ANNA UNIVERSITY, CHENNAI
AFFILIATED INSTITUTIONS
B.E. AEROSPACE ENGINEERING
REGULATIONS – 2017
CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES:

The graduates after completion of the degree will fulfil the following

PEO1. Research and development across disciplines to advance technology and foster innovation in order to compete successfully in the global economy.

PEO2. Updating and adapting their core knowledge and abilities to compete in the ever-changing global enterprise.

PEO3. Entrepreneurial ventures and fostering activities that support sustainable economic development that enhance the quality of life of people in the state, across the country, and around the world.

PROGRAMME OUTCOMES:

PO1. Ability to apply the knowledge of mathematics, science and engineering.

PO2. An engineering acumen in identifying, formulating, analysing and solving complex engineering problems.

PO3. Developing processes, solutions to the problems which are safe socially, culturally and environmentally.

PO4. Ability to model, analyse and simulate operations of aerospace vehicle components and parts.

PO5. A knowledge of aerodynamics, aerospace materials, structures, propulsion, flight mechanics, orbital mechanics, software, and stability and control.

PO6. Understanding of the impact of engineering solutions in a global, economic, environmental, and societal context.

PO7. An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.

PO8. Commitment to professional ethics and responsibilities and norms as prescribed by the Aviation bodies such as DGCA etc...

PO9. Ability to work in team and have practical exposure in modelling of Rockets, Re-entry Vehicles, Satellites etc...

PO10. Ability to communicate effectively with the aerospace community using reports, presentations and documentations.

PO11. Competence in the integration of aerospace science and engineering topics and their application in aerospace vehicle design.

PO12. A readiness to engage in lifelong learning and understanding of contemporary issues in aviation industry.

PEO / PO Mapping

PEO / PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PEO1	✓	✓	✓	✓	✓		✓					
PEO2			✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PEO3				✓		✓	✓		✓		✓	✓

SEMESTER COURSE WISE PO MAPPING

		Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
YEAR I	SEMESTER I	Communicative English						✓				✓		✓
		Engineering Mathematics I	✓	✓	✓	✓								
		Engineering Physics	✓	✓	✓	✓	✓		✓					
		Engineering Chemistry	✓	✓	✓	✓	✓		✓					
		Problem Solving and Python Programming	✓	✓	✓	✓								
		Engineering Graphics	✓	✓	✓	✓	✓		✓		✓		✓	
		Problem Solving and Python Programming Laboratory	✓	✓	✓	✓	✓		✓					
		Physics and Chemistry Laboratory	✓	✓	✓	✓	✓		✓					
	SEMESTER II	Technical English						✓				✓		✓
		Engineering Mathematics II	✓	✓	✓	✓								
		Materials Science	✓		✓		✓	✓	✓					
		Basic Electrical, Electronics and Instrumentation Engineering	✓		✓				✓					✓
		Introduction to Aerospace Engineering	✓		✓		✓			✓		✓		✓
		Engineering Mechanics	✓	✓	✓		✓		✓					
		Engineering Practices Laboratory	✓	✓	✓		✓		✓					
		Basic Electrical, Electronics and Instrumentation Engineering Laboratory	✓		✓				✓					✓

		Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
YEAR II	SEMESTER III	Transforms and Partial Differential Equations	✓	✓	✓	✓								
		Aero Engineering Thermodynamics	✓	✓	✓	✓	✓				✓		✓	✓
		Fluid Mechanics and Machinery	✓	✓	✓	✓	✓				✓		✓	✓
		Strength of Materials for Mechanical Engineers	✓	✓	✓	✓	✓				✓		✓	✓
		Manufacturing Technology	✓	✓	✓	✓	✓		✓		✓		✓	
		Space Science	✓	✓	✓	✓		✓				✓		✓
		Thermodynamics Laboratory	✓	✓	✓	✓	✓		✓					
		Strength of Materials Laboratory	✓	✓	✓	✓	✓		✓					
		Fluid Mechanics and Machinery Laboratory	✓	✓	✓	✓	✓		✓					
	SEMESTER IV	Numerical Methods	✓	✓	✓	✓								
		Aerodynamics	✓		✓	✓	✓				✓	✓	✓	✓
		Aerospace Structural Mechanics	✓		✓	✓	✓				✓	✓	✓	✓
		Flight Systems and Instrumentation	✓				✓		✓		✓		✓	✓
		Mechanics of Machines	✓	✓	✓		✓		✓					
		Environmental Science and Engineering			✓			✓						
		Low and High Speed Aerodynamics Laboratory	✓	✓	✓	✓	✓		✓					
		Structures Laboratory	✓	✓	✓	✓	✓		✓					
		Flight Systems Laboratory				✓	✓		✓				✓	
YEAR III	SEMESTER V	Space Mechanics	✓	✓	✓		✓		✓					
		Air Breathing Propulsion	✓		✓	✓	✓				✓	✓	✓	✓
		Flight Dynamics	✓	✓	✓	✓	✓				✓		✓	✓
		Fundamentals of Aerospace Control Engineering	✓		✓	✓	✓						✓	
		Elements of Spaceflight	✓	✓	✓	✓	✓		✓		✓		✓	
		Aerospace Propulsion Laboratory	✓	✓	✓	✓	✓		✓					
		Space Launch Vehicle Mini Project – I	✓	✓	✓	✓	✓		✓		✓		✓	
		Professional Communication						✓				✓		✓

		Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
	SEMESTER VI	Space Propulsion	✓	✓	✓	✓	✓		✓		✓		✓	
		Vibration and Elements of Aeroelasticity	✓	✓	✓	✓	✓				✓	✓	✓	✓
		Finite Element Methods	✓	✓		✓	✓				✓	✓	✓	✓
		Spacecraft Dynamics	✓	✓	✓		✓		✓					
		Avionics	✓	✓		✓	✓			✓			✓	✓
		CAD Laboratory	✓	✓	✓	✓	✓		✓					
		Space Launch Vehicle Mini Project – II	✓	✓	✓	✓	✓		✓		✓		✓	
		Avionics Laboratory	✓	✓	✓	✓	✓			✓			✓	✓
YEAR IV	SEMESTER VII	Hypersonic Aerodynamics for Aerospace Vehicles			✓			✓	✓					
		Computational Fluid Dynamics for Aerospace Engineering	✓	✓		✓	✓						✓	✓
		Rockets and Launch Vehicles	✓	✓	✓	✓	✓				✓	✓	✓	✓
		Computational Analysis Laboratory	✓	✓		✓	✓						✓	✓
		Industrial Training					✓	✓	✓		✓			
	SEMESTER VIII	Project Work	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓

ELECTIVES

	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
PROFESSIONAL ELECTIVES	**SEMESTER VI – Professional Elective I**												
	Computer Aided Design and Analysis	✓		✓		✓			✓	✓		✓	
	Cryogenics	✓		✓		✓			✓	✓		✓	
	Experimental Stress Analysis	✓		✓		✓			✓	✓		✓	
	Machining and Precision Manufacturing	✓		✓		✓			✓	✓		✓	
	Reliability and Quality Assurance	✓		✓			✓	✓	✓				✓
	Intellectual Property Rights						✓				✓		✓
	Fundamentals of Nanoscience	✓		✓		✓	✓	✓					

	Course Title	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
	SEMESTER VII – Professional Elective II												
	Aerospace Materials	✓		✓		✓			✓	✓		✓	
	Launch Vehicle Aerodynamics	✓	✓	✓	✓	✓				✓		✓	
	Additive Manufacturing												
	Launch Vehicle Configuration Design	✓	✓	✓	✓	✓		✓				✓	✓
	Foundation Skills in Integrated Product Development					✓			✓	✓		✓	
	Disaster Management						✓		✓		✓		✓
	Total Quality Management						✓				✓		✓
	SEMESTER VII – Professional Elective III												
	Automatic Control Systems	✓		✓		✓			✓	✓		✓	
	Composite Materials and structures	✓		✓		✓			✓	✓		✓	
	Heat Transfer in Space Applications	✓	✓	✓	✓	✓				✓		✓	
	Missile Guidance and Control	✓	✓	✓	✓	✓				✓		✓	
	Spacecraft Power Systems	✓	✓	✓	✓	✓				✓		✓	
	Satellite Navigation and Control	✓	✓	✓	✓							✓	✓
	Human Rights						✓				✓		✓
	SEMESTER VIII – Professional Elective IV												
	Combustion Engineering	✓		✓		✓			✓	✓		✓	
	Economics and Principles of Management	✓	✓	✓	✓	✓				✓		✓	
	Space Missions	✓	✓	✓	✓	✓	✓			✓		✓	✓
	Spacecraft Sensors and Instrumentation	✓	✓				✓	✓				✓	✓
	Spacecraft Systems Engineering	✓	✓	✓	✓	✓				✓		✓	
	Spacecraft Structures	✓	✓	✓	✓	✓		✓		✓			✓
	Professional Ethics in Engineering						✓				✓		✓

ANNA UNIVERSITY, CHENNAI
AFFILIATED INSTITUTIONS
B.E. AEROSPACE ENGINEERING
REGULATIONS – 2017
CHOICE BASED CREDIT SYSTEM
I TO VIII SEMESTERS CURRICULA AND SYLLABI

SEMESTER I

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	HS8151	Communicative English	HS	4	4	0	0	4
2	MA8151	Engineering Mathematics - I	BS	4	4	0	0	4
3	PH8151	Engineering Physics	BS	3	3	0	0	3
4	CY8151	Engineering Chemistry	BS	3	3	0	0	3
5	GE8151	Problem Solving and Python Programming	ES	3	3	0	0	3
6	GE8152	Engineering Graphics	ES	6	2	0	4	4
PRACTICALS								
7	GE8161	Problem Solving and Python Programming Laboratory	ES	4	0	0	4	2
8	BS8161	Physics and Chemistry Laboratory	BS	4	0	0	4	2
			TOTAL	**31**	**19**	**0**	**12**	**25**

SEMESTER II

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	HS8251	Technical English	HS	4	4	0	0	4
2	MA8251	Engineering Mathematics - II	BS	4	4	0	0	4
3	PH8251	Materials Science	BS	3	3	0	0	3
4	BE8253	Basic Electrical, Electronics and Instrumentation Engineering	ES	3	3	0	0	3
5	AC8201	Introduction to Aerospace Engineering	PC	3	3	0	0	3
6	GE8292	Engineering Mechanics	ES	5	3	2	0	4
PRACTICALS								
7	GE8261	Engineering Practices Laboratory	ES	4	0	0	4	2
8	BE8261	Basic Electrical, Electronics and Instrumentation Engineering Laboratory	ES	4	0	0	4	2
			TOTAL	**30**	**20**	**2**	**8**	**25**

SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	MA8353	Transforms and Partial Differential Equations	BS	4	4	0	0	4
2	AE8301	Aero Engineering Thermodynamics	PC	3	3	0	0	3
3	CE8394	Fluid Mechanics and Machinery	ES	4	4	0	0	4
4	CE8395	Strength of Materials for Mechanical Engineers	ES	3	3	0	0	3
5	ME8392	Manufacturing Technology	PC	3	3	0	0	3
6	AC8301	Space Science	PC	3	3	0	0	3
PRACTICALS								
7	AE8311	Thermodynamics Laboratory	PC	4	0	0	4	2
8	CE8481	Strength of Materials Laboratory	ES	4	0	0	4	2
9	CE8462	Fluid Mechanics and Machinery Laboratory	ES	4	0	0	4	2
			TOTAL	**32**	**20**	**0**	**12**	**26**

SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	MA8491	Numerical Methods	BS	4	4	0	0	4
2	AC8401	Aerodynamics	PC	3	3	0	0	3
3	AC8402	Aerospace Structural Mechanics	PC	3	3	0	0	3
4	AC8403	Flight Systems and Instrumentation	PC	3	3	0	0	3
5	PR8451	Mechanics of Machines	PC	3	3	0	0	3
6	GE8291	Environmental Science and Engineering	HS	3	3	0	0	3
PRACTICALS								
7	AC8411	Low and High Speed Aerodynamics Laboratory	PC	4	0	0	4	2
8	AC8412	Structures Laboratory	PC	4	0	0	4	2
9	AC8413	Flight Systems Laboratory	PC	4	0	0	4	2
			TOTAL	**31**	**19**	**0**	**12**	**25**

SEMESTER V

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	AE8001	Space Mechanics	PC	3	3	0	0	3
2	AC8501	Air Breathing Propulsion	PC	3	3	0	0	3
3	AE8501	Flight Dynamics	PC	5	3	2	0	4
4	AC8502	Fundamentals of Aerospace Control Engineering	PC	3	3	0	0	3
5	AC8503	Elements of Spaceflight	PC	3	3	0	0	3
6		Open Elective I	OE	3	3	0	0	3
PRACTICALS								
7	AC8511	Aerospace Propulsion Laboratory	PC	4	0	0	4	2
8	AC8512	Space Launch Vehicle Mini Project – I	EEC	4	0	0	4	2
9	HS8581	Professional Communication	EEC	2	0	0	2	1
			TOTAL	**30**	**18**	**2**	**10**	**24**

SEMESTER VI

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	AC8601	Space Propulsion	PC	3	3	0	0	3
2	AE8008	Vibration and Elements of Aeroelasticity	PC	3	3	0	0	3
3	AE8601	Finite Element Methods	PC	3	3	0	0	3
4	AC8602	Spacecraft Dynamics	PC	5	3	2	0	4
5	AE8751	Avionics	PC	3	3	0	0	3
6		Professional Elective I	PE	3	3	0	0	3
PRACTICALS								
7	AC8611	CAD Laboratory	PC	4	0	0	4	2
8	AC8612	Space Launch Vehicle Mini Project – II	EEC	4	0	0	4	2
9	AC8613	Avionics Laboratory	PC	4	0	0	4	2
			TOTAL	**32**	**18**	**2**	**12**	**25**

SEMESTER VII

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	AC8701	Hypersonic Aerodynamics for Aerospace Vehicles	PC	3	3	0	0	3
2	AC8702	Computational Fluid Dynamics for Aerospace Engineering	PC	3	3	0	0	3
3	AC8703	Rockets and Launch Vehicles	PC	3	3	0	0	3
4		Professional Elective II	PE	3	3	0	0	3
5		Professional Elective III	PE	3	3	0	0	3
6		Open Elective II	OE	3	3	0	0	3
PRACTICALS								
7	AC8711	Computational Analysis Laboratory	PC	4	0	0	4	2
8	AC8712	Industrial Training	EEC	2	0	0	2	1
			TOTAL	**24**	**18**	**0**	**6**	**21**

SEMESTER VIII

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1		Professional Elective IV	PE	3	3	0	0	3
PRACTICALS								
2	AC8811	Project Work	EEC	20	0	0	20	10
			TOTAL	**23**	**3**	**0**	**20**	**13**

TOTAL NUMBER OF CREDITS TO BE EARNED FOR AWARD OF THE DEGREE = 184

HUMANITIES AND SOCIAL SCIENCES (HS)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	HS8151	Communicative English	HS	4	4	0	0	4
2	HS8251	Technical English	HS	4	4	0	0	4
3	GE8291	Environmental Science and Engineering	HS	3	3	0	0	3
			TOTAL	**11**	**11**	**0**	**0**	**11**

BASIC SCIENCES (BS)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	MA8151	Engineering Mathematics - I	BS	4	4	0	0	4
2	PH8151	Engineering Physics	BS	3	3	0	0	3
3	CY8151	Engineering Chemistry	BS	3	3	0	0	3
4	BS8161	Physics and Chemistry Laboratory	BS	4	0	0	4	2
5	MA8251	Engineering Mathematics - II	BS	4	4	0	0	4
6	PH8251	Materials Science	BS	3	3	0	0	3
7	MA8353	Transforms and Partial Differential Equations	BS	4	4	0	0	4
8	MA8491	Numerical Methods	BS	4	4	0	0	4
			TOTAL	**29**	**25**	**0**	**4**	**27**

ENGINEERING SCIENCES (ES)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	GE8151	Problem Solving and Python Programming	ES	3	3	0	0	3
2	GE8152	Engineering Graphics	ES	6	2	0	4	4
3	GE8161	Problem Solving and Python Programming Laboratory	ES	4	0	0	4	2
4	BE8253	Basic Electrical, Electronics and Instrumentation Engineering	ES	3	3	0	0	3
5	GE8292	Engineering Mechanics	ES	5	3	2	0	4
6	GE8261	Engineering Practices Laboratory	ES	4	0	0	4	2
7	BE8261	Basic Electrical, Electronics and Instrumentation Engineering Laboratory	ES	4	0	0	4	2
8	CE8394	Fluid Mechanics and Machinery	ES	4	4	0	0	4
9	CE8395	Strength of Materials for Mechanical Engineers	ES	3	3	0	0	3
10	CE8481	Strength of Materials Laboratory	ES	4	0	0	4	2
11	CE8462	Fluid Mechanics and Machinery Laboratory	ES	4	0	0	4	2
			TOTAL	**44**	**18**	**2**	**24**	**31**

PROFESSIONAL CORES (PC)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	AC8201	Introduction to Aerospace Engineering	PC	3	3	0	0	3
2	AE8301	Aero Engineering Thermodynamics	PC	3	3	0	0	3
3	ME8392	Manufacturing Technology	PC	3	3	0	0	3
4	AC8301	Space Science	PC	3	3	0	0	3
5	AE8311	Thermodynamics Laboratory	PC	4	0	0	4	2
6	AC8401	Aerodynamics	PC	3	3	0	0	3
7	AC8402	Aerospace Structural Mechanics	PC	3	3	0	0	3
8	AC8403	Flight Systems and Instrumentation	PC	3	3	0	0	3
9	PR8451	Mechanics of Machines	PC	3	3	0	0	3
10	AC8411	Low and High Speed Aerodynamics Laboratory	PC	4	0	0	4	2
11	AC8412	Structures Laboratory	PC	4	0	0	4	2
12	AC8413	Flight Systems Laboratory	PC	4	0	0	4	2
13	AE8001	Space Mechanics	PC	3	3	0	0	3
14	AC8501	Air Breathing Propulsion	PC	3	3	0	0	3
15	AE8501	Flight Dynamics	PC	5	3	2	0	4
16	AC8502	Fundamentals of Aerospace Control Engineering	PC	3	3	0	0	3
17	AC8503	Elements of Space Flight	PC	3	3	0	0	3
18	AC8511	Aerospace Propulsion Laboratory	PC	4	0	0	4	2
19	AC8601	Space Propulsion	PC	3	3	0	0	3
20	AE8008	Vibration and Elements of Aeroelasticity	PC	3	3	0	0	3
21	AE8601	Finite Element Methods	PC	3	3	0	0	3
22	AC8602	Spacecraft Dynamics	PC	5	3	2	0	4
23	AE8751	Avionics	PC	3	3	0	0	3
24	AC8611	CAD Laboratory	PC	4	0	0	4	2
25	AC8613	Avionics Laboratory	PC	4	0	0	4	2
26	AC8701	Hypersonic Aerodynamics for Aerospace Vehicles	PC	3	3	0	0	3
27	AC8702	Computational Fluid Dynamics for Aerospace Engineering	PC	3	3	0	0	3
28	AC8703	Rockets and Launch Vehicles	PC	3	3	0	0	3
29	AC8711	Computational Analysis Laboratory	PC	4	0	0	4	2
			TOTAL	**99**	**63**	**4**	**32**	**81**

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	AC8512	Space Launch Vehicle Mini Project – I	EEC	4	0	4	0	2
2	HS8581	Professional Communication	EEC	2	0	0	2	1
3	AC8612	Space Launch Vehicle Mini Project – II	EEC	4	0	4	0	2
4	AC8712	Industrial Training	EEC	2	0	0	2	1
5	AC8811	Project Work	EEC	20	0	0	20	10
			TOTAL	**32**	**0**	**8**	**24**	**16**

PROFESSIONAL ELECTIVES

SEMESTER VI , ELECTIVE I

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	AC8001	Computer Aided Design and Analysis	PE	3	3	0	0	3
2	AC8002	Cryogenics	PE	3	3	0	0	3
3	AE8605	Experimental Stress Analysis	PE	3	3	0	0	3
4	AC8003	Machining and Precision Manufacturing	PE	3	3	0	0	3
5	AC8004	Reliability and Quality Assurance	PE	3	3	0	0	3
6	GE8075	Intellectual Property Rights	PE	3	3	0	0	3
7	GE8073	Fundamentals of Nanoscience	PE	3	3	0	0	3

SEMESTER VII, ELECTIVE II

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	AC8005	Aerospace Materials	PE	3	3	0	0	3
2	AC8006	Launch Vehicle Aerodynamics	PE	3	3	0	0	3
3	MF8071	Additive Manufacturing	PE	3	3	0	0	3
4	AC8007	Launch Vehicle Configuration Design	PE	3	3	0	0	3
5	GE8072	Foundation Skills in Integrated Product Development	PE	3	3	0	0	3
6	GE8071	Disaster Management	PE	3	3	0	0	3
7	GE8077	Total Quality Management	PE	3	3	0	0	3

SEMESTER VII, ELECTIVE III

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	RO8401	Automatic Control Systems	PE	3	3	0	0	3
2	AE8603	Composite Materials and Structures	PE	3	3	0	0	3
3	AC8008	Heat Transfer in Space Applications	PE	3	3	0	0	3
4	AC8009	Missile Guidance and Control	PE	3	3	0	0	3
5	AC8010	Spacecraft Power Systems	PE	3	3	0	0	3
6	AC8011	Satellite Navigation and Control	PE	3	3	0	0	3
7	GE8074	Human Rights	PE	3	3	0	0	3

SEMESTER VIII, ELECTIVE IV

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1	AC8012	Combustion Engineering	PE	3	3	0	0	3
2	AC8013	Economics and Principles of Management	PE	3	3	0	0	3
3	AC8014	Space Missions	PE	3	3	0	0	3
4	AC8015	Spacecraft Sensors and Instrumentation	PE	3	3	0	0	3
5	AC8016	Spacecraft Systems Engineering	PE	3	3	0	0	3
6	AC8017	Spacecraft Structures	PE	3	3	0	0	3
7	GE8076	Professional Ethics in Engineering	PE	3	3	0	0	3

SUMMARY

B. E., Aerospace Engineering											
S. No	Subject Area	Credits per Semester								Credits Total	Percentage %
		I	II	III	IV	V	VI	VII	VIII		
1	Humanities Sciences	4	4	-	3	-	-	-	-	11	**05.98**
2	Basic Sciences	12	7	4	4	-	-	-	-	27	**14.67**
3	Engineering Sciences	9	11	11	-	-	-	-	-	31	**16.85**
4	Professional Cores	-	3	11	18	18	20	11	-	81	**44.02**
5	Professional Electives	-	-	-	-	-	3	6	3	12	**06.52**
6	Open Electives	-	-	-	-	3	-	3	-	06	**03.26**
7	Employability Enhancement Courses	-	-	-	-	3	2	1	10	16	**08.70**
Total		**25**	**25**	**26**	**25**	**24**	**25**	**21**	**13**	**184**	**100.00**

HS8151	COMMUNICATIVE ENGLISH	L	T	P	C
		4	0	0	4

OBJECTIVES:

- To develop the basic reading and writing skills of first year engineering and technology students.
- To help learners develop their listening skills, which will, enable them listen to lectures and comprehend them by asking questions; seeking clarifications.
- To help learners develop their speaking skills and speak fluently in real contexts.
- To help learners develop vocabulary of a general kind by developing their reading skills

UNIT I SHARING INFORMATION RELATED TO ONESELF/FAMILY & FRIENDS 12

Reading- short comprehension passages, practice in skimming-scanning and predicting- **Writing**- completing sentences- - developing hints. **Listening**- short texts- short formal and informal conversations. **Speaking-** introducing oneself - exchanging personal information- **Language development**- Wh- Questions- asking and answering-yes or no questions- parts of speech. **Vocabulary development-**- prefixes- suffixes- articles - count/uncount nouns.

UNIT II GENERAL READING AND FREE WRITING 12

Reading - comprehension-pre-reading-post reading- comprehension questions (multiple choice questions and /or short questions/ open-ended questions)-inductive reading- short narratives and descriptions from newspapers including dialogues and conversations (also used as short Listening texts)- register- **Writing** – paragraph writing- topic sentence- main ideas- free writing, short narrative descriptions using some suggested vocabulary and structures –**Listening**- telephonic conversations. **Speaking –** sharing information of a personal kind—greeting – taking leave- **Language development** – prepositions, conjunctions **Vocabulary development-** guessing meanings of words in context.

UNIT III GRAMMAR AND LANGUAGE DEVELOPMENT 12

Reading- short texts and longer passages (close reading) **Writing-** understanding text structure- use of reference words and discourse markers-coherence-jumbled sentences **Listening** – listening to longer texts and filling up the table- product description- narratives from different sources. **Speaking**- asking about routine actions and expressing opinions. **Language development**- degrees of comparison- pronouns- direct vs indirect questions- **Vocabulary development –** single word substitutes- adverbs.

UNIT IV READING AND LANGUAGE DEVELOPMENT 12

Reading- comprehension-reading longer texts- reading different types of texts- magazines **Writing**- letter writing, informal or personal letters-e-mails-conventions of personal email- **Listening**- listening to dialogues or conversations and completing exercises based on them. **Speaking-** speaking about oneself- speaking about one's friend- **Language development-** Tenses- simple present-simple past- present continuous and past continuous- **Vocabulary development**- synonyms-antonyms- phrasal verbs

UNIT V EXTENDED WRITING 12

Reading- longer texts- close reading –**Writing**- brainstorming -writing short essays **– developing** an outline- identifying main and subordinate ideas- dialogue writing-**Listening** – listening to talks- conversations- **Speaking –** participating in conversations- short group conversations-**Language development**-modal verbs- present/ past perfect tense - **Vocabulary development**-collocations- fixed and semi-fixed expressions

TOTAL: 60 PERIODS

OUTCOMES:

At the end of the course, learners will be able to:

- Read articles of a general kind in magazines and newspapers.
- Participate effectively in informal conversations; introduce themselves and their friends and express opinions in English.
- Comprehend conversations and short talks delivered in English
- Write short essays of a general kind and personal letters and emails in English.

TEXT BOOKS:

1. Board of Editors. Using English A Course book for Undergraduate Engineers and Technologists. Orient BlackSwan Limited, Hyderabad: 2015
2. Richards, C. Jack. Interchange Students' Book-2 New Delhi: CUP, 2015.

REFERENCES

1 Bailey, Stephen. Academic Writing: A practical guide for students. New York: Rutledge,2011.

2 Means,L. Thomas and Elaine Langlois. English & Communication For Colleges. CengageLearning ,USA: 2007

3 Redston, Chris &Gillies Cunningham Face2Face (Pre-intermediate Student's Book& Workbook) Cambridge University Press, New Delhi: 2005

4 Comfort, Jeremy, et al. Speaking Effectively: Developing Speaking Skills for Business English. Cambridge University Press, Cambridge: Reprint 2011

5 Dutt P. Kiranmai and Rajeevan Geeta. Basic Communication Skills, Foundation Books: 2013

MA8151	**ENGINEERING MATHEMATICS – I**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

OBJECTIVES:

The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modeling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

UNIT I DIFFERENTIAL CALCULUS 12

Representation of functions - Limit of a function - Continuity - Derivatives - Differentiation rules - Maxima and Minima of functions of one variable.

UNIT II FUNCTIONS OF SEVERAL VARIABLES 12

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 – Maxima and minima of functions of two variables – Lagrange's method of undetermined multipliers.

UNIT III INTEGRAL CALCULUS 12

Definite and Indefinite integrals - Substitution rule - Techniques of Integration - Integration by parts, Trigonometric integrals, Trigonometric substitutions, Integration of rational functions by partial fraction, Integration of irrational functions - Improper integrals.

UNIT IV MULTIPLE INTEGRALS 12

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

UNIT V DIFFERENTIAL EQUATIONS 12

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

TOTAL: 60 PERIODS

OUTCOMES:

After completing this course, students should demonstrate competency in the following skills:

- Use both the limit definition and rules of differentiation to differentiate functions.
- Apply differentiation to solve maxima and minima problems.
- Evaluate integrals both by using Riemann sums and by using the Fundamental Theorem of Calculus.
- Apply integration to compute multiple integrals, area, volume, integrals in polar coordinates, in addition to change of order and change of variables.
- Evaluate integrals using techniques of integration, such as substitution, partial fractions and integration by parts.
- Determine convergence/divergence of improper integrals and evaluate convergent improper integrals.
- Apply various techniques in solving differential equations.

TEXT BOOKS:

1. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 43rd Ed., 2014.
2. James Stewart, "Calculus: Early Transcendentals", Cengage Learning, 7th Ed., New Delhi, 2015. [For Units I & III - Sections 1.1, 2.2, 2.3, 2.5, 2.7(Tangents problems only), 2.8, 3.1 to 3.6, 3.11, 4.1, 4.3, 5.1(Area problems only), 5.2, 5.3, 5.4 (excluding net change theorem), 5.5, 7.1 - 7.4 and 7.8].

REFERENCES:

1. Anton, H, Bivens, I and Davis, S, "Calculus", Wiley, 10th Ed., 2016.
2. Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”, Narosa Publications, New Delhi, 3rd Ed., 2007.
3. Narayanan, S. and Manicavachagom Pillai, T. K., “Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2007.
4. Srimantha Pal and Bhunia, S.C, "Engineering Mathematics" Oxford University Press, 2015.
5. Weir, M.D and Joel Hass, "Thomas Calculus", 12th Ed., Pearson India, 2016.

PH8151	ENGINEERING PHYSICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

UNIT I PROPERTIES OF MATTER 9

Elasticity – Stress-strain diagram and its uses - factors affecting elastic modulus and tensile strength – torsional stress and deformations – twisting couple - torsion pendulum: theory and experiment - bending of beams - bending moment – cantilever: theory and experiment – uniform and non-uniform bending: theory and experiment - I-shaped girders - stress due to bending in beams.

UNIT II WAVES AND FIBER OPTICS 9

Oscillatory motion – forced and damped oscillations: differential equation and its solution – plane progressive waves – wave equation. Lasers: population of energy levels, Einstein’s A and B coefficients derivation – resonant cavity, optical amplification (qualitative) – Semiconductor lasers: homojunction and heterojunction – Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibres (material, refractive index, mode) – losses associated with optical fibers - fibre optic sensors: pressure and displacement.

UNIT III THERMAL PHYSICS 9

Transfer of heat energy – thermal expansion of solids and liquids – expansion joints - bimetallic strips - thermal conduction, convection and radiation – heat conductions in solids – thermal conductivity - Forbe's and Lee's disc method: theory and experiment - conduction through compound media (series and parallel) – thermal insulation – applications: heat exchangers, refrigerators, ovens and solar water heaters.

UNIT IV QUANTUM PHYSICS 9

Black body radiation – Planck's theory (derivation) – Compton effect: theory and experimental verification – wave particle duality – electron diffraction – concept of wave function and its physical significance – Schrödinger's wave equation – time independent and time dependent equations – particle in a one-dimensional rigid box – tunnelling (qualitative) - sscanning tunneling microscope.

UNIT V CRYSTAL PHYSICS 9

Single crystalline, polycrystalline and amorphous materials – single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices – inter-planar distances - coordination number and packing factor for SC, BCC, FCC, HCP and diamond structures - crystal imperfections: point defects, line defects – Burger vectors, stacking faults – role of imperfections in plastic deformation - growth of single crystals: solution and melt growth techniques.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of this course,

- the students will gain knowledge on the basics of properties of matter and its applications,
- the students will acquire knowledge on the concepts of waves and optical devices and their applications in fibre optics,
- the students will have adequate knowledge on the concepts of thermal properties of materials and their applications in expansion joints and heat exchangers,
- the students will get knowledge on advanced physics concepts of quantum theory and its applications in tunneling microscopes, and
- the students will understand the basics of crystals, their structures and different crystal growth techniques.

TEXT BOOKS:

1. Bhattacharya, D.K. & Poonam, T. "Engineering Physics". Oxford University Press, 2015.
2. Gaur, R.K. & Gupta, S.L. "Engineering Physics". Dhanpat Rai Publishers, 2012.
3. Pandey, B.K. & Chaturvedi, S. "Engineering Physics". Cengage Learning India, 2012.

REFERENCES:

1. Halliday, D., Resnick, R. & Walker, J. "Principles of Physics". Wiley, 2015.
2. Serway, R.A. & Jewett, J.W. "Physics for Scientists and Engineers". Cengage Learning, 2010.
3. Tipler, P.A. & Mosca, G. "Physics for Scientists and Engineers with Modern Physics'. W.H.Freeman, 2007.

CY8151 ENGINEERING CHEMISTRY L T P C
3 0 0 3

OBJECTIVES:

- To make the students conversant with boiler feed water requirements, related problems and water treatment techniques.
- To develop an understanding of the basic concepts of phase rule and its applications to single and two component systems and appreciate the purpose and significance of alloys.
- Preparation, properties and applications of engineering materials.
- Types of fuels, calorific value calculations, manufacture of solid, liquid and gaseous fuels.
- Principles and generation of energy in batteries, nuclear reactors, solar cells, wind mills and fuel cells.

UNIT I WATER AND ITS TREATMENT 9

Hardness of water – types – expression of hardness – units – estimation of hardness of water by EDTA – numerical problems – boiler troubles (scale and sludge) – treatment of boiler feed water – Internal treatment (phosphate, colloidal, sodium aluminate and calgon conditioning) external treatment – Ion exchange process, zeolite process – desalination of brackish water – Reverse Osmosis.

UNIT II SURFACE CHEMISTRY AND CATALYSIS 9

Adsorption: Types of adsorption – adsorption of gases on solids – adsorption of solute from solutions – adsorption isotherms – Freundlich's adsorption isotherm – Langmuir's adsorption isotherm – contact theory – kinetics of surface reactions, unimolecular reactions, Langmuir - applications of adsorption on pollution abatement.

Catalysis: Catalyst – types of catalysis – criteria – autocatalysis – catalytic poisoning and catalytic promoters - acid base catalysis – applications (catalytic convertor) – enzyme catalysis– Michaelis – Menten equation.

UNIT III ALLOYS AND PHASE RULE 9

Alloys: Introduction- Definition- properties of alloys- significance of alloying, functions and effect of alloying elements- Nichrome and stainless steel (18/8) – heat treatment of steel. Phase rule: Introduction, definition of terms with examples, one component system -water system - reduced phase rule - thermal analysis and cooling curves - two component systems - lead-silver system - Pattinson process.

UNIT IV FUELS AND COMBUSTION 9

Fuels: Introduction - classification of fuels - coal - analysis of coal (proximate and ultimate) - carbonization - manufacture of metallurgical coke (Otto Hoffmann method) - petroleum - manufacture of synthetic petrol (Bergius process) - knocking - octane number - diesel oil - cetane number - natural gas - compressed natural gas (CNG) - liquefied petroleum gases (LPG) - 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).

UNIT V ENERGY SOURCES AND STORAGE DEVICES 9

Nuclear fission - controlled nuclear fission - nuclear fusion - differences between nuclear fission and fusion - nuclear chain reactions - nuclear energy - light water nuclear power plant - breeder reactor - solar energy conversion - solar cells - wind energy. Batteries, fuel cells and supercapacitors: Types of batteries – primary battery (dry cell) secondary battery (lead acid battery, lithium-ion-battery) fuel cells – H_2-O_2 fuel cell.

TOTAL: 45 PERIODS

OUTCOMES:

- The knowledge gained on engineering materials, fuels, energy sources and water treatment techniques will facilitate better understanding of engineering processes and applications for further learning.

TEXT BOOKS:

1. S. S. Dara and S. S. Umare, “A Textbook of Engineering Chemistry”, S. Chand & Company LTD, New Delhi, 2015
2. P. C. Jain and Monika Jain, “Engineering Chemistry” Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2015
3. S. Vairam, P. Kalyani and Suba Ramesh, “Engineering Chemistry”, Wiley India PVT, LTD, New Delhi, 2013.

REFERENCES:

1. Friedrich Emich, “Engineering Chemistry”, Scientific International PVT, LTD, New Delhi, 2014.
2. Prasanta Rath, “Engineering Chemistry”, Cengage Learning India PVT, LTD, Delhi, 2015.
3. Shikha Agarwal, “Engineering Chemistry-Fundamentals and Applications”, Cambridge University Press, Delhi, 2015.

GE8151 PROBLEM SOLVING AND PYTHON PROGRAMMING L T P C
3 0 0 3

OBJECTIVES:

- To know the basics of algorithmic problem solving
- To read and write simple Python programs.
- To develop Python programs with conditionals and loops.
- To define Python functions and call them.
- To use Python data structures –- lists, tuples, dictionaries.
- To do input/output with files in Python.

UNIT I ALGORITHMIC PROBLEM SOLVING 9

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

UNIT II DATA, EXPRESSIONS, STATEMENTS 9

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III CONTROL FLOW, FUNCTIONS 9

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

UNIT IV LISTS, TUPLES, DICTIONARIES 9

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, mergesort, histogram.

UNIT V FILES, MODULES, PACKAGES 9

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

TOTAL: 45 PERIODS

OUTCOMES:

Upon completion of the course, students will be able to

- Develop algorithmic solutions to simple computational problems
- Read, write, execute by hand simple Python programs.
- Structure simple Python programs for solving problems.
- Decompose a Python program into functions.
- Represent compound data using Python lists, tuples, dictionaries.
- Read and write data from/to files in Python Programs.

TEXT BOOKS:

1. Allen B. Downey, ‘‘Think Python: How to Think Like a Computer Scientist’’, 2nd Ed., Updated for Python 3, Shroff/O’Reilly Publishers, 2016 (http://greenteapress.com/wp/think-python/)
2. Guido van Rossum and Fred L. Drake Jr, “An Introduction to Python – Revised and updated for Python 3.2, Network Theory Ltd., 2011.

REFERENCES:

1. John V Guttag, “Introduction to Computation and Programming Using Python’’, Revised and expanded Ed., MIT Press, 2013
2. Robert Sedgewick, Kevin Wayne, Robert Dondero, “Introduction to Programming in Python: An Inter-disciplinary Approach, Pearson India Education Services Pvt. Ltd., 2016.
3. Timothy A. Budd, “Exploring Python”, Mc-Graw Hill Education (India) Private Ltd, 2015.
4. Kenneth A. Lambert, “Fundamentals of Python: First Programs”, CENGAGE Learning, 2012.
5. Charles Dierbach, “Introduction to Computer Science using Python: A Computational Problem-Solving Focus, Wiley India Ed., 2013.
6. Paul Gries, Jennifer Campbell and Jason Montojo, “Practical Programming: An Introduction to Computer Science using Python 3”, Second Ed., Pragmatic Programmers, LLC, 2013.

GE8152 ENGINEERING GRAPHICS L T P C
2 0 4 4

OBJECTIVES:

- To develop in students, graphic skills for communication of concepts, ideas and design of Engineering products.
- To expose them to existing national standards related to technical drawings.

CONCEPTS AND CONVENTIONS (Not for Examination) 1

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I PLANE CURVES AND FREEHAND SKETCHING 7+12

Basic Geometrical constructions, Curves used in engineering practices: Conics – Construction of ellipse, parabola and hyperbola by eccentricity method – Construction of cycloid – construction of involutes of square and circle – Drawing of tangents and normal to the above curves.

Visualization concepts and Free Hand sketching: Visualization principles – Representation of Three-Dimensional objects – Layout of views- Freehand sketching of multiple views from pictorial views of objects

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

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

UNIT III PROJECTION OF SOLIDS 5+12

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

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES 5+12

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

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS 6+12

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

TOTAL: 90 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- familiarize with the fundamentals and standards of Engineering graphics
- perform freehand sketching of basic geometrical constructions and multiple views of objects.
- project orthographic projections of lines and plane surfaces.
- draw projections and solids and development of surfaces.
- visualize and to project isometric and perspective sections of simple solids.

TEXT BOOKS:

1. Natrajan K.V., “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai, 2009.

2. Venugopal K. and Prabhu Raja V., “Engineering Graphics”, New Age International (P) Limited, 2008.

REFERENCES:

1. Bhatt N.D. and Panchal V.M., “Engineering Drawing”, Charotar Publishing House, 50th Ed., 2010.
2. Basant Agarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
3. Gopalakrishna K.R., “Engineering Drawing” (Vol. I&II combined), Subhas Stores, Bangalore, 2007.
4. Luzzader, Warren.J. and Duff,John M., “Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production, Eastern Economy Ed., Prentice Hall of India Pvt. Ltd, New Delhi, 2005.
5. N S Parthasarathy and Vela Murali, “Engineering Graphics”, Oxford University, Press, New Delhi, 2015.
6. Shah M.B., and Rana B.C., “Engineering Drawing”, Pearson, 2nd Ed., 2009.

Publication of Bureau of Indian Standards:

1. IS 10711 – 2001: Technical products Documentation – Size and lay out of drawing sheets.
2. IS 9609 (Parts 0 & 1) – 2001: Technical products Documentation – Lettering.
3. IS 10714 (Part 20) – 2001 & SP 46 – 2003: Lines for technical drawings.
4. IS 11669 – 1986 & SP 46 – 2003: Dimensioning of Technical Drawings.
5. IS 15021 (Parts 1 to 4) – 2001: Technical drawings – Projection Methods.

Special points applicable to University Examinations on Engineering Graphics:

1. There will be five questions, each of either-or type covering all units of the syllabus.
2. All questions will carry equal marks of 20 each making a total of 100.
3. The answer paper shall consist of drawing sheets of A3 size only. The students will be permitted to use appropriate scale to fit solution within A3 size.
4. The examination will be conducted in appropriate sessions on the same day

GE8161 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY **L T P C 0 0 4 2**

OBJECTIVES:

- To write, test, and debug simple Python programs.
- To implement Python programs with conditionals and loops.
- Use functions for structuring Python programs.
- Represent compound data using Python lists, tuples, dictionaries.
- Read and write data from/to files in Python.

LIST OF PROGRAMS

1. Compute the GCD of two numbers.
2. Find the square root of a number (Newton's method)
3. Exponentiation (power of a number)
4. Find the maximum of a list of numbers
5. Linear search and Binary search
6. Selection sort, Insertion sort
7. Merge sort
8. First n prime numbers
9. Multiply matrices
10. Programs that take command line arguments (word count)
11. Find the most frequent words in a text read from a file
12. Simulate elliptical orbits in Pygame
13. Simulate bouncing ball using Pygame

PLATFORM NEEDED

Python 3 interpreter for Windows/Linux

TOTAL :60 PERIODS

OUTCOMES:

Upon completion of the course, students will be able to

- Write, test, and debug simple Python programs.
- Implement Python programs with conditionals and loops.
- Develop Python programs step-wise by defining functions and calling them.
- Use Python lists, tuples, dictionaries for representing compound data.
- Read and write data from/to files in Python.

BS8161 PHYSICS AND CHEMISTRY LABORATORY (Common to all branches of B.E. / B.Tech. Programmes) **L T P C 0 0 4 2**

OBJECTIVES:

- To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics, properties of matter and liquids.

LIST OF EXPERIMENTS: PHYSICS LABORATORY (Any 5 Experiments)

1. Determination of rigidity modulus – Torsion pendulum
2. Determination of Young's modulus by non-uniform bending method
3. (a) Determination of wavelength, and particle size using Laser
   (b) Determination of acceptance angle in an optical fibre.
4. Determination of thermal conductivity of a bad conductor – Lee's Disc method.
5. Determination of velocity of sound and compressibility of liquid – Ultrasonic interferometer
6. Determination of wavelength of mercury spectrum – spectrometer grating
7. Determination of band gap of a semiconductor
8. Determination of thickness of a thin wire – Air wedge method

TOTAL: 30 PERIODS

OUTCOMES:

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

- apply principles of elasticity, optics and thermal properties for engineering applications.

CHEMISTRY LABORATORY: (Any seven experiments to be conducted)

OBJECTIVES:

- To make the student to acquire practical skills in the determination of water quality parameters through volumetric and instrumental analysis.
- To acquaint the students with the determination of molecular weight of a polymer by viscometery.

1. Estimation of HCl using Na_2CO_3 as primary standard and Determination of alkalinity in water sample.
2. Determination of total, temporary & permanent hardness of water by EDTA method.
3. Determination of DO content of water sample by Winkler's method.
4. Determination of chloride content of water sample by argentometric method.
5. Estimation of copper content of the given solution by Iodometry.
6. Determination of strength of given hydrochloric acid using pH meter.
7. Determination of strength of acids in a mixture of acids using conductivity meter.
8. Estimation of iron content of the given solution using potentiometer.
9. Estimation of iron content of the water sample using spectrophotometer (1, 10-Phenanthroline / thiocyanate method).
10. Estimation of sodium and potassium present in water using flame photometer.
11. Determination of molecular weight of polyvinyl alcohol using Ostwald viscometer.
12. Pseudo first order kinetics-ester hydrolysis.
13. Corrosion experiment-weight loss method.
14. Determination of CMC.
15. Phase change in a solid.
16. Conductometric titration of strong acid vs strong base.

TOTAL: 30 PERIODS

OUTCOME:

- The students will be outfitted with hands-on knowledge in the quantitative chemical analysis of water quality related parameters.

TEXTBOOK:

1. Vogel's Textbook of Quantitative Chemical Analysis (8^{TH} Ed., 2014)

HS8251 **TECHNICAL ENGLISH** **L T P C**
4 0 0 4

OBJECTIVES:

The Course prepares second semester engineering and Technology students to:

- Develop strategies and skills to enhance their ability to read and comprehend engineering and technology texts.
- Foster their ability to write convincing job applications and effective reports.
- Develop their speaking skills to make technical presentations, participate in group discussions.
- Strengthen their listening skill which will help them comprehend lectures and talks in their areas of specialization.

UNIT I INTRODUCTION TECHNICAL ENGLISH 12

Listening- Listening to talks mostly of a scientific/technical nature and completing information-gap exercises- Speaking –Asking for and giving directions- Reading – reading short technical texts from journals- newspapers- Writing- purpose statements – extended definitions – issue-writing instructions – checklists-recommendations-Vocabulary Development- technical vocabulary Language Development –subject verb agreement - compound words.

UNIT II READING AND STUDY SKILLS 12

Listening- Listening to longer technical talks and completing exercises based on them-Speaking – describing a process-Reading – reading longer technical texts- identifying the various transitions in a text- paragraphing- Writing- interpreting charts, graphs- Vocabulary Development-vocabulary used in formal letters/emails and reports Language Development-impersonal passive voice, numerical adjectives.

UNIT III TECHNICAL WRITING AND GRAMMAR 12

Listening- Listening to classroom lectures/ talks on engineering/technology -Speaking – introduction to technical presentations- Reading – longer texts both general and technical, practice in speed reading; Writing-Describing a process, use of sequence words- Vocabulary Development- sequence words- Misspelled words. Language Development- embedded sentences

UNIT IV REPORT WRITING 12

Listening- Listening to documentaries and making notes. Speaking – mechanics of presentations- Reading – reading for detailed comprehension- Writing- email etiquette- job application – cover letter –Résumé preparation (via email and hard copy)- analytical essays and issue-based essays--Vocabulary Development- finding suitable synonyms-paraphrasing-. Language Development- clauses- if conditionals.

UNIT V GROUP DISCUSSION AND JOB APPLICATIONS 12

Listening- TED/Ink talks; Speaking –participating in a group discussion -Reading– reading and understanding technical articles Writing– Writing reports- minutes of a meeting- accident and survey-Vocabulary Development- verbal analogies Language Development- reported speech

TOTAL :60 PERIODS

OUTCOMES:

At the end of the course learners will be able to:

- Read technical texts and write area- specific texts effortlessly.
- Listen and comprehend lectures and talks in their area of specialization successfully.
- Speak appropriately and effectively in varied formal and informal contexts.
- Write reports and winning job applications.

TEXT BOOKS:

1. Board of editors. Fluency in English A Course book for Engineering and Technology. Orient Black swan, Hyderabad: 2016
2. Sudharshana.N.P and Saveetha. C. English for Technical Communication. Cambridge University Press: New Delhi, 2016.

REFERENCES

1. Raman, Meenakshi and Sharma, Sangeetha- Technical Communication Principles and Practice.Oxford University Press: New Delhi,2014.
2. Kumar, Suresh. E. Engineering English. Orient Blackswan: Hyderabad,2015
3. Booth-L. Diana, Project Work, Oxford University Press, Oxford: 2014.
4. Grussendorf, Marion, English for Presentations, Oxford University Press, Oxford: 2007
5. Means, L. Thomas and Elaine Langlois, English & Communication for Colleges. Cengage Learning, USA: 2007

Students can be asked to read Tagore, Chetan Bhagat and for supplementary reading.

MA8251 ENGINEERING MATHEMATICS – II

L	T	P	C
4	0	0	4

OBJECTIVES:

This course is designed to cover topics such as Matrix Algebra, Vector Calculus, Complex Analysis and Laplace Transform. Matrix Algebra is one of the powerful tools to handle practical problems arising in the field of engineering. Vector calculus can be widely used for modelling the various laws of physics. The various methods of complex analysis and Laplace transforms can be used for efficiently solving the problems that occur in various branches of engineering disciplines.

UNIT I MATRICES **12**

Eigen values and Eigenvectors of a real matrix – Characteristic equation – Properties of Eigen values and Eigenvectors – Cayley-Hamilton theorem – Diagonalization of matrices – Reduction of a quadratic form to canonical form by orthogonal transformation – Nature of quadratic forms.

UNIT II VECTOR CALCULUS **12**

Gradient and directional derivative – Divergence and curl - Vector identities – Irrotational and Solenoidal vector fields – Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's, Gauss divergence and Stoke's theorems – Verification and application in evaluating line, surface and volume integrals.

UNIT III ANALYTIC FUNCTIONS **12**

Analytic functions – Necessary and sufficient conditions for analyticity in Cartesian and polar coordinates - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions $w = z + c, cz, \frac{1}{z}, z^2$ - Bilinear transformation.

UNIT IV COMPLEX INTEGRATION **12**

Line integral - Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – Singularities – Residues – Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semicircular contour.

UNIT V LAPLACE TRANSFORMS **12**

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

TOTAL: 60 PERIODS

OUTCOMES:

After successfully completing the course, the student will have a good understanding of the following topics and their applications:

- Eigen values and eigenvectors, diagonalization of a matrix, Symmetric matrices, Positive definite matrices and similar matrices.
- Gradient, divergence and curl of a vector point function and related identities.
- Evaluation of line, surface and volume integrals using Gauss, Stokes and Green's theorems and their verification.
- Analytic functions, conformal mapping and complex integration.
- Laplace transform and inverse transform of simple functions, properties, various related theorems and application to differential equations with constant coefficients.

TEXT BOOKS:

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

REFERENCES:

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

		L	T	P	C
PH8251	**MATERIALS SCIENCE** (Common to courses offered in Faculty of Mechanical Engineering Except B.E. Materials Science and Engineering)	**3**	**0**	**0**	**3**

OBJECTIVES:

- To introduce the essential principles of materials science for mechanical and related engineering applications.

UNIT I PHASE DIAGRAMS 9

Solid solutions - Hume Rothery's rules – the phase rule - single component system - one-component system of iron - binary phase diagrams - isomorphous systems - the tie-line rule - the lever rule - application to isomorphous system - eutectic phase diagram - peritectic phase diagram - other invariant reactions – free energy composition curves for binary systems - microstructural change during cooling.

UNIT II FERROUS ALLOYS 9

The iron-carbon equilibrium diagram - phases, invariant reactions - microstructure of slowly cooled steels - eutectoid steel, hypo and hypereutectoid steels - effect of alloying elements on the Fe-C system - diffusion in solids - Fick's laws - phase transformations - T-T-T-diagram for eutectoid steel – pearlitic, baintic and martensitic transformations - tempering of martensite – steels – stainless steels – cast irons.

UNIT III MECHANICAL PROPERTIES 9

Tensile test - plastic deformation mechanisms - slip and twinning - role of dislocations in slip - strengthening methods - strain hardening - refinement of the grain size - solid solution strengthening - precipitation hardening - creep resistance - creep curves - mechanisms of creep - creep-resistant materials - fracture - the Griffith criterion - critical stress intensity factor and its determination - fatigue failure - fatigue tests - methods of increasing fatigue life - hardness - Rockwell and Brinell hardness - Knoop and Vickers microhardness.

UNIT IV MAGNETIC, DIELECTRIC AND SUPERCONDUCTING MATERIALS 9

Ferromagnetism – domain theory – types of energy – hysteresis – hard and soft magnetic materials – ferrites - dielectric materials – types of polarization – Langevin-Debye equation – frequency effects on polarization - dielectric breakdown – insulating materials – Ferroelectric materials - superconducting materials and their properties.

UNIT V NEW MATERIALS 9

Ceramics – types and applications – composites: classification, role of matrix and reinforcement, processing of fiber reinforced plastics – 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 (bottom up and top down approaches), properties and applications – carbon nanotubes: types.

TOTAL : 45 PERIODS

OUTCOMES:

Upon completion of this course,

- the students will have knowledge on the various phase diagrams and their applications
- the students will acquire knowledge on Fe-Fe_3C phase diagram, various microstructures and alloys
- the students will get knowledge on mechanical properties of materials and their measurement
- the students will gain knowledge on magnetic, dielectric and superconducting properties of materials
- the students will understand the basics of ceramics, composites and nanomaterials.

TEXT BOOKS:

1. Balasubramaniam, R. “Callister’s Materials Science and Engineering”. Wiley India Pvt. Ltd., 2014.
2. Raghavan, V. “Physical Metallurgy: Principles and Practice”. PHI Learning, 2015.
3. Raghavan, V. “Materials Science and Engineering : A First course”. PHI Learning, 2015.

REFERENCES

1. Askeland, D. “Materials Science and Engineering”. Brooks/Cole, 2010.
2. Smith, W.F., Hashemi, J. & Prakash, R. “Materials Science and Engineering”. Tata McGraw Hill Education Pvt. Ltd., 2014.
3. Wahab, M.A. “Solid State Physics: Structure and Properties of Materials”, Narosa Publishing House, 2009.

BE8253 BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING **L T P C 3 0 0 3**

OBJECTIVES:

To impart knowledge on

- Electric circuit laws, single and three phase circuits and wiring
- Working principles of Electrical Machines
- Working principle of Various electronic devices and measuring instruments

UNIT I ELECTRICAL CIRCUITS **9**

Basic circuit components - Ohms Law - Kirchoff's Law – Instantaneous Power – Inductors - Capacitors – Independent and Dependent Sources - steady state solution of DC circuits - Nodal analysis, Mesh analysis- Thevinin's Theorem, Norton's Theorem, Maximum Power transfer theorem- Linearity and Superposition Theorem.

UNIT II AC CIRCUITS **9**

Introduction to AC circuits – waveforms and RMS value – power and power factor, single phase and three-phase balanced circuits – Three phase loads - housing wiring, industrial wiring, materials of wiring

UNIT III ELECTRICAL MACHINES **9**

Principles of operation and characteristics of; DC machines, Transformers (single and three phase), Synchronous machines, three phase and single-phase induction motors.

UNIT IV ELECTRONIC DEVICES & CIRCUITS **9**

Types of Materials – Silicon & Germanium- N type and P type materials – PN Junction –Forward and Reverse Bias –Semiconductor Diodes –Bipolar Junction Transistor – Characteristics —Field Effect Transistors – Transistor Biasing –Introduction to operational Amplifier –Inverting Amplifier – Non-Inverting Amplifier –DAC – ADC.

UNIT V MEASUREMENTS & INSTRUMENTATION **9**

Introduction to transducers - Classification of Transducers: Resistive, Inductive, Capacitive, Thermoelectric, piezoelectric, photoelectric, Hall effect and Mechanical - Classification of instruments - Types of indicating Instruments - multimeters –Oscilloscopes – three-phase power measurements – instrument transformers (CT and PT)

TOTAL: 45 PERIODS

OUTCOMES:

Ability to

- Understand electric circuits and working principles of electrical machines
- Understand the concepts of various electronic devices
- Choose appropriate instruments for electrical measurement for a specific application

TEXT BOOKS

1. D P Kothari and I.J Nagarath," Electrical Machines "Basic Electrical and Electronics Engineering", McGraw Hill Education (India) Private Limited, Third Reprint ,2016
2. Leonard S Bobrow, "Foundations of Electrical Engineering", Oxford University Press, 2013
3. Thereja .B.L., "Fundamentals of Electrical Engineering and Electronics", S. Chand & Co. Ltd., 2008.

REFERENCES:

1. A.E.Fitzgerald, David E Higginbotham and Arvin Grabel, "Basic Electrical Engineering", McGraw Hill Education(India) Private Limited, 2009
2. Allan S Moris, "Measurement and Instrumentation Principles", Elseveir, First Indian Ed., 2006
3. Del Toro, "Electrical Engineering Fundamentals", Pearson Education, New Delhi, 2007
4. John Bird, "Electrical Circuit Theory and Technology", Elsevier, First Indian Ed., 2006
5. N K De, Dipu Sarkar, "Basic Electrical Engineering", Universities Press (India)Private Limited 2016
6. Rajendra Prasad, "Fundamentals of Electrical Engineering", Prentice Hall of India, 2006

AC8201 INTRODUCTION TO AEROSPACE ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

- Use the standard atmosphere tables and equations.
- Find lift and drag coefficient data from NACA plots.
- Apply the concept of static stability to flight vehicles.
- Describe the concepts of stress, strain, Young's modulus, Poisson's ratio, yield strength.
- Demonstrate a basic knowledge of dynamics relevant to orbital mechanics.

UNIT I STANDARD ATMOSPHERE 7

History of aviation – standard atmosphere - pressure, temperature and density altitude.

UNIT II AERODYNAMICS 10

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.

UNIT III PERFORMANCE AND PROPULSION 10

Viscous and pressure drag - flow separation - aerodynamic drag - thrust calculations - thrust/power available and thrust/power required.

UNIT IV AIRCRAFT STABILITY AND STRUCTURAL THEORY 10

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.

UNIT V SPACE APPLICATIONS 8

History of space research - spacecraft trajectories and basic orbital manoeuvres - six orbital elements - Kepler's laws of orbits - Newtons law of gravitation.

TOTAL: 45 PERIODS

OUTCOME:

- Ability to understand aerodynamics, lift, drag, and the standard atmosphere, aircraft performance, stability, and control, propulsion, structures, rocket and spacecraft trajectories and orbits.

TEXT BOOKS:

1. John D. Anderson, Introduction to Flight, 8th Ed., McGraw-Hill Education, New York, 2015.
2. Stephen. A. Brandt, "Introduction to Aeronautics: A design perspective" American Institute of Aeronautics & Astronautics,1997.

REFERENCE:

1. Kermode, A.C., "Mechanics of Flight", Himalayan Book, 1997.

GE8292 **ENGINEERING MECHANICS** **L T P C**
3 2 0 4

OBJECTIVE:

- To develop capacity to predict the effect of force and motion in the course of carrying out the design functions of engineering.

UNIT I STATICS OF PARTICLES 9+6

Introduction – Units and Dimensions – 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 – Forces in space – Equilibrium of a particle in space – Equivalent systems of forces – Principle of transmissibility.

UNIT II EQUILIBRIUM OF RIGID BODIES 9+6

Free body diagram – Types of supports –Action and reaction forces – stable equilibrium – Moments and Couples – Moment of a force about a point and about an axis – Vectorial representation of moments and couples – Scalar components of a moment – Varignon's theorem – Single equivalent force -Equilibrium of Rigid bodies in two dimensions – Equilibrium of Rigid bodies in three dimensions

UNIT III PROPERTIES OF SURFACES AND SOLIDS 9+6

Centroids and centre of mass – Centroids of lines and areas - Rectangular, circular, triangular areas by integration – T section, I section, - Angle section, Hollow section by using standard formula –Theorems of Pappus - Area moments of inertia of plane areas – Rectangular, circular, triangular areas by integration – T section, I section, Angle section, Hollow section by using standard formula – Parallel axis theorem and perpendicular axis theorem – Principal moments of inertia of plane areas – Principal axes of inertia-Mass moment of inertia –mass moment of inertia for prismatic, cylindrical and spherical solids from first principle – Relation to area moments of inertia.

UNIT IV DYNAMICS OF PARTICLES 9+6

Displacements, Velocity and acceleration, their relationship – Relative motion – Curvilinear motion - Newton's laws of motion – Work Energy Equation– Impulse and Momentum – Impact of elastic bodies.

UNIT V FRICTION AND RIGID BODY DYNAMICS 9+6

Friction force – Laws of sliding friction – equilibrium analysis of simple systems with sliding friction –wedge friction-. Rolling resistance -Translation and Rotation of Rigid Bodies – Velocity and acceleration – General Plane motion of simple rigid bodies such as cylinder, disc/wheel and sphere.

TOTAL: 45+30=75 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- illustrate the vectorial and scalar representation of forces and moments
- analyse the rigid body in equilibrium
- evaluate the properties of surfaces and solids
- calculate dynamic forces exerted in rigid body
- determine the friction and the effects by the laws of friction

TEXT BOOKS:

1. Beer, F.P and Johnston Jr. E.R., "Vector Mechanics for Engineers (In SI Units): Statics and Dynamics", 8th Ed., Tata McGraw-Hill Publishing company, New Delhi (2004).
2. Vela Murali, "Engineering Mechanics", Oxford University Press (2010)

REFERENCES:

1. Bhavikatti, S.S and Rajashekarappa, K.G., “Engineering Mechanics”, New Age International (P) Limited Publishers, 1998.
2. Hibbeller, R.C and Ashok Gupta, “Engineering Mechanics: Statics and Dynamics”, 11th Ed., Pearson Education 2010.
3. Irving H. Shames and Krishna Mohana Rao. G., “Engineering Mechanics – Statics and Dynamics”, 4th Ed., Pearson Education 2006.
4. Meriam J.L. and Kraige L.G., “ Engineering Mechanics- Statics - Volume 1, Dynamics- Volume 2”, Third Ed., John Wiley & Sons,1993.
5. Rajasekaran S and Sankarasubramanian G., “Engineering Mechanics Statics and Dynamics”, 3rd Ed., Vikas Publishing House Pvt. Ltd., 2005.

GE8261 ENGINEERING PRACTICES LABORATORY L T P C
0 0 4 2

OBJECTIVES:

To provide exposure to the students with hands on experience on various basic engineering practices in Civil, Mechanical, Electrical and Electronics Engineering.

GROUP A (CIVIL & MECHANICAL)

I CIVIL ENGINEERING PRACTICE 13

Buildings:

(a) Study of plumbing and carpentry components of residential and industrial buildings. Safety aspects.

Plumbing Works:

(a) Study of pipeline joints, its location and functions: valves, taps, couplings, unions, reducers, elbows in household fittings.
(b) Study of pipe connections requirements for pumps and turbines.
(c) Preparation of plumbing line sketches for water supply and sewage works.
(d) Hands-on-exercise:
Basic pipe connections – Mixed pipe material connection – Pipe connections with different joining components.
(e) Demonstration of plumbing requirements of high-rise buildings.

Carpentry using Power Tools only:

(a) Study of the joints in roofs, doors, windows and furniture.
(b) Hands-on-exercise:
Wood work, joints by sawing, planing and cutting.

II MECHANICAL ENGINEERING PRACTICE 18

Welding:

(a) Preparation of butt joints, lap joints and T- joints by Shielded metal arc welding.
(b) Gas welding practice

Basic Machining:

(a) Simple Turning and Taper turning
(b) Drilling Practice

Sheet Metal Work:

(a) Forming & Bending:
(b) Model making – Trays and funnels.
(c) Different type of joints.

Machine assembly practice:

(a) Study of centrifugal pump
(b) Study of air conditioner

Demonstration on:

(a) Smithy operations, upsetting, swaging, setting down and bending. Example – Exercise – Production of hexagonal headed bolt.
(b) Foundry operations like mould preparation for gear and step cone pulley.
(c) Fitting – Exercises – Preparation of square fitting and V – fitting models.

GROUP B (ELECTRICAL & ELECTRONICS)

III ELECTRICAL ENGINEERING PRACTICE 13

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

IV ELECTRONICS ENGINEERING PRACTICE 16

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

TOTAL: 60 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- fabricate carpentry components and pipe connections including plumbing works.
- use welding equipments to join the structures.
- Carry out the basic machining operations
- Make the models using sheet metal works
- Illustrate on centrifugal pump, Air conditioner, operations of smithy, foundary and fittings
- Carry out basic home electrical works and appliances
- Measure the electrical quantities
- Elaborate on the components, gates, soldering practices.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

CIVIL

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

MECHANICAL

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

ELECTRICAL

1. Assorted electrical components for house wiring	15 Sets
2. Electrical measuring instruments	10 Sets
3. Study purpose items: Iron box, fan and regulator, emergency lamp	1 each
4. Megger (250V/500V)	1 No.

5. Power Tools: (a) Range Finder	2 Nos
(b) Digital Live-wire detector	2 Nos

ELECTRONICS

1. Soldering guns	10 Nos.
2. Assorted electronic components for making circuits	50 Nos.
3. Small PCBs	10 Nos.
4. Multimeters	10 Nos.
5. Study purpose items: Telephone, FM radio, low-voltage power supply	

BE8261 BASIC ELECTRICAL, ELECTRONICS AND INSTRUMENTATION ENGINEERING LABORATORY

L T P C
0 0 4 2

OBJECTIVE:

- To train the students in performing various tests on electrical drives, sensors and circuits.

LIST OF EXPERIMENTS:

1. Load test on separately excited DC generator
2. Load test on Single phase Transformer
3. Load test on Induction motor
4. Verification of Circuit Laws
5. Verification of Circuit Theorems
6. Measurement of three phase power
7. Load test on DC shunt motor.
8. Diode based application circuits
9. Transistor based application circuits
10. Study of CRO and measurement of AC signals
11. Characteristics of LVDT
12. Calibration of Rotometer
13. RTD and Thermistor

Minimum of 10 Experiments to be carried out: -

TOTAL: 60 PERIODS

OUTCOMES:

- Ability to determine the speed characteristic of different electrical machines
- Ability to design simple circuits involving diodes and transistors
- Ability to use operational amplifiers

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S.No.	NAME OF THE EQUIPMENT	Qty.
1	D. C. Motor Generator Set	2
2	D.C. Shunt Motor	2
3	Single Phase Transformer	2
4	Single Phase Induction Motor	2
5	Ammeter A.C and D.C	20
6	Voltmeters A.C and D.C	20
7.	Watt meters LPF and UPF	4
8.	Resistors & Breadboards	-
9.	Cathode Ray Oscilloscopes	4
10.	Dual Regulated power supplies	6
11.	A.C. Signal Generators	4
12.	Transistors (BJT, JFET)	-

MA8353 TRANSFORMS AND PARTIAL DIFFERENTIAL EQUATIONS L T P C
4 0 0 4

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 12

Formation of partial differential equations – Singular integrals - 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 12

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

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 12

Classification of PDE – Method of separation of variables - Fourier Series Solutions of one-dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two-dimensional equation of heat conduction.

UNIT IV FOURIER TRANSFORMS 12

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

UNIT V Z - TRANSFORMS AND DIFFERENCE EQUATIONS 12

Z-transforms - Elementary properties – Inverse Z-transform (using partial fraction and residues) – Initial and final value theorems - Convolution theorem - Formation of difference equations – Solution of difference equations using Z-transform.

TOTAL: 60 PERIODS

OUTCOMES:

Upon successful completion of the course, students should be able to:

- Understand how to solve the given standard partial differential equations.
- Solve differential equations using Fourier series analysis which plays a vital role in engineering applications.
- Appreciate the physical significance of Fourier series techniques in solving one- and two-dimensional heat flow problems and one-dimensional wave equations.
- Understand the mathematical principles on transforms and partial differential equations would provide them the ability to formulate and solve some of the physical problems of engineering.
- Use the effective mathematical tools for the solutions of partial differential equations by using Z-transform techniques for discrete time systems.

TEXT BOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", 43rd Ed., Khanna Publishers, New Delhi, 2014.
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.

REFERENCES:

1. B.V Ramana., "Higher Engineering Mathematics", McGraw Hill Education Pvt. Ltd, New Delhi, 2016.
2. Erwin Kreyszig, "Advanced Engineering Mathematics ", 10th Ed., John Wiley, India, 2016.
3. G. James, "Advanced Modern Engineering Mathematics", 3rd Ed., Pearson Education, 2007.
4. L.C Andrews, L.C and Shivamoggi, B, "Integral Transforms for Engineers" SPIE Press, 1999.
5. N.P. Bali. and Manish Goyal, "A Textbook of Engineering Mathematics", 9th Ed., Laxmi Publications Pvt. Ltd, 2014.
6. R.C. Wylie, and Barrett, L.C., “Advanced Engineering Mathematics “Tata McGraw Hill Education Pvt. Ltd, 6th Ed., New Delhi, 2012.

AE8301 AERO ENGINEERING THERMODYNAMICS L T P C
3 0 0 3

OBJECTIVES:

- Aero Thermodynamics study includes quantitative analysis of machine and processes for transformation of energy and between work and heat.
- Laws of thermodynamics would be able to quantify through measurement of related properties, to these energies and their interactions.
- To develop basic concept of air cycle, gas turbine engines and heat transfer.

UNIT I FUNDAMENTAL CONCEPT AND FIRST LAW 9

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

UNIT II SECOND LAW AND ENTROPY 9

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

UNIT III AIR STANDARD CYCLES 8

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

UNIT IV FUNDAMENTALS OF VAPOUR POWER CYCLES 9

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

UNIT V BASICS OF PROPULSION AND HEAT TRANSFER 10

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

TOTAL: 45 PERIODS

OUTCOMES

- Able to relate laws of thermodynamics to jet engine components.
- Understands principle operation of piston engine and jet engines.
- Able to identify efficient cycle of air and jet engines.
- Capable to illustrate condition of working medium.
- Eligible to recognize and calculate heat transfer in complex systems involving several heat transfer mechanisms.

TEXT BOOKS:

1. Nag.P.K., “Engineering Thermodynamics”, Tata McGraw-Hill, New Delhi, 2013.
2. Rathakrishnan E., “Fundamentals of Engineering Thermodynamics”, Prentice-Hall India, 2005.
3. Yunus A. Cengel and Michael A. Boles, “Thermodynamics: An Engineering Approach” McGraw-Hill Science/Engineering/Math; 7thedition 2010.

REFERENCES:

1. Arora C.P, “Thermodynamics”, Tata McGraw-Hill, New Delhi, 2003.
2. Holman.J.P., “Thermodynamics”, 3rd Edition, McGraw-Hill, 2007.

3. Merala C, Pother, Craig W, Somerton, “Thermodynamics for Engineers”, Schaum Outline Series,Tata McGraw-Hill, New Delhi, 2004.
4. Ramalingam K.K. “Thermodynamics”, Sci-Tech Publications, 2006
5. Venwylen and Sontag, “Classical Thermodynamics”, Wiley Eastern, 1987

CE8394 FLUID MECHANICS AND MACHINERY L T P C
4 0 0 4

OBJECTIVES:

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

UNIT I FLUID PROPERTIES AND FLOW CHARACTERISTICS 12

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

UNIT II FLOW THROUGH CIRCULAR CONDUITS 12

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

UNIT III DIMENSIONAL ANALYSIS 12

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

UNIT IV PUMPS 12

Impact of jets - Euler's equation - Theory of roto-dynamic machines – various efficiencies– velocity components at entry and exit of the rotor- velocity triangles - Centrifugal pumps– working principle - work done by the impeller - performance curves - Reciprocating pump- working principle – Rotary pumps –classification.

UNIT V TURBINES 12

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

TOTAL: 60 PERIODS

OUTCOMES:

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

- Apply mathematical knowledge to predict the properties and characteristics of a fluid.
- Can analyse and calculate major and minor losses associated with pipe flow in piping networks.
- Can mathematically predict the nature of physical quantities
- Can critically analyse the performance of pumps
- Can critically analyse the performance of turbines.

TEXT BOOK:

1. Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi 2013.

REFERENCES:

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

CE8395 STRENGTH OF MATERIALS FOR MECHANICAL ENGINEERS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the concepts of stress, strain, principal stresses and principal planes.
- To study the concept of shearing force and bending moment due to external loads in determinate beams and their effect on stresses.
- To determine stresses and deformation in circular shafts and helical spring due to torsion.
- To compute slopes and deflections in determinate beams by various methods.
- To study the stresses and deformations induced in thin and thick shells.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids – Tension, Compression and Shear Stresses – Deformation of simple and compound bars – Thermal stresses – Elastic constants – Volumetric strains – Stresses on inclined planes – principal stresses and principal planes – Mohr's circle of stress.

UNIT II TRANSVERSE LOADING ON BEAMS AND STRESSES IN BEAM 9

Beams – types transverse loading on beams – Shear force and bending moment in beams – Cantilevers – Simply supported beams and over – hanging beams. Theory of simple bending– bending stress distribution – Load carrying capacity – Proportioning of sections – Flitched beams – Shear stress distribution.

UNIT III TORSION 9

Torsion formulation stresses and deformation in circular and hollows shafts – Stepped shafts– Deflection in shafts fixed at the both ends – Stresses in helical springs – Deflection of helical springs, carriage springs.

UNIT IV DEFLECTION OF BEAMS 9

Double Integration method – Macaulay's method – Area moment method for computation of slopes and deflections in beams - Conjugate beam and strain energy – Maxwell's reciprocal theorems.

UNIT V THIN CYLINDERS, SPHERES AND THICK CYLINDERS 9

Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders – spherical shells subjected to internal pressure – Deformation in spherical shells – Lame's theorem.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

- Understand the concepts of stress and strain in simple and compound bars, the importance of principal stresses and principal planes.
- Understand the load transferring mechanism in beams and stress distribution due to shearing force and bending moment.
- Apply basic equation of simple torsion in designing of shafts and helical spring
- Calculate the slope and deflection in beams using different methods.
- Analyze and design thin and thick shells for the applied internal and external pressures.

TEXT BOOKS:

1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2007
2. Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2007

REFERENCES:

1. Egor. P.Popov "Engineering Mechanics of Solids" Prentice Hall of India, New Delhi, 2002
2. Ferdinand P. Been, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", Tata McGraw Hill Publishing 'co. Ltd., New Delhi, 2005.
3. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2013
4. Subramanian R., "Strength of Materials", Oxford University Press, Oxford Higher Education Series, 2010.

ME8392 MANUFACTURING TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

- The automobile components such as piston, connecting rod, crankshaft, engine block, front axle, frame and body are manufactured by various types of production processes involving casting, welding, machining, metal forming and power metallurgy.

UNIT I CASTING 8

Casting types, procedure to make sand mould, types of core making, moulding tools, machine moulding, special moulding processes – CO2 moulding; shell moulding, investment mounding, permanent mould casting, pressure die casting, centrifugal casting, continuous casting, casting defects.

UNIT II WELDING 8

Classification of welding processes. Principles of Oxy-acetylene gas welding. A.C metal arc welding, resistance welding, submerged arc welding, tungsten inert gas welding, metal inert gas welding, plasma arc welding, thermit welding, electron beam welding, laser beam welding, defects in welding, soldering and brazing.

UNIT III MACHINING 13

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

UNIT IV FORMING AND SHAPING OF PLASTICS 7

Types of plastics - Characteristics of the forming and shaping processes – Moulding of Thermoplastics – Working principles and typical applications of - Injection moulding – Plunger and screw machines – Blow moulding – Rotational moulding – Film blowing – Extrusion - Typical industrial applications – Thermoforming – Processing of Thermosets – Working principles and typical applications - Compression moulding – Transfer moulding – Bonding of Thermoplastics – Fusion and solvent methods – Induction and Ultrasonic methods

UNIT V METAL FORMING AND POWDER METALLURGY 9

Principles and applications of the following processes: Forging, Rolling, Extrusion, Wire drawing and Spinning, Powder metallurgy – Principal steps involved advantages, disadvantages and limitations of powder metallurgy.

TOTAL: 45 PERIODS

OUTCOME:

- The Students can able to use different manufacturing process and use this in industry for component production

TEXT BOOKS

1. Hajra Choudhury, “Elements of Workshop Technology”, Vol. I and II, Media Promoters and Publishers Pvt., Ltd., Mumbai, 2005.
2. Nagendra Parashar B.S. and Mittal R.K., “Elements of Manufacturing Processes”, Prentice-Hall of India Private Limited, 2007.

REFERENCES

1. Adithan. M and Gupta. A.B., “Manufacturing Technology”, New Age, 2006.
2. “H.M.T. Production Technology – Handbook”, Tata McGraw-Hill, 2000.
3. Jain. R.K. and S.C. Gupta, “Production Technology”, Khanna Publishers. 16th Edition,2001.
4. Roy. A. Linberg, “Process and Materials of Manufacture”, PHI, 2000.
5. Serope Kalpajian, Steven R.Schmid, “Manufacturing Processes for Engineering Materials”, Fourth Edition, Pearson Education, Inc. 2007.

AC8301 **SPACE SCIENCE**

L	T	P	C
3	0	0	3

OBJECTIVES:

- 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.

UNIT I INTRODUCTION 9

Introduction to space science and applications – historical development – Space Environment-Vacuum and its Effects, Plasma & Radiation Environments and their Effects, Debris Environment and its Effects - Newton's Law of gravitation – Fundamental Physical Principles.

UNIT II ORIGIN OF UNIVERSE 9

Early history of the universe – Big-Bang and Hubble expansion model of the universe – cosmic microwave background radiation – dark matter and dark energy.

UNIT III GALAXIES 7

Galaxies, their evolution and origin – active galaxies and quasars – Galactic rotation – Stellar populations – galactic magnetic field and cosmic rays.

UNIT IV STARS 10

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.

UNIT V SOLAR SYSTEM 10

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

OUTCOMES:

On successful completion of this course, the student will be able to

- Obtain a broad, basic knowledge of the space sciences.
- Understand the scientific concepts such as evolution by means of natural selection, age of the Earth and solar system and the Big-Bang.
- Detail the main features and formation theories of the various types of observed galaxies, in particular the Milky Way.
- Explain stellar evolution, including red giants, supernovas, neutron stars, pulsars, white dwarfs and black holes, using evidence and presently accepted theories;
- Detail the presently accepted formation theories of the solar system based upon observational and physical constraints;

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.

AE8311 THERMODYNAMICS LABORATORY L T P C
0 0 4 2

OBJECTIVE:

- To enhance the basic knowledge in applied thermodynamics

LIST OF EXPERIMENTS

1. Performance test on a 4-stroke engine
2. Valve timing of a 4 – stroke engine and port timing of a 2-stroke engine
3. Determination of effectiveness of a parallel flow heat exchanger
4. Determination of effectiveness of a counter flow heat exchanger
5. Determination of heating value of a fuel
6. Determination of specific heat of solid
7. Determination of thermal conductivity of solid.
8. Determination of thermal resistance of a composite wall.
9. COP test on a vapour compression refrigeration test rig
10. COP test on a vapour compression air-conditioning test rig

TOTAL: 60 PERIODS

OUTCOMES:

- Ability to perform test on diesel/petrol engine
- Ability to explain the characteristics of the diesel/Petrol engine
- Ability to determine the properties of the fuels.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl.No	Details of Equipment	Qty Req.	Experiment No.
1.	4 stroke twin cylinder diesel engine	1	1
2.	Cut section model of 4 stroke diesel engine and cut section model of 2 stroke petrol engine	1	2
3.	Parallel and counter flow heat exchanger test rig	1	3,4
4.	Bomb Calorimeter	1	5
5.	Vapour compression refrigeration test rig	1	9
6.	Vapour compression air-conditioning test rig	1	10
7.	Conductive heat transfer set up	1	7
8.	Composite wall	1	8

CE8481 STRENGTH OF MATERIALS LABORATORY L T P C
0 0 4 2

OBJECTIVE:

- To expose the students to the testing of different materials under the action of various forces and determination of their characteristics experimentally.

LIST OF EXPERIMENTS

1. Tension test on steel rod
2. Compression test on wood
3. Double shear test on metal
4. Torsion test on mild steel rod
5. Impact test on metal specimen (Izod and Charpy)
6. Hardness test on metals (Rockwell and Brinell Hardness Tests)
7. Deflection test on metal beam
8. Compression test on helical spring
9. Deflection test on carriage spring

TOTAL: 60 PERIODS

OUTCOME:

- The students will have the required knowledge in the area of testing of materials and components of structural elements experimentally.

REFERENCES:

1. Strength of Materials Laboratory Manual, Anna University, Chennai - 600 025.
2. IS1786-2008 (Fourth Revision, Reaffirmed 2013), 'High strength deformed bars and wires for concrete reinforcement – Specification', 2008.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

Sl. No.	Description of Equipment	Quantity
1.	UTM of minimum 400 kN capacity	1
2.	Torsion testing machine	1
3.	Izod impact testing machine	1
4.	Hardness testing machine Rockwell Vicker's } (any 2) Brinnel	1 each
5.	Beam deflection test apparatus	1
6.	Extensometer	1
7.	Compressometer	1
8.	Dial gauges	Few
9	Le Chatelier's apparatus	2
10	Vicat's apparatus	2
11	Mortar cube moulds	10

CE8462 FLUID MECHANICS AND MACHINERY LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- Upon Completion of this subject, the students can able to have hands on experience in flow measurements using different devices.
- Also perform calculation related to losses in pipes and also perform characteristic study of pumps, turbines.

LIST OF EXPERIMENTS

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

TOTAL: 60 PERIODS

OUTCOMES:

- Ability to use the measurement equipment for flow measurement
- Ability to do performance trust on different fluid machinery

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

S. NO.	NAME OF THE EQUIPMENT	Qty.
1	Orifice meter setup	1
2	Venturi meter setup	1
3	Rotameter setup	1
4	Pipe Flow analysis setup	1
5	Centrifugal pump/submergible pump setup	1
6	Reciprocating pump setup	1
7	Gear pump setup	1
8	Pelton wheel setup	1
9	Francis turbine setup	1
10	Kaplan turbine setup	1

MA8491 **NUMERICAL METHODS** **L T P C**
4 0 0 4

OBJECTIVES:

- To introduce the basic concepts of solving algebraic and transcendental equations.
- To introduce the numerical techniques of interpolation in various intervals in real life situations.
- To acquaint the student with understanding of numerical techniques of differentiation and integration which plays an important role in engineering and technology disciplines.
- To acquaint the knowledge of various techniques and methods of solving ordinary differential equations.
- To understand the knowledge of various techniques and methods of solving various types of partial differential equations.

UNIT I SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 12

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 matrix by Power method and Jacobi's method for symmetric matrices.

UNIT II INTERPOLATION AND APPROXIMATION 12

Interpolation with unequal intervals - Lagrange's interpolation – Newton's divided difference interpolation – Cubic Splines - Difference operators and relations - Interpolation with equal intervals - Newton's forward and backward difference formulae.

UNIT III NUMERICAL DIFFERENTIATION AND INTEGRATION 12

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 rule – Romberg's Method - Two point and three-point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's 1/3 rules.

UNIT IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS 12

Single step methods - Taylor's series method - Euler's method - Modified Euler's method - Fourth order Runge - Kutta method for solving first order equations - Multi step methods - Milne's and Adams - Bash forth predictor corrector methods for solving first order equations.

UNIT V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 12

Finite difference methods for solving second order two - point linear boundary value problems - Finite difference techniques for the solution of two-dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.

TOTAL: 60 PERIODS

OUTCOMES:

Upon successful completion of the course, students should be able to:

- Understand the basic concepts and techniques of solving algebraic and transcendental equations.
- Appreciate the numerical techniques of interpolation and error approximations in various intervals in real life situations.
- Apply the numerical techniques of differentiation and integration for engineering problems.
- Understand the knowledge of various techniques and methods for solving first and second order ordinary differential equations.
- Solve the partial and ordinary differential equations with initial and boundary conditions by using certain techniques with engineering applications.

TEXT BOOKS:

1. Burden, R.L and Faires, J.D, "Numerical Analysis", 9th Edition, Cengage Learning, 2016.
2. Grewal, B.S., and Grewal, J.S., "Numerical Methods in Engineering and Science", Khanna Publishers, 10th Edition, New Delhi, 2015.

REFERENCES:

1. Brian Bradie, “A Friendly Introduction to Numerical Analysis”, Pearson Education, Asia, New Delhi, 2007.
2. Gerald. C. F. and Wheatley. P. O., “Applied Numerical Analysis”, Pearson Education, Asia, 6th Edition, New Delhi, 2006.
3. Mathews, J.H. “Numerical Methods for Mathematics, Science and Engineering”, 2nd Edition, Prentice Hall, 1992.
4. Sankara Rao. K., “Numerical Methods for Scientists and Engineers”, Prentice Hall of India Pvt. Ltd, 3rd Edition, New Delhi, 2007.
5. Sastry, S.S, “Introductory Methods of Numerical Analysis”, PHI Learning Pvt. Ltd, 5th Edition, 2015

AC8401	AERODYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To recall the governing equations of fluid mechanics.
- To understand the behaviour of airflow over bodies with particular emphasis on aerofoil sections in the incompressible and compressible flow regime.
- 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 – Rayleigh and Fanno flows – isentropic flows – Prandtl Meyer expansion and expansion fans – interaction of shock and expansion waves.

TOTAL = 45 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Calculate the airspeed, static and dynamic pressure of the flow at any point using Continuity and Bernoulli equations.
- Explain the effect of airflow on an aircraft and its components using the laws of physics and fundamental mathematical methods
- Describe the conformal transformation and its application to fluid flow problems
- Understand the fluid flow characteristics over aerofoils, wings, and airplanes.
- Obtain the knowledge in shock phenomenon and fluid waves.

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.

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.

AC8402	AEROSPACE STRUCTURAL MECHANICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Appreciate the roles that structures and structural materials play in aerospace vehicles.
- Understand general design concepts for aerospace structures, components, vehicles, and materials.
- Develop the analysis tools and skills needed to analyse the static and dynamic performance of aerospace structures.
- Gain experience in identifying, formulating, and solving aerospace structural engineering problems.

UNIT I INTRODUCTION 9

Semi-monocoque aerospace structures – Loads and Design considerations – construction concepts – layout – nomenclature and structural function of parts – strength vs stiffness-based design – Energy Method – Beam bending.

UNIT II BENDING, SHEAR AND TORSION OF THIN-WALLED BEAMS (TWB) 9

Bending and shear of open, closed, and thin-walled beams – torsion on single-cell thin-walled beams – torsion on multiple-cell thin-walled beams.

UNIT III BUCKLING OF THIN-WALLED BEAMS 9

Concept of structural instability – flexural buckling analysis – bending of beams under combined axial and lateral loads – short column and inelastic buckling – Pure torsional buckling and coupled flexural-torsional buckling of open TWBs – concept of buckling of plates, local buckling of TWBs – buckling and post-buckling of stiffened skin panels – ultimate load carrying capacity of a typical semi-monocoque TW box section – tension-field beams.

UNIT IV PLATE THEORY 9

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

UNIT V COMPOSITE AND SANDWICH STRUCTURES 9

Introduction to Advanced Fibre Composites – Analysis of Orthotropic Composite Plies – Laminate theory – Analysis of Composite Laminates: Stiffness Matrix – Stress and Strain – Thermal Expansion – Failure Mechanisms and Analysis – failure criteria – composite beams – sandwich structures.

TOTAL = 45 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Recognize phenomena such as deformation, stress, and strain in simple aerospace structural elements.
- Solve the simple 1D axial deformation, torsion, and bending problems.
- Compute shear stresses and twist angles in torsion for solid sections, closed thin-walled sections and open thin-walled sections.
- Understand the shear centre of a beam and an ability to predict its location.
- Evaluate the suitability of composite materials for the simple structural elements for specific aerospace applications.

TEXT BOOKS:

1. Megson, T. H. G., “Aircraft Structures for Engineering Students”, Butterworth-Heinemann, 4th Ed., 2007.
2. Peery, D. J., “Aircraft Structures”, McGraw-Hill Education, 2nd Ed., 1982.

REFERENCES:

1. Allen, D.D. and Haisler, W.E., Introduction to Aerospace Structural Analysis, Wiley, 1985.
2. Bruhn. E.H. “Analysis and Design of Flight Vehicles Structures”, Tri – state off set company, USA, 1985.
3. Cutler, J. and Liber, J., “Understanding Aircraft Structures”, 4th Ed., Wiley Blackwell, 2006.
4. Donaldson, B. K., “Analysis of Aircraft Structures” (Cambridge Aerospace Series), 2nd Ed., Cambridge University Press, 2008.
5. Sun, C. T., “Mechanics of Aircraft Structures”, 2nd Ed., Wiley-Interscience, 2006.

AC8403	FLIGHT SYSTEMS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To describe the principle and working of flight systems and instruments.
- To interpret the basics of guided missile systems.
- To outline the basics of spacecraft systems.

UNIT I FLIGHT CONTROL SYSTEMS 9

Conventional Systems – Power assisted and fully powered flight controls – Power actuated systems – Engine control systems – Push pull rod system – flexible push full rod system – Components – Modern control systems – Digital fly by wire systems – Auto pilot system active control Technology – Communication and Navigation systems – Instrument landing systems.

UNIT II FLIGHT SYSTEMS 9

Hydraulic systems, Components – Hydraulic system controllers – Modes of operation – Pneumatic systems – Working principles – Typical Air pressure system – Brake system – Typical Pneumatic power system, Components – Landing Gear systems – Classification – Shock absorbers – Retractive mechanism – Rocket Separation mechanism.

UNIT III ENGINE SYSTEMS 9

Fuel systems for Piston and jet engines – Components of multi engines – Lubricating systems for piston and jet engines – Starting and Ignition systems – Typical examples for piston and jet engines.

UNIT IV GUIDED MISSILE SYSTEMS 9

Introduction – Airframe – Propulsion System – Types of Control Systems – Gyroscope and its types – Roll and Lateral Control System – Fin Actuation Servos – Roll and Lateral Autopilot – Guidance System.

UNIT V SPACECRAFT SYSTEMS 9

Basics: Structure – Power – Thermal - Communications and Data Handling - Propulsion System - Attitude Stabilisation and Control.

TOTAL = 45 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Understand the controls and operation of an aircraft.
- Understand the aircraft systems are maintained.
- Understand the systems available in the aircraft engines.
- Know the systems available in a missile.
- Know the basics of systems available in a spacecraft.

TEXT BOOKS:

1. Mohan S. R., “Fundamentals of Guided Missiles”, Cataloguing-in-Publication, 2016.
2. Pallet, E.H.J., “Aircraft Instruments: Principles and Applications”, Pearson, 2009.

REFERENCES:

1. David Harris, “Flight Instruments and Automatic Flight Control”, Blackwell, Sixth Ed., 2004.
2. “General Hand Books of Airframe and Powerplant Mechanics”, U.S. Dept. of Transportation, Federal Aviation Administration, The English Book Store, New Delhi, 1995.
3. McKinley, J.L. and Bent, R.D., “Aircraft Power Plants”, McGraw-Hill, 1993.
4. Treager, S., “Gas Turbine Technology”, McGraw-Hill, 1997.
5. Vincent L. Pisacane, “Fundamentals of Space Systems”, 2nd Ed., Oxford University Press, Inc., 2005.

PR8451 MECHANICS OF MACHINES L T P C
3 0 0 3

OBJECTIVES:

- To understand the principles in the formation of mechanisms and their kinematics.
- To understand the effect of friction in different machine elements.
- To understand the importance of balancing and vibration.

UNIT I KINEMATICS OF MACHINES 9

Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slide crank chain – kinematics analysis in simple mechanisms – velocity and acceleration polygons – Cam and followers – classifications – displacement diagrams - layout of plate cam profiles – derivatives of followers motion

UNIT II GEARS AND GEAR TRAINS 9

Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth action interference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – epicyclic gear trains.

UNIT III FRICTION 9

Types of friction – Friction Drives -friction in screw threads – bearings – Friction clutches – Belt drives

UNIT IV BALANCING AND MECHANISM FOR CONTROL 9

Static and Dynamic balancing – Balancing of revolving and reciprocating masses – Balancing machines -Balancing a single cylinder engine – Balancing of Multi-cylinder inline, V-engines – Partial balancing in engines- Governors and Gyroscopic effects.

UNIT V VIBRATION 9

Free, forced and damped vibrations of single degree of freedom systems – force transmitted to supports – vibration Isolation – vibration absorption – torsional vibration of shafts – single and multirotor systems – geared shafts – critical speed of shafts.

TOTAL: 45 PERIODS

OUTCOMES:

Student will be able to

- Understand the principles in the formation of mechanisms and their kinematics.
- Understand the construction features of Gears and Gear Trains.
- Understand the effect of friction in different machine elements.
- Understand the importance of balancing.
- Understand the importance of Governors and Gyroscopic effects.
- Understand the importance of vibration.

TEXT BOOKS:

1. Ambekar A.G.,Mechanism and Machine Theory‖ Prentice Hall of India, New Delhi, 2007
2. Shigley J.E., Pennock G.R and Uicker J.J., —Theory of Machines and Mechanisms‖, Oxford University Press, 2003

REFERENCES:

1. Ghosh.A, and A.K.Mallick, —Theory and Machine ‖, Affiliated East-West Pvt. Ltd., New Delhi, 1988.
2. Ramamurthi. V., "Mechanisms of Machine", Narosa Publishing House, 2005.
3. Rao.J.S. and Dukkipatti R.V. —Mechanisms and Machines ‖, Wiley-Eastern Ltd., New Delhi, 1998.
4. Robert L.Norton, "Design of Machinery", McGraw-Hill, 2012.
5. Thomas Bevan, —Theory of Machines‖, CBS Publishers and Distributors, 2010.

GE8291 ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To study the nature and facts about environment.
- To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the dynamic processes and understand the features of the earth‟s interior and surface.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 14

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds; Field study of simple ecosystems – pond, river, hill slopes.

UNIT II ENVIRONMENTAL POLLUTION 8

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – solid waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over- utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation

– consumerism and waste products – environment production act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health – Case studies.

TOTAL: 45 PERIODS

OUTCOMES:

- Environmental Pollution or problems cannot be solved by mere laws. Public participation is an important aspect which serves the environmental Protection. One will obtain knowledge on the following after completing the course.
- Public awareness of environmental is at infant stage.
- Ignorance and incomplete knowledge have led to misconceptions
- Development and improvement in std. of living has led to serious environmental disasters

TEXT BOOKS:

1. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2006.
2. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education, 2004.

REFERENCES:

1. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD,New Delhi, 2007.
2. Erach Bharucha, "Textbook of Environmental Studies", Universities Press(I) PVT, LTD, Hydrabad, 2015.
3. G. Tyler Miller and Scott E. Spoolman, "Environmental Science", Cengage Learning India PVT, LTD, Delhi, 2014.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 2005.

AC8411 LOW AND HIGH SPEED AERODYNAMICS LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVE:

To study experimentally the aerodynamic forces on different bodies at low and high speeds.

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 aerofoils.
4. Illustrate the Pressure distribution over cambered aerofoils & thin aerofoils.
5. Measure the forces acting on a model using wind tunnel balance.
6. Demonstrate the flow over a flat plate at different angles of incidence.
7. Show the flow visualisation studies in low speed flows over cylinders.
8. Show the flow visualisation studies in low speed flows over aerofoil with different angle of incidence.
9. Calibration of supersonic wind tunnel.
10. Show the Supersonic flow visualization with Schlieren system.

TOTAL: 60 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Critically assess the wind tunnel for wall effect, blockage and support interference on the measurements as well as determining the uncertainty in the measurement technique.
- Find the pressure distribution and forces acting over aerodynamical models.
- Understand flow over the aerodynamical model through flow visualisation.
- Understand the limits and usefulness of the experimental approach.
- Present the experimental findings in clear oral and concise report.

LIST OF EQUIPMENTS

(For a batch of 30 students)

S. No	Details of Equipment	Qty Req.	Experiment No.
1	Wind Tunnel	1 No.	1, 2,3,4,5
2	Wings of various aerofoil sections (Symmetrical & cambered aerofoils)	2 Nos. each	3, 4
3	Angle of incidence changing mechanism	1 No.	3, 4
4	Multiple Manometer stands	4 Nos.	2,3,4
5	U-Tube Manometer	1 No.	1,2,3,4
6	Static Pressure Probes	4 Nos.	1,2,3,4
7	Total Pressure Probes	4 Nos.	1,2,3,4
8	Pitot-Static Tubes	4 Nos.	1,2,3,4
9	Wooden Models of Three-Dimensional bodies	2 Nos. each	2
10	Wind Tunnel balances (3 or 5 or 6 components)	1 No.	5
11	Pressure Transducers with digital display	1 No.	1,2,3,4
12	Hele-Shaw apparatus, Smoke Tunnel, Water flow channel	1 each	6,7,8
13	Supersonic Wind tunnel	1 No.	9,10
14	Wooden models of cone, wedge and blunt body configurations of suitable size for flow visualization in a supersonic wind tunnel test section	1 No.	9,10
15	Schlieren System	1 No.	10

AC8412 **STRUCTURES LABORATORY**

L	T	P	C
0	0	4	2

OBJECTIVE:

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

LIST OF EXPERIMENTS:

1. Unsymmetrical bending of beams.
2. Find the shear centre location for open sections.
3. Find the shear centre location for closed sections.
4. Experiment the constant strength beam.
5. Draw the flexibility matrix for cantilever beam.
6. 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.

TOTAL: 60 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Understand the effects of bending in the aerospace structures.
- Find the shear centre of the aerospace structures.
- Conduct test on beams for the structural analysis.
- Use the photo-elastic techniques on the aerospace structures.
- Present the experimental findings in clear oral and concise report.

LIST OF EQUIPMENTS

(For a batch of 30 students)

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

AC8413 **FLIGHT SYSTEMS LABORATORY** **L T P C**
0 0 4 2

OBJECTIVE:
To train the students with hands on experience in maintenance of various systems in Flight and rectification of common snags.

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

TOTAL: 60 PERIODS

OUTCOMES:
On successful completion of this course, the student will be able to
- Understand the procedure of ground level checking.
- Conduct test on the various systems available in the spacecraft.
- Understand the procedures of maintenance and rectification.
- Present the experimental findings in clear oral and concise report.

LIST OF EQUIPMENTS
(For a batch of 30 students)

S. No	Details of Equipment	Qty Req.	Experiment No.
1	Serviceable Flight with all above systems	1	1,2,3,4,5,6,7,8,9,10
2	Hydraulic Jacks (Screw Jack)	5	1,2,4,8
3	Trestle adjustable	5	1,2,4,8
4	Spirit Level	2	8
5	Levelling Boards	2	8
6	Cable Tensiometer	1	8
7	Adjustable Spirit Level	1	8
8	Plumb Bob	1	8

AE8001 **SPACE MECHANICS** **L T P C**
3 0 0 3

OBJECTIVE:

- To introduce concepts of satellite injection and satellite perturbations, trajectory computation for interplanetary travel and flight of ballistic missiles based on the fundamental concepts of orbital mechanics.

UNIT I SPACE ENVIRONMENT 8

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

UNIT II BASIC CONCEPTS AND THE GENERAL N- BODY PROBLEM 10

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 - many body problem - Lagrange-Jacobi identity – circular restricted three body problem – libration points – general N-body problem – two body problem – relations between position and time.

UNIT III SATELLITE INJECTION AND SATELLITE PERTURBATIONS 10

General aspects of satellite injection – satellite orbit transfer – various cases – orbit deviations due to injection errors – special and general perturbations – Cowell's method and Encke's method – method of variations of orbital elements – general perturbations approach.

UNIT IV INTERPLANETARY TRAJECTORIES 8

Two-dimensional interplanetary trajectories – fast interplanetary trajectories – three dimensional interplanetary trajectories – launch of interplanetary spacecraft – trajectory estimation about the target planet – concept of sphere of influence – Lambert's theorem

UNIT V BALLISTIC MISSILE TRAJECTORIES 9

Introduction to ballistic missile trajectories – boost phase – ballistic phase – trajectory geometry – optimal flights – time of flight – re-entry phase – position of impact point – influence coefficients.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to perform satellite injection, satellite perturbations and trajectory control
- Apply orbital mechanics to control ballistic missile.
- Estimate the trajectory/orbit of a space vehicle or a satellite in a suitable coordinate system.
- Calculate the delta-v required for transferring a spacecraft from one orbit to another.
- Perform orbit perturbation analysis for satellite orbits.

TEXT BOOKS:

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

REFERENCE:

1. Sutton, G.P., "Rocket Propulsion Elements", Wiley, New York, 9th Ed., 2017.

AC8501 **AIR BREATHING PROPULSION** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the principles of operation of aircraft propulsion systems.
- To extend the performances of aircraft propulsion systems.
- To understand the basics of integral ram-rocket and its performance.

UNIT I SUBSONIC AND SUPERSONIC INTAKES 9

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 – Gas Turbine Combustors – Afterburners – Fuel injection in combustion chamber – Important factors affecting combustor design – Combustion chamber performance – 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

OUTCOMES:

On successful completion of this course, the student will be able to

- Acquire the fundamentals in internal flow, turbomachinery aerodynamics, and air-breathing propulsion system design.
- Understand the performance characteristics of the compressors.
- Understand the performance characteristics of the turbines.
- Develop physical insight into the phenomena which characterize the fluid dynamic behaviour of air-breathing propulsion systems.
- Determine the approximate use parameters of an existing gas turbine engine.

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.

AE8501 **FLIGHT DYNAMICS** **L T P C**
3 2 0 4

OBJECTIVE:
To study the performance of airplanes under various operating conditions and the static and dynamic response of aircraft for both voluntary and involuntary changes in flight conditions

UNIT I CRUISING FLIGHT PERFORMANCE 9+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 power required

UNIT II MANOEUVERING FLIGHT PERFORMANCE 9+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) – Take-off and landing – Turning performance (Turning rate turn radius). Bank angle and load factor – limitations on turn – V-n diagram and load factor.

UNIT III STATIC LONGITUDINAL STABILITY 9+6
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 manoeuvres – Stick force gradients – Stick force per ‘g’ – Aerodynamic balancing.

UNIT IV LATERAL AND DIRECTIONAL STABILITY 9+6
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+6
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: 75 PERIODS

OUTCOMES:
- Know about the forces and moments that are acting on an aircraft, the different types of drag, drag polar, ISA, variation of thrust, power, SFC with velocity and altitude.
- Have understanding about performance in level flight, minimum drag and power required, climbing, gliding and turning flight, v-n diagram and load factor.
- Knowledge about degrees of stability, stick fixed and stick free stability, stability criteria, effect of fuselage and CG location, stick forces, aerodynamic balancing.
- Understanding about lateral control, rolling and yawing moments, static directional stability, rudder and aileron control requirements and rudder lock.
- Understanding about dynamic longitudinal stability, stability derivatives, modes and stability criterion, lateral and directional dynamic stability.

TEXT BOOKS:

1. Mc Cornick. W., “Aerodynamics, Aeronautics and Flight Mechanics”, John Wiley, NY, 1979.
2. Nelson, R.C. “Flight Stability and Automatic Control”, McGraw-Hill Book Co., 2004.
3. Perkins, C.D., and Hage, R.E., “Airplane Performance stability and Control”, John Wiley & Son:, Inc, NY, 1988.

REFERENCES:

1. Babister, A.W., “Aircraft Dynamic Stability and Response”, Pergamon Press, Oxford, 1980.
2. Dommasch, D.O., Sherby, S.S., and Connolly, T.F., “Aeroplane Aero dynamics”, Third Edition, Issac Pitman, London, 1981.
3. Etkin, B., “Dynamics of Flight Stability and Control”, Edn. 2, John Wiley, NY, 1982.
4. Mc Cornick B. W, “Aerodynamics, Aeronautics and Flight Mechanics”, John Wiley, NY, 1995.

AC8502 FUNDAMENTALS OF AEROSPACE CONTROL ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the basic concepts of Aerospace control systems.
- To construct the root locus and to analyse the effect of gain in the feedback path.
- To illustrate the plots related to the frequency responses.
- To design the space vehicles control systems.

UNIT I INTRODUCTION AND SYSTEM RESPONSE 9

Control objectives and tasks – open and closed-loop control structures – negative and positive feedback – Impulse response – convolution integral – response of higher order systems to arbitrary and standard inputs in Laplace and time domains – qualitative dependence on poles and zeros – dominant poles.

UNIT II STABILITY AND ROOT LOCUS ANALYSIS 9

Asymptotic and bounded-input bounded-output stability – characteristic equation and its roots – role of characteristic roots in stability – Routh's criterion – relative and absolute stability – Impact of positive feedback on stability – Closed-loop stability analysis using root locus – Impact of open-loop poles and zeros on the root locus – root locus for positive feedback systems – effect of gain in the feedback path – root loci for multiple parameters.

UNIT III FREQUENCY RESPONSE 9

Magnitude and phase – frequency response of higher order systems – Bode, polar and Nichols plots – bandwidth – Nyquist stability criterion – gain and phase margins.

UNIT IV STANDARD CONTROL ACTIONS 9

Proportional control – steady state error constants – system type – tracking control and integral control – lag compensator – transient response improvement and derivative control – lead compensators.

UNIT V ASPECTS OF SPACE VEHICLE CONTROL DESIGN 9

Control Systems – Attitude Control – Having the Right Attitude – Attitude Dynamics – Disturbance Torques – Spacecraft Attitude Sensors – Spacecraft Attitude – Actuators – Controller.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Characterise the behaviour of elementary feedback control systems.
- Synthesise feedback controllers using root locus, Nyquist and Bode techniques.
- Analytically quantify the time and frequency domain behaviour of dynamic systems.
- Specify steady state control system requirements and select prototype controller structures to achieve these requirements.
- Formulate dynamic feedback controller design specifications in the frequency domain.

TEXT BOOKS:

1. Gopal, M., "Control Systems – Principles and Design", 3rd Ed., Tata McGraw-Hill, 2008.
2. Ogata, K., "Modern Control Engineering", 5th Ed., Prentice Hall India, Eastern Economy Ed., 2010.

REFERENCES:

1. Azzo, J.J.D. and C.H. Houpis, "Feedback control system analysis and synthesis", McGraw – Hill International, 3rd Ed., 1998.
2. Houpis, C.H. and Lamont, G.B., "Digital Control Systems", McGraw-Hill Book Co. New York, USA 1995.
3. John H. Blackelock, "Automatic Control of aircraft and Missiles", John Wiley & Sons, 2nd Ed.1990.
4. Kuo, B. C. and Golnaraghi, F., "Automatic Control Systems", 8th Ed., John Wiley & Sons, 2003.
5. Naresh K. Sinha, "Control Systems", New Age International Publishers, New Delhi, 2008.

AC8503	ELEMENTS OF SPACEFLIGHT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To describe the historical evolution of different types of flight vehicles with classifications.
- Know the basic principles on which the development of aerodynamics and other principal sub disciplines of aerospace engineering are made.

UNIT I HISTORICAL EVOLUTION 9

Early airplanes, biplanes, monoplanes, Launch vehicles and Missiles – Developments in aerodynamics, materials, structures and propulsion over the years – Different types of flight vehicles, classifications – Conventional control and Powered control.

UNIT II PRINCIPLES OF FLIGHT 9

Physical properties and structure of the atmosphere – Temperature, pressure and altitude relationships – Evolution of lift, drag, moment and thrust – Manoeuvring Principles.

UNIT III SPACECRAFT STRUCTURES 10

Introduction – Design Philosophy – Design for Launch – Configuration Examples – Design Verification – future for space structures.

UNIT IV POWER PLANTS USED IN AEROSPACE VEHICLES 9

Principles of operation of IC engine, turboprop and jet engines – use of propeller and jets for thrust production – Comparative merits – Principles of operation of rocket, types of rockets and missiles - typical applications – Exploration into space.

UNIT V BASICS OF SPACE DYNAMICS 8

Overview of astronomy – reference coordinate system in space, telescopes, flux, magnitudes – Satellite Missions and introduction to orbital mechanics – Different types of satellites and their applications.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Summarise the historical evaluation of aviation.
- Explain the forces and moments acting on a space flight.
- Understand the materials used in the manufacturing of aerospace structures.
- Identify the suitable power plant for the aerospace vehicles.
- Explain the governing dynamics of spaceflight, with emphasis on rocket dynamics and basic orbital mechanics.

TEXT BOOK:

1. Anderson J.D., “Introduction to Flight”, McGraw-Hill, 6th Ed., 2010.
2. Dave Doody, “Basics of Space Flight”, NASA/JPL-Caltech, 2011.

REFERENCES:

1. Francis J. Hale, “Introduction to Space Flight”, Pearson, 1994.
2. George Cary Comstock, “A Text-Book of Field Astronomy for Engineers”, J. Wiley & sons, 2009.
3. Kermode, A.C., “Flight without Formulae”, Pearson Education; 5th Ed., 2004.
4. Wijker J.J., “Spacecraft Structures”, Springer-Verlag Berlin Heidelberg, 2008.

AC8511 **AEROSPACE PROPULSION LABORATORY**

L	T	P	C
0	0	4	2

OBJECTIVE:

To understand the basic concepts of aerodynamic and thermodynamic characteristics of major engine components and to carryout experiments in Aerospace Propulsion.

LIST OF EXPERIMENTS:

1. Conduct the performance test on a propeller.
2. Measure the wall pressure of subsonic diffuser.
3. Measure the wall pressure of supersonic nozzles.
4. Conduct the wall pressure study of Single Expansion Ramp Nozzle (SERN).
5. Show the flow visualisation of shock waves at the lip of supersonic intake.
6. Show the flow visualisation of secondary injection in a supersonic flow.
7. Experimental study of supersonic free jet.
8. Experimental study of supersonic wall jet.
9. Conduct the cold flow studies in a Ramjet duct.
10. Experiment with the cascade Testing of turbine blades.

TOTAL: 60 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Analyse the performance of the propeller.
- Measure the wall pressure of the engine components.
- Visualize the flow pattern in the engine components.
- Explain the concepts of free jet and wall jet.

LIST OF EQUIPMENT

(for a batch of 30 students)

Sl. No	Equipment	Qty	Experiments No.
1	Subsonic Wind Tunnel	1	1,2
2	Supersonic Wind Tunnel	1	3 – 10
3	Propeller Blade	1	1
4	Pressure Probe Rack	1	2
5	Multi-tube Manometers	3 Sets	2,3,4,9,10
6	Pressure Scanner	2 Sets	2,3,4,9,10
7	High Resolution CCD Camera for Flow Visualization	1	5,6
8	Shadowgraph Technique	1	5,6
9	2D Traversing Mechanism with Pressure Probe holder and Pressure Scanner	1	7,8

AC8512	SPACE LAUNCH VEHICLE MINI PROJECT – I	L	T	P	C
		0	0	4	2

OBJECTIVE:

This course is intended to provide basic knowledge and practice in the design skills for initial sizing of vehicles for powered flight to orbit.

TASKS:

1. Classification of rocketry & launch vehicles.
2. Current & future launch vehicles, Orbit/trajectory requirements and missions.
3. Rocket propulsion: generation of thrust, the rocket equation. Specific impulse, types of engines, Launch vehicle parameters & performance.
4. Staging, Structure & propulsion design trades.
5. 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.

TOTAL: 60 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Translate a design brief for a complex, indeterminate aerospace system into a set of well-defined engineering requirement.
- Generate, using creative techniques, credible design concepts for aerospace systems based on a set of engineering requirements.
- Evaluate design concepts for aerospace systems using analysis, experiment or simulation methods.
- Demonstrate effective teamworking and project management skills.

REFERENCES:

1. Griffin and French, “Space Vehicle Design”, AIAA, 2004, ISBN 1563475391.
2. Meyer R., “Elements of Space Technology”, Academic Press, 1999, ISBN 0124929400
3. Sforza, “Manned Spacecraft Design Principles”, Elsevier, 2016, ISBN 9780128044254
4. Walter U., “Astronautics”, WILEY-VCH, 2008, ISBN 9783527406852.

HS8581	PROFESSIONAL COMMUNICATION	L	T	P	C
		0	0	2	1

OBJECTIVES: The course aims to:

- Enhance the Employability and Career Skills of students
- Orient the students towards grooming as a professional
- Make them Employable Graduates
- Develop their confidence and help them attend interviews successfully.

UNIT I

Introduction to Soft Skills – Hard skills & soft skills – employability and career Skills – Grooming as a professional with values – Time Management – General awareness of Current Affairs.

UNIT II

Self-Introduction-organizing the material - Introducing oneself to the audience – introducing the topic – answering questions – individual presentation practice— presenting the visuals effectively – 5 minute presentations.

UNIT III

Introduction to Group Discussion – Participating in group discussions – understanding group dynamics – brainstorming the topic – questioning and clarifying – GD strategies – activities to improve GD skills.

UNIT IV

Interview etiquette – dress code – body language – attending job interviews – telephone/skype interview – one to one interview &panel interview – FAQs related to job interviews.

UNIT V

Recognizing differences between groups and teams – managing time-managing stress – networking professionally – respecting social protocols – understanding career management – developing a long-term career plan-making career changes.

TOTAL : 30 PERIODS

OUTCOMES: At the end of the course Learners will be able to:

- Make effective presentations
- Participate confidently in Group Discussions.
- Attend job interviews and be successful in them.
- Develop adequate Soft Skills required for the workplace

Recommended Software

1. Open Source Software
2. Win English

REFERENCES:

1. Butterfield, Jeff Soft Skills for Everyone. Cengage Learning: New Delhi, 2015
2. E. Suresh Kumar et al. Communication for Professional Success. Orient Blackswan: Hyderabad, 2015
3. Interact English Lab Manual for Undergraduate Students,. OrientBalckSwan: Hyderabad, 2016.
4. Raman, Meenakshi and Sangeeta Sharma. Professional Communication. Oxford University Press: Oxford, 2014
5. S. Hariharanetal. Soft Skills. MJP Publishers: Chennai, 2010.

AC8601	SPACE PROPULSION	L	T	P	C
		3	0	0	3

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.

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 – 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 Rate – Analytical Models - Vortex Injection – 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 – Plane Diode – Electrostatic Thruster Performance – Arcjet – Pulsed-Magnetoplasma Accelerators – Laser Propulsion-Different Types, Advantages and Applications.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Explain hypersonic propulsion systems and their application to aerospace vehicles.
- Understand the traditional propulsion concepts, including liquid, solid, hybrid, ion, and thermal rockets.
- Know the applications and principles of solid, liquid, and hybrid rocket propulsion systems.
- Understand the performances of various rocket propulsion systems.
- Apply the concepts of electrical propulsion in rocket.

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.

AE8008 VIBRATION AND ELEMENTS OF AEROELASTICITY L T P C
3 0 0 3

OBJECTIVES:

- To study the effect of time dependent forces on mechanical systems and to get the natural characteristics of system with more degree of freedom systems.
- To study the aeroelastic effects of aircraft wing.

UNIT I SINGLE DEGREE OF FREEDOM SYSTEMS 10

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 10

Two degrees of freedom systems - static and dynamic couplings - vibration absorber- Multi degree of freedom systems - principal co-ordinates - principal modes and orthogonal conditions - Eigen value problems - Hamilton's principle - Lagrangean equations and application.

UNIT III CONTINUOUS SYSTEMS 8

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, matrix iteration method.

UNIT V ELEMENTS OF AEROELASTICITY 8

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

OUTCOMES

- Gaining understanding of single and multi-degree vibrating systems
- Ability to use numerical techniques for vibration problems
- Knowledge acquired in aero elasticity and fluttering.
- Differentiate types of vibrations according to dampness and particle motion.
- Solve Rayleigh and Holzer method to find natural frequency of an object.
- Understand the formation of Aileron reversal, flutter and wing divergence.

TEXT BOOKS:

1. Grover. G.K., "Mechanical Vibrations", 7th Edition, Nem Chand Brothers, Roorkee, India, 2003
2. Leonard Meirovitch, "Elements of Vibration Analysis". McGraw Hill International Edition,2007
3. Thomson W T, 'Theory of Vibration with Application' - CBS Publishers, 1990.

REFERENCES:

1. Bisplinghoff R.L., Ashely H and Hogman R.L., "Aeroelasticity", Addision Wesley Publication, New Tork, 1983.
2. Den Hartog, "Mechanical Vibrations" Crastre Press, 2008.
3. TSE. F.S., Morse, I.F., Hinkle, R.T., "Mechanical Vibrations" – Prentice Hall, New York, 1984.
4. William W Seto, "Mechanical Vibrations" – McGraw Hill, Schaum Series.
5. William Weaver, Stephen P. Timoshenko, Donovan H. Yound, Donovan H. Young. 'Vibration Problems in Engineering' – John Wiley and Sons, New York, 2001.

AE8601 FINITE ELEMENT METHODS L T P C
3 0 0 3

OBJECTIVE:

- To give exposure various methods of solution and in particular the finite element method. Gives exposure to the formulation and the procedure of the finite element method and its application to varieties of problems.

UNIT I INTRODUCTION 8

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

UNIT II DISCRETE ELEMENTS 10

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

UNIT III CONTINUUM ELEMENTS 8

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

UNIT IV ISOPARAMETRIC ELEMENTS 9

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

UNIT V FIELD PROBLEM AND METHODS OF SOLUTIONS 10

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 (L:45): 45 PERIODS

OUTCOMES:

- Write flow chart of finite element steps and understand the convergence of the problem
- Solve stiffness matrix for bar, beam and frame problems using suitable boundary condition.
- Plane stress and plane strain condition are used to understand 2d structures.
- Modelling of 2d and 3d structures using isoparametric elements
- Apply the concepts of finite element methods to solve fluid flow and heat transfer problems.

TEXT BOOKS:

1. Reddy J.N., "An Introduction to Finite Element Method", McGraw Hill, third edition, 2005.
2. Tirupathi.R. Chandrapatha and Ashok D. Belegundu, "Introduction to Finite Elements in Engineering", Prentice Hall India, Fourth edition, 2012.

REFERENCES:

1. Bathe, K.J. and Wilson, E.L., "Numerical Methods in Finite Elements Analysis", Prentice Hall of India, 1985.
2. Krishnamurthy, C.S., "Finite Element Analysis", Tata McGraw Hill, 2000.
3. Rao. S.S., "Finite Element Methods in Engineering," Butterworth and Heinemann, 2001.

AC8602	SPACECRAFT DYNAMICS	L	T	P	C
		3	2	0	4

OBJECTIVE:

- 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.

UNIT I ORBITAL MECHANICS 9+6

Types of spacecraft – present-day satellites and launch vehicles – orbit determination from injection conditions, position and velocity prediction from orbital elements.

UNIT II SATELLITE OPERATIONS 9+6

Geostationary orbit – Hohmann transfer – Inclination change manoeuvres – launch windows for rendezvous missions – perturbation effects due to earth oblateness – sun synchronous orbits.

UNIT III MECHANICS 9+6

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 GYRODYNAMICS 9+6

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+6

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: (L:45 + T:30) = 75 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Develop math models of flight vehicles.
- Understand the operations of the satellite.
- Analyse dynamics and control of flight vehicles.
- Make effective use of gyroscopes.
- Demonstrate knowledge on the attitude dynamics of aerospace flight vehicles.

TEXTS:

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.

AE8751 **AVIONICS** **L T P C**
3 0 0 3

OBJECTIVES:

- To introduce the basic of avionics and its need for civil and military aircrafts
- To impart knowledge about the avionic architecture and various avionics data buses
- To gain more knowledge on various avionics subsystems

UNIT I INTRODUCTION TO AVIONICS 9

Need for avionics in civil and military aircraft and space systems – integrated avionics and weapon systems – typical avionics subsystems, design, technologies – Introduction to digital computer and memories.

UNIT II DIGITAL AVIONICS ARCHITECTURE 9

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

UNIT III FLIGHT DECKS AND COCKPITS 9

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

UNIT IV INTRODUCTION TO NAVIGATION SYSTEMS 9

Radio navigation – ADF, DME, VOR, LORAN, DECCA, OMEGA, ILS, MLS – Inertial Navigation Systems (INS) – Inertial sensors, INS block diagram – Satellite navigation systems – GPS.

UNIT V AIR DATA SYSTEMS AND AUTO PILOT 9

Air data quantities – Altitude, Air speed, Vertical speed, Mach Number, Total air temperature, Mach warning, Altitude warning – Auto pilot – Basic principles, Longitudinal and lateral auto pilot.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to build Digital avionics architecture
- Ability to Design Navigation system
- Ability to design and perform analysis on air system.
- Integrate avionics systems using data buses.
- Analyze the performance of various cockpit display technologies.
- Design autopilot for small aircrafts using MATLAB

TEXT BOOKS:

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

REFERENCES:

1. Middleton, D.H., Ed., "Avionics systems, Longman Scientific and Technical", Longman Group UK Ltd., England, 1989.
2. Pallet.E.H.J., "Aircraft Instruments and Integrated Systems", Pearsons, Indian edition 2011.
3. Spitzer, C.R. "Digital Avionics Systems", Prentice-Hall, Englewood Cliffs, N.J.,U.S.A. 1993.
4. Spitzer. C.R. "The Avionics Hand Book", CRC Press, 2000

AC8611	CAD LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVE:

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

LIST OF EXPERIMENTS

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

TOTAL: 60 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Use commercial design software and understand its structure.
- Design the aircraft and spacecraft components and solve engineering problems.
- Write formal technical report and convey engineering.

LIST OF EQUIPMENT

(for a batch of 30 students)

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

AC8612	SPACE LAUNCH VEHICLE MINI PROJECT – II	L	T	P	C
		0	0	4	2

OBJECTIVE:

To enhance the knowledge in continuation of the space launch vehicle mini project–I, each student is assigned with following assignments to be carried out.

TASKS:

1. *Δv* & initial sizing, inboard profile & layout, Engine selection, Preliminary mass estimation.
2. Loads from ground winds, loads during flight: thrust, aero, & inertial forces, Trimmed flight, Max-q, Calculation of internal forces, moments, shears.
3. Calculation of stresses due to external loads, internal pressurization, Tank & inter-stage structural design, Vibration, shock, acoustic, and thermal effects.
4. VS&A, thermal, concluded Guidance, stability & control.
5. Structural flexibility effects, Instabilities, Manufacturing, Launch pad & facilities.
6. Ground testing, Safety & flight termination systems.

TOTAL: 60 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- execute the conceptual stage of a spacecraft design in respect of its stability.
- plan and co-ordinate the activities of a mini project.
- implement the necessary phases in the design process and produce the required outcomes of each phase.
- communicate design outcomes to technical and lay readers.
- apply a number of standard methods to various phases of the design process.

REFERENCES:

1. Griffin and French, “Space Vehicle Design”, AIAA, 2004, ISBN 1563475391.
2. Meyer R., “Elements of Space Technology”, Academic Press, 1999, ISBN 0124929400
3. Sforza, “Manned Spacecraft Design Principles”, Elsevier, 2016, ISBN 9780128044254
4. Walter U., “Astronautics”, WILEY-VCH, 2008, ISBN 9783527406852.

AC8613	AVIONICS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVE:

This laboratory is divided into three parts to train the students to learn about basic digital electronics circuits, programming with microprocessors, design and implementation of data buses in avionics with MIL-Std. 1553B and remote terminal configuration and their importance in different applications in the field of Avionics.

LIST OF EXPERIMENTS

MATLAB

1. Working with Matrices
2. Expressions
3. Relational and Logical Operations

MICROPROCESSORS

4. Addition and Subtraction of 8-bit and 16-bit numbers.
5. Sorting of Data in Ascending & Descending order.
6. Sum of a given series with and without carry.
7. Greatest in a given series & Multi-byte addition in BCD mode.
8. Interface programming with 4-digit 7 segment Display & Switches & LED's.
9. 16 Channel Analog to Digital Converter & Generation of Ramp, Square, Triangular wave by Digital to Analog Converter.

AVIONICS DATA BUSES

10. Study of Different Avionics Data Buses.
11. MIL-Std – 1553 Data Buses Configuration with Message transfer.
12. MIL-Std – 1553 Remote Terminal Configuration.

TOTAL: 60 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Research at the lab deals with the different aspects of the Guidance, Navigation and Control loop which is instrumental to all modern aerospace ventures.
- Understand the applications of current activities include rendezvous and docking between spacecraft, grasping and deorbiting of space debris, command of rovers.
- Understand the significant heritage on formation flying, large and deployable space systems and structures and swarm-like, behavioural controlled systems, Global Navigation Satellite Systems (GPS, Galileo), inertial and optical navigation is present.
- Know the lab stresses, whenever possible, real world testing with the available experimental setups.

LIST OF EQUIPMENT

(for a batch of 30 students)

Sl. No	Equipment	Qty	Experiments No.
1	MATLAB Software	30	1,2,3,4
2	Microprocessor 8085 Kit	10	5,6,7,8
3	Computers and	10	9
4	Analog to Digital Converter	10	10
5	MIL-Std – 1553 Data Bus	10	11,12,13

AC8701	HYPERSONIC AERODYNAMICS FOR AEROSPACE VEHICLES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn basics of hypersonic flow, shock wave, boundary layer interaction and aerodynamic heating.
- To extend the surface inclination methods for hypersonic inviscid flows.
- To explain the approximate methods for inviscid hypersonic flows.

UNIT I BASICS OF HYPERSONIC AERODYNAMICS 8

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.

UNIT II SURFACE INCLINATION METHODS FOR HYPERSONIC INVISCID FLOWS 9

Local surface inclination methods – modified Newtonian Law – Newtonian theory – tangent wedge or tangent cone and shock expansion methods – Calculation of surface flow properties.

UNIT III APPROXIMATE METHODS FOR INVISCID HYPERSONIC FLOWS 9

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.

UNIT IV VISCOUS HYPERSONIC FLOW THEORY 10

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.

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

OUTCOMES:

On successful completion of this course, the student will be able to

- Analyse the trajectories of ballistic missiles, space planes, and air-breathing hypersonic vehicles.
- Have a basic understanding of real gas effects such as vibrational activation, dissociation, ionization, and molecular transport phenomena.
- Perform perfect and real gas analyses of shock waves.
- Determine the stagnation properties of a hypersonic vehicle.
- Determine profiles of pressure, skin friction, and heat transfer around a vehicle.

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.

AC8702	COMPUTATIONAL FLUID DYNAMICS FOR AEROSPACE ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Understand the basic flow equations, characteristics of mathematical models for a given flow.
- Know the importance and significance of panel methods
- Familiarize with Finite Volume techniques in Computational fluid analysis.

UNIT I FUNDAMENTAL CONCEPTS 9

Introduction – Basic Equations of Fluid Dynamics – Mathematical properties of Fluid Dynamics Equations – Elliptic, Parabolic and Hyperbolic equations – Well posed problems – discretization of partial Differential Equations – Transformations and grids – Explicit finite difference methods of subsonic, supersonic and viscous flows.

UNIT II GRID GENERATION 9

Need for grid generation – Various grid generation techniques – Algebraic, conformal and numerical grid generation – importance of grid control functions – boundary point control – orthogonality of grid lines at boundaries – Elliptic grid generation using Laplace's equations for geometries like aerofoil and CD nozzle.

UNIT III PANEL METHODS 9

Elements of two and three-dimensional panels, panel singularities – Application of panel methods to incompressible, compressible, subsonic and supersonic flows – Numerical solution of flow over a cylinder using 2D panel methods using both vertex and source panel methods for lifting and non-lifting cases respectively.

UNIT IV TIME DEPENDENT METHODS 9

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

UNIT V FINITE VOLUME TECHNIQUES 9

Finite Volume Techniques – Cell Centred Formulation – Lax-Vendoroff Time Stepping – Runge-Kutta Time Stepping – Multi-stage Time Stepping – Accuracy – Cell Vertex Formulation – Multistage Time Stepping – FDM-like Finite Volume Techniques – Central and Up-wind Type Discretization – Treatment of Derivatives.

TOTAL = 45 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Explain and calculate the governing equations for fluid flow.
- Explain how grids are generated and conduct a grid-convergence assessment.
- Understand the issues about two-phase flow modelling.
- Understand the concept of discretization, upwind differencing and implicit, explicit solutions.
- Apply finite difference and finite volume methods to fluid flow problems.

TEXT BOOKS:

1. Blazek, J., "Computational Fluid Dynamics: Principles and Applications", 2nd Ed., Elsevier, 2006.
2. Fletcher, C.A.J., "Computational Techniques for Fluid Dynamics", Vols. I and II, Springer - Verlag, Berlin, 1998.

REFERENCES:

1. Anderson J. D., "Fundamentals of Aerodynamics", 5th Ed., McGraw-Hill, 2010.
2. Charles Hirsch, "Numerical Computation of Internal and External Flows", Vols. I and II. Butterworth-Heinemann, 2nd Ed., 2007.

3. John F. Wendt (Editor), "Computational Fluid Dynamics - An Introduction", Springer - Verlag, Berlin, 2009.
4. Klaus A Hoffmann and Steve T. Chiang. "Computational Fluid Dynamics for Engineers", Vols. I & II Engineering Education System, P.O. Box 20078, W. Wichita, K.S., 67208 - 1078 USA, 2000.

AC8703	ROCKETS AND LAUNCH VEHICLES	L	T	P	C
		3	0	0	3

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.

UNIT I ROCKET DYNAMICS 9

Classification of launch vehicles and missiles – Rocket systems – Airframe components – Forces and moments acting on a rocket – Propulsion, aerodynamics, gravity – inertial and non-inertial frames – coordinate transformation – Equations of motion for three-dimensional motion through atmosphere and vacuum – numerical problems.

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 DYNAMICS 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 DESIGN, MATERIALS AND TESTING OF ROCKETS 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

OUTCOMES:

On successful completion of this course, the student will be able to

- Learn about the different systems of rockets and launch vehicles, formulation of the equation of motion and about the advanced rockets for future missions.
- Understand the function of the solid propellant propulsion and pyrotechnic systems and the design principles.
- Understand the function of the liquid propellant propulsion and control systems and the design principles.
- Formulate the equation of motions for a mission and spent stage separation dynamics, understanding the principles of navigation, guidance and control of rockets and launch vehicles, and design of a multistage rocket.
- Understand the system design, construction, function, performance and testing aspects. and to familiarize with the selection of suitable materials for different rocket systems.

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.
3. Sutton, G.P., “Rocket Propulsion Elements”, Wiley, New York, 9th Ed., 2017.

REFERENCES:

1. George M. Siouris, “Missile Guidance and Control Systems”, Springer-Verlag New York, 2004.
2. Joseph Jimmerson, “The Rocket Files”, Lulu.com, 2nd Ed., 2013
3. Ronald Humble, Henry and Larson, “Space Propulsion Analysis and Design”, McGraw-Hill. 1995.

AC8711	COMPUTATIONAL ANALYSIS LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVE:

To familiarize with the Structural analysis, Flow analysis, and Thermal analysis.

LIST OF EXPERIMENTS:

1. Inspect the Static & Dynamic analysis of beams.
2. Inspect the Structural analysis of wing structure.
3. Construct the 2D design and conduct flow analysis of subsonic and supersonic wind tunnels.
4. Construct the 2D design and conduct flow analysis of subsonic and supersonic flow over bluff body and streamlined body.
5. Construct the 3D design and conduct flow analysis of subsonic and supersonic wind tunnels.
6. Construct the 3D design and conduct flow analysis of subsonic flow over bluff body and streamlined body.
7. Construct the 3D design and conduct flow analysis of supersonic flow over blunt body and slender body.
8. Conduct the thermal analysis of structural components.
9. Conduct the simulation of combustion process.
10. Conduct the simulation of heat transfer process.

TOTAL: 60 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Effectively employ solid modelling and simulation tools.
- Read a specification and create a simple trade diagram.
- Choose appropriate structural models.

LIST OF EQUIPMENTS

(for a batch of 30 students)

S. No.	Items	Quantity
1.	Internal server (or) Work station	1
2.	Computers	30
3.	Modelling and Analysis packages (i) CATIA (ii) ANSYS (iii) Pro E (iv) NASTRAN	30 licenses
4.	UPS	1
5.	Printer	1

AC8712	INDUSTRIAL TRAINING (Training to be undergone after VI semester)	L	T	P	C
		0	0	2	1

OBJECTIVES

Students have to undergo two – week practical training in Aerospace Engineering related industry / project site or design / planning office so that they become aware of the practical application of theoretical concepts studied in the class rooms.

ASSESSMENT PROCESS

This course is mandatory and the student has to pass the course to become eligible for the award of degree. The student shall make a presentation before a committee constituted by the department which will assess the student based on the report submitted and the presentation made. Marks will be awarded out of 100 and appropriate grades assigned as per the regulations.

2-week practical training in industry

OUTCOMES:

On successful completion of this course, the student will be able to

- Work in actual working environment.
- Utilize technical resources.
- Write technical documents and give oral presentations related to the work completed.

AC8811	PROJECT WORK	L	T	P	C
		0	0	20	10

OBJECTIVES:

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

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

TOTAL: 300 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

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

AC8001	COMPUTER AIDED DESIGN AND ANALYSIS	L	T	P	C
		3	0	0	3

OBJECTIVES:

To familiarize with

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

UNIT I INTRODUCTION 9

Introduction to CAD – I/O devices – various graphics standards – coordinate systems – Geometric Modelling: Introduction – types of geometric modelling – wire frame – surface and solid modelling. Wireframe entities – types of curves and its mathematical representation - 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

OUTCOMES:

On successful completion of this course, the student will be able to

- Prepare and read engineering drawings.
- Visualize an engineering object.
- Understand solid models created in computer.
- Understand the relation between 2D drafting and 3D models.
- Understand 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, TMH, 2001.
3. Radhakrishnan, P., “CAD / CAM / CIM”, New Age International, 2000.

REFERENCES

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

AC8002	CRYOGENICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To analyse cryogenic systems
- To calculate the efficiency of cryogenic systems
- To know cryogenic applications in aerospace engineering

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

OUTCOMES:

On successful completion of this course, the student will be able to

- Describe various methods to produce low temperature and phenomena at cryogenic temperature.
- Understand the working principle of different cryogenic refrigeration and liquification system.
- Understand the functions and working principles of insulations and various low temperature measuring and storage devices.
- Understand the application of Cryogenic technology in engineering research and Industry.

TEXT BOOKS

1. Barron, R. F., “Cryogenic Systems”, Oxford University, 1985.
2. Haselden, G., “Cryogenic Fundamentals”, Academic Press, 1971.

REFERENCES:

1. Parner, S. F., “Propellant Chemistry”, Reinhold Publishing Corp., New York 1985.
2. Weisend, J. G., “The Handbook of Cryogenic Engineering”, Taylor & Francis, 1998.

AE8605 EXPERIMENTAL STRESS ANALYSIS L T P C
3 0 0 3

OBJECTIVE:

- To study the various experimental techniques involved for measuring displacements, stresses, strains in structural components.

UNIT I EXTENSOMETERS AND DISPLACEMENT SENSORS 8

Principles of measurements, Accuracy, Sensitivity and range of measurements, Mechanical, Optical, Acoustical and Electrical extensometers and their uses, Advantages and disadvantages**,** Capacitance gauges, Laser displacement sensors.

UNIT II ELECTRICAL RESISTANCE STRAIN GAUGES 12

Principle of operation and requirements, Types and their uses, Materials for strain gauges, Calibration and temperature compensation, cross sensitivity, Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators, Rosette analysis, stress gauges, load cells, Data acquisition, six component balance.

UNIT III PHOTOELASTICITY 11

Two-dimensional photo elasticity, Photo elastic materials, Concept of light - photoelastic effects, stress optic law, Transmission photoelasticity, Jones calculus, plane and circular polariscopes, Interpretation of fringe pattern, Calibration of photoelastic materials, Compensation and separation techniques, Introduction to three-dimensional photo elasticity.

UNIT IV BRITTLE COATING AND MOIRE TECHNIQUES 7

Relation between stresses in coating and specimen, use of failure theories in brittle coating, Moire method of strain analysis.

UNIT V NON – DESTRUCTIVE TESTING 7

Fundamentals of NDT, Acoustic Emission Technique, Radiography, Thermography, Ultrasonics, Eddy Current testing, Fluorescent Penetrant Testing,

TOTAL: 45 PERIODS

OUTCOMES

- Knowledge of stress and strain measurements in loaded components.
- Acquiring information’s, the usage of strain gauges and photo elastic techniques of measurement.
- Formulate and solve general three-dimensional problems of stress-strain analysis especially fundamental problems of elasticity.
- Analyse the strain gauge data under various loading condition by using gauge rosette method.
- Experimentally evaluate the location and size of defect in solid and composite materials by using various Non-destructive Testing methods.

TEXT BOOKS:

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

REFERENCES:

1. Durelli. A.J., "Applied Stress Analysis", Prentice Hall of India Pvt Ltd., New Delhi, 1970
2. Hetenyi, M., "Hand book of Experimental Stress Analysis", John Wiley and Sons Inc., New York, 1972.
3. Max Mark Frocht, "Photo Elasticity", John Wiley and Sons Inc., New York, 1968
4. Pollock A.A., Acoustic Emission in Acoustics and Vibration Progress, Ed. Stephens R.W.B., Chapman and Hall,1993.
5. Ramesh, K., Digital Photoelasticity, Springer, New York, 2000.

AC8003 MACHINING AND PRECISION MANUFACTURING

L	T	P	C
3	0	0	3

OBJECTIVES:

- To Emphasis on design and performance of precision machinery for manufacturing.
- To show the errors during the manufacturing.
- To develop the student's skills and knowledge in precision engineering.

UNIT I MACHINE DESIGN AND PRINCIPLES OF MEASUREMENT 8

Background; philosophy; sources of error - Measurement basics; Abbe error - Metrology techniques - Metrology techniques, subsurface damage.

UNIT II ERRORS 12

Intro to mechanical error; Kinematic design - Review; Macro/micro-scale compliance; Bearings and spindles - Thermal effects; transfer parameters; specific examples; enclosures - Error budgets and mapping - Error mapping review; Intro to compliance errors - Deformation errors; structural effects - Vibrational errors.

UNIT III SENSORS 8

Intro to sensors - Need for sensors; technology; signal processing - Applications; integration - Tool/material effects; scale effects.

UNIT IV PROCESSES 8

Diamond milling/turning; Micromachining - Ultraprecision abrasive methods; CMP; non-traditional - Semiconductor processes; nanotechnology; MEMS; microfluidics.

UNIT V PROCESS PLANNING 9

Process planning; capability; systems - Role of CAD/CAM in precision manufacturing - Metrics; measurement methods; energy consumption in processes.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Understand the machine tool elements and structure, sources of error.
- Understand the precision machining processes and process models.
- Understand the sensors for process monitoring and control, metrology, actuators, and machine design case studies.
- Understand the precision component manufacture, role of CAD/CAM in precision manufacturing, and aspects of sustainable manufacturing and design for sustainability.

TEXT BOOKS:

1. David Dornfeld and Dae-Eun Lee, "Precision Manufacturing", Springer, 2008.
2. Nakazawa H., "Principles of Precision Engineering", Oxford University Press, 1994.
3. Slocum A. H., "Precision Machine Design", Prentice-Hall, 1992.

REFERENCES:

1. Evans C., "Precision Engineering; An Evolutionary View", Cranfield Press, 1989.
2. Seyfried P., Kuntzmann H., McKeown P., and Weck M., "Progress in Precision Engineering", Springer-Verlag, 1991.
3. Tlusty, J., "Manufacturing Processes and Equipmen"t, Prentice-Hall, Upper Saddle River NJ, 2000.
4. Thomas, T., "Rough Surfaces", 2nd Ed., Imperial College Press, London, 1999.
5. Whitehouse, D. J., "Handbook of Surface Metrology", Institute of Physics Publishing, Philadelphia PA, 1994.

AC8004	RELIABILITY AND QUALITY ASSURANCE	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To minimize the number of defects which are undetected at a particular stage and surface at next levels of processes due to deficiencies in the Reliability Assurance Processes
- To aim for Zero non-conformances in Reliability Assurance Processes.

UNIT I STATISTICAL QUALITY CONTROL 9

Methods and Philosophy of statistical process control – Control charts for variables Attributes – Cumulative sum and Exponentially weighted moving average control charts – Other SPC Techniques – Process – Capability analysis.

UNIT II ACCEPTANCE SAMPLING 9

Acceptance sampling problem – Single sampling plans for attributes – double multiple and sequential sampling – Military standards – Dodge Roaming sampling plans.

UNIT III INTRODUCTION TO TQM 9

Need for quality – Definition of quality – Continuous process improvement – Contributions of Deming, Juran and Crosby - Basic concepts of TQM – Six Sigma: concepts, methodology, application to manufacturing.

UNIT IV FAILURE DATA ANALYSIS RELIABILITY PREDICTION 9

Repair time distributions – Exponential, normal, log normal, gamma and Weibull – reliability data requirements – Graphical evaluation - Failure rate estimates – Effect of environment and stress – Series and Parallel systems – RDB analysis – Standby systems – Complex systems – Reliability demonstration testing – Reliability growth testing – Duane curve – Risk assessment – FMEA, Fault tree.

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000, ISO 9000-2000 Quality system – Elements, Documentation, Quality auditing – QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – Case studies of TQM implementation in manufacturing and service sectors including IT.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Understand the advanced concepts of reliability and quality assurance manned space missions to the engineers.
- Provide the necessary mathematical knowledge that are needed in understanding their significance and operation.
- Deploy the skills effectively in the understanding of reliability and quality assurance.

TEXT BOOKS:

1. John Bank, “The Essence of Total Quality Management”, Prentice Hall Direct, 2nd Ed., 2001.
2. Mohamed Zairi, “Total Quality Management for Engineers”, Woodhead Publishing Ltd, 1991.

REFERENCES:

1. Harvid Noori and Russel, “Production and Operations Management – Total Quality and Responsiveness”, McGraw Hill Inc., 1995.
2. Suresh Dalela and Saurabh, “ISO 900, A manual for Total Quality Management”, S.Chand and Company Ltd, 1997.

GE8075 INTELLECTUAL PROPERTY RIGHTS L T P C
3 0 0 3

OBJECTIVE:

- To give an idea about IPR, registration and its enforcement.

UNIT I INTRODUCTION 9

Introduction to IPRs, Basic concepts and need for Intellectual Property - Patents, Copyrights, Geographical Indications, IPR in India and Abroad – Genesis and Development – way from WTO to WIPO –TRIPS, Nature of Intellectual Property, Industrial Property, technological Research, Inventions and Innovations – Important examples of IPR.

UNIT II REGISTRATION OF IPRs 10

Meaning and practical aspects of registration of Copy Rights, Trademarks, Patents, Geographical Indications, Trade Secrets and Industrial Design registration in India and Abroad

UNIT III AGREEMENTS AND LEGISLATIONS 10

International Treaties and Conventions on IPRs, TRIPS Agreement, PCT Agreement, Patent Act of India, Patent Amendment Act, Design Act, Trademark Act, Geographical Indication Act.

UNIT IV DIGITAL PRODUCTS AND LAW 9

Digital Innovations and Developments as Knowledge Assets – IP Laws, Cyber Law and Digital Content Protection – Unfair Competition – Meaning and Relationship between Unfair Competition and IP Laws – Case Studies.

UNIT V ENFORCEMENT OF IPRs 7

Infringement of IPRs, Enforcement Measures, Emerging issues – Case Studies.

TOTAL :45 PERIODS

OUTCOME:

- Ability to manage Intellectual Property portfolio to enhance the value of the firm.

TEXT BOOKS

1. S.V. Satakar, Intellectual Property Rights and Copy Rights, Ess Ess Publications, New Delhi, 2002.
2. V. Scople Vinod, Managing Intellectual Property, Prentice Hall of India pvt Ltd, 2012.

REFERENCES

1. Deborah E. Bouchoux, “Intellectual Property: The Law of Trademarks, Copyrights, Patents and Trade Secrets”, Cengage Learning, Third Ed., 2012.
2. Edited by Derek Bosworth and Elizabeth Webster, The Management of Intellectual Property, Edward Elgar Publishing Ltd., 2013.
3. Prabuddha Ganguli, “Intellectual Property Rights: Unleashing the Knowledge Economy”, McGraw Hill Education, 2011.

GE8073 FUNDAMENTALS OF NANOSCIENCE L T P C
3 0 0 3

OBJECTIVE:
To learn about basis of nanomaterial science, preparation method, types and application

UNIT I INTRODUCTION 8
Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thinfilms-multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT II GENERAL METHODS OF PREPARATION 9
Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III NANOMATERIALS 12
Nanoforms of Carbon - Buckminster fullerene- graphene and carbon nanotube, Single wall carbon Nanotubes (SWCNT) and Multi wall carbon nanotubes (MWCNT)- methods of synthesis(arc-growth, laser ablation, CVD routes, Plasma CVD), structure-property Relationships applications-Nanometal oxides-ZnO, TiO2,MgO, ZrO2, NiO, nanoalumina, CaO, AgTiO2, Ferrites, Nanoclays-functionalization and applications-Quantum wires, Quantum dots-preparation, properties and applications.

UNIT IV CHARACTERIZATION TECHNIQUES 9
X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques-AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation.

UNIT V APPLICATIONS 7
NanoInfoTech: Information storage- nanocomputer, molecular switch, super chip, nanocrystal, Nanobiotechlogy: nanoprobes in medical diagnostics and biotechnology, Nano medicines, Targetted drug delivery, Bioimaging - Micro Electro Mechanical Systems (MEMS), Nano Electro Mechanical Systems (NEMS)- Nanosensors, nano crystalline silver for bacterial inhibition, Nanoparticles for sunbarrier products - In Photostat, printing, solar cell, battery.

TOTAL : 45 PERIODS

OUTCOMES:
- Will familiarize about the science of nanomaterials
- Will demonstrate the preparation of nanomaterials
- Will develop knowledge in characteristic nanomaterial

TEXT BOOKS:

1. A.S. Edelstein and R.C. Cammearata, eds., “Nanomaterials: Synthesis, Properties and Applications”, Institute of Physics Publishing, Bristol and Philadelphia, 1996.
2. N John Dinardo, “Nanoscale Characterization of surfaces & Interfaces”, 2nd Ed., Weinheim Cambridge, Wiley-VCH, 2000.

REFERENCES:

1. Akhlesh Lakhtakia,“The Hand Book of Nano Technology, Nanometer Structure, Theory, Modeling and Simulations”. Prentice-Hall of India (P) Ltd, New Delhi, 2007.
2. G Timp, “Nanotechnology”, AIP press/Springer, 1999.

AC8005	AEROSPACE MATERIALS	L	T	P	C
		3	0	0	3

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.

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 10

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 – Carbon/Carbon composites, Fabrication processes involved in metal matrix composites - shape memory alloys – applications in aerospace vehicle design.

UNIT V HIGH TEMPERATURE MATERIALS & CHARACTERIZATION 8

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

OUTCOMES:

On successful completion of this course, the student will be able to

- Understand the advanced concepts of aerospace materials.
- Provide the necessary mathematical knowledge that are needed in understanding their significance and operation.
- Have an exposure on various topics such elements of aerospace materials, mechanical behaviour of materials, ceramics and composites.
- Deploy the skills effectively in the understanding of aerospace materials.

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.

AC8006	LAUNCH VEHICLE AERODYNAMICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To learn the concept of high-speed aerodynamics and configurations of launch vehicles.
- Understanding of aerodynamics in competitive design.
- Testing and analysis methods in different speed regimes.
- Design trade-offs between aerodynamics and other considerations.

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

OUTCOME:

On successful completion of this course, the student will be able to

- Learn the concept of high-speed aerodynamics and configurations of launch vehicles.
- Understand the effects of boundary layer while launching.
- Know the forces on the vehicle during atmospheric flight.
- Understand the flow characteristics of launch vehicles.

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.

MF8071 **ADDITIVE MANUFACTURING** **L T P C**
3 0 0 3

OBJECTIVES:

- To know the principle, methods, possibilities and limitations as well as environmental effects of Additive Manufacturing technologies.
- To be familiar with the characteristics of the different materials those are used in Additive Manufacturing technologies.

UNIT I INTRODUCTION 9

Overview **–** Need - Development of Additive Manufacturing Technology -Principle **–** AM Process Chain- Classification **–**Rapid Prototyping- Rapid Tooling **–** Rapid Manufacturing **–** Applications-Benefits **–** Case studies.

UNIT II DESIGN FOR ADDITIVE MANUFACTURING 9

Design tools: Data processing - CAD model preparation **–** Part orientation and support structure generation **–** Model slicing **–**Tool path generation- Design for Additive Manufacturing: Concepts and objectives- AM unique capabilities **–** DFAM for part quality improvement- Customised design and fabrication for medical applications.

UNIT III PHOTOPOLYMERIZATION AND POWDER BED FUSION PROCESSES 9

Photo polymerization: SLA-Photo curable materials **–** Process - Advantages and Applications. Powder Bed Fusion: SLS-Process description **–** powder fusion mechanism **–** Process Parameters **–** Typical Materials and Application. Electron Beam Melting.

UNIT IV EXTRUSION BASED AND SHEET LAMINATION PROCESSES 9

Extrusion Based System: FDM-Introduction **–** Basic Principle **–** Materials **–** Applications and Limitations **–** Bioextrusion. Sheet Lamination Process:LOM- Gluing or Adhesive bonding **–** Thermal bonding.

UNIT V PRINTING PROCESSES AND BEAM DEPOSITION PROCESSES 9

Droplet formation technologies **–** Continuous mode **–** Drop on Demand mode **–** Three Dimensional Printing **–** Advantages **–** Bioplotter - Beam Deposition Process:LENS- Process description **–** Material delivery **–** Process parameters **–** Materials **–** Benefits **–** Applications.

TOTAL: 45 PERIODS

OUTCOME:

- On completion of this course, students will learn about a working principle and construction of Additive Manufacturing technologies, their potential to support design and manufacturing, modern development in additive manufacturing process and case studies relevant to mass customized manufacturing.

TEXT BOOKS:

1 Chua C.K., Leong K.F., and Lim C.S., **"**Rapid prototyping: Principles and applications**"**, Third edition, World Scientific Publishers, 2010.
2 Ian Gibson, David W.Rosen, Brent Stucker **"**Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing**"** Springer , 2010.

REFERENCES:

1 Andreas Gebhardt **"**Understanding Additive Manufacturing: Rapid Prototyping, Rapid Manufacturing**"** Hanser Gardner Publication 2011.
2 Kamrani A.K. and Nasr E.A., **"**Rapid Prototyping: Theory and practice**"**, Springer, 2006.
3 Liou L.W. and Liou F.W., **"**Rapid Prototyping and Engineering applications :A tool box for prototype development**"**, CRC Press, 2007.
4 Tom Page **"**Design for Additive Manufacturing**"** LAP Lambert Academic Publishing, 2012.

AC8007	LAUNCH VEHICLE CONFIGURATION DESIGN	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand 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.

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

OUTCOMES:

On successful completion of this course, the student will be able to

- Know exotic space propulsion concepts, such as nuclear, solar sail, and antimatter.
- Gain knowledge in selecting the appropriate rocket propulsion systems.
- Understand the air-breathing propulsion suitable for initial stages and fly-back boosters.
- Have an aerodynamics aspect, including boost-phase lift and drag, hypersonic, and re-entry.
- Conversion training for 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.

REFERENCE:

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, 2012.
3. Marcel J. Sidi, “Spacecraft Dynamics and Control: A Practical Engineering Approach”, Cambridge University Press, 2000.

GE8072	FOUNDATION SKILLS IN INTEGRATED PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the global trends and development methodologies of various types of products and services
- To conceptualize, prototype and develop product management plan for a new product based on the type of the new product and development methodology integrating the hardware, software, controls, electronics and mechanical systems
- To understand requirement engineering and know how to collect, analyse and arrive at requirements for new product development and convert them in to design specification
- To understand system modelling for system, sub-system and their interfaces and arrive at the optimum system specification and characteristics
- To develop documentation, test specifications and coordinate with various teams to validate and sustain up to the EoL (End of Life) support activities for engineering customer

UNIT I FUNDAMENTALS OF PRODUCT DEVELOPMENT 9

Global Trends Analysis and Product decision - Social Trends - Technical Trends- Economical Trends - Environmental Trends - Political/Policy Trends **- Introduction to Product Development Methodologies and Management -** Overview of Products and Services - Types of Product Development - Overview of Product Development methodologies **-** Product Life Cycle – Product Development Planning and Management.

UNIT II REQUIREMENTS AND SYSTEM DESIGN 9

Requirement Engineering - Types of Requirements - Requirement Engineering - traceability Matrix and Analysis - Requirement Management - **System Design & Modeling -** Introduction to System Modeling - System Optimization - System Specification - Sub-System Design - Interface Design.

UNIT III DESIGN AND TESTING 9

Conceptualization - Industrial Design and User Interface Design - Introduction to Concept generation Techniques – **Challenges in Integration of Engineering Disciplines** - Concept Screening & Evaluation - **Detailed Design -** Component Design and Verification – **Mechanical, Electronics and Software Subsystems** - High Level Design/Low Level Design of S/W Program **-** Types of Prototypes, S/W Testing- Hardware Schematic, Component design, Layout and Hardware Testing – **Prototyping -** Introduction to Rapid Prototyping and Rapid Manufacturing - **System Integration, Testing, Certification and Documentation**

UNIT IV SUSTENANCE ENGINEERING AND END-OF-LIFE (EOL) SUPPORT 9

Introduction to Product verification processes and stages - Introduction to Product Validation processes and stages - Product Testing Standards and Certification - Product Documentation - **Sustenance -**Maintenance and Repair – Enhancements - **Product EoL -** Obsolescence Management – Configuration Management - EoL Disposal

UNIT V BUSINESS DYNAMICS – ENGINEERING SERVICES INDUSTRY 9

The Industry - Engineering Services Industry - Product Development in Industry versus Academia –**The IPD Essentials -** Introduction to Vertical Specific Product Development processes -Manufacturing/Purchase and Assembly of Systems - Integration of Mechanical, Embedded and Software Systems – Product Development Trade-offs - Intellectual Property Rights and Confidentiality – Security and Configuration Management.

TOTAL: 45 PERIODS

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

- Define, formulate and analyze a problem
- Solve specific problems independently or as part of a team
- Gain knowledge of the Innovation & Product Development process in the Business Context
- Work independently as well as in teams
- Manage a project from start to finish

TEXTBOOKS:

1. Book specially prepared by NASSCOM as per the MoU.
2. Karl T Ulrich and Stephen D Eppinger, "Product Design and Development", Tata McGraw Hill, Fifth Ed., 2011.
3. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Ed., 2005.

REFERENCES:

1. Hiriyappa B, “Corporate Strategy – Managing the Business”, Author House, 2013.
2. Peter F Drucker, “People and Performance”, Butterworth – Heinemann [Elsevier], Oxford, 2004.
3. Vinod Kumar Garg and Venkita Krishnan N K, “Enterprise Resource Planning – Concepts”, Second Ed., Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Ed., 2013

GE8071 DISASTER MANAGEMENT

L	T	P	C
3	0	0	3

OBJECTIVES:

- To provide students an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional processes in the country and
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

UNIT I INTRODUCTION TO DISASTERS 9

Definition: Disaster, Hazard, Vulnerability, Resilience, Risks – Disasters: Types of disasters – Earthquake, Landslide, Flood, Drought, Fire - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial - Differential impacts- in terms of caste, class, gender, age, location, disability - Global trends in disasters: urban disasters, pandemics, complex emergencies, Climate change- Dos and Don’ts during various types of Disasters.

UNIT II APPROACHES TO DISASTER RISK REDUCTION (DRR) 9

Disaster cycle - Phases, Culture of safety, prevention, mitigation and preparedness community based DRR, Structural- nonstructural measures, Roles and responsibilities of- community, Panchayati Raj Institutions/Urban Local Bodies (PRIs/ULBs), States, Centre, and other stake-holders- Institutional Processes and Framework at State and Central Level- State Disaster Management Authority (SDMA) – Early Warning System – Advisories from Appropriate Agencies.

UNIT III INTER-RELATIONSHIP BETWEEN DISASTERS AND DEVELOPMENT 9

Factors affecting Vulnerabilities, differential impacts, impact of Development projects such as dams, embankments, changes in Land-use - Climate Change Adaptation- IPCC Scenario and Scenarios in the context of India - Relevance of indigenous knowledge, appropriate technology and local resources.

UNIT IV DISASTER RISK MANAGEMENT IN INDIA 9

Hazard and Vulnerability profile of India, Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional arrangements (Mitigation, Response and Preparedness, Disaster Management Act and Policy - Other related policies, plans, programmes and legislation – Role of GIS and Information Technology Components in Preparedness, Risk Assessment, Response and Recovery Phases of Disaster – Disaster Damage Assessment.

UNIT V DISASTER MANAGEMENT: APPLICATIONS AND CASE STUDIES AND FIELD WORKS 9

Landslide Hazard Zonation: Case Studies, Earthquake Vulnerability Assessment of Buildings and Infrastructure: Case Studies, Drought Assessment: Case Studies, Coastal Flooding: Storm Surge Assessment, Floods: Fluvial and Pluvial Flooding: Case Studies; Forest Fire: Case Studies, Man Made disasters: Case Studies, Space Based Inputs for Disaster Mitigation and Management and field works related to disaster management.

TOTAL: 45 PERIODS

OUTCOMES:

The students will be able to

- Differentiate the types of disasters, causes and their impact on environment and society
- Assess vulnerability and various methods of risk reduction measures as well as mitigation.
- Draw the hazard and vulnerability profile of India, Scenarios in the Indian context, Disaster damage assessment and management.

TEXT BOOKS:

1. Gupta Anil K, Sreeja S. Nair. Environmental Knowledge for Disaster Risk Management, NIDM, New Delhi, 2011.
2. Kapur Anu Vulnerable India: A Geographical Study of Disasters, IIAS and Sage Publishers, New Delhi, 2010.
3. Singhal J.P. “Disaster Management”, Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423
4. Tushar Bhattacharya, “Disaster Science and Management”, McGraw Hill India Education Pvt. Ltd., 2012. **ISBN-10:** 1259007367, **ISBN-13:** 978-1259007361]

REFERENCES

1. Govt. of India: Disaster Management Act, Government of India, New Delhi, 2005
2. Government of India, National Disaster Management Policy, 2009.

GE8077 TOTAL QUALITY MANAGEMENT L T P C
3 0 0 3

OBJECTIVE:

- To facilitate the understanding of Quality Management principles and process.

UNIT I INTRODUCTION 9

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

UNIT II TQM PRINCIPLES 9

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

UNIT III TQM TOOLS AND TECHNIQUES I 9

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

UNIT IV TQM TOOLS AND TECHNIQUES II 9

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

UNIT V QUALITY MANAGEMENT SYSTEM 9

Introduction—Benefits of ISO Registration—ISO 9000 Series of Standards—Sector-Specific Standards—AS 9100, TS16949 and TL 9000-- ISO 9001 Requirements—Implementation—Documentation—Internal Audits—Registration--**ENVIRONMENTAL MANAGEMENT SYSTEM:** Introduction—ISO 14000 Series Standards—Concepts of ISO 14001—Requirements of ISO 14001—Benefits of EMS.

TOTAL: 45 PERIODS

OUTCOME:

- The student would be able to apply the tools and techniques of quality management to manufacturing and services processes.

TEXT BOOK:

1. Dale H.Besterfiled, Carol B.Michna,Glen H. Besterfield,Mary B.Sacre,Hemant Urdhwareshe and Rashmi Urdhwareshe, “Total Quality Management”, Pearson Education Asia, Revised Third Ed., Indian Reprint, Sixth Impression, 2013.

REFERENCES:

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

RO8401 AUTOMATIC CONTROL SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To study the basics of control system and its response, stability of mechanical and electrical systems. Use of MATLAB to design a stable control system.
- To introduce the elements of control system and their modeling using various Techniques.
- To introduce methods for analyzing the time response.
- To impart knowledge about the frequency response and the stability of systems
- To introduce the state variable analysis method

UNIT I INTRODUCTION 9

Open loop and closed loop systems - Examples - Elements of closed loop systems - Transfer function - Modeling of physical systems – Mechanical, Thermal, Hydraulic systems and Electric Networks - Transfer function of DC generator, DC servomotor, AC servomotor ,Potentiometer, Synchros, Tacho-generator, Stepper motor - Block diagram - reduction techniques, Signal flow graph – Mason‟ gain formula. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

UNIT II TIME DOMAIN ANALYSIS 9

Standard Test signals – Time response of second order system - Time domain specifications - Types of systems - Steady state error constants - Introduction to P, PI and PID modes of feedback control. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

UNIT III FREQUENCY DOMAIN ANALYSIS 9

Frequency domain specifications - Time and frequency response correlation – Polar plot – Bode plot – All pass minimum phase and non-minimum phase systems. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

UNIT IV SYSTEM STABILITY 9

Characteristic equation - Routh Hurwitz criterion of stability - Absolute and Relative stability - Nyquist stability - Nyquist stability criterion - Assessment of relative stability – Gain and Phase Margin. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

UNIT V ROOT LOCUS METHOD 9

Root locus concepts - Construction of root loci – Root contours. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions) STATE SPACE ANALYSIS: Limitations of conventional control theory - Concepts of state, state variables and state model – state model for linear time invariant systems - Introduction to state space representation using physical - Phase and canonical variables. (Related Tutorials Using MATLAB/ Simulink – Toolboxes & Functions)

TOTAL: 45 PERIODS

OUTCOMES:

- To understand the basic of the control system
- Ability to know about the time and frequency domain analysis
- To know about the different stability of the systems
- To expose students to the state space representation and its analysis.
- To introduce non-linear systems and their control and to impart knowledge on advanced control techniques

TEXT BOOKS:

1. Nagrath I J, and Gopal, M, 'Control Systems Engineering" Prentice Hall of India, New Delhi, 2008.
2. Richard C Dorf and Robert H Bishop, "Modern Control Systems.", Addison-Wesley -2007

REFERENCES:

1. Ogata K, "Modern Control Engineering", Pearson Education, New Delhi, 2006.
2. Kuo B C, "Automatic Control Systems", Prentice-Hall of India Pvt. Ltd, New Delhi, 2004.
3. Norman C. Nise S, "Control system Engineering", John Wiley & Sons, Singapore, 2004.

AE8603 COMPOSITE MATERIALS AND STRUCTURES L T P C
3 0 0 3

OBJECTIVE:

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

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 – fibre 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 fibres, 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

OUTCOMES

- Understanding the mechanics of composite materials
- Ability to analyse the laminated composites for various loading eases
- Knowledge gained in manufacture of composites.
- Should analyse sandwich and laminated plates
- Should be able to construct and analysis different composite technique

TEXT BOOKS:

1. Autar K Kaw, 'Mechanics of Composite Materials', CRC Press, 2nd edition, 2005.
2. Isaac M. Daniel & Ori Ishai, "Mechanics of Composite Materials," OUP USA publishers, 2nd edition, 2005.
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., New York, 1989.
5. Michael F. Ashley, "Material Selection in Mechanical Design", 5th edition, Butterworth-Heiner, 2016.

AC8008 HEAT TRANSFER IN SPACE APPLICATIONS

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the applications of heat transfer in space.
- To explain the thermal properties of spacecraft components.
- To interpret the thermal control testing of spacecraft components.

UNIT I INTRODUCTION TO SPACECRAFT THERMAL CONTROL 9

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 SPACECRAFT THERMAL ANALYSIS 9

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 SPACECRAFT THERMAL ENVIRONMENTS 9

Launch and ascent – earth bound orbits – interplanetary mission and re-entry mission.

UNIT IV DEVICES AND HARDWARE FOR SPACECRAFT 9

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 DESIGN AND ANALYSIS OF SPACECRAFT 9

Application of principles described above for development of spacecraft Thermal Control System.

TOTAL = 45 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Apply the mechanisms for different heat transfer modes and their relevance to a wide range of mechanical engineering themes
- Use the engineering practices for enhancing heat transfer or increasing thermal insulation.
- Have mathematical underpinning of heat transfer analysis and corresponding problem-solving techniques.
- The relevant thermal properties of materials and working fluids and the considerations for material selection according to the application requirements
- The use commercial software for heat transfer analysis.

TEXT BOOKS:

1. Chapra, S. C. and Canale, R. P., “Numerical Methods for Engineers”, 7th Ed., McGraw-Hill, 2014.
2. Howell J. R., Siegel R., Mengüç M. P., “Thermal Radiation Heat Transfer” 5th Ed., Taylor & Francis, 2010.
3. Incropera, F. P. and DeWitt, D. P., “Fundamentals of Heat and Mass Transfer”, 7th Ed., John Wiley, 2011.

REFERENCES:

1. Pattan, B., “Satellite Systems: Principles and Technologies”, Chapman & Hall, 1993.
2. Meyer, R. X., “Elements of Space Technology”, Academic Press, 1999.
3. Meseguer J., Pérez-Grande I., Sanz-Andrés A., “Spacecraft Thermal Control”, Woodhead Publishing Limited, 2012.
4. Gilmore, D. G. (Ed.), “Spacecraft Thermal Control Handbook”, Volume I: Fundamental Technologies, 2nd Ed., The Aerospace Press, AIAA, 2002.

AC8009 **MISSILE GUIDANCE AND CONTROL**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To understand the advanced concepts of missile systems, missile airframes, autopilots, guidance laws.
- To find the key drivers in the missile guidance design and system engineering process.
- To explain the critical trade-offs, methods, and technologies in missile guidance sizing.
- To illustrate the targeting system, launch platform, and-missile guidance integration.

UNIT I INTRODUCTION TO MISSILE SYSTEMS 8

History of guided missile for defence applications- Classification of missiles– Generalized Missile Equations of Motion- Coordinate Systems- Lagrange's Equations for Rotating Coordinate Systems- Rigid-Body Equations of Motion-missile system elements, missile ground systems.

UNIT II MISSILE AIRFRAMES, AUTOPILOTS AND CONTROL 9

Missile aerodynamics- Force Equations, Moment Equations, Phases of missile flight. Missile control configurations. Missile Mathematical Model. Autopilots — Definitions, Types of Autopilots, Example Applications. Open-loop autopilots. Inertial instruments and feedback. Autopilot response, stability, and agility- Pitch Autopilot Design, Pitch-Yaw-Roll Autopilot Design.

UNIT III MISSILE GUIDANCE LAWS 10

Tactical Guidance Intercept Techniques, Derivation of the Fundamental Guidance Equations, explicit, Proportional Navigation, Augmented Proportional Navigation, beam riding, bank to turn missile guidance, Three-Dimensional Proportional Navigation, comparison of guidance system performance, Application of Optimal Control of Linear Feedback Systems.

UNIT IV STRATEGIC MISSILES 10

Introduction, Two-Body Problem, Lambert's Theorem, First-Order Motion of a Ballistic Missile, Correlated Velocity and Velocity-to-Be-Gained Concepts, Derivation of the Force Equation for Ballistic Missiles, Atmospheric Re-entry, Ballistic Missile Intercept, Missile Tracking Equations of Motion, Introduction to Cruise Missiles, Terrain-Contour Matching (TERCOM) Concept.

UNIT V WEAPON DELIVERY SYSTEMS 8

Weapon Delivery Requirements, Factors Influencing Weapon Delivery Accuracy, Unguided Weapons, Bombing Problem, Guided Weapons, Integrated Flight Control in Weapon Delivery, Missile Launch Envelope, Mathematical Considerations Pertaining to the Accuracy of Weapon Delivery Computations.

TOTAL: 45 PERIODS

OUTCOME:

On successful completion of this course, the student will be able to

- Understand the advanced concepts of missile guidance and control to the engineers.
- Provide the necessary mathematical knowledge that are needed in understanding the physical processes.
- Have an exposure on various topics such as missile systems, missile airframes, autopilots, guidance laws and will be able to deploy these skills effectively in the understanding of missile guidance and control
- Develop linear guidance, control, and navigation laws.
- Analyse performance of the integrated guidance and navigation controller.

TEXT BOOKS:

1. Blakelock, J. H., "Automatic Control of Aircraft and Missiles", 2nd Ed., John Wiley & Sons, 1990.
2. Fleeman, Eugene L., "Tactical Missile Design", First Ed., AIAA Education series, 2001.
3. Siouris, G.M., "Missile Guidance and control systems", Springer, 2003.

REFERENCES:

1. Garnell, P., "Guided Weapon Control Systems", 2nd Ed., Pergamon Press, 1980.
2. Joseph Ben Asher and Isaac Yaesh, “Advances in Missile Guidance Theory”, AIAA Education series, 1998.
3. Paul Zarchan, “Tactical and Strategic Missile Guidance”, AIAA Education series, 2007.

AC8010	SPACECRAFT POWER SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the various Power system elements, energy storage technology and power converters in a spacecraft.
- Design driving requirements for a space power system.
- Solar cell technology and environmental susceptibility.
- Battery technologies, including battery selection and sizing.
- Design Example: Sample power system concept design of a LEO mission.

UNIT I SPACECRAFT ENVIRONMENT & DESIGN CONSIDERATION 9

Orbit definition /Mission Requirements of LEO, GEO, GTO & 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 & 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

OUTCOME:

On successful completion of this course, the student will be able to

- Understand the advanced concepts of Spacecraft power systems.
- Provide the necessary mathematical knowledge that are needed in modelling the power systems.
- Have an exposure on various Power system elements, energy storage technology and power converters.
- Deploy these skills effectively in the analysis and understanding of power systems in a spacecraft.

TEXT BOOKS:

1. Anspaugh B.E., “GaAs Solar Cell Radiation Handbook”, NASA, 2014
2. Chetty P. R. K., “Spacecraft Power Systems”, 1988.
3. Patel, Mukund R, “Spacecraft Power Systems”, CRC Press Boca Raton, 2005.

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., Willey, 2011.
4. Ned Mohan, et al, “Power Electronics, convertors Applications and Design”, John Wiley & Sons, 1989.

AC8011	SATELLITE NAVIGATION AND CONTROL	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The course gives an exposure to the satellite navigation and control.
- To introduce students in engineering and the sciences to the methods of satellite radio navigation.
- The key physical principles will be described in terms of their application to make a complete navigation system work.
- The specific architecture of the Global Positioning System (GPS) will be emphasized.

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

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 & 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

OUTCOMES:

On successful completion of this course, the student will be able to

- Get a thorough introduction to classical control theory, including analysis and design.
- Apply concepts of aircraft autopilot design emphasizing the relevance of the topics discussed in the class.
- Introduce modern control theory which can be useful in taking advanced courses offered in the controls stream.
- Know the radar theory and applications, navigation principles and guidance laws

TEXT BOOKS:

1. Albert D. Helfrick, "Modern Aviation Electronics", Second Ed., Prentice Hall Career & Technology, 1994.
2. James R Wertz, "Spacecraft Attitude Determination and control", Reidel Publications, 1978.
3. Kaplan, M. H., "Modern Spacecraft Dynamics and Control", Wiley India Pvt Ltd, 2011.
4. Marcel J. Sidi, "Spacecraft Dynamics and Control: A Practical Engineering Approach", Cambridge University Press, 2000.
5. Maxwell Noton, "Spacecraft navigation and guidance", Springer (London, New York), 1998.
6. Slater, J. M. Donnel, C.F.O and others, "Inertial Navigation Analysis and Design", McGraw-Hill Book Company, New York, 1964.

REFERENCES:

1. Blake Lock, J.H, “Automatic control of Aircraft and missiles”, John Wiley Sons, New York, 1990.
2. George M Siouris, “Aerospace Avionics System; A Modern Synthesis”, Academic Press Inc., 1993.
3. Meyer Rudolph X, “Elements of Space Technology for Aerospace Engineers”, Academic Press,1999.
4. Myron Kyton, Walfred Fried, “Avionics Navigation Systems”, John Wiley & Sons, 1997
5. Tsui. J. B.Y, “Fundamentals of Global Positioning System Receiver”, John Wiley an Sons Inc, 2000.
6. Vladimir A Chobotov, “Spacecraft Attitude Dynamics and Control (Orbit)”, Krieger Publishing Company Publishers.

GE8074 **HUMAN RIGHTS** **L T P C**
3 0 0 3

OBJECTIVE:

- To sensitize the Engineering students to various aspects of Human Rights.

UNIT I **9**

Human Rights – Meaning, origin and Development. Notion and classification of Rights – Natural, Moral and Legal Rights. Civil and Political Rights, Economic, Social and Cultural Rights; collective / Solidarity Rights.

UNIT II **9**

Evolution of the concept of Human Rights Magana carta – Geneva convention of 1864. Universal Declaration of Human Rights, 1948. Theories of Human Rights.

UNIT III **9**

Theories and perspectives of UN Laws – UN Agencies to monitor and compliance.

UNIT IV **9**

Human Rights in India – Constitutional Provisions / Guarantees.

UNIT V **9**

Human Rights of Disadvantaged People – Women, Children, Displaced persons and Disabled persons, including Aged and HIV Infected People. Implementation of Human Rights – National and State Human Rights Commission – Judiciary – Role of NGO's, Media, Educational Institutions, Social Movements.

TOTAL: 45 PERIODS

OUTCOME:

- Engineering students will acquire the basic knowledge of human rights.

REFERENCES:

1. Chandra U., "Human Rights", Allahabad Law Agency, Allahabad, 2014.
2. Kapoor S.K., "Human Rights under International law and Indian Laws", Central Law Agency, Allahabad, 2014.
3. Upendra Baxi, The Future of Human Rights, Oxford University Press, New Delhi.

AC8012 **COMBUSTION ENGINEERING**

L	T	P	C
3	0	0	3

OBJECTIVES:

- To know the concepts in combustion, make combustion calculations, and to know supersonic combustion.
- This course starts with a review of chemical thermodynamics, statistical mechanics, equilibrium chemistry, chemical kinetics, and conservation equations.
- To explain the chemical and dynamic structure of laminar premixed, diffusion, and partially premixed flames; turbulent premixed combustion; turbulent diffusive combustion.

UNIT I FUNDAMENTAL CONCEPTS IN COMBUSTION 9

Thermo-chemical equations - Heat of reaction first order, second order and third order reactions – premixed flames - Diffusion flames

UNIT II CHEMICAL KINETICS AND FLAMES 9

Measurement of burning velocity - Various methods - Effect of various parameters on burning velocity - Flame stability - Detonation - Deflagration - Rankine – Hugoniot curve - Radiation by flames.

UNIT III COMBUSTION IN GAS TURBINE ENGINES 9

Combustion in gas turbine combustion chambers - Re-circulation – Combustion efficiency - Factors affecting combustion efficiency - Fuels used for gas turbine combustion chambers - Combustion stability - Flame holder types – Numerical problems.

UNIT IV COMBUSTION IN ROCKETS 9

Solid propellant combustion - Double base and composite propellant combustion - Various combustion models - Combustion in liquid rocket engines - Single fuel droplet combustion model - Combustion in hybrid rockets.

UNIT V SUPERSONIC COMBUSTION 9

Introduction - Supersonic combustion controlled by mixing, diffusion and heat convection - Analysis of reaction and mixing processes - Supersonic burning with detonation shocks.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Understand the concept of gaseous fuels.
- Differentiate solid, gaseous, and liquid fuels.
- Relate the thermo chemistry and kinetics of combustion to evolve mathematical models for combustion.
- Apply the different principles of flame stabilization and ignition to design combustor.
- Understands the fundamentals in combustion of fuels and propellants.

TEXT BOOKS:

1. Loh, W.H.T., “Jet, Rocket, Nuclear, Ion and Electric Propulsion Theory and Design”, Springer Verlag, New York, 1982.
2. Sharma, S.P., and Chandra Mohan, “Fuels and Combustion”, Tata McGraw Hill Publishing Co., Ltd, New Delhi 1987.

REFERENCES:

1. Beer, J.M. and Chigier, N.A., “Combustion Aerodynamics”, Applied Science Publishers Ltd, London, 1981.
2. Chowdhury, R., “Applied Engineering Thermodynamics”, Khanna Publishers, New Delhi, 1986.
3. Mathur, M., and Sharma, R.P., “Gas Turbines and Jet and Rocket Propulsion”, Standard Publishers, New Delhi, 1988.
4. Sutton, G.P., “Rocket Propulsion Elements”, Wiley, New York, 9th Ed., 2017.
5. Turns, S.R., “An Introduction to Combustion Concepts and Applications”, 2nd Ed., McGraw Hill International Editions, New Delhi, 2000.

AC8013	ECONOMICS AND PRINCIPLES OF MANAGEMENT	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To know the different engineering economic principles and strategies.
- Principles of organizational management.
- Behaviour of human at organizations with modern management concepts.

UNIT I ENGINEERING ECONOMICS 9

Introduction - Economics - Scope and Definition - Importance of Economics in Engineering - Economic optimization- Demand and Revenue Analysis - Law of Demand - Demand Forecasting - Methods of Demand Forecasting - Demand curves - Factors affecting Demand - Demand Elasticity - Production Analysis - simple problems.

UNIT II SUPPLY, COST AND OUTPUT 9

Supply - Supply schedule - Law of Supply - Elasticity of Supply - Cost and Supply Analysis - Types of Costs - Price and output Determination - Price Fixation - Pricing methods - Pricing Policies - Factors governing Pricing Policies - Break- Even analysis - Estimation of Break-Even Point - Usefulness of BEP - Limitations - simple problems.

UNIT III MANAGEMENT AND ITS ENVIRONMENT 9

Management - Definition - Functions - Evolution of Modern Management movement - Different Schools of Management - Types and Forms of Business Organization - Designing effective organizations - Individual ownership - Partnership - Joint stock companies - Cooperative enterprises - Public Sector Undertakings.

UNIT IV MANAGEMENT OF HUMAN AT WORK 9

Human Resource Development - Motivating individuals and workgroups - Leadership for Managerial Effectiveness - Team working and Creativity - Managerial Communication - Time Management - Performance Appraisal- Career Planning.

UNIT V MODERN MANAGEMENT CONCEPTS 9

Management by Objectives (MBO) - Principles and Steps - Advantages and Disadvantages - Management by Exception (MBE) - Strategic management - SWOT analysis - Enterprise Resource Planning (ERP) - Supply Chain Management (SCM) - Activity Based Management (ABM).

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Define and explain how basic concepts of microeconomics (such as elasticity, scarcity or choice) can be used to explain the behaviour of individuals, household or firms.
- Represent supply and demand, in graphical form, including the downward/upward slope of the curves and what shifts/moves along the curves.
- Describe and explain how basic macroeconomic policies (such as fiscal or monetary) can be used to analyse the economy as a whole.
- Explain basic management, business and marketing principles to be able to continue studies on a higher level.
- Understand the role of PESTLE factors on the SWOT of corporations, in the domestic and the international business environment.

TEXT BOOKS:

1. Chandran, J. S., “Organizational Behaviours”, Vikas Publishing House Pvt. Ltd, New Delhi, 1994.
2. Ernest Dale, “Management Theory and Practice”, International Student Ed., McGraw Hill Publishing Co., New Delhi, 1973.
3. Sasmita Mishra, “Engineering Economics and Costing”, Eastern economy Ed., 2009.

REFERENCES:

1. Barathwal R.R., "Engineering Economics", McGraw Hill, 1997.
2. Chaiger, N. A., “Energy Consumption and Environment”, McGraw Hill, New Delhi, 1981.
3. Gail Freeman - Bell and Janes Balkwill, "Management in Engineering - Principles and Practive", Prentice Hall of India Pvt.Ltd, 1998.
4. Richard Pettinger, “Mastering Organizational Behaviour”, Macmillan Press, London, 2000.

AC8014	SPACE MISSIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the life support systems, mission logistics and planning.
- Fundamental laws of mechanics, orbital mechanics, and Orbital manoeuvres.
- Types of space missions and their objectives in the Space environment.
- General concepts of space vehicle architecture, Attitude determination, and control.

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 COUNTERMEASURES 8

Life Support Systems and Space Survival Overview - Environment Controlled Life Support Systems (ECLSS) - Human/Machine Interaction - Human Factors in Control Design – Crew Accommodations.

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 Subsystems: Space Operations - Space Architecture, Attitude Determination and Control - Designing Power Systems - Extravehicular Activity (EVA) Systems - Space Robotics - Mission Operations for Crewed Spaceflight - Command, Control, and Communications Architecture.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of this course, the student will be able to

- Understand the advanced concepts of manned space missions.
- Provide the necessary mathematical knowledge that are needed in understanding their significance and operation.
- Have an exposure on various topics such as missile space stations, space vs earth environment, life support systems, mission logistics and planning.
- Deploy these skills effectively in the understanding of manned space missions.

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, P., “Spaceflight Life Support and Biospherics”, 1996.

AC8015	SPACECRAFT SENSORS AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To provide an overview of the different types of sensors and instruments flown on spacecraft.
- To provide students with an appreciation and understanding of the development of the design processes involved for different instruments.
- To explain, how the sensors and instruments interface with the spacecraft platform.

UNIT I INTRODUCTION 8

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 10

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

OUTCOMES:

On successful completion of this course, the student will be able to

- Explains how mathematics, physics, and engineering-based concepts are used to develop and design a sensor which complies with a set of specific requirements.
- Discusses essential topics such as cost estimation, signal processing, noise reduction, filters, phased arrays, radars, optics, and radiometers used in space operation.
- Covers a range of typical sensors used in the spacecraft industry such as infrared, passive microwave, radars and space-based GPS sensors.
- Spacecraft Sensors is an invaluable resource for engineers, technical consultants, those in the business division, and research scientists associated with spacecraft projects.

TEXT BOOKS:

1. Abid, Mohamed M., “Spacecraft Sensors”, Chichester, England; Hoboken, NJ: J. Wiley, 2005.
2. Kohichiro Oyama, Chio-Zong Cheng, “An introduction to space instrumentation”, Tokyo, Japan: Terrapub, 2013.

REFERENCE:

1. Yuri Surkov, “Exploration of Terrestrial Planets from Spacecraft: Instrumentation, Investigation, Interpretation”, Wiley-Praxis Series in Astronomy & Astrophysics, Ellis Horwood Ltd, 2nd Ed., 1990.

AC8016	SPACECRAFT SYSTEMS ENGINEERING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The main objective of the course is to introduce the concept of space system design and engineering.
- 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.

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 - Solar Cell Physics - Solar Cell Operating Characteristics - 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

OUTCOMES:

On successful completion of this course, the student will be able to

- Analyse the issues in the spacecraft structures.
- Understand the functions of spacecraft power systems.
- Detect the error and correct in the spacecraft computer systems.
- Learn system engineering by designing, building, and testing a small satellite in laboratory.
- Understand the selection process of the launch 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.
3. Vincent L. Piscane, “Fundamentals of Space Systems”, Oxford University Press, 2nd Ed., 2005.

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.

AC8017	SPACECRAFT STRUCTURES	L	T	P	C
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OBJECTIVES:

- The course gives an exposure to the Spacecraft structural requirements.
- Structural configuration concepts and trade-offs
- Types of environmental loading during launch
- Factors to consider in material selection and types of structural tests

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

OUTCOMES:

On successful completion of this course, the student will be able to

- Identify simplifying assumptions and applicability of 1 structural element theories.
- Solve by hand simple 1-D axial deformation, torsion, and bending problems.
- Solve more complex structural mechanics problems using commercial finite element software.
- Solve simple discrete degree of freedom structural stability problems.
- Solve simple structural dynamics problems.

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.

GE8076 PROFESSIONAL ETHICS IN ENGINEERING L T P C
3 0 0 3

OBJECTIVE:

- To enable the students to create an awareness on Engineering Ethics and Human Values to instill Moral and Social Values and Loyalty and to appreciate the rights of others.

UNIT I HUMAN VALUES 10

Morals, values and Ethics – Integrity – Work ethic – Service learning – Civic virtue – Respect for others – Living peacefully – Caring – Sharing – Honesty – Courage – Valuing time – Cooperation – Commitment – Empathy – Self-confidence – Character – Spirituality – Introduction to Yoga and meditation for professional excellence and stress management.

UNIT II 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 III ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as Experimentation – Engineers as responsible Experimenters – Codes of Ethics – A Balanced Outlook on Law.

UNIT IV SAFETY, RESPONSIBILITIES 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.

UNIT V GLOBAL ISSUES 8

Multinational Corporations – Environmental Ethics – Computer Ethics – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Moral Leadership –Code of Conduct – Corporate Social Responsibility.

TOTAL: 45 PERIODS

OUTCOME:

- Upon completion of the course, the student should be able to apply ethics in society, discuss the ethical issues related to engineering and realize the responsibilities and rights in the society.

TEXT BOOKS:

1. Govindarajan M, Natarajan S, Senthil Kumar V. S, "Engineering Ethics", Prentice Hall of India, New Delhi, 2004.
2. Mike W. Martin and Roland Schinzinger, "Ethics in Engineering", Tata McGraw Hill, New Delhi, 2003.

REFERENCES:

1. Charles B. Fleddermann, "Engineering Ethics", Pearson Prentice Hall, New Jersey, 2004.
2. Charles E. Harris, Michael S. Pritchard and Michael J. Rabins, "Engineering Ethics – Concepts and Cases", Cengage Learning, 2009.
3. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, Oxford, 2001.
4. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, New Delhi, 2003
5. Laura P. Hartman and Joe Desjardins, "Business Ethics: Decision Making for Personal Integrity and Social Responsibility" Mc Graw Hill education, India Pvt. Ltd., New Delhi, 2013.
6. World Community Service Centre, 'Value Education', Vethathiri publications, Erode, 2011.

Web sources:

1. www.onlineethics.org
2. www.nspe.org
3. www.globalethics.org
4. www.ethics.org