2008.

REFERENCES:	
1	Burrough, Peter A., Rachael A. McDonnell, and Christopher D. Lloyd. "Principles of geographical information systems". Oxford University Press, USA, 2015.
2	Pick, James B. "Geographic information systems: A tutorial and introduction." The Communications of the Association for Information Systems 14(1), 2004.
3	Kashkin, V. B., and A. I. Sukhinin. "Digital processing of aerospace images." IPK SFU, Krasnoyarsk,2008.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	1	-	-	-	-	-	-	-	-	2	-	-
2	2	2	1	1	-	-	-	-	-	-	-	-	2	-	-
3	2	2	1	1	-	-	-	-	-	-	-	-	2	-	-
4	3	2	1	1	-	-	-	-	-	-	-	-	2	-	-
5	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
6	3	2	2	1	-	-	-	-	-	-	-	-	3	-	-
Overall Correlation	3	2	2	1	-	-	-	-	-	-	-	-	3	-	-

23AS038	SPACE EXPLORATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand risks in human space missions, including crew safety, health, performance, and risk management strategies.
- To study environmental control and life support systems of space stations, focusing on crew health, safety, and emergency provisions.
- To explore shielding strategies against space radiation, biological impacts, and integrated design methodologies for human safety.
- To analyze various space missions, including technology missions, deep space exploration, and advanced space systems.
- To examine applications of remote sensing and meteorology in resource management, disaster prediction, and weather forecasting.

UNIT I	RISK IN HUMAN SPACE EXPLORATION MISSIONS	9

Mission success: maintaining crew safety, health, and performance; carrying out key scientific goals; returning selected specimens or data; and completing public outreach activities-Cost risk from budgetary issues, including unplanned expenditures or inadequate funding. Programmatic risk: risk created by political, management, or technical challenges – Biomedical risk: crew safety, health – Risk management schemes.

UNIT II	ENVIRONMENTAL CONTROL AND LIFE SUPPORT SYSTEM OF SPACE STATIONS	9

Space Environment – Human-rated vehicle requirements – Crew health and safety- emergency provisions- Oxygen regeneration for metabolic consumption- Oxygen Generation Assembly – Maintenance of cabin partial pressure, Temperature and humidity – Air purification for particulates and VOCs– Carbon dioxide reduction assembly- Fire detection and suppression subsystem- case studies.

UNIT III	**SHIELDING STRATEGIES FOR HUMAN SPACE EXPLORATION**	**9**
Ionosphere – Space radiation sources, models, and environmental uncertainty- Human risk models and risk uncertainty- Biological response to heavy ion exposure – Human factors implications for shielding- Radiation shielding design issues- Assessment of current shielding issues – Integrated shield design methodologies- Case studies.		
UNIT IV	**SPACE MISSION**	**9**
Space Missions: Technology missions, deep space planetary missions, Lunar missions, zero gravity experiments, Space biology and International space Missions. Advanced space systems: Remote sensing cameras, Planetary payloads, Space shuttle, Space station, Inter-space communication systems.		
UNIT V	**APPLICATION**	**9**
Remote Sensing: Visual bands, Agricultural, Crop vegetation, Forestry, water Resources, Land use, Land mapping, geology, Urban development resource Management, and image processing techniques. Metrology: Weather forecast (Long term and Short term), Weather modelling, Cyclone predictions, Disaster and Flood warning, Rainfall predictions using satellites.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Interpret the advanced concepts of manned space missions.
CO2:	Make use of mathematical knowledge that are needed in understanding their significance and operation.
CO3:	Explain about the missile space stations, space vs earth environment, life support systems, mission logistics and planning.
CO4:	Take part in the space exploration technique and implement in future application.

CO5:	Evaluate the real time data form the satellite.
CO6:	Elaborate the problems on the implementation of the space mission.
TEXT BOOKS:	
1	Stine G H. Living in Space: "A Handbook for Work and Exploration Stations Beyond the Earth"s Atmosphere". M. Evans and Company, New York, 2014.
2	Allen, Christopher S., Rebeka Burnett, John Charles, Frank Cucinotta, Richard Fullerton, Jerry R. Goodman, Anthony D. Griffith Sr et al, "Guidelines and Capabilities for Designing Human Missions", NASA Exploration Team Human Subsystem Working Group, 2003.
REFERENCES:	
1	Wilson J W, Miller J. A. Konradi, and Cucinotta F. A ."Shielding strategies for Human space explorations", Ed: NASA Conference Publication, NASA 1997.
2	Robin des Bois "Space Waste, environmental Non Governmental Organization", 2011.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	-	1	1	1	1	1	1	1	1	2	1	1
2	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1
3	3	3	2	2	1	1	1	1	1	1	1	1	3	1	1
4	3	3	2	2	1	1	1	1	1	1	1	1	3	1	1
5	3	3	3	2	1	1	1	1	1	1	1	1	3	1	1
6	3	3	3	3	1	1	1	1	1	1	1	1	3	1	1
Overall Correlation	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

VERTICAL -2 COMPUTATIONAL ENGINEERING

<table>
<tr><td rowspan="2">23AE039</td><td rowspan="2">NUMERICAL METHODS IN FLUID DYNAMICS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

COURSE OBJECTIVES:

- To make students understand the complexity of general fluid dynamic equations in partial differential form in the mathematical nature of the equations.
- To make students understand the complexity of general fluid dynamic equations under different flow conditions.
- To impart knowledge to students on the basic aspects of finite differences and finite volume methods.
- To impart knowledge to students on the basic aspects of finite element methods.
- 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 EQUATION	9

Governing equations of fluid dynamics and modelling of fluid flow – Eulerian and Legrangian approaches – Mathematical nature of fluid dynamic equations – Classification of partial differential equations – General behaviour of different classes of fluid dynamic equations – Practical examples of fluid dynamic problems governed by different classes of partial differential equations – Ill posed and well posed problems.

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**	**9**
Introduction to finite difference methods and their areas of application- Explicit and Implicit approaches. A brief description of implementing methodologies for finite difference 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 FLOW**	**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:		
After completion of the course, the students will be able to:		
CO1:	Develop 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:	Explain modern engineering tools such as CFD software tools to solve and analyse the flow fields over the airplanes.
CO4:	Apply panel methods to solve basic fluid flows.
CO5:	Apply skills to develop algorithms for the solutions of inviscid supersonic flow problems pertaining to aerospace field.
CO6:	Apply new computational techniques in computational methods such as FDM using the imparted knowledge
TEXT BOOKS:	
1	Fletcher, Clive AJ. "Computational techniques for fluid dynamics: Specific techniques for different flow categories". Springer Science & Business Media, 2012.
2	Fletcher, Clive AJ. "Computational techniques for fluid dynamics 2: Specific techniques for different flow categories". Springer Science & Business Media, 2012.
REFERENCES:	
1	Chung T. J., "Computational Fluid Dynamics", Cambridge University Press; 2nd edition, 2010.
2	Gary A. Sod., "Numerical Methods in Fluid Dynamics: Initial and Initial Boundary-Value Problems", Cambridge University Press, Year: 1985.
3	John F Wendt , "Computational Fluid Dynamics – An Introduction", 3rd Edition, Springer Verlag, Berlin Heidelberg, 2009.
4	Versteeg H.K. and Malalsekera W. "An Introduction to Computational Fluid Dynamics, PHI; 2nd edition 2007.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	-	-	-	-	2	-	-
2	3	2	1	1	1	-	-	-	-	-	-	-	3	1	-
3	3	3	2	2	-	-	-	-	-	-	-	-	3	-	-
4	3	2	1	1	1	-	-	-	-	-	-	-	3	1	-
5	3	2	1	1	1	-	-	-	-	-	-	-	3	1	-
6	3	2	1	1	1	-	-	-	-	-	-	-	3	1	-
Overall Correlation	**3**	**3**	**2**	**2**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**1**	**-**

23AE040	COMPUTATIONAL HEAT TRANSFER	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge to students in the fundamental principles of various numerical methods which are useful to obtain numerical solutions to heat transfer problems.
- To make the students learn numerical methods to obtain solution to 1-D, 2-D and 3-D conductive heat transfer problems.
- To introduce both implicit and explicit methods for numerical solution of transient heat conduction problems to students.
- To make the students familiarize with the numerical treatment of convective heat transfer problems to compute velocity and temperature profiles in boundary problems.
- To acquaint students with the use of finite volume method in radiative heat transfer problems.

UNIT I	INTRODUCTION	9

Finite Difference Method-Introduction-Taylor's series expansion - Discretization Methods Forward, backward and central differencing scheme for first order and second order Derivatives – Types of partial differential equations-Types of errors. Solution to algebraic equation-Direct Method and Indirect Method-Types of boundary condition. FDM - FEM – FVM

UNIT II	CONDUCTIVE HEAT TRANSFER	9

General 3D-heat conduction equation in Cartesian, cylindrical and spherical coordinates. Computation (FDM) of One – Dimensional steady state heat conduction with Heat generation-without Heat generation- 2D-Heat conduction problem with different boundary conditions-Numerical treatment for extended surfaces - Numerical treatment for 3D- Heat conduction -Numerical treatment to 1D-Steady heat conduction using FEM.

UNIT III	TRANSIENT HEAT CONDUCTION	9
Introduction to Implicit, explicit Schemes and crank-Nicolson Schemes Computation(FDM) of One – Dimensional un-steady heat conduction –With heat Generation-Without Heat generation - 2D-transient heat conduction problem with different boundary conditions using Implicit, Explicit Schemes. Importance of Courant number - Analysis for I-D,2-D transient heat Conduction problems.		
UNIT IV	**CONVECTIVE HEAT TRANSFER**	**9**
Convection- Numerical treatment (FDM) of steady and unsteady 1 -D and 2-D heat convection-diffusion steady-unsteady problems- Computation of thermal and Velocity boundary layer flows -Upwind scheme - Stream function-vorticity approach-Creeping flow.		
UNIT V	**RADIATIVE HEAT TRANSFER**	**9**
Radiation fundamentals-Shape factor calculation-Radiosity method- Absorption Method – Montacalro method-Introduction to Finite Volume Method- Numerical treatment of radiation enclosures using finite Volume method - Developing a numerical code for 1D, 2D heat transfer problems.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the basic concepts on the applications of numerical methods for the heat transfer problem solutions.
CO2:	Compare the role of boundary conditions in defining the complexities and the methodology for numerical solutions of heat transfer problems.
CO3:	Solve implicit and explicit schemes for transient heat conduction problems.

CO4:	Solve the temperature profiles in thermal boundary layer.
CO5:	Apply finite volume methods for radiative heat transfer problems and the role of Montecarlo methods in radiative heat transfer.
CO6:	Develop a new code for 1D, 2D heat transfer problems
TEXT BOOKS:	
1	Sachdeva, S.C., “Fundamentals of Engineering Heat and Mass Transfer”, NEW AGE publishers,2010.
2	Yunus A. Cengel, “Heat Transfer – A Practical Approach” Tata McGraw Hill 4thEdition, 2009.
REFERENCES:	
1	Necati Ozisik, “Finite Difference Method in Heat Transfer”, CRC Press, 2nd edition, 2017.
2	Yogesh Jaluria, Kenneth E Torrence, “Computational Heat transfer”, CRC Press, 3rd Edition, 2017.
3	Pradip Majumdar, “Computational Methods for Heat & Mass Transfer”, CRC Press, 2005.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	1	2	-	-	-	-	-	-	1	3	2	-
2	3	3	2	2	2	-	-	-	-	-	-	1	3	2	-
3	3	2	2	2	2	-	-	-	-	-	-	1	3	2	-
4	3	2	2	2	2	-	-	-	-	-	-	1	3	2	-
5	3	2	2	2	2	-	-	-	-	-	-	1	3	2	-
6	3	2	2	2	2	-	-	-	-	-	-	1	3	2	-
Overall Correlation	**3**	**2**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	**3**	**2**	**-**

<table>
<tr><td rowspan="2">23AE041</td><td rowspan="2">BASICS OF COMPUTATIONAL FLUID DYNAMICS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">

To understand the governing equations of fluid dynamics and their application in CFD.
To develop proficiency in finite difference and finite volume methods for solving diffusion problems.
To apply advanced discretization techniques for convection-diffusion problems using various numerical schemes.
To analyze flow fields using algorithms like SIMPLE and PISO for pressure and velocity corrections.
To explore turbulence models and mesh generation techniques, including structured and unstructured grids.

</td></tr>
<tr><td>UNIT I</td><td colspan="4">GOVERNING EQUATIONS AND BOUNDARY CONDITION</td><td>9</td></tr>
<tr><td colspan="6">Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.</td></tr>
<tr><td>UNIT II</td><td colspan="4">FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION</td><td>9</td></tr>
<tr><td colspan="6">Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three-dimensional diffusion problems –Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods.</td></tr>
</table>

UNIT III	**FINITE VOLUME METHOD FOR CONVECTION DIFFUSION**	**9**
Steady one-dimensional convection and diffusion – Central, upwind differencing schemes , properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, QUICK Schemes.		
UNIT IV	**FLOW FIELD ANALYSIS**	**9**
Finite volume methods -Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms.		
UNIT V	**TURBULENCE MODELS AND MESH GENERATION**	**9**
Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation – Mesh refinement – Adaptive mesh – Software tools.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Construct governing differential equations for CFD.
CO2:	Make use of FDM for discretizing PDE.
CO3:	Analyze the pure diffusion type fluid flow and heat transfer problems using numerical modeling.
CO4:	Analyze convection diffusion problems using FVM..
CO5:	Analyze fluid flow and heat transfer problems using SIMPLE, SIMPLEC and PISO schemes.
CO6:	Apply turbulence modeling techniques for solving fluid flow and to develop grid for the domain

TEXT BOOKS:

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

REFERENCES:

1. Anil W. Date "Introduction to Computational Fluid Dynamics" Cambridge University Press,2005.
2. Chung, T.J. "Computational Fluid Dynamics", Cambridge University, Press, 2002.
3. Ghoshdastidar P.S., "Heat Transfer", Oxford University Press, 2005
4. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2014.
5. Patankar, S.V. "Numerical Heat Transfer and Fluid Flow", Hemisphere Publishing Corporation, 2004

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	1	-	1	1	-	-	1	1	-
2	3	2	1	1	1	-	1	-	1	1	-	-	1	1	-
3	3	3	2	2	1	-	1	-	1	1	-	-	1	1	-
4	3	3	2	2	1	-	1	-	1	1	-	-	1	1	-
5	3	3	2	2	1	-	1	-	1	1	-	-	1	1	-
6	3	2	1	1	1	-	1	-	1	1	-	-	1	1	-
Overall Correlation	**3**	**3**	**2**	**2**	**1**	**-**	**1**	**-**	**1**	**1**	**-**	**-**	**1**	**1**	**-**

23AE042	COMPUTER AIDED DESIGN AND ANALYSIS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the concepts of modelling of 2D and 3D geometrical elements
- To gain the knowledge of concepts of computer graphics
- To explore the CAD Packages and its features.
- To explain the Indian standards on drawing practices and standard components.
- To learn the effects of real-world conditions on a part or assembly.

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 - Line- Circle- 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 generation- Boundary 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:

After completion of the course, the students will be able to:

CO1:	Plan and read engineering drawings.
CO2:	Identify engineering objects and components from drawings.
CO3:	Utilize solid models created in computer.
CO4:	Analyze convection diffusion problems using FVM..
CO5:	Compare the relation between 2D drafting and 3D models.
CO6:	Choose the graphical models for further engineering applications

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”, McGraw-Hill Higher Education, 2001
REFERENCES:	
1	Radhakrishnan, Pezhingattil, S. Subramanyan, and V. Raju., “Cad/Cam/Cim”,New Age International, 2008.
2	Chandupatla and Bolagundu., “Introduction to Finite Element Methods in Engineering”, Pearson Education India, 4th Ed., 2015.
3	Mikell P. Groover, “CAD/CAM: Computer-Aided Design and Manufacturing”, PHI, 2003.
4	Govil-Pai, Shalini. “Principles of Computer Graphics: Theory and Practice Using OpenGL and Maya”. Springer Science & Business Media, 2004.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	2	2	-	2	-	2	3	-	-	3	2	-
2	3	2	2	1	2	-	2	-	2	3	-	-	2	2	-
3	3	2	2	1	2	-	2	-	2	3	-	-	2	2	-
4	3	3	2	2	2	-	2	-	2	3	-	-	2	2	-
5	3	3	2	2	2	-		-	2	3	-	-	2	2	-
6	3	2	1	1	3	-	2	-	2	3	-	-	2	3	-
Overall Correlation	**3**	**3**	**2**	**2**	**3**	**-**	**2**	**-**	**2**	**3**	**-**	**-**	**2**	**3**	**-**

23AE043	GRID GENERATION TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To make students understand the need for grid generation for numerical solutions.
- To impart the exposure to both structured and unstructured grid generation methods.
- To impart knowledge on the areas of application and on the implementation methods for structured and unstructured grid generation techniques.
- To expose the students on the benefits of adaptive meshing and its methodology
- To impart training to students on the control of grid quality.
- To apply Best Practices in Grid Generation techniques for steady flows.

UNIT I	BASIC ASPECTS IN GRID GENERATION	9

Methodology of grid generation- classification of grid generation techniques – Structured, Unstructured and Hybrid grids and their characteristic features – Areas of application – Geometry related issues for grid generation – Grid or mesh topology – Conformal Mapping-Domain decomposition with multi blocking.

UNIT II	STRUCTURED GRID GENERATION	9

Algebraic methods for structured grid generation – Use of blending functions for grid generation- Use of partial differential equations for structured grid generation – Elliptic schemes for structured grid generation – Implementation of boundary conditions for smooth grid generation – Variational methods – Applications – A brief introduction to hyperbolic schemes for grid generation.

UNIT III	UNSTRUCTURED GRID GENERATION	9

Use of triangular, quadrilateral and tetrahedral grids/meshes – Concept of dual mesh – Connectivity Information and data structure in unstructured grid generation – Hierarchy in unstructured grid Generation – Composite grid schemes in unstructured grid generation – Moving front technique- Delaunay base method – Octree approach.

UNIT IV	ADAPTIVE MESHING	9
Description of adaptive mesh refinement – Adaption control – Strategies for mesh adaption- Solution gradient based adaption – Discretization error and Recovery based adaption - r adaption, h adaption and p adaption methods – Elementary concepts in dynamic meshing and mesh motion – Role of adaptive meshing in solution accuracy and convergence.		
UNIT V	**GRID QUALITY AND QUALITY CONTROL**	**9**
A brief description of metrics for grid quality – Aspect ratio – Orthogonality – Skewness – Warpage- Jacobian- Best practices for grid quality and grid control – mesh/grid quality aspects in surface meshing – Volume meshing and quality check – Grid quality aspects in boundary layer flows – Prismatic layers – Quality control in hybrid mesh transition – guideline for checking mesh quality and control.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Explain the basic principles of grid generation and its application in aerospace industry.
CO2:	Solve multi-block grid designs of computational domain in aerospace related problems.
CO3:	Solve structured grid designs and be able to take decisions on selection of suitable grid blocks for the computational domains in aerospace applications.
CO4:	Solve unstructured grid designs and be able to take decisions on selection of suitable grid blocks for the computational domains in aerospace applications.
CO5:	Apply adaptive meshing methods for better management of computer resources and cost effective solutions in aerospace engineering.

CO6:	Apply skills in ensuring the good quality of grid that is essential to get reasonably accurate numerical solutions for complex aerospace engineering problems
TEXT BOOKS:	
1	Fletcher, Clive AJ. "Computational techniques for fluid dynamics: Specific techniques for different flow categories". Springer Science & Business Media, 2012..
2	Liseikin, Vladimir D. "Grid generation methods". Vol. 1. Berlin: Springer, 1999.
REFERENCES:	
1	Chung T. J., "Computational Fluid Dynamics", Cambridge University Press; 2nd edition, 2010.
2	Patrick Knupp & Stanly Steinberg, "Fundamentals of Grid Generation" CRC Press 1st edition 1993.
3	Versteeg H.K. and Malalsekera W. "An Introduction to Computational Fluid Dynamics, The Finite Volume Method", PHI; 2nd edition 2007.
4	John F Wendt , "Computational Fluid Dynamics – An Introduction", 3rd Edition, Springer- Verlag, Berlin Heidelberg, 2009.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	1	1	-	1	-	1	1	1	-	2	1	-
2	3	2	1	1	1	-	-	1	1	1	--	-	3	1	1
3	3	2	1	1	1	-	1	-	2	--	1	1	3	1	-
4	3	2	2	1	1	1	-	1	1	1	1	-	3	1	1
5	3	2	1	1	1	-	-	-	1	-	-	1	3	1	-
6	3	2	1	1	1	1	1	-	1	1	-	1	3	1	-
Overall Correlation	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**3**	**1**	**1**

23MT041	COMPUTER INTEGRATED MANUFACTURING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To provide the overview of evolution of automation, CIM and its principles.
- To learn the various Automation tools, include various material handling system.
- To train students to apply group technology and FMS.
- To familiarize the computer aided process planning in manufacturing.
- To introduce to basics of data transaction, information integration and control of CIM.

UNIT I	INTRODUCTION	9

Introduction to CAD, CAM, CAD/CAM and CIM - Evolution of CIM – CIM wheel and cycle – Production concepts and mathematical models – Simple problems in production models – CIM hardware and software – Major elements of CIM system – Three step process for implementation of CIM – Computers in CIM – Computer networks for manufacturing – The future automated factory – Management of CIM – safety aspects of CIM– advances in CIM.

UNIT II	AUTOMATED MANUFACTURING SYSTEMS	9

Automated production line – system configurations, work part transfer mechanisms – Fundamentals of Automated assembly system – System configuration, Part delivery at workstations – Design for automated assembly – Overview of material handling equipments – Consideration in material handling system design – The 10 principles of Material handling. Conveyor systems – Types of conveyors – Operations and features. Automated Guided Vehicle system – Types &applications – Vehicle guidance technology – Vehicle management and safety. Storage system performance – storage location strategies – Conventional storage methods and equipments – Automated storage/Retrieval system and Carousel storage system Deadlocks in Automated manufacturing systems – Petrinet models – Applications in Dead lock avoidance – smart manufacturing – Industry 4.0 - Digital manufacturing – Virtual manufacturing.

UNIT III	GROUP TECHNOLOGY AND FMS	9
Part families – Visual – Parts classification and coding – Production flow analysis – Grouping of parts and Machines by rank order clustering method – Benefits of GT – Case studies. FMS – Components – workstations – FMS layout configurations – Computer control systems – FMS planning and implementation issues – Architecture of FMS – flow chart showing various operations in FMS – Machine cell design – Composite part concept, Holier method, Key machine concept – Quantitative analysis of FMS – Bottleneck model – Simple and complicated problems – Extended Bottleneck model - sizing the FMS — FMS applications, Benefits.		
UNIT IV	**PROCESS PLANNING**	**9**
Process planning – Activities in process planning, Informations required. From design to process planning classification of manufacturing processes – Selection of primary manufacturing processes – Sequencing of operations according to Anteriorities – various examples – forming of Matrix of Anteriorities – Case study. Typical process sheet – case studies in Manual process planning. Computer Aided Process Planning – Process planning module and data base – Variant process planning – Two stages in VPP – Generative process planning – Flow chart showing various activities in generative PP – Semi generative process planning- Comparison of CAPP and Manual PP.		
UNIT V	**PROCESS CONTROL AND DATA ANALYSIS**	**9**
Principle, Interaction of X-Ray with matter, Imaging, Film and Film less techniques, types and use of filters and screens, Geometric factors, Inverse square law, characteristics of films - Graininess, density, Speed, Contrast, Characteristic curves. Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Digital Radiography.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Interpret the basics of computer aided engineering.
CO2:	Choose appropriate automotive tools and material handling systems.
CO3:	Summarize the overview of group technology, FMS and automation identification methods.
CO4:	Apply the concepts of computer aided process planning for manufacturing of various components.
CO5:	Interpret computer process control techniques.
CO6:	Illustrate the overview of data identification methods.
TEXT BOOKS:	
1	Shivanand H K, Benal M M and Koti V, Flexible Manufacturing System, New Age, 2016.
2	August-Wilhelm Scheer, "CIM: Computer Integrated Manufacturing: Computer Steered Industry",Springer-Verlag,Second edition, 2012.
REFERENCES:	
1	A lavudeen and Venkateshwaran, Computer Integrated Manufacturing‖, PHI Learning Pvt. Ltd., New Delhi, 2013.
2	Gideon Halevi and Ronald D. Weill, Principles of Process Planning‖, Chapman Hall, 1995.
3	James A. Retrg, Herry W. Kraebber, Computer Integrated Manufacturing‖, Pearson Education, Asia, 3rdEdition, 2004.
4	Mikell P. Groover, Automation, Production system and Computer integrated Manufacturing, Prentice Hall of India Pvt. Ltd., 4thEdition, 2014.
5	Radhakrishnan P, Subramanian S and Raju V, CAD/CAM/CIM, New Age International Publishers, 3rd Edition, 2008.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	1	-	1	-	-	-	1	2	1	1
2	2	1	-	-	1	1	-	1	-	-	-	1	2	1	1
3	2	1	-	-	1	1	-	1	-	-	-	1	2	1	1
4	3	2	1	-	1	1	-	1	-	-	-	1	2	1	1
5	2	1	-		1	1	-	1	-	-	-	1	2	1	1
6	2	1	-	-	1	1	-	1	-	-	-	1	2	1	1
Overall Correlation	3	2	1	-	1	1	-	1	-	-	-	1	2	1	1

23AE044	BOUNDARY LAYER THEORY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To acquaint students with the fundamental concepts in boundary layer flow and with the governing equations of viscous flow
- To make students familiarize with obtaining analytical solutions for low speed viscous flow problems commonly found in engineering applications
- To introduce the basic concepts in laminar boundary layer theory and its applications in engineering to students
- To elucidate students on the complex phenomenon in turbulent boundary layer theory and turbulence modelling
- To make students knowledgeable on the techniques used for boundary layer control.

UNIT I	FUNDAMENTAL EQUATIONS OF VISCOUS FLOW	9

Fundamental equations of viscous flow- Conservation of mass, momentum equations- Navier-Stokes equations- Energy equation- Mathematical character of basic equations- Dimensional parameters in viscous flow- Non - dimensional the basic equations and boundary conditions- Vorticity considerations-Creeping flow and Boundary layer flow.

UNIT II	SOLUTIONS OF VISCOUS FLOW EQUATIONS	9

Solutions of viscous flow equations- Couette flows- Hagen-Poisuelle flow- Flow between rotating concentric cylinders- Combined Couette-Poiseuille Flow between parallel plates- Creeping motion- Stokes solution for an immersed sphere- Development of boundary layer- Displacement thickness, Momentum and Energy thickness.

UNIT III	LAMINAR BOUNDARY LAYER	9
Laminar boundary layer equations- Flat plate Integral analysis of Karman – Integral analysis of energy equation – Laminar boundary layer equations – Boundary layer over a curved body-Flow separation- Similarity solutions, Blasius solution for flat-plate flow, Falkner–Skan wedge flows, Boundary layer temperature profiles for constant plate temperature –Reynold's analogy –Pohlhausen method.		
UNIT IV	**TURBULENT BOUNDARY LAYER**	**9**
Turbulence-physical and mathematical description, Two-dimensional turbulent boundary layer equations –– Velocity profiles – The law of the wall – The law of the wake – Turbulent flow in pipes and channels – Turbulent boundary layer on a flat plate – Boundary layers with pressure gradient, Eddy Viscosity and mixing length.		
UNIT V	**BOUNDARY LAYER CONTROL**	**9**
Boundary layer control in laminar flow-Methods of Boundary layer control: Acceleration of the boundary layer-Suction-Injection of a different gas-Prevention of transition - Cooling of the wall Boundary layer suction- Practical examples of Boundary Layer Control.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply fundamental equations of the viscous flow for practical examples.
CO2:	Analyze the viscous flow problems for solutions.
CO3:	Explain the importance of viscosity and shear flow adjacent to the airframe of the aerospace vehicles.
CO4:	Analyze the phenomena of flow separation and the solutions for laminar boundary layers, such as Blasius solutions and Falkner–Skan wedge flows.

CO5:	Examine turbulent flow behavior in pipes, channels, and flat plates to understand the effects of different flow conditions.
CO6:	Analyze the Boundary layer control in laminar flow
TEXT BOOKS:	
1	White, Frank M., and Joseph Majdalani. "Viscous fluid flow". Vol. 3. New York: McGraw-Hill, 2006.
2	A.J. Reynolds, "Turbulent flows in Engineering", John Wiley & Sons, 1980.
REFERENCES:	
1	Schlichting, Hermann, and Klaus Gersten. "Boundary-layer theory". Springer, 2016.
2	Panton, Ronald L. "Incompressible flow". John Wiley & Sons, 2024.
3	Tuncer Cebeci and Peter Bradshaw, "Momentum transfer in boundary layers", Hemisphere Publishing Corporation, 1977.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	1	-	1	1	-	-	1	1	-
2	3	3	2	2	1	-	1	-	1	1	-	-	1	1	-
3	2	1	-	-	1	-	1	-	1	1	-	-	1	1	-
4	3	3	2	2	1	-	1	-	1	1	-	-	1	1	-
5	3	3	2	2	1	-	1	-	1	1	-	-	1	1	-
6	3	3	2	2	1	-	1	-	1	1	-	-	1	1	-
Overall Correlation	**3**	**3**	**2**	**2**	**1**	**-**	**1**	**-**	**1**	**1**	**-**	**-**	**1**	**1**	**-**

23AE045	PROGRAMMING TOOLS IN AEROSPACE ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To grasp the basics of programming languages commonly used in aerospace engineering.
- To acquire knowledge of numerical methods essential for aerospace applications, such as root finding, numerical integration, and differential equations solving.
- To learn data analysis techniques and libraries, enabling them to process and interpret aerospace-related datasets effectively.
- To gain an understanding of computational fluid dynamics (CFD) principles and their applications in aerospace engineering.
- To earn the importance of high-performance computing (HPC) in aerospace engineering simulations and understand the basics of parallel computing.
- To enhance their problem-solving abilities and analytical thinking in the context of aerospace engineering.

UNIT I	INTRODUCTION	9

Overview of programming languages, Basics of programming: Variables, Data Types, Operators, Control Structures - Loops, Conditionals, Functions, and Arrays. Basic Aerodynamics in Python.

UNIT II	NUMERICAL METHODS	9

Introduction to numerical methods - Root finding, Numerical integration, Differential equations solving , Aerospace applications such as Orbit determination, Flight dynamics, and Propulsion system analysis, Case studies in aerospace engineering.

UNIT III	DATA ANALYSIS AND VISUALIZATION	9
Data analysis techniques and libraries in programming languages - NumPy, Pandas, Visualization techniques for aerospace engineering data - Plotting trajectories, 3D visualization of aircraft models, Statistical analysis methods commonly used in aerospace engineering - Regression analysis, hypothesis testing.		
UNIT IV	**COMPUTATIONAL FLUID DYNAMICS (CFD)**	**9**
Introduction to computational fluid dynamics, Basics of CFD: governing equations, discretization methods-Finite difference, Finite volume, finite element, Turbulence modeling, CFD software packages-ANSYS Fluent, Open FOAM- Case studies aerospace-related fluid flow problems -Airfoil analysis, Aircraft aerodynamics.		
UNIT V	**INTRODUCTION TO HIGH-PERFORMANCE COMPUTING (HPC)**	**9**
Importance of high-performance computing (HPC) in aerospace engineering simulations, Basics of parallel computing: Parallel architectures, Parallel programming models-MPI, OpenMP, HPC resources - Supercomputers, Cloud computing.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Demonstrate Proficiency in Programming Fundamentals.
CO2:	Apply Numerical Methods to Aerospace Engineering Challenges.
CO3:	Analyze and Visualize Aerospace Data Effectively.
CO4:	Develop Computational Fluid Dynamics (CFD) Simulations.
CO5:	High-Performance Computing (HPC) Techniques for Aerospace Simulations.
CO6:	Solve Complex Aerospace Engineering Problems

TEXT BOOKS:	
1	Kenan A. "Python for Mechanical and Aerospace Engineering". Alex Kenan; 2021.
2	Dorfman M, Anderson C,. "Aerospace software engineering: a collection of concepts". American Institute of Aeronautics and astronautics; 1991.

REFERENCES:	
1	Computational tools and facilities for the next-generation analysis and design environment. Vol. 3346. National Aeronautics and Space Administration, Langley Research Center, 1997.
2	Rizzi A, Oppelstrup J. Aircraft aerodynamic design with Computational Software. Cambridge University Press; 2021.
3	Matthews C. Aeronautical engineer's data book. Elsevier; 2001.
4	Cummings RM, Mason WH, Morton SA, McDaniel DR. Applied computational aerodynamics: A modern engineering approach. Cambridge University Press; 2015.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	-	2	-	-	-	-	1	-	2	2	2	-
2	3	2	1	1	1	-	-	-	-	1	-	2	2	1	-
3	3	3	2	2	2	1	1	-	-	-	1	1	2	2	-
4	3	2	1	1	1	-	-	2	-	-	1	1	2	1	2
5	3	2	1	1	2	1	-	2	1	1	2	2	2	2	2
6	3	2	2	1	2	1	1	-	-	-	1	1	2	2	-
Overall Correlation	**2**	**2**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**2**	**2**	**1**

VERTICAL 3- AERODYNAMICS AND PROPULSION

23AE046	EXPERIMENTAL AERODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the basic measurement technique in Fluid mechanics.
- To provide extensive treatment of the operating principles and limitations of pressure and temperature measurements.
- To cover both operating and application procedures of hot wire anemometer.
- To describe flow visualization techniques and to highlight in depth discussion of analog methods.
- 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:	
After completion of the course, the students will be able to:	
CO1:	Explain the knowledge on measurement techniques in aerodynamic flow.
CO2:	Analyse the Lift and drag measurements through various techniques in wind tunnel
CO3:	Apply the flow visualization technique to study flow pattern of aerodynamic model.
CO4:	Illustrate the Specific instruments for flow parameter measurement like pressure, velocity

CO5:	Apply the Wind tunnel boundary corrections and Scale effects
CO6:	Identify the internal errors and uncertainty calculation

TEXT BOOKS:

1	Rathakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids," CRC Press – Taylor & Francis, 2007.
2	Northrop, Robert B. "Introduction to instrumentation and measurements". CRC press, 2018.

REFERENCES:

1	Bradshaw, Peter. "Experimental Fluid Mechanics: Thermodynamics and Fluid Mechanics Division". Elsevier, 2016..
2	Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", John Wiley, 1985.
3	Jewel B. Barlow,William H. Rae, Jr.Alan Pope," Low-Speed Wind Tunnel Testing", 3 rd Edition,John Wiley & Sons, Inc,1999.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	-	-	-	-	-	-	-	-	-	2	-	-
2	3	3	2	1	3	-	-	-	-	-	-	-	3	3	-
3	3	2	1	1	1	-	-	-	-	-	-	-	3	1	-
4	3	2	1	1	3	-	-	-	-	-	-	-	2	3	-
5	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
6	3	2	1	1	1	-	-	-	-	-	-	-	3	1	-
Overall Correlation	**3**	**2**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**-**

23AE047	HIGH-SPEED AERODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To get insight into the basic aspects of compressible flow.
- To arrive at the shock wave and expansion wave relations.
- To get exposure on potential equation for 2-dimensional compressible flow.
- To get knowledge on high-speed flow over aerofoils, wings and airplane configuration.
- To gain basic knowledge on low and high-speed gas properties.

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	SHOCK AND EXPANSION WAVES	9

Normal shock relations, Prandtl's relation-Hugoniot equation, Raleigh Supersonic Pitot tube equation-Moving normal shock waves, Oblique shocks, θ-β-M relation, Shock Polar, Reflection of oblique shocks, left running and right running waves-Interaction of oblique shock waves, slip line, Rayleigh flow, Fanno flow, Expansion waves, Prandtl-Meyer expansion, Maximum turning angle, Simple and non-simple regions, operating characteristics of Nozzles, under expansion, over expansion.

UNIT III	TWO-DIMENSIONAL COMPRESSIBLE FLOW	9

Potential equation for 2-dimensional compressible flow, Linearization of potential equation, perturbation potential, Linearized Pressure Coefficient, Linearized subsonic flow, Prandtl- Glauert rule, Linearized supersonic flow, Method of characteristics.

UNIT IV	**HIGH-SPEED FLOW OVER AIRFOILS, WINGS AND AIRPLANECONFIGURATION**	**9**
Critical Mach number, Drag divergence Mach number, Shock Stall, Supercritical Airfoil Sections, Transonic area rule, Swept wing, Airfoils for supersonic flows, Lift, drag, Pitching moment and Centre of pressure for supersonic profiles, Shock expansion theory, wave drag, supersonic wings, Design considerations for supersonic aircrafts.		
UNIT V	**CHARACTERIZATION OF HIGH SPEED FLOWS**	**9**
Shock-Boundary layer interaction, Wind tunnels for transonic, Supersonic and Hypersonic flows, Shock tube, Gun tunnels, Supersonic flow visualization, Introduction to Hypersonic Flows.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Analyze the effect of compressibility at high-speeds and to make intelligent design decisions based on this understanding.
CO2:	Compare the shock waves and expansion waves.
CO3:	Solve 2D compressible flows.
CO4:	Analyze the method of characteristics of a supersonic 2 Dimensional CD nozzle design.
CO5:	Estimate the high speed flow over airfoils and wings for an aircraft.
CO6:	Classify different types of flows and their applications.

TEXT BOOKS:	
1	Anderson, J. D, "Modern Compressible Flow: With Historical Perspective" McGraw-Hill Education; 3rd edition, 2003.
2	Rathakrishnan. E, "Gas Dynamics", Prentice-Hall of India Pvt., Ltd, 2008

REFERENCES:	
1	Oosthuizen,P.H., & Carscallen,W.E., “Compressible Fluid Flow”, CRC Press; 2nd edition (July 22, 2013).
2	Shapiro, A. H., “Dynamics and Thermodynamics of Compressible Fluid Flow”, Ronald Press, 1982.
3	Zucrow, M. J. and Anderson, J. D., “Elements of Gas Dynamics”, McGraw- Hill &Co., 1989.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	1	1	1	1	1	-	1	1	2	3	1	1
2	3	2	2	1	1	1	1	1	-	1	1	2	3	1	1
3	3	2	1	-	1	-	-	-	-	-	-	1	2	1	-
4	3	3	2	2	2	-	-	-	-	-	-	1	2	2	-
5	3	3	3	2	3	1	1	1	-	1	1	2	2	3	1
6	3	3	2	1	3	1	1	1	-	1	1	2	2	3	1
Overall Correlation	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**1**	**-**	**1**	**1**	**2**	**3**	**2**	**1**

23AE048	INDUSTRIAL AERODYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the concepts of non-aeronautical usages of aerodynamics.
- To introduce the topic of wind energy collectors.
- To impart concepts of analysing vibrations during flow.
- To learn the concepts of Atmospheric boundary layer.
- To introduce the basics 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:	
After completion of the course, the students will be able to:	
CO1:	Explain the aerodynamics for non- aerodynamic structure such as vehicle, building.
CO2:	Identify the problems and able to analyze vibrations during flow
CO3:	Identify the Atmospheric boundary layer and applications of wind energy collectors.
CO4:	Analyse the aerodynamics of road vehicles and problems of flow induced vibrations.
CO5:	Analyse the aerodynamics of buildings and problems of flow induced vibrations.
CO6:	Analyse the aerodynamics of bluff shapes and problems of vortex induced vibrations
TEXT BOOKS:	
1	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.
REFERENCES:	
1	Blevins. R.D., "Flow Induced Vibrations", Van Nostrand, 1990.
2	Calvent. N.G., "Wind Power Principles", Charles Griffin & Co., London, 1979.
3	Cook N J, "Design Guides to wind loading of buildings structures. Part I & II", Butterworths, don, 1990.
4	Tom Lawson, "Building Aerodynamics", Imperial College Press London, 1st edition, 2001.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	1	-	2	-	-	-	-	-	-	-	2	2	-
2	3	2	1	1	2	-	-	-	-	-	-	-	2	2	-
3	3	2	1	1	2	-	-	-	-	-	-	-	2	2	-
4	3	3	2	2	2	-	-	-	-	-	-	-	2	2	-
5	3	3	2	2	2	-	-	-	-	-	-	-	2	2	-
6	3	3	2	2	2	-	-	-	-	-	-	-	2	2	-
Overall Correlation	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**2**	**-**

23AE049	ROCKET PROPULSION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To make students understand the basic operating principle of rocket propulsion.
- To make students understand the parameter required to estimate the performance of Rockets.
- To impart knowledge to students on different types of rocket propulsion systems.
- To learn the concepts of rocket propulsion applications and disadvantages.
- To expose the students to the methods of multi-staging of rocket vehicles.
- To understand 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 behaviour 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 the 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:		
After completion of the course, the students will be able to:		
CO1:	Explain the basic principles and develop an interest in joining the 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 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:	Summarize the acquired knowledge and apply the skills in the preliminary design of rocket subsystems.	
CO6:	Explain the internal ballistics of the rocket.	

TEXT BOOKS:

1	David H. Heiser and David T. Pratt., "Hypersonic Air Breathing Propulsion", AIAA Education Series, 1999.
2	Sutton, G.P., "Rocket Propulsion Elements", Wiley, New York, 9th Ed., 2017.

REFERENCES:

1	Martin J. Chiaverini and Kenneth K. Kuo, "Fundamentals of Hybrid Rocket Combustion and Propulsion", Progress in Astronautics and Aeronautics, 2007.
2	Ramamurthi K, "Rocket Propulsion", Macmillian publishers India Ltd, 1st edition, 2010.
3	Mathur, M.L. and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers & Distributors, Delhi, 2nd edition 2014.
4	H. S. Mukunda " Understanding Aerospace Chemical Propulsion", Krishan Makhijani Publishers Pvt. Ltd, 2017.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	-	1	1	-	1	-	-	-	-	2	1	1
2	3	2	1	1	1	1	-	1	-	-	-	-	2	1	1
3	3	3	3	2	1	1	-	1	-	-	-	-	2	1	1
4	2	1	1	1	1	1	-	1	-	-	-	-	2	1	1
5	2	1	1	1	1	1	-	1	-	-	-	-	2	1	1
6	2	1	1	1	1	1	-	1	-	-	-	-	2	1	1
Overall Correlation	**2**	**1**	**1**	**1**	**1**	**1**	-	**1**	-	-	-	-	**2**	**1**	**1**

<table>
<tr><td rowspan="2">23AE050</td><td colspan="2" rowspan="2">ADVANCED PROPULSION SYSTEMS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">• To impart knowledge on the basic concepts of space propulsion.
• To learn about the physics of ionized gases.
• To get familiarize with the types of nuclear rockets and the basic concepts of nuclear propulsion systems.
• To study about the radioisotope propulsion.
• To realize the importance of advanced space propulsion concepts.
• To develop skills in Propulsion System Analysis.</td></tr>
<tr><td>UNIT I</td><td colspan="5">INTRODUCTION TO SPACE PROPULSION SYSTEMS</td><td>9</td></tr>
<tr><td colspan="7">Historical outline- Scramjet Propulsion-Scramjet Inlets- Scramjet Performance- Chemical rocket Propulsion -Tripropellants - Metalized Propellants - Free Radical Propulsion- Electric Propulsion- Micro propulsion - Micro Propulsion Requirements- MEMS and MEMS- Hybrid Propulsion Systems.</td></tr>
<tr><td>UNIT II</td><td colspan="5">BASIC CONCEPTS OF IONIZED GASES</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
<tr><td>UNIT III</td><td colspan="5">NUCLEAR ROCKET PROPULSION</td><td>9</td></tr>
<tr><td colspan="7">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.</td></tr>
</table>

UNIT IV	RADIOISOTOPE PROPULSION	9
Alternative Approaches - Direct Recoil Method - Thermal Heating Method - Basic Thruster Configurations - Propulsion System and Upper Stage - Relative Mission Capabilities - 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:	
After completion of the course, the students will be able to:	
CO1:	Illustrate the Scramjet engine design and performance.
CO2:	Explain about the chemical rocket propulsion and its classification.
CO3:	Explain the physics of ionized gases, including relevant theories and particle collision phenomena.
CO4:	Explain the operation, various types, and performance characteristics of nuclear rockets, along with their design considerations.
CO5:	Explain the basics of radioisotope propulsion with their performance studies.

CO6:	Explain the core principles, operational mechanisms, and performance metrics of advanced propulsion systems.
TEXT BOOKS:	
1	Czysz, Paul A., Bruno, Claudio, Chudoba, Bernd “Future Spacecraft Propulsion Systems and Integration”, Springer, Praxis Publishing Ltd, 2018.
2	George W. Sutton, “Engineering Magneto hydrodynamics”, Dover Publications Inc., New York, 2006.
REFERENCES:	
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.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	1	1	-	1	-	2	1	1	1	3	1	-
2	2	1	1	1	-	1	-	-	1	1	-	-	2	-	-
3	2	1	1	1	1	-	-	-	-	-	-	-	2	1	-
4	2	1	1	1	-	-	-	-	1	1	1	-	2	-	-
5	2	1	1	1	-	-	-	-	1	1	-		3	-	-
6	2	1	1	1	-	-	-	-	1	-	-	1	2	-	-
Overall Correlation	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**-**	**1**	**1**	**1**	**1**	**2**	**1**	**-**

<table>
<tr><td rowspan="2">23AE051</td><td rowspan="2">HYPERSONIC AERODYNAMICS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">To get insight into the basic aspects of hypersonic flows and the shock wave interactions..
To arrive at the surface inclination methods for hypersonic inviscid flows.
To get exposure on an approximate method for inviscid hypersonic flows.
To get knowledge on viscous hypersonic flow theory.
To gain basic knowledge on viscous interactions in hypersonic flows.</td></tr>
<tr><td>UNIT I</td><td colspan="4">BASICS OF HYPERSONIC AERODYNAMICS</td><td>9</td></tr>
<tr><td colspan="6">Thin shock layers – Entropy layers – Low density and High-density flows – hypersonic flight paths – Hypersonic flight similarity parameters – Shock wave and expansion wave relations of inviscid hypersonic flows.</td></tr>
<tr><td>UNIT II</td><td colspan="4">SURFACE INCLINATION METHODS FOR HYPERSONIC INVISCID FLOWS</td><td>9</td></tr>
<tr><td colspan="6">Local surface inclination methods – Modified Newtonian Law – Newtonian theory – tangent wedge or tangent cone and shock expansion methods – Calculation of surface flow properties.</td></tr>
<tr><td>UNIT III</td><td colspan="4">APPROXIMATE METHODS FOR INVISCID HYPERSONIC FLOWS</td><td>9</td></tr>
<tr><td colspan="6">Approximate methods – Hypersonic small disturbance equation and theory – Thin shock layer theory blast wave theory – Entropy effects – Rotational method of characteristics – Hypersonic shock wave, shapes and correlations.</td></tr>
<tr><td>UNIT IV</td><td colspan="4">VISCOUS HYPERSONIC FLOW THEORY</td><td>9</td></tr>
<tr><td colspan="6">Navier-Stokes equations – Boundary layer equations for hypersonic flow – Hypersonic boundary layer – Hypersonic boundary layer theory and non-similar hypersonic boundary layers – Hypersonic aerodynamic heating and entropy layers effects on aerodynamic heating – Heat flux estimation.</td></tr>
</table>

UNIT V	**VISCOUS INTERACTIONS IN HYPERSONIC FLOWS**	**9**
Strong and weak viscous interactions – Hypersonic shockwaves and boundary layer interactions – Estimation of hypersonic boundary layer transition – Role of similarity parameter for laminar viscous interactions in hypersonic viscous flow.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Explain shock wave and expansion wave relations of inviscid hypersonic flows	
CO2:	Explain the solution methods for hypersonic inviscid flows.	
CO3:	Analyze the hypersonic boundary layers.	
CO4:	Explain the viscous interaction in hypersonic flows.	
CO5:	Analyze chemical and temperature effects in hypersonic flow.	
CO6:	Compare the similarity parameter for a laminar viscous interaction in hypersonic flow.	
TEXT BOOKS:		
1	Anderson J. D., "Hypersonic and High Temperature Gas Dynamics", AIAA Education Series, 2nd Ed., 2006.	
2	Anderson J. D., "Modern Compressible Flow with Historical Perspective", TMH, 3rd Ed., 2012	
REFERENCES:		
1	Heiser, W. H. and Pratt, D. T., "Hypersonic Air Breathing Propulsion", AIAA, 1994.	
2	John T. Bertin, "Hypersonic Aerothermodynamics", AIAA Inc., Washington DC, 1994.	

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	1	1	-	-	-	-	1	1	1	3	1	-
2	2	2	1	1	2	-	-	-	-	1	1	1	3	2	-
3	3	3	2	2	2	-	-	-	-	1	1	2	3	2	-
4	2	2	1	1	2	-	-	-	-	1	1	1	3	2	-
5	3	3	2	1	2	-	-	-	-	1	1	1	3	2	-
6	3	2	1	1	1	-	-	-	-	1	1	1	3	1	-
Overall Correlation	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**1**	**1**	**1**	**3**	**2**	**-**

23AE052	WIND TUNNEL TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the Types of low speed Wind tunnels and non-dimensional numbers with itsapplications.
- To learn the Types of high speed Wind tunnels and with its calibration methods.
- To Understand the Special Wind tunnels and with its calibration methods with its designmethods.
- To describe flow visualization techniques and data acquisition methods.
- To understand the functions of various instruments associated with wind tunnel.
- To learn about the Imageprocessing methods.

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 - sample design calculations and Calibration methods.

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 – calibration of measuring instruments – Error estimation and uncertainty analysis.

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 – Image processing and data deduction.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the uses of various types of tunnels and its losses.
CO2:	Test for 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:	Develop various techniques for aerodynamic data generation.
CO6:	Explain various flow visualization techniques and flow diagnostics.

TEXT BOOKS:	
1	Ahmed, Noor, "Wind tunnel designs and their diverse engineering applications". Intechopen Publishers, 2013.
2	Rae, W.H. and Pope, A., "Low Speed Wind Tunnel Testing", John Wiley Publication, 1984.

REFERENCES:	
1	Bradshaw, Peter. "Experimental Fluid Mechanics: Thermodynamics and Fluid Mechanics Division". Elsevier, 2016.

2	Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", John Wiley, 1985.
3	Rathakrishnan, E., "Instrumentation, Measurements, and Experiments in Fluids," CRC Press – Taylor & Francis, 2007.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	-	-	-	-	-	-	-	-	-	2	-	-
2	3	3	2	1	3	-	-	-	-	-	-	-	3	3	-
3	3	2	1	1	1	-	-	-	-	-	-	-	3	1	-
4	3	2	1	1	3	-	-	-	-	-	-	-	2	3	-
5	3	2	1	1	-	-	-	-	-	-	-	-	3	-	-
6	2	1	1	-	-	-	-	-	-	-	-	-	2	-	-
Overall Correlation	**3**	**2**	**1**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**-**

23AE053	FUNDAMENTALS OF COMBUSTION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge to students on basic fuel and oxidizer characteristics.
- To impart the concept of various governing equation and role of chemical kinetic in combustion process.
- To make the students to understand various kinds flame and factors affecting flame.
- The concept of diffusion flames.
- Application of calculation in the field of Aerospace engineering.

UNIT I	THERMODYNAMICS OF COMBUSTION	9

Combustion, types of fuels and oxidizers, calorific value measurements, flash point, fire point, smoke point, specific gravity, auto ignition temperature, Proximate analysis, ultimate analysis, Ideal gas law, gas mixture, sensible enthalpy, stoichiometry, equivalence ratio, heat of reaction, heat of combustion, heat of formation, adiabatic flame temperature, determination of equilibrium composition.

UNIT II	TRANSPORT PHENOMENA AND CHEMICAL KINETIC OF COMBUSTION	9

Mass Transfer Rate Laws, Species Conservation, Some Applications of Mass Transfer, Global Versus Elementary Reactions, Rates of Reaction for Multistep Mechanisms, Net Production Rates, Compact Notation, Relation Between Rate Coefficients and Equilibrium Constants, Steady-State Approximation, The Mechanism for unimolecular Reactions, Chain and Chain Branching Reactions, Chemical Time Scales, Partial Equilibrium, Reduced Mechanisms

UNIT III	PREMIXED FLAMES	9

Physical Description, detonation and deflagration, Hugoniot curve, Determination of CJ points, Governing Equations, Boundary Conditions, Structure of CH4–Air Flame, Factors Influencing Flame Velocity and Thickness, Flame Speed Correlations, Quenching, Flammability, and Ignition, Quenching by a Cold Wall Flammability Limits Ignition, Flame Stabilization.

UNIT IV	LAMINAR DIFFUSION FLAMES	9
Non-reacting Constant-Density Laminar Jet, Physical Description, Conservation Laws, Boundary Conditions, Solution, Jet Flame Physical Description, Simplified Theoretical Descriptions, Flame Lengths for Circular-Port and Slot Burners, Roper's Correlations ,Flow rate and Geometry Effects, Factors Affecting Stoichiometry, Soot Formation and Destruction Counter flow.		
UNIT V	**DROPLET EVAPORATION AND BURNING**	**9**
Simple Model of Droplet Evaporation, Gas-Phase Analysis, Droplet, Simple Model of Droplet Burning, Burning Rate Constant and Droplet, Lifetimes, Extension to Convective Environments, Additional Factors, One-Dimensional Vaporization-Controlled Combustion.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Demonstrate knowledge of the fundamental characteristics of fuels and oxidizers, including their properties and significance in combustion processes.
CO2:	Apply the principles of governing equations and chemical kinetics to understand and analyze combustion phenomena.
CO3:	Analyze various types of flames and identify the factors influencing flame behavior and stability.
CO4:	Explain the concept of diffusion flames and their role in practical combustion applications.
CO5:	Utilize combustion theories to solve problems and perform calculations relevant to aerospace engineering applications.
CO6:	Integrate the concepts of combustion chemistry and fluid dynamics to design and evaluate efficient aerospace propulsion systems.

TEXT BOOKS:	
1	Glassman, Irvin, Richard A. Yetter, and Nick G. Glumac. Combustion. 5th ed. Amsterdam: Academic Press, 2014.
2	Turns, Stephen R. An Introduction to Combustion: Concepts and Applications. 3rd ed. New York: McGraw-Hill Education, 2011.
REFERENCES:	
1	Kenneth K.Kuo, “Principles of combustion”, John Wiley & sons Inc, 2nd edition, 2012.
2	Mishra, DP, “Fundamentals of Combustion”,PHI publishers, 2008.
3	VasudevanRaghavan, “Combustion Technology: essentials of flames and burners”, Ane Books Pvt.Ltd, 1st edition, 2016.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	-	-	3	3	-	-	-	-	-	-	-	-
2	3	2	1	1	-	3	3	-	-	-	-	-	-	-	-
3	3	3	2	1	-	3	3	-	-	-	-	-	-	-	-
4	2	2	1	-	-	2	3	-	-	-	-	-	-	-	-
5	2	2	1	-	-	2	3	-	-	-	-	-	-	-	-
6	2	2	1	-	-	3	3	-	-	-	-	-	-	-	-
Overall Correlation	3	2	2	1	-	3	3	-	-	-	-	-	-	-	-

VERTICAL 4 - AEROSPACE STRUCTURES

23AE054	FATIGUE AND FRACTURE MECHANICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn about mathematics and principles of fracture mechanics.
- To impart knowledge about the fundamental source of failure of mechanical components.
- To make students understand the fatigue design curve approaches and limitations.
- To make the students learn the characterization of variables in cyclic loads.
- To expand student's knowledge on testing of the material for fatigue failure.
- To examine real-world case studies.

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

Propulsion Elements for Solid Rocket Motors – Solid Propellant Grain Design – Prediction and Measurement of Specific Impulse – Solid Propellant Combustion and Internal Ballistics of Motors –Plume, Signal Interference and Plume Signature – Structural Analysis of Propellant Grains –Safety Characteristics of Solid Propellants and Hazards of Solid Rocket Motors.

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-Case Study of any accident due to fatigue load in Aircraft and spacecraft.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply the mathematical knowledge to define fatigue behaviours of the materials.
CO2:	Explain the damage theory to predict life of the material under fatigue load.
CO3:	Explain the causes of the crack initiation & its growth.
CO4:	Apply principles of fracture mechanics to analyze the strength of cracked bodies.
CO5:	Apply the design philosophies to fatigue design and testing of aerospace structures.
CO6:	Explain the importance of the fracture mechanics in composite materials.
TEXT BOOKS:	
1	Barrois W, Ripely, E.L., "Fatigue of aircraft structure," Pergamon press. Oxford, 1983.
2	Kumar, Prashant. "Elements of fracture mechanics". McGraw-Hill Education LLC., 2009.

REFERENCES:	
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.
4	Rene Alderliesten, "Fatigue and Fracture of Fibre Metal Laminates" , Springer, 1st ed. 2017 edition.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	3	2	1	1	-	-	-	-	1	1	1	-	3	-	-
2	2	1	1	1	1	-	-	1	1	1	1	-	3	1	1
3	2	1	1	1	-	1	-	-	1	1	1	-	3	-	-
4	3	2	2	1	-	-	-	-	1	1	1	-	3	-	-
5	3	2	2	1	1	-	-	-	1	1	1	1	3	1	-
6	2	1	1	-	-	-	1	-	-	-	1	1	2	-	-
Overall Correlation	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**3**	**1**	**1**

23AE055	EXPERIMENTAL STRESS ANALYSIS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To be able to understand the various experimental techniques involved for measuring displacements, stresses, strains in structural components.
- To familiarize with the different types of strain gages used.
- To familiarize with the instrumentation system used for strain gauges.
- To be able to use photo elasticity techniques and methods for stress analysis.
- To 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 Photo elastic 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 Photo elastic Stress Analysis – Fringe Multiplication and Fringe Sharpening-Materials for Two-Dimensional Photo elasticity- Properties and Calibration of Commonly Employed Photo elastic Materials – Introduction to Three-Dimensional Photo elasticity.		
UNIT V	**NON-DESTRUCTIVE TESTING**	**9**
Different types of NDT Techniques - Acoustic Emission Technique – Ultrasonic – 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:	
After completion of the course, the students will be able to:	
CO1:	Analyse the performance of measuring instrumentation.
CO2:	Make use of knowledge on different methods of strain measurement.
CO3:	Design different strain gauge circuits.
CO4:	Experiment with polariscope for stress analysis.
CO5:	Apply the different types of non-destructive testing methods for flaw detection.
CO6:	Make Use of compensation and separation techniques of photoelasticity for material analysis.

TEXT BOOKS:	
1	Dally, J.W., and Riley, W.F., Experimental Stress Analysis, McGraw Hill Inc., New York1998.
2	Sadhu Singh, Experimental Stress Analysis, Khanna Publishers, New Delhi, 2009.
REFERENCES:	
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.,New York, 1972.
4	James F. Doyle and James W. Phillips, 'Manual on Experimental Stress Analysis', 5thEdition, 1989.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	1	1	-	1	-	-	-	-	-	3	1	-
2	3	2	1	1	1	-	2	-	-	-	-	-	3	1	-
3	3	3	2	1	1	-	1	-	-	-	-	-	3	1	-
4	3	3	2	1	1	-	1	-	-	-	-	-	3	1	-
5	3	2	1	1	1	-	2	-	-	-	-	-	3	1	-
6	3	2	1	1	1	-	1	-	-	-	-	-	3	1	-
Overall Correlation	**3**	**3**	**2**	**1**	**1**	**-**	**2**	**-**	**-**	**-**	**-**	**-**	**3**	**1**	**-**

23AE056	VIBRATION AND AEROELASTICITY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- 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.
- To study the solving methods of multi degree of freedom systems.
- To introduce approximates method to solve vibration problems.
- To make the student to understand the solving techniques of vibration of continuous system.
- To study the aeroelastic effects of aircraft wings.
- To study the coupling effect of vibration.

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 - Lagrangian 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:		
After completion of the course, the students will be able to:		
CO1:	Solve the free and forced vibration of single degree of freedom systems with and without damping.	
CO2:	Apply the energy method and matrix method to multi degree of freedom system.	
CO3:	Solve the frequency and displacement of the continuous system.	
CO4:	Apply approximate methods to find natural frequency of a system.	
CO5:	Explain the coupling effects of bending and torsion in vibration problems and their significance in aeroelastic phenomena.	
CO6:	Explain the significance of Collar's triangle in aeroelasticity, identifying key regions of stability and instability.	
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.	
REFERENCES:		
1	Thomson W T, ‘Theory of Vibration with Application’ - CBS Publishers, 1990.	
2	Bisplinghoff R.L., Ashely H and Hogman R.L., "Aeroelasticity", Addision Wesley Publication, New Tork, 1983.	

3	Den Hartog, "Mechanical Vibrations" Crastre Press, 2008.
4	TSE. F.S., Morse, I.F., Hinkle, R.T., "Mechanical Vibrations" – Prentice Hall, New York, 1984.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	1	-	-	-	-	1	1	1	-	2	-	-
2	3	2	2	1	1	-	-	-	1	1	1	-	3	1	-
3	3	2	2	1	-	1	-	-	1	1	-	-	3	-	-
4	3	2	2	1	-	-	-	-	1	1	-	-	3	-	-
5	2	1	1	1	-	-	-	-	1	1	-	-	3	-	-
6	2	1	1	1	-	-	-	-	-	-	1	-	3	-	-
Overall Correlation	**3**	**3**	**2**	**1**	**1**	**1**	**-**	**-**	**1**	**1**	**1**	**-**	**3**	**1**	**-**

<table>
<tr><td rowspan="2">23ME031</td><td rowspan="2">ADDITIVE MANUFACTURING</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">
To introduce the development of Additive Manufacturing (AM), various business opportunities and applications.
To familiarize various software tools, processes and techniques to create physical objects that satisfy product development / prototyping requirements, using AM.
To be acquainted with vat polymerization and direct energy deposition processes.
To be familiar with powder bed fusion and material extrusion processes.
To gain knowledge on applications of binder jetting, material jetting and sheet lamination processes.
</td></tr>
<tr><td>UNIT I</td><td colspan="4">INTRODUCTION</td><td>9</td></tr>
<tr><td colspan="6">Overview - Need - Development of Additive Manufacturing (AM) Technology: Rapid Prototyping Rapid Tooling - Rapid Manufacturing - Additive Manufacturing. AM Process Chain- ASTM/ISO 52900 Classification - Benefits. Applications: Building Printing - Bio Printing - Food Printing Electronics Printing. Business Opportunities and Future Directions – Case studies: Automobile, Aerospace, Healthcare.</td></tr>
<tr><td>UNIT II</td><td colspan="4">DESIGN FOR ADDITIVE MANUFACTURING (DFAM)</td><td>9</td></tr>
<tr><td colspan="6">Concepts and Objectives - AM Unique Capabilities - Part Consolidation – Topology Optimization Generative design - Lattice Structures - Multi-Material Parts and Graded Materials - Data Processing: CAD Model Preparation - AM File formats: STL-Problems with STL- AMF Design for Part Quality Improvement: Part Orientation - Support Structure - Slicing - Tool Path Generation – Design rules for Extrusion based AM.</td></tr>
</table>

UNIT III	**VAT POLYMERIZATION AND DIRECTED ENERGY DEPOSIT**	**9**
Photo polymerization: Stereolithography Apparatus (SLA) - Materials -Process – top down and bottom up approach - Advantages - Limitations - Applications. Digital Light Processing (DLP) - Process - Advantages - Applications. Continuous Liquid Interface Production (CLIP) Technology. Directed Energy Deposition: Laser Engineered Net Shaping (LENS) - Process - Material Delivery - Materials -Benefits - Applications.		
UNIT IV	**POWDER BED FUSION AND MATERIAL EXTRUSION**	**9**
Powder Bed Fusion: Selective Laser Sintering (SLS): Process - Powder Fusion Mechanism Materials and Application. Selective Laser Melting (SLM), Electron Beam Melting (EBM): Materials - Process - Advantages and Applications. Material Extrusion: Fused Deposition Modeling (FDM)- Process-Materials - Applications and Limitations.		
UNIT V	**OTHER ADDITIVE MANUFACTURING PROCESSES**	**9**
Binder Jetting: Three-Dimensional Printing - Materials - Process - Benefits- Limitations - Applications. Material Jetting: Multijet Modeling- Materials - Process - Benefits - Applications. Sheet Lamination: Laminated Object Manufacturing (LOM)- Basic Principle- Mechanism: Gluing or Adhesive Bonding - Thermal Bonding- Materials-Application and Limitation.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the development of AM technology in businesses.
CO2:	Explain the process of transforming a concept into the final product in AM technology.

CO3:	Explain the vat polymerization processes and its applications.
CO4:	Explain direct energy deposition processes and its applications.
CO5:	Explain the process and applications of powder bed fusion and material extrusion.
CO6:	Explain the advantages, limitations, applications of binder jetting, material jetting and sheet lamination processes.
TEXT BOOKS:	
1	Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani "Additive manufacturing technologies". 3rd edition Springer Cham, Switzerland. (2021). ISBN: 978-3-030-56126-0.
2	Andreas Gebhardt and Jan-Steffen Hötter "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing", Hanser publications, United States, 2015, ISBN: 978-1-56990-582-1.
REFERENCES:	
1	Andreas Gebhardt, "Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing", Hanser Gardner Publication, Cincinnati., Ohio, 2011, ISBN: 9783446425521.
2	Milan Brandt, "Laser Additive Manufacturing: Materials, Design, Technologies, and Applications", Woodhead Publishing., United Kingdom, 2016, ISBN: 9780081004333.
3	Amit Bandyopadhyay and Susmita Bose, "Additive Manufacturing", 1st Edition, CRC Press., United States, 2015, ISBN-13: 978-1482223590.
4	Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer., United States, 2006, ISBN: 978-1-4614-9842-1.

5	Liou, L.W. and Liou, F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press., United States, 2011, ISBN: 9780849334092.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	-	-	1	1	-	-	-	-	1	1	2	1	-
2	2	1	-	-	1	1	-	-	-	-	1	1	2	1	-
3	2	1	-	-	1	1	-	-	-	-	1	1	2	1	-
4	2	1	-	-	1	1	-	-	-	-	1	1	2	1	-
5	2	1	-	-	1	1	-	-	-	-	1	1	2	1	-
6	2	1	-	-	1	1	-	-	-	-	1	1	2	1	-
Overall Correlation	2	1	-	-	1	1	-	-	-	-	1	1	2	1	-

23ME036	NON-DESTRUCTIVE TESTING AND EVALUATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the importance, principle, concept and inspection methods of various surface NDT methods and develop the skills of interpretation of results effectively.
- To study the working and instrumentation of thermography and eddy current testing methods and apply to interpret the results and investigate the possible defects.
- To get full exposure about principle, instrumentation and standards of various radiographic NDT methods and improve the skill to identify the defects suitably.
- To get deep insight into the principle, types of waves, instrumentation, standards, and calibration methods of ultrasonic NDT methods.
- To understand the importance, principle, concept and inspection methods of various surface NDT methods and develop the skills of interpretation of results effectively.

UNIT I	INTRODUCTION	9

NDT Versus Mechanical testing – Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterization. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT- Visual inspection – Unaided and aided.

UNIT II	SURFACE NDT METHODS	9

Liquid Penetrant Inspection – Principles, Types of dye and methods of application, developers, advantages and limitations of various methods, Interpretation of results. Magnetic Particle Inspection- Magnetic particle testing, Basic theory of magnetism, Magnetization methods, Interpretation of field indicators, Particle application, Inspection, Residual magnetism Principles and methods of demagnetization.

UNIT III	THERMOGRAPHY AND EDDY CURRENT TESTING	9
Thermography- Principles, Contact and non-contact inspection methods, Advantages and limitation – infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Applications, advantages, Limitations, Interpretation/Evaluation.		
UNIT IV	**ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE)**	**9**
Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique – Principle, AE parameters, Applications		
UNIT V	**RADIOGRAPHY**	**9**
Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square law, characteristics of films - graininess, density, speed, contrast, characteristic curves. Penetrometers, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Digital Radiography.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the fundamental concepts of NDT
CO2:	Interpret the different methods of NDE
CO3:	Explain the concept of Thermography and Eddy current testing
CO4:	Explain the concept of Ultrasonic Testing
CO5:	Explain the concept of Acoustic Emission
CO6:	Explain the concept of Radiography

TEXT BOOKS:	
1	"ASM Metals Handbook, Non-Destructive Evaluation and Quality Control, American Society of Metals", Metals Park, Ohio, USA, 200, 2018.
2	Baldev Raj, T. Jayakumar, M. Thavasimuthu "Practical Non-Destructive Testing", Narosa Publishing House, 2014.
REFERENCES:	
1	Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010.
2	Paul E Mix, "Introduction to Non-destructive testing: a training guide", Wiley, 2nd Edition New Jersey, 2005.
3	Charles, J. Hellier, "Handbook of Nondestructive evaluation", McGraw Hill, New York 2001.
4	B.P.C. Rao, "Practical Eddy Current Testing", Alpha Science International Limited (2006).
5	Ravi Prakash, "Non-Destructive Testing Techniques", 1st revised edition, New Age International Publishers, 2010.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	-	-	1	-	-	1	-	-	1	-	2	1	1
2	2	1	-	-	1	-	-	1	-	-	1	-	2	1	1
3	2	1	-		1	-	-	1	-	-	1	-	2	1	1
4	2	1	-	-	1	-	-	1	-	-	1	-	2	1	1
5	2	1	-	-	1	-	-	1	-	-	1	-	2	1	1
6	2	1	-	-	1	-	-	1	-	-	1	-	2	1	1
Overall Correlation	2	1	-	-	1	-	-	1	-	-	1	-	2	1	1

23AE057	AEROSPACE MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the elements of aerospace materials, mechanical behaviour of materials, ceramics and composites.
- To explain the theory, concepts, principles and governing equations of solid mechanics.
- To analyse the stresses in simple structures as used in the aerospace industry.
- To learn the concepts of corrosion and heat treatment.
- To acquire knowledge in high temperature materials and characterization.

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 – Effect 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 – Introduction to Nano composites- 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:	
After completion of the course, the students will be able to:	
CO1:	Interpret the importance of material and its application
CO2:	Infer about the various mechanical behaviour of material
CO3:	Explain about the corrosion in materials
CO4:	Choose the suitable heat treatment process based on material applications
CO5:	Summarize the usage of composite materials in aerospace design component
CO6:	Illustrate application of high temperature material in space vehicles

TEXT BOOKS:

1. Martin, J.W., “Engineering Materials, Their properties and Applications”, Wykedham Publications (London) Ltd, 1987.
2. Titterton.G. “Aircraft Materials and Processes”, 5th Ed., Pitman Publishing Co., 1998.

REFERENCES:

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.
3. Mouritz AP. Introduction to aerospace materials. Elsevier; 2012 May 23.
4. Prasad NE, Wanhill RJ, editors. Aerospace materials and material technologies. Singapore: Springer; 2017.Wang, C. T., Applied Elasticity, McGraw – Hill Co., New York, 1993.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	-	1	-	-	1	-	-	1	-	2	1	1
2	2	1	1	-	1	-	-	-	1	1	1	1	2	1	-
3	2	1	1	-	1	-	-	1	1	1	1	1	3	1	1
4	3	2	1	1	1	-	-	-	1	1	1	1	3	1	-
5	2	1	1	-	1	-	-	1	1	1	1	1	3	1	1
6	2	1	1	1	1	1	1	1	1	1	1	1	2	1	1
Overall Correlation	**3**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**3**	**1**	**1**

<table>
<tr><td rowspan="2">23AE058</td><td rowspan="2" colspan="2">THEORY OF ELASTICITY</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">

To study the effect of periodic and a periodic force on mechanical systems
To learn the natural characteristics of large sized problems using approximate methods.
To learn the concepts of plane stress and plane strain problems
To understand the natural frequency of vibrations of the beams and torsional vibrations of systems.
To make students aware of theory of plates and shells

</td></tr>
<tr><td>UNIT I</td><td colspan="5">BASIC EQUATIONS OF ELASTICITY</td><td>9</td></tr>
<tr><td colspan="7">Definition of Stress and Strain: Stress - Strain relationships - Equations of Equilibrium, Compatibility equations, Boundary Conditions, Saint Venant's principle - Principal Stresses, Stress Ellipsoid - Stress invariants</td></tr>
<tr><td>UNIT II</td><td colspan="5">PLANE STRESS AND PLANE STRAIN PROBLEMS</td><td>9</td></tr>
<tr><td colspan="7">Airy's stress function, Bi-harmonic equations, Polynomial solutions, Simple two-dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams</td></tr>
<tr><td>UNIT III</td><td colspan="5">POLAR COORDINATES</td><td>9</td></tr>
<tr><td colspan="7">Equations of equilibrium, Strain - Displacement relations, Stress – strain relations, Airy's stress function, Axi – symmetric problems, Introduction to Dunder's table, Curved beam analysis, Lame's, Kirsch, Michell's and Boussinesque problems – Rotating discs.</td></tr>
<tr><td>UNIT IV</td><td colspan="5">TORSION</td><td>9</td></tr>
<tr><td colspan="7">Navier's theory, St. Venant's theory, Prandtl's theory on torsion, Semi- inverse method and applications to shafts of circular, Elliptical, Equilateral triangular and rectangular sections. Membrane Analogy.</td></tr>
</table>

UNIT V	INTRODUCTION TO THEORY OF PLATES AND SHELLS	9
Classical plate theory – Assumptions – Governing equations – Boundary conditions Navier's method of solution for simply supported rectangular plates – Levy's method of solution for rectangular plates under different boundary conditions		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Estimate the linear elasticity in the analysis of structures such as beams, plates etc.
CO2:	Determine the facture mechanics of the curved beam subject to loads.
CO3:	Interpret the two-dimensional problems in Cartesian and polar coordinates
CO4:	Determine the response of elastomers-based objects
CO5:	Explain the structural section subjected to torsion
CO6:	Identify the governing equations and numerical solution for plates and shells

TEXT BOOKS:	
1	Ansel C Ugural and Saul K Fenster, 'Advanced Strength and Applied Elasticity', 4th Edition, Prentice Hall, New Jersey,4th edition 2003.
2	Bhaskar, K., and Varadan, T. K., Theory of Isotropic/Orthotropic Elasticity, CRC Press USA, 2009.
3	Timoshenko, S.P, and Goodier, T.N., Theory of Elasticity, McGraw – Hill Ltd., Tokyo, 1990.

REFERENCES:	
1	Barber, J. R., Elasticity (Solid Mechanics and Its Applications), Springer publishers, 3rd edition, 2010.

2	Sokolnikoff, I. S., Mathematical Theory of Elasticity, McGraw – Hill, New York, 1978.Wang, C. T., Applied Elasticity, McGraw – Hill Co., New York, 1993.
3	Wang, C. T., Applied Elasticity, McGraw – Hill Co., New York, 1993.
4	Volterra & J.H. Caines Advanced Strength of Materials, Prentice Hall, New Jersey, 1991.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	3	2	-	-	-	-	-	-	-	-	2	-	-
2	3	3	3	2	-	1	-	-	1	1	1	1	2	-	
3	3	3	2	2	2	-	1	-	-	-	1	-	2	2	-
4	3	3	2	2	2	1	1	-	1	-	-	1	2	2	-
5	3	3	3	2	2	1	1	-	-	1	1	1	2	2	-
6	3	2	2	1	2	1	1	-	-	1	1	1	2	2	-
Overall Correlation	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**-**	**1**	**1**	**1**	**1**	**2**	**2**	**-**

23AE059	SPACECRAFT STRUCTURES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- The course gives an exposure to the Spacecraft structural requirements.
- To learn concepts of Structural configuration and trade-offs
- To understand types of environmental loading during launch
- To understand the factors to consider in material selection and types of structural tests
- To design a spacecraft structure

UNIT I	SPACECRAFT DESIGN LOADS	9

Transportation load factors – Steady-State Loads – Mechanical Dynamic loads – Acoustic loads – Shock loads – Static pressure variations – Micro-meteorites / Orbital Debris.

UNIT II	DESIGN OF SPACECRAFT STRUCTURE	9

Introduction – Determination of Spacecraft Configuration – First Design Spacecraft Structure – Basic Design Supporting Structure – Detailed Analyses – Manufacturing of the spacecraft structure.

UNIT III	SPACECRAFT MASS AND MODAL EFFECTIVE MASS	9

Introduction - Structure Mass - Total Mass Calculation - Enforced Acceleration - Modal Effective Masses of an MDOF System.

UNIT IV	FATIGUE LIFE PREDICTION	9

Introduction – Palmgren-Miner Linear Cumulative Damage Rule – Analysis of Load-time Histories – Failure due to Sinusoidal Vibrations – Failure due to Narrow-banded Random Vibrations

UNIT V	DAMAGE TO SPACECRAFT BY METEOROIDS AND ORBITAL DEBRIS	9
Introduction – Micro-Meteoroids and Space Debris Environment – Micro-Meteoroids Environment – Orbital debris Environment – Hyper Velocity Impact Damage Models – Single Plate Penetration Equations – Multi-shock shield – Probability of Impacts.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Identify simplifying assumptions and applicability of structural element theories.
CO2:	Solve by hand simple 1-D axial deformation, torsion, and bending problems.
CO3:	Calculate the complex structural mechanics problems using commercial finite element software.
CO4:	Solve simple discrete degree of freedom structural stability problems.
CO5:	Estimate the simple structural dynamics problems.
CO6:	Explain the damage to spacecrafts by space debris
TEXT BOOKS:	
1	Thomas P. Sarafin, Wiley J. Larson, "Spacecraft Structures and Mechanisms: From Concept to Launch", Springer Netherlands, 1995.
2	Wijker J.J., "Spacecraft Structures", Springer-Verlag Berlin Heidelberg, 2008.
REFERENCES:	
1	Carl C. Osgood, "Spacecraft Structures", Prentice-Hall, 1966.

2	Junqiao Xiong, “Spacecraft Structures, Materials and Mechanical Testing”, Trans Tech Publication, 2013.
3	Meirovitch, Leonard. "Dynamics of spacecraft structures." Shock and Vibration Computer Programs: Reviews and Summaries 10 ,1975.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	1	2	3	-	-	-	-	2	1	2	2	-
2	3	2	2	1	2	3	1	2	-	-	2	1	2	2	2
3	3	2	2	1	2	3	1	2	2	1	1	2	2	2	2
4	3	2	2	1	2	3	1	2	2	1	2	1	2	2	2
5	3	3	2	2	2	3	1	2	1	1	1	1	2	2	2
6	2	2	1	2	2	3	1	2	1	1	2	1	2	2	2
Overall Correlation	**3**	**2**	**3**	**2**	**2**	**3**	**1**	**2**	**2**	**1**	**2**	**1**	**2**	**2**	**2**

VERTICAL 5 - AIRCRAFT MAINTENANCE AND PRACTICES

23AE060	AIRFRAME MAINTENANCE AND REPAIR	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the maintenance processes of aircraft structural components, including welding, sheet metal repair, and non-destructive testing techniques.
- To gain knowledge of the types, repair methods, and special precautions for plastics and composite materials in aircraft.
- To learn the procedures for aircraft jacking, weighing, control surface balancing, and helicopter rotor tracking and balancing.
- To study troubleshooting, inspection, and maintenance of hydraulic, pneumatic, landing gear, and auxiliary systems in aircraft.
- To ensure familiarity with safety practices, hazardous material handling, and troubleshooting methodologies in aviation maintenance

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 - NDT 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 - Equipment's. Trouble shooting. Theory and practices.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		

CO1:	Explain the welding equipment's and its uses in maintenance of aircraft structural components
CO2:	Make use of various sheet metals in aircraft components.
CO3:	Relate the maintenance practices of plastics and Composite materials used in the airframe structures.
CO4:	Illustrate the aircraft Ground handlings.
CO5:	Identify the snag on aircraft hydraulic and pneumatic system.
CO6:	Identify the hazardous materials and safety precaution on aviation.

TEXT BOOKS:	
1	Kroes Watkins Delp, "Aircraft Maintenance and Repair", McGraw Hill, New York, 1993.
2	Loong, Michael. “The essentials of airplane maintenance”, Partridge Publishing Singapore, 2015.

REFERENCES:	
1	A&P Mechanics, "Aircraft Hand Book", F A A Himalayan Book House, New Delhi, 1996
2	“Aviation Maintenance Technician Handbook—Airframe Vol 1&2, “ FAA U.S. Department of Transportation, 2012
3	Delp. Bent and Mckinely “Aircraft Maintenance Repair”, McGraw Hill, New York, 1987

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	-	1	1	1	-	-	-	-	1	2	1	-
2	3	2	1	1	1	1	-	-	-	-	1	-	2	1	-
3	2	2	1	-	-	1	1	1	-	-	-	-	2	-	1
4	2	1	1	-	1	-	-	-	-	-	1	1	2	1	-
5	3	2	1	1	1	1	1	-	-	-	-	1	2	1	-
6	3	2	1	1	1	3	2	1	-	-	-	2	2	1	1
Overall Correlation	**3**	**2**	**1**	**1**	**1**	**2**	**1**	**1**	**-**	**-**	**1**	**1**	**2**	**1**	**1**

23AE061	AIRCRAFT GENERAL ENGINEERING AND MAINTENANCE PRACTICES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To carryout aircraft ground handling procedure.
- To understand about the ground servicing of the various aircraft subsystem.
- To understand the procedure of aircraft system maintenance and safety.
- To understand the importance of periodic inspection of aircraft.
- To understand the specification of aircraft hardware components and its materials.
- To impart the knowledge of aircraft safety and system process

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 SYSTEM	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 and aircraft safety – Environmental cleanliness – Precautions- Hand tools – Precision instruments Special tools and equipment's in an airplane maintenance shop – Identification terminology.

UNIT IV	INSPECTION AND PUBLICATIONS	9
Process – Purpose – Types – Inspection intervals – Techniques – Checklist – Special inspection – Publications, bulletins, various manuals – FAA, DGCA and EASA 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:	
After completion of the course, the students will be able to:	
CO1:	Explain the procedures and equipment used in various ground support system for aircraft operations.
CO2:	Apply knowledge of engine starting procedures for piston engines and GTE. Illustrate the ground servicing of critical aircraft systems.
CO3:	Interpret the ground servicing procedures for aircraft subsystems
CO4:	Utilize advanced hand tools, precision instruments, for efficient aircraft maintenance, and modern safety standards in aerospace technology.
CO5:	Summarize the purpose, types, and techniques of aircraft inspection processes in FAA Airworthiness directives and ATA specifications.
CO6:	Explain the specifications standards of aircraft hardware systems and materials.

TEXT BOOKS:	
1	Kroes Watkins Delp, "Aircraft Maintenance and Repair", McGraw Hill, New York, 1993.
2	A&P Mechanics, "Aircraft Hand Book", F A A Himalayan Book House, New Delhi, 1996

REFERENCES:	
1	A&P Mechanics," General Hand Book", F A A Himalayan Bok House, New Delhi, 1996
2	Weerasekera, Shevantha. “Introduction to Maintenance, Repair and Overhaul of Aircraft, Engines and Components”. SAE International, 2020.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	-	-	1	-	1	-	-	-	-	2	-	1
2	3	2	1	1	-	1	-	1	-	-	-	-	3	-	1
3	2	1	1	-	-	1	-	1	-	-	-	-	3	-	1
4	3	2	1	1	-	1	-	1	-	-	-	-	3	-	1
5	2	1	1	-	-	1	-	1	-	-	-	-	3	-	1
6	2	1	1	-	-	1		1	-	-	-	-	3	-	1
Overall Correlation	**3**	**2**	**1**	**-**	**-**	**1**	**-**	**1**	**-**	**-**	**-**	**-**	**3**	**-**	**1**

23AE062	CIVIL AVIATION REGULATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Understand the requirement of airworthiness certification in civil aircraft
- Can understand how to record the various data for future investigation in civil aircraft.
- Can know the basic requirements and knowledge for institution certification.
- To provide basic knowledge of eligibility and requirements for maintenance licensing
- Explore the various flight testing and basic requirements for safe flying.
- Understand the requirement of airworthiness certification in civil aircraft

UNIT I	CAR SERIES 'A'	9

Introduction- Module I CAR series 'A' - Procedure for civil air worthiness requirements and responsibility operators - Air worthiness directorate.

UNIT II	CAR SERIES 'C'	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. CAR 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 TBO initial & revisions.

UNIT III	CAR SERIES 'E' and 'F' - 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. CAR 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	CAR SERIES 'L' - AIRCRAFT MAINTENANCE ENGINEE LICENSING	9
Issue of AME license, its classification and experience requirements, complete Series 'L'. CAR SERIES 'M' Mandatory Modifications and Inspections: mandatory modifications and inspections. Procedure for issue of type approval of aircraft components and equipment including instruments		
UNIT V	**CAR 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. CAR 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:	
	After completion of the course, the students will be able to:
CO1:	Explain the maintenance requirement for airworthiness of aircraft and systems.
CO2:	Summarize the procedure followed for airworthiness certificate.
CO3:	Illustrate the Airworthiness procedures based on Regulation Authorities.
CO4:	Explain the issuance, renewal and experience requirements of AMEs.
CO5:	Compare the Flight Testing of aircraft.
CO6:	Explain about the aircraft maintenances procedures.

TEXT BOOKS:	
1	Kroes Watkins Delp, "Aircraft Maintenance and Repair", McGraw Hill, New York, 1993.
2	Aircraft Manual (India) ", Volume - Latest Edition, The English Book Store, 171, Connaught Circus, New Delhi."
REFERENCES:	
1	A&P Mechanics, "Aircraft Hand Book", FAA Himalayan Book House, New Delhi, 1996
2	A&P Mechanics," General Hand Book", FAA Himalayan Bok House, New Delhi, 1996
3	Civil Aviation Requirements with latest Amendment (Section 2 Airworthiness) ", Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi.
4	"Aeronautical Information Circulars (relating to Airworthiness) ", from DGCA.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	-	-	2	1	2	-	-	-	-	2	-	2
2	2	1	1	-	-	2	1	2	-	-	-	-	2	-	2
3	2	1	1	-	-	2	1	2	-	-	-	-	2	-	2
4	2	1	1	-	-	2	1	2	-	-	-	-	2	-	2
5	2	1	1	-	-	2	1	2	-	-	-	-	2	-	2
6	2	1	1	-	-	2	1	2					2		2
Overall Correlation	**2**	**1**	**1**	**-**	**-**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**2**	**-**	**2**

23AE036	AIRCRAFT ENGINE MAINTENANCE AND REPAIR	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To make the students to familiarize with the Aircraft engine maintenance procedure and practice
- To acquire knowledge of basics of Aeronautics and engine components.
- To learn the concepts of Piston engines.
- To make students aware of aircraft propellers and repair
- To make students aware of aircraft jet engines and repair.
- To make the students to familiarize with the Aircraft engine maintenance procedure and practice

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 equipment's for overhaul: Tools and equipment's 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:

After completion of the course, the students will be able to:

CO1:	Apply maintenance procedure to Aircraft Piston Engines.
CO2:	Identify the engine components and faults.

CO3:	Explain the maintenance procedure for the propellers.
CO4:	Apply non-destructive testing procedures to identify the defects.
CO5:	Apply overhauling procedure to new engines.
CO6:	Apply the compression testing of cylinders.

TEXT BOOKS:	
1	Kroes Watkins Delp, "Aircraft Maintenance and Repair", McGraw Hill, New York, 1993.
2	Kroes & Wild, "Aircraft Power plants ", 7th Edition - McGraw Hill, New York, 1994."

REFERENCES:	
1	A&P Mechanics, "Aircraft Hand Book", FAA Himalayan Book House, New Delhi, 1996
2	A&P Mechanics," General Hand Book", FAA Himalayan Bok House, New Delhi, 1996
3	Turbomeca, "Gas Turbine Engines ", The English Book Store ", New Delhi, 1993.
4	United Technologies' Pratt & Whitney, "The Aircraft Gas Turbine Engine and its Operation", The English Book Store, New Delhi. "

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	-	-	1	-	-	1	2	1	-
2	3	2	1	1	1	2	-	-	1	-	-	1	3	1	-
3	2	1	-	-	1	1	-	-	1	-	-	1	3	1	-
4	3	2	1	1	2	1	-	-	1	-	-	1	3	2	-
5	3	2	1	1	1	1	-	-	1	-	-	1	3	1	-
6	3	2	1	1	1	2	-	-	1	-	-	2	2	1	-
Overall Correlation	**3**	**2**	**1**	**1**	**2**	**2**	**-**	**-**	**1**	**-**	**-**	**1**	**3**	**2**	**-**

23AE064	AIR TRAFFIC CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the basic of air traffic control.
- To impart knowledge about air traffic systems.
- To gain more knowledge on flight information systems.
- To learn about aerodrome data.
- 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:	
After completion of the course, the students will be able to:	
CO1:	Explain airspace standards and various parts of ATC.
CO2:	Utilize the flight plan and position report.
CO3:	Explain the various navigation systems.
CO4:	Summarize the flight information service and alerting service.
CO5:	Interpret the basic terminology of aerodrome.
CO6:	Explain the physical characteristic of runway and visual navigation aid used in aerodrome.

TEXT BOOKS:	
1	Isaac, Anne R., and Bert Ruitenberg. "Air traffic control: human performance factors". Routledge, 2017.
2	McGee, James P., Anne S. Mavor, and Christopher D. Wickens, eds. "Flight to the future: Human factors in air traffic control". National Academies Press, 1997.
REFERENCES:	
1	Bradbury, John N. "ICAO and future air navigation systems." In Automation and systems issues in air traffic control, pp. 79-99. Berlin, Heidelberg: Springer Berlin Heidelberg, 1991.
2	Michael S. Nolan., "Fundamentals of Air Traffic Control", Cengage Learning,1990.

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.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-
2	3	2	1	1	1	2	-	-	1	-	-	3	-	1	-
3	2	1	1	-	2	2	-	-	1	-	-	3	-	2	-
4	2	1	1	-	3	2	-	-	1	-	-	3	-	3	-
5	2	1	1	-	3	2	-	-	1	-	-	3	-	3	-
6	2	1	1	-	3	2	-	-	1	-	-	3	-	3	-
Overall Correlation	**2**	**1**	**1**	**1**	**3**	**2**	**-**	**-**	**1**	**-**	**-**	**2**	**-**	**3**	**-**

23AE065	AIRPORT MANAGEMENT	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To acquire solid background of managerial skills in airport management.
- To develop personality to face business difficulties.
- To control multicultural conditions.
- To identify the relevant analytical and logical skills to deal with problems in the airline industry.
- 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 from an Indian perspective.

UNIT II	AIRPORT INFRASTRUCTURE AND MANAGEMENT	9

Airport planning – Terminal planning design and operation – Airport operations – airport functions -Organization structure in an airline – Airport authority of India – comparison of global and Indian airport management – Role of AAI -Airline privatization – Full privatization – Gradual privatization – Partial privatization.

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 operations – Airport development fees, rates, tariffs.

UNIT IV	**INSTITUTIONAL FRAMEWORK**	**9**
Role of DGCA – Slot allocation – Methodology followed by ATE and DGCA -management of bilateral -Economic regulations.		
UNIT V	**CONTROLLING**	**9**
Role of air traffic control – Airspace and navigational aids – Control process – Case studies in airline industry – Mumbai Delhi airport privatization – Navi Mumbai airport tendering process – 6 cases in the airline industry.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Interpret business difficulties.
CO2:	Develop airport infrastructure and management
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:	Explain the aircraft management and flight information system

TEXT BOOKS:

1	Graham. A. Managing airports: an international perspective – butterworts – Heinemann, Oxford 2001.
2	Wells. A. Airport planning and management, 4th edition McGraw- Hill, London 2000.

REFERENCES:

1	Bradbury, John N. "ICAO and future air navigation systems." In Automation and systems issues in air traffic control",. Berlin, Heidelberg: Springer Berlin Heidelberg, 1991.

2	Michael S. Nolan., "Fundamentals of Air Traffic Control", Cengage Learning,1990
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.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	-	1	1	1	-	-	-	1	1	2	1	-
2	3	2	1	1	1	2	1	-	-	-	1	1	3	1	-
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5	3	2	1	1	2	1	1	-	-	-	1	2	3	1	-
6	2	1	1	-	1	2	1	-	-	-	1	1	3	1	-
Overall Correlation	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**-**	**-**	**-**	**1**	**1**	**3**	**1**	**-**

23AE066	AIRCRAFT SAFETY AND OPERATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the basic of air traffic control.
- To impart knowledge about air traffic systems.
- To gain more knowledge on flight information systems.
- To learn about aerodrome data.
- To gain knowledge on navigation systems

UNIT I	HUMAN FACTORS IN AVIATION SAFETY	9

Theory of Risk – Changing the behaviour of the risk takers – Attitudes – Discipline – Punishment – Protection of Safety – Motivating Safe behaviour – Training involving human factors – Human Performance Concerns – Human Performance Factors.

UNIT II	AVIATION SAFETY	9

Aviation safety – Meaning, Need, Economic of Aviation safety – Safety Vs Mission – Zero Accident Rate – Accident Causes – Multiple Vs Single Cause – Aircraft Accident – Aircraft Mishap – Aircraft Incident – Building Aviation Safety Program

UNIT III	AVIATION SAFETY PROGRAM ELEMENTS	9

Internal Reporting Systems – Information Distribution systems – Aviation Safety Committees – Aviation safety Inspection Programs – Aviation safety program evaluation– Flight operation safety inspection – Aviation safety education and training – Accident preparation and investigation

UNIT IV	AIRCRAFT MAINTENANCE SAFETY	9

Aircraft Discrepancies – Delayed and Deferred Discrepancies – Training – Configuration control – Maintenance Engine Runs and Taxiing – Maintenance Test Flights – Maintenance Analysis – Maintenance Safety Programs – Maintenance Safety Inspections.

UNIT V	AIRPORT EMERGENCY	9
Airport Certification Manual – Airport Emergency Plan – Airports - Heliports Criteria – Airport and Heliport Safety Inspections.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Infer aviation safety management, accident and incident, building aviation safety program.
CO2:	Explain the involvement of human factors in aviation safety.
CO3:	Summarize the Aviation safety program and internal reporting system.
CO4:	Interpret the Aircraft maintenance safety regulations and appropriate inspections.
CO5:	Identify about the airport emergence response plans initiated.
CO6:	Explain about the various types of safety procedures in aero industries.

TEXT BOOKS:

1	Stolzer, Alan J., Robert L. Sumwalt, and John J. Goglia. “Safety management systems in aviation”. CRC Press, 2023.
2	Wells, Alexander T., and Seth B. Young. “Airport planning & management”. McGraw-Hill, 2004

REFERENCES:

1	Müller, Roland, Andreas Wittmer, and Christopher Drax. "Aviation risk and safety management." Cham: Springer (2014): 45-48.

2	Yeun, Richard, Paul Bates, and Patrick Murray. "Aviation safety management systems." World Review of Intermodal Transportation Research 5, no. 2 (2014): 168-196.
3	Maniriho, Emmy Arsonval, and Edissa Uwayo. “Airline and Airport Operations”. Éditions universitaires européennes, 2018.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	-	1	1	1	-	-	-	1	1	2	1	-
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6	2	1	1	-	1	1	2	-	-	-	1	1	3	1	-
Overall Correlation	**3**	**2**	**1**	**1**	**2**	**2**	**2**	**-**	**-**	**-**	**2**	**2**	**3**	**2**	**-**

23AE067	CRISIS MANAGEMENT IN AIRCRAFT INDUSTRY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn about the fundamentals of Aviation Safety
- To understand about the Human Factors in Aviation Safety
- To get knowledge about Aviation Safety Programs
- To learn about the Aircraft Maintenance Safety
- To impart knowledge about the crisis management in airline industry

UNIT I	INTRODUCTION TO CRISIS MANAGEMENT	9

Crisis management- Context of the crisis in the aircraft industry- Crisis management basics- Crisis stages- Establishing a crisis management team- The role of the crisis manager.

UNIT II	CRISIS MANAGEMENT IN ACTION	9

Putting crisis management into action- Psychology of crisis management decisions-Emergency response scenarios- Contingency plans- Damage control- A crisis management checklist.

UNIT III	AIRLINE CRISIS MANAGEMENT	9

Context of the crisis - The airline industry; Organizational crisis and communication- Causes, Crisis typologies- Coombs typology; Characteristics of the crises- Consequences- Modeling crises- Crisis communication- Strategic communication.

UNIT IV	CRASH MANAGEMENT	9

Pre-crisis - Existing in pre-crisis phase- preparing for the worst- Contingency planning- Crisis-stage Disaster strike- Confronting the crisis- Post-crisis The National Transportation Board- Director General of Civil Aviation.

UNIT V	CASE STUDIES	9
Northwest airlines flight 255- American airlines flight 191- Delta airlines flight 191- Trans world airlines flight 800- Pan American World Airways flight 103- US Air flight 427- Value jet flight 592.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Infer aviation safety management, accident and incident, building aviation safety program.
CO2:	Explain the involvement of human factors in aviation safety.
CO3:	Summarize the Aviation safety program and internal reporting system.
CO4:	Identify the Aircraft maintenance safety regulations and appropriate inspections.
CO5:	Make use of knowledge about the airport emergence response plans initiated.
CO6:	Explain about the various types of safety procedures in aero industries.
TEXT BOOKS:	
1	Sally J. Ray, "Strategic communication in crisis management: Lessons from the Airline Industry", 1999.
2	Reese, Peter. "In Turbulent Skies: British Aviation Successes and Setbacks-1945-1975". The History Press, 2020.
REFERENCES:	
1	Cushing, S. "Fatal Words: Communication clashes and aircraft crashes", University of Chicago Press, 1994.
2	Fink S. "Crisis Management: Planning for the inevitable", Newyork, 1986.

3	Pauchant, T., Mitro, I. “Transforming the crisis prone organization: Preventing individual, organizational and environmental tragedies”, San Fransisco: Jossey-Bass.
4	Maniriho, Emmy Arsonval, and Edissa Uwayo. “Airline and Airport Operations”. Éditions universitaires européennes, 2018.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	-	1	2	1	-	-	-	1	2	2	1	-
2	2	1	1	-	1	1	1	-	-	-	1	1	3	1	-
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4	3	2	1	1	2	1	1	-	-	-	2	1	3	2	-
5	2	2	1	1	1	1	2	-	-	-	1	1	3	1	-
6	2	1	1	1	1	1	1	-	-	-	1	2	3	1	-
Overall Correlation	**3**	**2**	**1**	**1**	**2**	**1**	**1**	**-**	**-**	**-**	**1**	**1**	**3**	**2**	**-**

VERTICAL 6 - SATELLITE TECHNOLOGY

23AS039	SPACECRAFT POWER SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To design the various Power system elements, energy storage technology and power converters in a spacecraft.
- To design driving requirements for a space power system.
- To evaluate available chemical storage and power generation systems.
- To analyze various types of power converters.
- To explore the Power control and conditioning and distribution systems.

UNIT I	SPACECRAFT ENVIRONMENT AND DESIGN CONSIDERATION	9

Orbit definition and Mission Requirements - LEO, GEO, GTO and HEO, Lunar orbits, IPO with respect to Power Generation – Power System Elements - Solar aspect angle Variations.

UNIT II	POWER GENERATION	9

Study of Solar spectrum - Solar cells - Solar Panel design - Solar Panel Realization – Solar Panel testing - Effects of Solar cells and panels -IR, UV, Particles.

UNIT III	ENERGY STORAGE TECHNOLOGY	9

Types of batteries – Primary and Secondary batteries - Nickel Cadmium - Nickel-hydrogen – Nickel metal hydride - Lithium-ion –Lithium Polymer - Silver Zinc– Electrical circuit model – Performance characteristics of batteries - Application of batteries in launch vehicles and satellites – Fuel Cell –Polymer Electrolyte membrane Fuel Cell – Regenerative Fuel Cell.

UNIT IV	POWER CONVERTERS	9

DC-DC converters – Basic Convertors - Buck, Boost, Buck-boost converter –Derived converters: Fly back converter – Transformer coupled forward converter – Push-Pull converter -

CUKs convertor– Resonant converter – Voltage and current regulators.		
UNIT V	**POWER CONTROL, CONDITIONING AND DISTRIBUTION**	**9**
Solar Array Regulators – Battery changing schemes – Protection Schemes - Distribution –Harness - Thermal Design – EMI, EMC, ESD Grounding schemes for various types of circuits and systems.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Classify electrical power systems and their technology.	
CO2:	Analyze the elements of solar cell technologies.	
CO3:	Develop space-qualified components and the array of chemical storage technologies.	
CO4:	Analyze the power converters.	
CO5:	Classify different types of Power control and battery charging schemes.	
CO6:	Apply integration to the systems present in the spacecraft.	
TEXT BOOKS:		
1	Anspaugh B.E., “GaAs Solar Cell Radiation Handbook”, NASA, 2014.	
2	Patel, Mukund R, “Spacecraft Power Systems”, CRC Press Boca Raton, 2023.	
REFERENCES:		
1	Bauer P., “Batteries for Space Power Systems”, NASA SP-172, 1968.	
2	Hyder, A k et.al, “Space Power Technologies”, Imperial	

	College Press London, 2000.
3	Peter Fortescue, Graham Swinerd, John Stark, “Spacecraft Systems Engineering”, 4th Ed., Wiley, 2011.
4	Ned Mohan, et al, “Power Electronics, convertors Applications and Design”, John Wiley &Sons, 1989.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	2	1	-	-	-	-	-	-	-	2	1	-
2	3	3	2	2	1	-	-	-	-	-	-	-	3	1	-
3	3	2	1	1	1	-	-	-	-	-	-	-	3	1	-
4	3	3	2	2	1	-	-	-	-	-	-	-	3	1	-
5	3	3	2	2	1	-	-	-	-	-	-	-	3	1	-
6	3	2	1	1	1									1	
Overall Correlation	3	2	2	1	1	-	-	-	-	-	-	-	3	1	-

23AS040	SATELLITE NAVIGATION AND CONTROL	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explore different types of space navigation systems.
- To introduce students in engineering and the sciences to the methods of satellite radio navigation.
- To study different types of navigation systems.
- To analyze various types of hybrid navigation systems.
- To explore the Attitude stabilization of satellites.
- To explore orbit manoeuvres of satellites.

UNIT I	NAVIGATION CONCEPTS	9

Fundamentals of spacecraft navigation systems and Position Fixing – Geometric concepts of Navigation – Elements - Earth in inertial space - Earth's Rotation - Revolution of Earth – Different Coordinate Systems – Coordinates Transformation - Euler angle formulations - Direction cosine formulation - Quaternion formulation.

UNIT II	CONTROL ACTUATORS	9

Thrusters, Momentum Wheel, Control Moment Gyros, Reaction Wheel, Magnetic Torquers, Reaction Jets, Ion Propulsion, Electric propulsion, solar sails.

UNIT III	INERTIAL NAVIGATION SYSTEMS	9

Accelerometers – Pendulous type – Force Balance type – MEMs Accelerometers - Basic Principles of Inertial Navigation – Types - Platform and Strap down - Mechanization INS system –Rate Corrections - Block diagram – Acceleration errors – -Coriolis effect - Schuler Tuning – Cross coupling - Gimbal lock - Alignment.

UNIT IV	GPS & HYBRID NAVIGATION SYSTEMS	9

DC-GPS overview – Concept – GPS Signal – Signal Structure-GPS data – Signal Processing – GPS Clock – GPS for position and velocity determination – DGPS Concepts - LAAS & WAAS Technology - Hybrid Navigation - Introduction to Kalman filtering – Case Studies -Integration of GPS and INS using Kalman Filter.

UNIT V	ATTITUDE STABILIZATION SCHEMES AND ORBIT MANEUVERS	9
Spin, Dual spin, Gravity gradient, Zero momentum system, Momentum Biased system, Reaction control system, Single and Multiple Impulse orbit Adjustment, Station Keeping and fuel Budgeting.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Discuss the different types of navigation and position estimation.
CO2:	Analyze the control actuators.
CO3:	Design and analyze the inertial navigation systems.
CO4:	Explore the concept of Hybrid navigation systems and Global position navigation system.
CO5:	Design and develop the concept of stabilization and control.
CO6:	Apply integration to the navigation and control systems present in the satellite.

TEXT BOOKS:

1	Anil K. Maini, Varsha Agrawal, Satellite Technology: Principles and Applications, 3rd Edition, Wiley.
2	James R Wertz, "Spacecraft Attitude Determination and control", Reidel Publications, 1978.

REFERENCES:

1	Meyer Rudolph X, "Elements of Space Technology for Aerospace Engineers", Academic Press, 1999.
2	Myron Kyton, Walfred Fried, "Avionics Navigation Systems", John Wiley & Sons, 1997.

3	Tsui. J. B.Y, “Fundamentals of Global Positioning System Receiver”, John Wiley and Sons Inc, 2000.
4	Vladimir A. Chobotov, “Spacecraft Attitude Dynamics and Control (Orbit)”, Krieger Publishing Company Publishers, Reprint Ed. 2008.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	-	-	-	-	-	-	2	1	-
2	3	3	2	2	1	-	-	-	-	-	-	-	3	1	-
3	3	3	2	2	1	-	-	-	-	-	-	-	3	1	-
4	3	3	2	2	1	-	-	-	-	-	-	-	3	1	-
5	3	2	2	2	1	-	-	-	-	-	-	-	3	1	-
6	3	2	1	1	1								3	1	
Overall Correlation	3	3	2	2	1	-	-	-	-	-	-	-	3	1	-

<table>
<tr><td rowspan="2">23AS041</td><td rowspan="2">SPACECRAFT SENSORS AND INSTRUMENTATION</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
</table>

COURSE OBJECTIVES:

- To understand the scientific background and parameters to be observed during satellite missions, and the role of sensing platforms like rocket engines and satellites.
- To learn the methods of measuring charged and neutral particles, including pulse height spectra, counting curves, and the use of various detectors and analysers.
- To explore the techniques for measuring magnetic and electric fields using fluxgate magnetometers, search coil magnetometers, and the double probe method for electric field measurement.
- To gain knowledge about photon counting sensors and imagers, including auroral imagers, X-ray sensors, and other optical and UV imaging techniques for space exploration.

To understand the spacecraft systems, satellite subsystems, testing, qualifications, and the impact of orbital techniques such as L1 orbit and lunar swing-by on mission objectives.

UNIT I	INTRODUCTION	9

Scientific Background – Parameters to be observed – Sensing platforms (rocket engine, satellites)- introduction to various sensors and instrumentation needed for satellite mission function.

UNIT II	MEASUREMENTS OF CHARGED AND NEUTRAL PARTICLES	9

Pulse and Current modes – Pulse height spectra and analysis – Counting curves and plateaus –Energy resolution - Detector efficiency – Dead time – Analysers: Electrostatic, Magnetic-field, Time-of-flight – Detectors: Solid state, Scintillation counters, Electron multipliers – Actual instruments – Analog or pulse height spectroscopy electronics – Digital techniques – Impact of microprocessors on inflight data processing units – Power supplies – Neutral particle imagers.

UNIT III	**MEASUREMENT OF MAGNETIC AND ELECTRIC FIELDS**	**9**
Fluxgate magnetometer – Search coil magnetometer – Optical absorption magnetometer. Electric Fields: Double probe technique – Beam experiments – Observation of electric fields parallel to the magnetic field.		
UNIT IV	**PHOTON COUNTING SENSORS AND IMAGERS**	**9**
Auroral imagers: Optical, UV, X-ray – X-ray sensors and imagers - Detection techniques, Grazing incidence optics – Charged Coupled Devices – Other imaging techniques – tomography.		
UNIT V	**SPACECRAFT SYSTEMS AND SATELLITE ORBITS**	**9**
Subsystems – Testing and Qualifications – Trade-offs – Role of orbit to investigation – Unusual orbital techniques: L1 orbit, double lunar swing-by.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Explain the fundamental concepts of spacecraft sensors and instrumentation used in satellite missions.
CO2:	Analyze the performance of various particle detectors and measurement systems, including pulse and current modes.
CO3:	Explain the working principles of magnetic and electric field measurement instruments such as fluxgate magnetometers and double probe techniques.
CO4:	Explain the principles of photon counting sensors and imaging systems, including X-ray sensors and tomography techniques.

CO5:	Apply spacecraft subsystems testing and qualification techniques to assess their readiness for space missions
CO6:	Apply knowledge of orbital mechanics to analyze the role of specific orbital configurations in space investigations.
TEXT BOOKS:	
1	Pallet, E.H.J.: Aircraft instruments and integrated systems. Longman 1992.
2	Davies, M.: The standard handbook for aeronautical and astronautical engineers. McGRAW-HILL 2002.
REFERENCES:	
1	Fortescu, P., Stark, J., Swinerd, G., "Spacecraft Systems Engineering", John Wiley ; Sons, Ltd. 2003.
2	Helfrick, A," Principles of Avionics", Avionics Communications Inc. 2004.
3	Moir, I., Seabridge, A, "Aircraft systems", John Wiley Sons, Ltd. 2008.
4	Spitzer, C. R, "Avionics development and implementation"Press 2007.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	-	-	-	-	-	-	-	-	-	2	-	-
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6	2	2	1	-	-	-	-	-	-	-	-	-	3	-	-
Overall Correlation	**3**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**-**	**-**

23AS042	SPACECRAFT SYSTEMS ENGINEERING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To make familiar with the concept of space system design and engineering.
- To provide an overview spacecraft structures.
- To describe the various subsystems involved in the design of a satellite and Launch Vehicle.
- To describe the techniques of systems engineering that are used to obtain a coherent satellite design.
- To explain, how the satellite communication system works.

UNIT I	SPACECRAFT STRUCTURES	9

Deployment and Geometry Maintenance – Deployment for Aperture Maintenance - Origins Telescope Dynamics and Controls - SIM Dynamics and Control Block Diagram - Dynamic Disturbance Sources - Disturbance Analysis - Modal Sensitivity Analysis - Thermal Issues with Structures - Impedance Matched Tether Termination - Control-Structure Interaction - SPECS Geometry - Tether Vibration Control.

UNIT II	SPACECRAFT POWER SYSTEMS	9

Electrical Power System - Power Sources - Power Source Applicability - Design Space for RTGs - Primary Battery Types - Secondary Battery Types - Depth of Discharge - Fuel Cells and Characteristics - Radioisotope Thermoelectric Generators - Thermoelectric Generator - Solar Cell - Temperature Effects - Radiation Effects - Solar Array Construction - Cell Shadowing - Power Distribution Systems - DET Power Regulation Systems - PPT Power Distribution Systems.

UNIT III	SPACECRAFT COMPUTER SYSTEMS	9

Computer system specification - Estimating throughput and processor speed requirements - Computer selection – Memory - Mass storage - Input/Output - Radiation hardness - Fault tolerance - Error detection and correction - Integration and test.

UNIT IV	**SATELLITE COMMUNICATION SYSTEM**	**9**
Satellite Communications Architecture - Advantages of Digital Communication - Data Collection Mission - Link Design Process - Power Flux Density - Received Power - System Noise Temperature - Modulation Techniques - Bit Error Rate - Convolutional Coding with Viterbi Decoding – Attenuation - Frequency Selection Drivers - Multiple Access Strategies - Antijam Techniques - Differential Pulse Code Modulation (DPCM).		
UNIT V	**LAUNCH SYSTEMS**	**9**
Launch System Selection Process - Launch Sites Criteria - Payload Integration - Fairings - Structural & Electrical Interface - Payload Environments - Acceleration Load Factors - Vibration Environments - Shock Loads - Acoustic Environments - Injection Accuracy - Payload Integration Procedures - Payload Processing - Launch System Cost Estimate.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Analyse the issues in the spacecraft structures.	
CO2:	Interpret the functions of spacecraft power systems.	
CO3:	Inspect the error and correct in the spacecraft computer systems.	
CO4:	Design, build, and test a small satellite in laboratory.	
CO5:	Interpret the selection process of the launch systems.	
CO6:	Illustrate Satellite communication systems.	
TEXT BOOKS:		
1	James R. Wertz, Wiley Larson, “Space Mission Analysis and Design”, 3rd Ed., Springer Netherlands, 1999.	
2	Peter Fortescue, Graham Swinerd, John Stark, “Spacecraft Systems Engineering”, 4th Ed., Willey, 2011.	

REFERENCES:

1. James R. Wertz, “Spacecraft Attitude Determination and Control”, Springer, 1978.
2. Kaplan, M. H., “Modern Spacecraft Dynamics and Control”, Wiley India Pvt Ltd, 2011.
3. Maral G., and Vousquet M., “Satellite Communications Systems: Systems, Techniques, and Technology”, 5th Ed., 2010.
4. Markley F. Landis, Crassidis John L., “Fundamentals of Spacecraft Attitude Determination and Control”, Springer, 2014.
5. Roger R. Bate, Donald D. Mueller, and Jerry E. White, “Fundamentals of Astrodynamics”, Dover Publications, Inc., New York, 1971.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	1	3	-	1	-	-	1	1	1	3	3	-
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5	2	2	1	1	2	-	-	-	-	1	1	1	3	2	-
6	2	1	1	-	2	-	2	-	-	1	1	2	2	2	-
Overall Correlation	3	2	2	1	3	-	2	-	-	1	1	2	3	3	-

23AS043	SATELLITE ARCHITECTURE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To make understand the basic aspects of the satellite architectural framework.
- To expose the various subsystems involved in the construction of a satellite.
- To familiarize the students with satellite data handling procedures and the requirements of propulsion systems for maneuvering the satellite.
- To learn the concepts of satellite power and thermal control systems.
- To make the students aware of satellite telemetry and command systems and data handling.
- To make the students aware of data handling of satellites.

UNIT I	BASICS OF SATELLITE ARCHITECTURE	9

Brief description of satellite architecture layout – Importance of design of satellite architecture in space missions-Satellite Payload and Bus – Different types of payload and their missions – Subsystems of Satellite Bus – A brief description and functions of subsystems of satellite bus -Satellite Structure – Power System – Attitude and orbit control - Telemetry and command –Satellite thermal control system – Data handling system – Satellite propulsion system.

UNIT II	SATELLITE POWER AND THERMAL CONTROL SYSTEMS	9

Satellite power system elements – Solar arrays –Fuel cells – Radioisotope generators and batteries– Spacecraft thermal balance – View factors – Equilibrium temperature – Skin temperature –Passive and Active thermal control systems.

UNIT III	SATELLITE ATTITUDE CONTROL SYSTEM	9
Active control system layout – Three-axis stabilized, spin-stabilized and hybrid spacecraft –Magnetic, gravity gradient and aerodynamic torques – Momentum storage torquers – Attitude measurement system fundamentals – Inertial sensors – Active control system computation.		
UNIT IV	**SATELLITE TELEMETRY AND COMMAND SYSTEM**	**9**
Basics of transponder system and antenna subsystem – Filters and transmitters – telemetry data classification – Telemetry data encoding – Telemetry list and data format – Error control – Downlink frequencies and modulation – Telecommand user interface.		
UNIT V	**SATELLITE PROPULSION SYSTEM**	**9**
Use of liquid chemical rocket propulsion – Propellant management – Use of secondary propulsion systems such as cold gas systems - Solid propellant apogee motors – Propulsive roles for electric rockets – Use of electric rocket propulsion systems – Types of electric propulsion systems.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply the basic knowledge gained, for the preliminary design of small satellite systems.
CO2:	Interpret power and thermal control systems.
CO3:	Analyze satellite stability and control problems.
CO4:	Analyze satellite telemetry data at a preliminary level and understand the operation of the telecommand user interface.
CO5:	Explain different types of satellite propulsion systems.

CO6:	Evaluate the suitability of satellite systems designed for a particular mission.
TEXT BOOKS:	
1	Lecture notes on “Satellite Architecture”, ISRO Satellite Centre Bangalore–560017.
2	Anil K. Maini Varsha Agrawal, Satellite Technology Principles and Applications, Wiley, Second Edition,2007.
REFERENCES:	
1	James R.Wertz, “Spacecraft Attitude Determination and Control”, Kluwer Academic Publisher, Re-edition 2012.
2	James R Wertz & Wiley J. Larsen, “Space Mission Analysis and Design”, (Space Technology Library), Vol. 8, Microcosm Publisher, 1999.
3	Ned Mohan, et al, “Power Electronics, convertors Applications and Design”, John Wiley &Sons, 1989.
4	Marcel J.Sidi, “Spacecraft Dynamics and Control-A Practical Engineering Approach”, Cambridge University Press, 2000.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	-	-	-	-	-	-	2	1	-
2	2	1	1	-	1	-	-	-	-	-	-	-	3	1	-
3	3	3	2	2	1	-	-	-	-	-	-	-	3	1	-
4	3	3	2	2	1	-	-	-	-	-	-	-	3	1	-
5	2	1	1	-	1	-	-	-	-	-	-	-	3	1	-
6	3	3	2	2	3	-	-	-	-	-	-	-	1	3	-
Overall Correlation	**3**	**3**	**2**	**1**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**3**	**2**	**-**

23AS044	SPACECRAFT DYNAMICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the modern spacecraft attitude dynamics and control.
- To study the rotational kinematics and dynamics of the spacecraft in orbit and different methods to passively or actively control the attitude.
- To interpret the implementation of nonlinear control laws for reaction wheels and variable speed control moment gyroscopes.
- To study the mechanism of Gyro dynamics.
- To Formulate the Numerical Solution of Flight Dynamics Equations of Motion.
- To introduce the attitude determination and control instruments & techniques.

UNIT I	ORBITAL MECHANICS	9

Types of spacecrafts – Present-day satellites and launch vehicles – Orbit determination from injection conditions, Position and Velocity prediction from orbital elements.

UNIT II	SATELLITE OPERATIONS	9

Geostationary orbit – Hohmann transfer – Inclination changes manoeuvres – launch windows for rendezvous missions – Perturbation effects due to earth oblateness – Sun synchronous orbits.

UNIT III	MECHANICS	9

Kinematics relative to moving frames – Rotations and angular velocity – Angular momentum of a system of particles – Rotational dynamics for a system of particles.

UNIT IV	GYRO DYNAMICS	9

Displacement, Moment of Momentum, and Kinetic Energy of a Rigid Body – Euler's equation for Principal axes – Stability of rotation about Principal axes – General motion of a symmetric Gyro –Steady precession of a symmetric Gyro.

UNIT V	ATTITUDE MEASUREMENT AND SPACECRAFT ATTITUDE RESPONSE	9
Rotation matrices – Euler angles – attitude kinematics – Euler's equations for rotational dynamics – torque free motion of asymmetric and axi-symmetric rigid bodies – Effect of energy dissipation on stability of rotational motion – Attitude control of spinning and Non-spinning satellites – Overview of actuation mechanisms for attitude control.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the types of spacecrafts and orbit determination based on injection conditions.
CO2:	Explain the Earth's equatorial bulge (oblateness) affects satellite orbits, causing perturbations such as precession and changes in inclination.
CO3:	Apply the kinematic principle to the flight vehicles.
CO4:	Show the use of gyroscopes.
CO5:	Solve dynamics and control of flight vehicles.
CO6:	Solve the numerical problems in attitude determination and control instruments techniques.

TEXT BOOKS:	
1	Peter Fortescue, Graham Swinerd, John Stark, "Spacecraft Systems Engineering", 4th Ed., Willey, 2011.
2	Wiesel, W. E., "Spaceflight Dynamics", 3rd Ed., McGraw Hill, 2012.
REFERENCES:	
1	Cornelisse, J. W., "Rocket Propulsion and Spaceflight Dynamics", Pitman, London, 1982.
2	Kaplan, M. H., "Modern Spacecraft Dynamics and Control", Wiley India Pvt Ltd, 2011.

3	Thompson, W. T., "Introduction to Space Dynamics", Dover Publications, New York, 1986.
4	Maxwell Noton, "Spacecraft navigation and guidance", Springer, New York,1986.
5	Marcel J. Sidi, "Spacecraft Dynamics and Control-A Practical Engineering Approach", Cambridge University press, 2000.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	1	1	1		-	-	-	1	1	1	-	2		-
2	2	2	1	1	-	-	-	-	1	1	1	-	3	-	-
3	3	2	2	1	-		-	-	1	1	1	-	3	-	-
4	2	1	1	-	-	-	-	-	1	1	1	-	2	-	-
5	3	2	1	1	1	-	-	-	1	1	1	1	3	1	-
6	3	2	1	1	1	-	-	-	-	-	1	1	3	1	-
Overall Correlation	**3**	**2**	**2**	**1**	**1**	**-**	**-**	**-**	**1**	**1**	**1**	**1**	**3**	**1**	**-**

<table>
<tr><td rowspan="2">23AS045</td><td colspan="2" rowspan="2">SPACE SCIENCE ENVIRONMENT</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="7">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="7">• To outline the space environment and their effects.
• To extend the origin of universe and development.
• To classify the galaxies and their evolution.
• To interpret the variable stars in the galaxies.
• To explain theory of formation of our solar system.</td></tr>
<tr><td>UNIT I</td><td colspan="5">INTRODUCTION</td><td>9</td></tr>
<tr><td colspan="7">Introduction to space science and applications – historical development – Space Environment- Vacuum and its Effects, Plasma and Radiation Environments and their Effects, Debris Environment and its Effects - Newton's Law of gravitation – Fundamental Physical Principles.</td></tr>
<tr><td>UNIT II</td><td colspan="5">ORIGIN OF UNIVERSE</td><td>9</td></tr>
<tr><td colspan="7">Early history of the universe – Big-Bang and Hubble expansion model of the universe – cosmic microwave background radiation – Dark matter and Dark energy.</td></tr>
<tr><td>UNIT III</td><td colspan="5">GALAXIES</td><td>9</td></tr>
<tr><td colspan="7">Galaxies, their evolution and origin – Active galaxies and Quasars – Galactic rotation – Stellar populations – Galactic magnetic field and cosmic rays.</td></tr>
<tr><td>UNIT IV</td><td colspan="5">STARS</td><td>9</td></tr>
<tr><td colspan="7">Stellar spectra and structure – Stellar evolution – Nucleo-synthesis and formation of elements – Classification of stars – Harvard classification system – Hertsprung-Russel diagram – Luminosity of star – variable stars – composite stars (white dwarfs, Neutron stars, black hole, star clusters, supernova and binary stars) – Chandrasekhar limit.</td></tr>
</table>

UNIT V	SOLAR SYSTEM	9
Nebular theory of formation of our Solar System – Solar wind and nuclear reaction as the source of energy – Sun and Planets: Brief description about shape size – Period of rotation about axis and period of revolution – distance of planets from sun – Bode's law – Kepler's Laws of planetary motion – Newton's deductions from Kepler's Laws – correction of Kepler's third law – Determination of mass of earth – Determination of mass of planets with respect to earth – Brief description of Asteroids – Satellites and Comets.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Explain the fundamental concepts of space sciences.
CO2:	Make use of scientific theories, including evolution by natural selection, the age of the Earth and solar system, and the Big Bang theory.
CO3:	Analyze stellar evolution processes such as red giants, supernovas, neutron stars, pulsars, white dwarfs, and black holes using evidence and current theories.
CO4:	Summarize the main characteristics and formation theories of various galaxy types, with a focus on the Milky Way..
CO5:	Explain solar system theories based on observational data and physical principles.
CO6:	Explain satellite types and their key concepts.

TEXT BOOKS:

1	Hess W., "Introduction to Space Science", Gordon & Breach Science Pub; Revised Ed., 1968.
2	Krishnaswami K. S., "Astrophysics: A modern Perspective", New Age International, 2006.

REFERENCES:

1. Arnab Rai Choudhuri, “Astrophysics for Physicists”, Cambridge University Press, New York, 2010.
2. Krishnaswami K. S., “Understanding cosmic Panorama”, New Age International, 2008.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	2	1	-	-	-	-	-	-	-	-	-	2	-	-
2	3	2	1	1	-	-	-	-	-	-	-	-	2	-	-
3	3	3	2	1	-	-	-	-	-	-	-	-	2	-	-
4	2	2	1	-	-	-	-	-	-	-	-	-	2	-	-
5	2	2	1	-	-	-	-	-	-	-	-	-	3	-	-
6	2	2	1	-	-	-	-	-	-	-	-	-	3	-	-
Overall Correlation	3	3	2	1	-	-	-	-	-	-	-	-	3	-	-

23AS046	FUNDAMENTALS OF SATELLITE COMMUNICATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To identify the basics of satellite orbits.
- To analyze the satellite segment and earth segment.
- To analyze and design the uplink and downlink of the satellite.
- To explore the various satellite access and coding technology.
- To study the applications of satellites.
- To explore the various types of satellites.

UNIT I	SATELLITE ORBITS	9

Kepler's Laws, Newton's law, Orbital parameters, Orbital perturbations, Station keeping, geo stationary and non-geo-stationary orbits – Look Angle Determination- Limits of visibility – Eclipse Sub satellite point –Sun transit outage-Launching Procedures - Launch vehicles and propulsion.

UNIT II	SPACE SEGMENT	9

Spacecraft Technology- Structure, Primary power, Attitude and Orbit control, Thermal control and Propulsion, communication Payload and Supporting subsystems, Telemetry, Tracking and command-Transponders Antenna Subsystem.

UNIT III	SATELLITE LINK DESIGN	9

Basic link analysis, Uplink and Downlink Design equation, Free space loss-Atmospheric effects, Ionospheric scintillation, Rain induced attenuation and interference, system noise temperature, Link Design with and without frequency reuse.

UNIT IV	SATELLITE ACCESS AND CODING TECHNIQUES	9

Modulation and Multiplexing: Voice, Data, Video, Analog–digital transmission system, Digital video Broadcast, multiple access: FDMA, TDMA, CDMA, PAMA and DAMA Assignment Methods, compression – Encryption, Coding Schemes.

UNIT V	**SATELLITE APPLICATIONS**	**9**
INTELSAT Series, INSAT, VSAT, Mobile satellite services: GSM, GPS, LEO, MEO, Satellite Navigational System. GPS-Position Location Principles, Differential GPS, Direct Broadcast satellites (DBS and DTH).		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
	After completion of the course, the students will be able to:
CO1:	Identify the satellite orbits.
CO2:	Explain the launching procedures of the satellites.
CO3:	Analyze the satellite subsystems.
CO4:	Evaluate the satellite link power design.
CO5:	Identify various coding techniques for satellites.
CO6:	Explain various satellite applications
TEXT BOOKS:	
1	Dennis Roddy, "Satellite Communication", 4th Edition, McGraw Hill International, 2017.
2	TimothyPratt, Charles, W.Bostain, JeremE.Allnutt, "SatelliteCommunication", 3rd Edition, Wiley Publications,2021.
REFERENCES:	
1	Tri T. Ha, "Digital Satellite Communications", 2nd edition, Mc Graw Hill education, 2017.
2	Wilbur L.Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, "Satellite Communications Systems Engineering", 2nd edition , Prentice Hall/Pearson , 2013.
3	M.Richharia, "Satellite Communication Systems-Design Principles", Macmillan, 1999.
4	Brian Ackroyd, "World Satellite Communication and Earth Station Design", BSP professional Books, 1990.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	1	-	-	-	-	-	-	2	-	-
2	3	3	2	2	-	1	-	-	-	-	-	-	3	-	-
3	3	3	2	2	-	1	-	-	-	-	-	-	3	-	-
4	3	2	2	1	-	1	-	-	-	-	-	-	3	-	-
5	2	2	1	1	-	1	-	-	-	-	-	-	3	-	-
6	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-
Overall Correlation	3	2	2	2	-	1	-	-	-	-	-	-	3	-	-

VERTICAL 7 -DIVERSIFIED COURSES

23AE068	FOUNDATION OF MANUFACTURING TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To make familiar with the working principles of various metal casting processes.
- To learn and apply the working principles of various metal joining processes.
- To analyse the working principles of bulk deformation of metals.
- To learn the working principles of sheet metal forming process.
- To study and practice the working principles of plastics molding.

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.

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.

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.		
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.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		

CO1:	Explain the principle of different metal casting processes.
CO2:	Illustrate the various metal joining processes.
CO3:	Outline the different bulk deformation processes.
CO4:	Summarize the various sheet metal forming processes.
CO5:	Demonstrate the use of suitable molding techniques for manufacturing of plastics components.
CO6:	Illustrate the Manufacturing process control techniques.

TEXT BOOKS:	
1	Kalpakjian. S, "Manufacturing Engineering and Technology", Pearson Education India Edition, 2006.
2	P.N.Rao Manufacturing Technology Volume 1 Mc Graw hill Education 2017.
REFERENCES:	
1	Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.
2	S. Gowri P. Hariharan, A.Suresh Babu, 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.

COs	POs												PSOs		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	2	1	1	1	3	-	1	-	-	1	1	1	3	3	-
2	2	1	1	1	2	-	2	-	-	1	1	1	3	2	-
3	2	2	1	-	2	-	2	-	-	1	1	2	3	2	-
4	3	2	1	1	3	-	1	-	-	1	1	1	3	3	-
5	3	2	1	1	2	-	-	-	-	1	1	1	3	2	-
6	3	2	1	1	3	1	1	2	-	1	1	2	1	3	2
Overall Correlation	**3**	**2**	**1**	**1**	**3**	**1**	**2**	**2**	**-**	**1**	**1**	**2**	**3**	**3**	**2**

23AE069	DRONE TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamental concepts, history, and business opportunities associated with drone technology.
- To acquire knowledge of drone design, fabrication, and programming, including assembling and configuring components.
- To learn drone flight operations, control mechanisms, and the integration of sensors and storage devices.
- To explore commercial applications of drones in various industries such as agriculture, logistics, and inspection services.
- To understand safety practices, aviation regulations, licensing, and advancements in drone autonomy and swarm technology.

UNIT I	INTRODUCTION TO DRONE TECHNOLOGY	9

Drone Concept - Vocabulary Terminology - History of drone - Types of current generation of drones based on their method of propulsion - Drone technology impact on the businesses - Drone business through entrepreneurship - Opportunities/applications for entrepreneurship and employability.

UNIT II	DRONE DESIGN, FABRICATION AND PROGRAMMING	9

Classifications of the UAV - Overview of the main drone parts - Technical characteristics of the parts - Function of the component parts - Assembling a drone - The energy sources - Level of autonomy- Drones configurations -The methods of programming drone - Download program - Install program on computer- Running Programs - Multi rotor stabilization - Flight modes - Wi-Fi connection.

UNIT III	DRONE FLYING AND OPERATION	9
Concept of operation for drone - Flight modes - Operate a small drone in a controlled environment - Drone controls Flight operations – management tool – Sensors - Onboard storage capacity - Removable storage devices - Linked mobile devices and applications.		
UNIT IV	**DRONE COMMERCIAL APPLICATIONS**	**9**
Choosing a drone based on the application - Drones in the insurance sector - Drones in delivering mail, Parcels and other cargo - Drones in agriculture - Drones in inspection of transmission lines and power distribution - Drones in filming and panoramic picturing.		
UNIT V	**FUTURE DRONES AND SAFETY**	**9**
The safety risks - Guidelines to fly safely - Specific aviation regulation and standardization - Drone license - Miniaturization of drones - Increasing autonomy of drones - The use of drones in swarms.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Infer various types of drone and the technologies used in it on different applications.
CO2:	Design and fabricate drones of different configurations and execute program for autonomous drones.
CO3:	Execute the suitable operating procedures for functioning a drone.
CO4:	Develop a drones for specific commercial applications.
CO5:	Infer the guidelines and safety standards associated with Aviation regulations.
CO6:	Implement the autonomy functions in swarm drones.

TEXT BOOKS:	
1	Daniel Tal and John Altschuld, “Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation”, John Wiley & Sons, Inc. 2021.
2	Garvit Pandya, “Basics of Unmanned Aerial Vehicles: Time to start working on Drone Technology”, Notion Press, 2021.
REFERENCES:	
1	John Baichtal, “Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs”, Que Publishing, 2016.
2	Jha, A. R. “Theory, design, and applications of unmanned aerial vehicles”. CRC Press, 2016.
3	Sachi Nandan Mohanty, J.V.R. Ravindra, “Drone Technology: Future Trends and Practical Applications”, Wiley, 2023.
4	Terry Kilby and Belinda Kilby, “Make: Getting Started with Drones “, Maker Media, Inc., 2016.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	2	1	1	1	1	2	-	-	-	2	2	1	2
2	3	3	2	1	1	2	1	2	-	-	-	3	2	1	2
3	3	3	3	2	1	2	1	2	-	-	-	3	2	1	2
4	3	2	2	1	1	1	1	2	-	-	-	2	2	1	2
5	3	3	3	3	1	2	1	2	-	-	-	3	2	1	2
6	2	2	1	1	1	2	1	2	-	-	-	3	2	1	2
Overall Correlation	**3**	**3**	**3**	**2**	**1**	**2**	**1**	**2**	**-**	**-**	**-**	**3**	**2**	**1**	**2**

23AS047	SPACE WEAPONS AND WARFARE	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand missile trajectories, satellite orbits, and the principles behind various space and terrestrial weapons systems.
- To explore the functions, tasks, and operational command structures of space weapon systems, including their advantages and limitations.
- To analyze ballistic missile defence systems, including threat assessment, classification, and boost-phase interception strategies.
- To study defence system architecture, external cueing processes, and radar-based defence planning against threats.
- To learn interception guidance techniques, proportional navigation, and mathematical modelling for maneuvering targets.

UNIT I	INTRODUCTION	9

Fundamentals concepts in missile trajectories and satellite orbits – Bombardment satellites – Directed energy weapons – General characteristics – Use of laser for missile targets – Kinetic energy weapons above the atmosphere – Weapons against terrestrial targets – Conventional weapons against terrestrial targets.

UNIT II	EMPLOYMENT AND COMMAND	9

Functions and tasks – Component and sequence about commanding space weapon systems –Advantages with respect to access and reach, Responsiveness, Distance and difficulty in defending against the weapons – Limitations and uses and implications.

UNIT III	BALLISTIC MISSILE DEFENCE	9

Introduction to ballistic missile defence – Theatre Ballistic Missiles (TBM) – Classification – threat assessment – limitations and uncertainties - Threat analysis for Boost phase interception – Typical assessment errors.

UNIT IV	**ARCHITECTURE AND EXTERNAL CUEING**	**9**
Selection of defended assets and threat scenario – Defence system qualities and constraints –Defence architecture process and development – External cueing process and uses – calculation of launch point – Cued acquisition – Defence planning using external cueing – Radar degraded performance multiple radars and cue sources – system characteristics and use of cues.		
UNIT V	**INTERCEPTION GUIDANCE AND INTERCEPTION OF MANEUVERING TARGETS**	**9**
Proportional navigation geometry – Proportional navigation linearized system and zero miss distance proportional navigation – Optimal guidance law – Mathematical modeling of pursuit – Evasion –Solution with constrained evader – Stochastic analysis.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Make use of the fundamental concept in the missile building.
CO2:	Apply the concept of aerodynamics and other technical aspect in space missile.
CO3:	Identify the limitation of the missile and its technology.
CO4:	Utilize the defensive technology against missile.
CO5:	Interpret the knowledge of radar and missile detection systems.
CO6:	Utilize the guidance and navigation for missile planning.

TEXT BOOKS:	
1	Larson, W. J. and Pranke, L. K., “Human Spaceflight: Mission Analysis and Design”, McGraw- Hill Higher Education, Washington, DC, 1999.
2	McNamara, Bernard, “Into the Final Frontier: The Human Exploration of Space”, Brooks Cole Publishing, 2000.
REFERENCES:	
1	Connors, M.M., Harrison, A.A., and Akins, F.R., “Living Aloft: Human Requirements for Extended Spaceflight”, University Press of Pacific, Honolulu, Hawaii: ISBN:1-4102-1983-6. 2005.
2	Eckart, Peter. “Spaceflight life support and biospherics”. Vol. 5. Springer Science & Business Media, 2013.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	-	-	-	-	1	1	1	1	2	-	-
2	3	2	1	1	-	-	-	-	1	1	1	1	3	-	-
3	3	2	1	-	-	-	-	-	-	-	-	1	3	-	-
4	3	2	1	1	-	-	-	-	1	-	-	-	3	-	-
5	2	1	1	1	-	-	-	-	-	-	1	-	3	-	-
6	3	2	1	1	-	-	-	-	1	-	-	-	3	-	-
Overall Correlation	3	2	1	1	-	-	-	-	1	1	1	1	3	-	-

23AS048	TURBO MACHINES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the energy transfer in rotor and stator parts of the turbo machines.
- To study the function of various elements of centrifugal fans and blowers.
- To evaluating the working and performance of centrifugal compressor.
- To analyzing flow behaviour and flow losses in axial flow compressor.
- To study the types and working of axial and radial flow turbines.
- To study the behaviour of elements.

UNIT I	WORKING PRINCIPLES	9

Classification of Turbomachines. 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 Turbomachines.

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:

After completion of the course, the students will 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:	Explain the behavior of the turbomachine elements.

TEXT BOOKS:

1	Ganesan, V., "Gas Turbines", 3rd Edition, Tata McGraw Hill, 2011.
2	Yahya, S.M., "Turbines, Compressor and Fans", 4th Edition, Tata McGraw Hill, 2011.

REFERENCES:

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

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	2	2	1	-	-	-	-	-	1	-	-	-	3	-	-
2	2	2	1	-	-	-	-	-	1	-	-	-	3	-	-
3	2	2	1	-	-	-	-	-	1	-	-	-	3	-	-
4	3	3	2	1	-	-	-	-	1	-	-	-	3	-	-
5	2	2	1	-	-	-	-	-	1	-	-	-	3	-	-
6	2	2	1	-	-	-	-	-	1	-	-	-	3	-	-
Overall Correlation	3	3	2	1	-	-	-	-	1	-	-	-	3	-	-

23AS049	HEAT TRANSFER IN SPACE APPLICATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge to students in the fundamental principles of heat transfer.
- To make the students to learn the concepts of thermal analysis on spacecraft vehicles.
- To study about the Space environment and interplanetary missions.
- To make the students gain knowledge about the thermal control systems and their techniques.
- To acquaint students study about the application of the Spacecraft.

UNIT I	PRINCIPLES OF HEAT TRANSFER IN SPACECRAFT	9

Introduction Spacecraft Thermal Control: need of spacecraft thermal control – temperature specification – Energy balance in a spacecraft – Modes of heat transfer – factors that influence energy balance in a spacecraft – Principles of spacecraft thermal control.

UNIT II	THERMAL ENERGY IN SPACECRAFT	9

Spacecraft Thermal Analysis: formulation of energy – Momentum and continuity equations for problems in spacecraft heat transfer – Development of discretized equation – Treatment of radiative heat exchange (for non-participative media based on radiosity and Gebhart method) – Incorporation of environmental heat flux in energy equation – Numerical solution methods – Input parameters required for analysis.

UNIT III	ENVIRONMENTS IN SPACE	9

Spacecraft Thermal Environments: launch and ascent – Earth bound orbits – Interplanetary mission and reentry mission.

UNIT IV	THERMAL CONTROL SYSTEMS FOR SPACECRAFT	9
Devices and Hardware for Spacecraft TCS (Principles & Operation): passive thermal control - mechanical joints – heat sinks and doublers – Phase change materials – Thermal louvers and switches – Heat pipes – Thermal coating materials – Thermal insulation – ablative heat transfer – Active thermal control techniques: electrical heaters, HPR fluid systems, space borne cooling systems.		
UNIT V	**SPACECRAFT APPLICATIONS**	**9**
Design and Analysis of Spacecraft: application of principles described above for development of spacecraft TCS.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Explain the concept of heat transfer and energy balance in spacecraft's.
CO2:	Categorize the thermal energy systems in the spacecraft's.
CO3:	Explain the concepts of environment in space.
CO4:	Classify the thermal control systems and their space materials.
CO5:	Explain the spacecraft thermal control techniques and their fluid and cooling systems.
CO6:	Identify the applications of spacecraft.

TEXT BOOKS:	
1	Bengt Sundén and Juan Fu.," Heat Transfer in Aerospace Applications" , 1 st ed, Elsevier, 2017.
2	Incropera, F. P. and DeWitt, D. P., "Fundamentals of Heat and Mass Transfer" , 7th ed., John Wiley ,2011.

REFERENCES:	
1	Incropera, F. P. and DeWitt, D. P., "Fundamentals of Heat and Mass Transfer", 7th ed., John Wiley ,2011.
2	Chapra, S. C. and Canale, R. P., "Numerical Methods for Engineers", 7th ed., McGraw-Hill ,2014.
3	Pattan, B., "Satellite Systems: Principles and Technologies", Chapman & Hall ,1993.
4	Meyer, R. X., "Elements of Space Technology, Academic Press" ,1999.
5	Gilmore, D. G. (Ed.), "Spacecraft Thermal Control Handbook, Volume I: Fundamental Technologies", 2nd ed., The Aerospace Press, AIAA ,2002.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	2	2	-	-	-	-	-	-	2	3	1	1
2	3	3	2	2	2	-	-	-	-	-	-	2	3	1	1
3	3	2	2	2	2	-	-	-	-	-	-	2	3	1	1
4	3	2	2	2	2	-	-	-	-	-	-	2	3	1	1
5	3	3	2	2	2	-	-	-	-	-	-	2	3	1	1
6	3	2	1	2	2	-	-	-	-	-	-	2	3	1	1
Overall Correlation	**3**	**3**	**2**	**2**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**2**	**3**	**1**	**1**

<table>
<tr><td rowspan="2">23AS050</td><td rowspan="2">DIGITAL IMAGE PROCESSING IN AEROSPACE APPLICATIONS</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td></tr>
<tr><td colspan="6">COURSE OBJECTIVES:</td></tr>
<tr><td colspan="6">
• To understand the basic elements of visual perception and the key steps in image processing systems.
• To explore techniques for spatial domain gray level transformations, histogram processing, and spatial filtering in image enhancement.
• To develop skills in detecting image discontinuities, applying edge operators, and understanding thresholding for image segmentation.
• To learn the principles of multi-resolution analysis, image pyramids, and wavelet transforms.
• To explore the principles of digital aerial photography, sensors for aerial photography, and applications in aerospace.
</td></tr>
<tr><td>UNIT I</td><td colspan="4">FUNDAMENTALS OF IMAGE PROCESSING</td><td>9</td></tr>
<tr><td colspan="6">Introduction – Elements of visual perception, Steps in Image Processing Systems – Image Acquisition – Sampling and Quantization – Pixel Relationships – Colour Fundamentals and Models, File Formats Introduction to the Mathematical tools.</td></tr>
<tr><td>UNIT II</td><td colspan="4">IMAGE ENHANCEMENT</td><td>9</td></tr>
<tr><td colspan="6">Spatial Domain Gray level Transformations Histogram Processing Spatial Filtering – Smoothing and Sharpening. Frequency Domain: Filtering in Frequency Domain – DFT, FFT, DCT, Smoothing and Sharpening filters – Homomorphic Filtering.</td></tr>
<tr><td>UNIT III</td><td colspan="4">IMAGE SEGMENTATION AND FEATURE ANALYSIS</td><td>9</td></tr>
<tr><td colspan="6">Detection of Discontinuities – Edge Operators – Edge Linking and Boundary Detection – Thresholding – Region Based Segmentation – Motion Segmentation, Feature Analysis and Extraction.</td></tr>
</table>

UNIT IV	**MULTI RESOLUTION ANALYSIS**	**9**
Multi Resolution Analysis: Image Pyramids – Multi resolution expansion – Wavelet Transforms, Fast Wavelet transforms, Wavelet Packets.		
UNIT V	**AEROSPACE APPLICATIONS**	**9**
Principles of digital aerial photography- Sensors for aerial photography - Aerial Image Exploration - Photo-interpretation, objective analysis and image quality - Image Recognition - Image Classification – Image Fusion – Colour Image Processing - Video Motion Analysis – Case studies – vision based navigation and control.		
		TOTAL: 45 PERIODS
COURSE OUTCOMES:		
After completion of the course, the students will be able to:		
CO1:	Apply mathematical tools for image processing to enhance and analyze images effectively.	
CO2:	Compare advanced frequency domain techniques, including DFT, FFT, and DCT, for filtering and processing images in aerospace applications.	
CO3:	Apply image segmentation techniques, edge linking, and feature analysis to address real- world aerospace challenges.	
CO4:	Utilize multi-resolution analysis techniques, such as image pyramids and wavelet transforms, for effective aerospace imagery analysis.	
CO5:	Apply digital image processing methods to solve aerospace-specific problems, such as digital aerial photography, image recognition, classification, and video motion analysis.	
CO6:	Develop vision-based navigation and control solutions using case studies and practical examples in aerospace contexts.	

TEXT BOOKS:

1	Gorbachev, Sergeĭ Viktorovich, S. G. Emelyanov, Dmitry S. Zhdanov, S. Yu Miroshnichenko, Vladimir I. Syryamkin, Dmitry V. Titov, and Dmitriy V. Shashev. “Digital processing of aerospace images”. Red Square Scientific, Ltd., 2018.
2	Solomon, Chris, and Toby Breckon. “Fundamentals of Digital Image Processing: A practical approach with examples in MATLAB”. John Wiley & Sons, 2011.

REFERENCES:

1	Gonzalez, Rafael C. “Digital image processing”. Pearson education India, 2009.
2	Blackledge, Jonathan M. “Digital image processing: mathematical and computational methods”. Elsevier, 2005.

COs	POs												PSOs		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	-	-	-	-	1	1	1	2	1	-
2	2	1	1	-	1	-	-	-	-	1	1	1	2	1	-
3	3	2	1	1	1	-	-	-	-	1	1	1	2	1	-
4	3	2	1	1	1	-	-	-	-	1	1	1	2	1	-
5	3	2	1	1	1	-	-	-	-	1	1	1	2	1	-
6	3	2	1	1	1	-	-	-	-	1	1	1	2	1	-
Overall Correlation	3	2	1	1	1	-	-	-	-	1	1	1	2	1	-

23AE071	FUNDAMENTALS OF MACHINE THEORY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamental concepts of kinematics, including the terminology, inversions, and analysis of simple mechanisms like 4-bar and slider-crank chains.
- To analyze the motion and force transmission in cam mechanisms, create displacement diagrams, and design plate cam profiles.
- To gain knowledge of toothed gearing systems, gear trains, and related concepts, including the law of gearing, interference, undercutting, and epicyclic gear trains.
- To explore the role of friction in machine components, including applications in screw threads, clutches, brakes, and belt drives, and assess their operational impacts.
- To develop an understanding of mass balancing in machines, including static and dynamic balancing, and analyze the effects of gyroscopic forces and vibrations in mechanical systems.

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	**BALANCING OF MASSES**	**9**
Static and Dynamic balancing – Balancing of revolving masses – Balancing machines- Gyroscope and Porter Governor.		
UNIT V	**VIBRATION**	**9**
Free vibrations – Natural Frequency – Damped Vibration – Bending critical speed of simple shaft – Forced vibration – Harmonic Forcing – Vibration isolation.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:	
After completion of the course, the students will be able to:	
CO1:	Apply the linkages and the cam mechanisms for specified output motions.
CO2:	Construct the features of Gears and Gear Trains
CO3:	Apply friction principles in the design of engineering components such as screw threads, clutches, brakes, and belt drives.
CO4:	Apply analytical and graphical methods to balance revolving masses
CO5:	Apply the concepts of gyroscope and its effects
CO6:	Solve the free and forced vibration system.
TEXT BOOKS:	
1	Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", Oxford University Press, 2017.
2	Thomas Bevan, "The Theory of Machines", Pearson Education Ltd., 2010.

REFERENCES:	
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.

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	2	1	1	1	1	1	1	1	1	1	1	2	1	1
2	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1
3	3	2	1	1	1	1	1	1	1	1	1	1	3	1	1
4	3	3	2	2	1	1	1	1	1	1	1	1	3	1	1
5	2	1	-	-	1	1	1	1	1	1	1	1	3	1	1
6	3	3	2	2	1	1	1	1	1	1	1	1	3	1	1
Overall Correlation	**3**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

23AE072	HIGH TEMPERATURE MATERIALS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the mechanisms of creep deformation, including its various stages, and identify the metallurgical factors influencing component performance at elevated temperatures.
- To explore methods for designing components to resist creep, including transient creep models, strain hardening concepts, and life prediction using empirical relationships like the Monkman-Grant equation.
- To analyze different types of fractures, including brittle and ductile failure mechanisms, and study fracture behavior across temperature ranges for various materials.
- To examine oxidation and hot corrosion processes, understand their effects on materials, and learn methods to prevent or mitigate their impact through alloy design and protective measures.
- To gain knowledge of high-temperature materials, particularly superalloys, and understand their strengthening mechanisms, phase transformations, and suitability for extreme environmental conditions.

UNIT I	CREEP	9

Factors influencing functional life of components at elevated temperatures, definition of creep curve, various stages of creep, metallurgical factors influencing various stages, effect of stress, temperatures and strain rate.

UNIT II	DESIGN FOR CREEP RESISTANCE	9

Design of transient Creep time, Hardening, Strain hardening, Expressions of rupture life of Creep, Ductile and Brittle materials, Monkman-Grant relationship.

UNIT III	FRACTURE	9

Various types of fracture, brittle to ductile from low temperature to high temperature, cleavage fracture due to micro void coalescence – Diffusion controlled void growth; fracture maps for different alloys and oxides.

UNIT IV	OXIDATION AND HOT CORROSION	9
Oxidation, Pilling, Bedworth ratio, Kinetic laws of oxidation – Defect structure and control of Oxidation by alloy additions- Hot gas corrosion deposit- Modified hot gas corrosion- Fluxing mechanisms- effect of alloying elements on hot corrosion- Interaction of hot corrosion and creep- Methods of combat hot corrosion.		
UNIT V	**SUPER ALLOYS AND OTHER MATERIALS**	**9**
Iron base- Nickel base and Cobalt base super alloys- Composition control- Solid solution strengthening- precipitation hardening by gamma prime- grain boundary strengthening- TCP phase- Embrittlement- solidification of single crystals- Intermetallics- High temperature ceramics.		
		TOTAL: 45 PERIODS

COURSE OUTCOMES:

After completion of the course, the students will be able to:

CO1:	Analyze the factors that influence the functional life of components at elevated temperatures, focusing on creep behavior and its stages.
CO2:	Apply design principles for creep resistance by evaluating transient creep time, hardening mechanisms, and rupture life expressions for ductile and brittle materials.
CO3:	Examine different fracture mechanisms in materials subjected to high temperatures, including brittle-to-ductile transitions and micro void coalescence.
CO4:	Inspect oxidation and hot corrosion mechanisms, and apply methods to control and combat these processes through alloying and other techniques.
CO5:	Analyze the interaction between hot corrosion and creep in high-temperature environments and apply strategies to mitigate their combined effects on material degradation.
CO6:	Apply knowledge of superalloys, including iron, nickel, and cobalt-based alloys, to understand their strengthening mechanisms and high-temperature performance.

TEXT BOOKS:	
1	Raj. R., "Flow and Fracture at Elevated Temperatures", American Society for MetalsUSA, 1985.
2	Hertzberg R.W., "Deformation and Fracture Mechanics of Engineering materials", 4thEdition, John Wiley, USA, 1996.

REFERENCES:	
1	Boyle J.T, Spencer J, "Stress Analysis for Creep" ,Butterworths, UK, 1983.
2	Bressers.J., "Creep and Fatigue in High Temperature Alloys", Applied Science, 1981.
3	McLean D., "Directionally Solidified Materials for High Temperature Service", The Metals Society, USA, 1985.
4	Courtney T .H, "Mechanical Behaviour of Materials",McGraw-Hill, USA, 1990

COs	**POs**												**PSOs**		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1	3	3	2	2	-	-	-	-	-	-	-	-	2	-	-
2	3	2	1	1	-	-	-	-	-	-	-	-	2	-	-
3	3	3	2	2	-	-	-	-	-	-	-	-	2	-	-
4	3	3	2	2	-	-	-	-	-	-	-	-	2	-	-
5	3	3	2	2	-	-	-	-	-	-	-	-	2	-	-
6	3	2	1	1	-	-	-	-	-	-	-	-	2	-	-
Overall Correlation	**3**	**3**	**2**	**2**	**-**	**-**	**-**	**-**	**--**	**-**	**-**	**-**	**2**	**-**	**-**