ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

B.E. AERONAUTICAL ENGINEERING

This education is meant to prepare our students to thrive, to lead and to prepare them to achieve four **Programme Educational Objectives (PEOs)**

PEO 1: Adaptability to industry: Graduates of the programme will receive adequate academic input to adapt themselves in any aircraft and allied industries

PEO 2: Successful Career Development: Graduates of the programme will have successful technical and professional careers in Aeronautical and allied industries and management.

PEO 3: Contribution to Aeronautical Field: Graduates of the programme will have innovative ideas and potential to contribute for the development and current needs of the aeronautical industries.

PEO 4: Sustainable interest for Lifelong learning: Graduates of the programme will have sustained interest continuously to learn and adapt new technology and development to meet the changing industrial scenarios.

The Technology Program in Aeronautical Engineering attains the following student learning Program Outcomes:

a. Graduate will demonstrate strong basics in mathematics, science and engineering.
b. Graduate will demonstrate the ability to design and conduct experiments, as well as to analyze and interpret data.
c. Graduate will demonstrate the ability to design a system or a component to meet the design requirements with constraints exclusively meant for Aeronautical Engineering.
d. Graduate will become familiar with modern engineering tools and analyze the problems within the domains of Aeronautical Engineering as a member of multidisciplinary teams.
e. Graduate will acquire the capability to identify, formulate and solve complex engineering problems of Aeronautical Engineering.
f. Graduate will demonstrate an understanding of professional and ethical responsibility with reference to their career in the field of Aeronautical Engineering and other professional fields.
g. Graduate will be able to communicate effectively both in verbal and non verbal forms.
h. Graduate will be trained towards developing and understanding the importance of design and development of Airplanes from system integration point of view.

i. Graduate will be capable of understanding the value for life-long learning.

j. Graduate will exhibit the awareness of contemporary issues focusing on the necessity to develop new material, design, testing and solution for environmental problems pertaining to aircraft industry.

k. Graduate will be able to use the techniques, skills and modern engineering tools that are necessary for engineering practice in the field of Aeronautical Engineering.

l. Graduation Graduate will have a firm scientific, technological and communication base that helps them to find a placement in the Aircraft industry and R & D organisations related to Aero Engineering and other professional fields.

m. Graduate will be capable of doing higher studies and research in inter and multidisciplinary areas.

Mapping PEO with POs:

PEO/PO	a	b	c	d	e	f	g	h	i	j	k	l	m
1	√	√	√	√	√	√		√		√	√	√	
2	√	√	√	√	√	√	√	√		√	√	√	√
3			√	√	√			√		√	√	√	
4	√	√	√	√	√		√	√	√	√			√

MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES:

Subjects/PO	Category	Sem/Year	a	b	c	d	e	f	g	h	i	j	k	l	m
Foundational English	HS	I/I							√		√			√	
Mathematics-I	BS	I/I	√		√		√								
Engineering Physics	BS	I/I	√	√	√			√							
Engineering Chemistry	BS	I/I	√	√	√			√							
Engineering Graphics	ES	I/I			√		√								
Basic Sciences Laboratory	BS	I/I	√	√	√			√							
Engineering Practices Laboratory	ES	I/I	√	√											
Technical English	HS	II/I							√		√			√	
Mathematics-II	BS	II/I	√		√		√								
Materials Science	BS	II/I	√	√	√			√							
Computing Techniques	ES	II/I	√	√	√	√	√				√	√		√	
Production Processes	ES	II/I	√	√			√							√	
Subjects/PO	**Category**	**Sem/Year**	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**m**
Engineering Mechanics	ES	II/I	√	√	√		√							√	√
Production Processes Laboratory	ES	II/I	√	√	√	√							√	√	
Computer Practices Laboratory	ES	II/I	√	√			√				√	√			
Numerical Methods	BS	III/II	√		√		√								
Engineering Fluid Mechanics and Machinery	ES	III/II	√	√	√		√							√	√
Aero Engineering Thermodynamics	ES	III/II	√	√	√		√							√	√
Solid Mechanics	ES	III/II	√	√	√		√							√	√
Principles of Flight	PC	III/II	√	√	√									√	√
Basic Electrical and Electronics Engineering	ES	III/II	√	√			√					√			
Electrical and Electronics Engineering Laboratory	ES	III/II	√	√	√	√							√	√	
Mechanical Sciences Laboratory	ES	III/II	√	√	√			√							
Subjects/PO	**Category**	**Sem/Year**	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**m**
Transform Techniques and Partial Differential Equations	BS	IV/II	√		√		√								
Aircraft Systems and Instruments	PC	IV/II		√	√					√					
Aerodynamics-I	PC	IV/II		√	√	√	√			√		√	√	√	√
Propulsion-I	PC	IV/II		√	√	√	√			√		√	√	√	√

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Aircraft Structures-I	PC	IV/II		√	√	√	√			√		√	√	√	√
Kinematics and Dynamics of Machines	PC	IV/II	√	√			√					√			
Aerodynamics laboratory	PC	IV/II		√	√	√						√			
Aircraft Component Drawing laboratory	PC	IV/II		√	√	√						√			
Flight Mechanics	PC	V/III		√	√	√	√			√		√	√	√	√
Aerodynamics-II	PC	V/III		√	√	√	√			√		√	√	√	√
Propulsion-II	PC	V/III		√	√	√	√			√		√	√	√	√
Aircraft Structures-II	PC	V/III		√	√	√	√			√		√	√	√	√
Subjects/PO	**Category**	**Sem/Year**	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**m**
Propulsion Laboratory	PC	V/III		√	√	√						√			
Aircraft Structures laboratory	PC	V/III		√	√	√						√			
Aircraft Stability and Control	PC	VI/III		√	√	√	√			√		√	√	√	√
Computational Fluid Dynamics	PC	VI/III		√	√	√						√			
Finite Element Methods	PC	VI/III		√	√	√	√			√		√	√	√	√
Environmental Science and Engineering	HS	VI/III							√		√			√	
Aircraft Design Project –I	EEC	VI/III		√	√	√	√			√		√	√	√	√
Aeromodelling	EEC	VI/III		√	√	√						√			
Experimental Aerodynamics	PC	VII/IV		√	√	√	√			√		√	√	√	√
Heat Transfer	PC	VII/IV		√	√	√	√			√		√	√	√	√
Composite Materials and structures	PC	VII/IV		√	√	√	√			√		√	√	√	√
Rockets and Launch Vehicles	PC	VII/IV		√	√	√	√			√		√	√	√	√
Aircraft Design Project-II	EEC	VII/IV		√	√	√	√			√		√	√	√	√
Subjects/PO	**Category**	**Sem/Year**	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**m**
Communication Skills and Soft Skills	EEC	VII/IV		√	√	√		√		√		√	√	√	√
Experiments in Flight Laboratory	EEC	VIII/IV		√	√	√	√			√		√	√	√	
Project Work	EEC	VIII/IV		√	√	√	√			√		√	√	√	√
Aero Elasticity	PE	Elective		√	√	√	√			√		√	√	√	√
Theory of Elasticity	PE	Elective		√	√	√	√			√		√	√	√	√
Theory of Vibrations	PE	Elective		√	√	√	√			√		√	√	√	√

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Approximate Methods in Structural Mechanics	PE	Elective		√	√	√	√			√		√	√	√	√
Fatigue and Fracture Mechanics	PE	Elective		√	√	√	√			√		√	√	√	√
Fundamentals of Control Engineering	PE	Elective		√	√	√	√			√		√	√	√	√
Avionics	PE	Elective		√	√	√	√			√		√	√	√	√
Aircraft Engine Repairs and Maintenance	PE	Elective		√	√	√	√			√		√	√	√	√
Subjects/PO	**Category**	**Sem/Year**	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**m**
Aircraft Rules and Regulations CAR I & II	PE	Elective		√	√	√	√			√		√	√	√	√
Airframe Repair and Maintenance	PE	Elective		√	√	√	√			√		√	√	√	√
Boundary Layer Theory	PE	Elective		√	√	√	√			√		√	√	√	√
Combustion in Aerospace Vehicles	PE	Elective		√	√	√	√			√		√	√	√	√
Design of Gas Turbine Engine Components	PE	Elective		√	√	√	√			√		√	√	√	√
Wind Tunnel Techniques	PE	Elective		√	√	√	√			√		√	√	√	√
Hypersonic Aerodynamics	PE	Elective		√	√	√	√			√		√	√	√	√
Structural dynamics	PE	Elective		√	√	√	√			√		√	√	√	√
Satellite Technology	PE	Elective		√	√	√	√			√		√	√	√	√
Space Mechanics	PE	Elective		√	√	√	√			√		√	√	√	√
UAV system design	PE	Elective		√	√	√	√			√		√	√	√	√
Theory of Plates and Shells	PE	Elective		√	√	√	√			√		√	√	√	√
Aircraft design	PE	Elective		√	√	√	√			√		√	√	√	√
Subjects/PO	**Category**	**Sem/Year**	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**	**l**	**m**
Fundamentals of Nanoscience	PE	Elective		√	√	√	√			√		√	√	√	√
Aircraft systems Engineering	PE	Elective		√	√	√	√			√		√	√	√	√
Wind Engineering	PE	Elective		√	√	√	√			√		√	√	√	√
Missile Aerodynamics	PE	Elective		√	√	√	√			√		√	√	√	√
Experimental Stress Analysis	PE	Elective		√	√	√	√			√		√	√	√	√
Helicopter Aerodynamics	PE	Elective		√	√	√	√			√		√	√	√	√
Numerical Heat Transfer	PE	Elective		√	√	√	√			√		√	√	√	√
Aerospace Materials	PE	Elective		√	√	√	√			√		√	√	√	√
Disaster Management	PE	Elective		√	√	√	√			√		√	√	√	√
Human Rights	PE	Elective		√	√	√	√			√		√	√	√	√

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UNIVERSITY DEPARTMENTS

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REGULATIONS – 2015

CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI I - VIII SEMESTERS

SEMESTER I

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	HS7151	Foundational English	HS	4	4	0	0	4
2.	MA7151	Mathematics-I	BS	4	4	0	0	4
3.	PH7151	Engineering Physics	BS	3	3	0	0	3
4.	CY7151	Engineering Chemistry	BS	3	3	0	0	3
5.	GE7152	Engineering Graphics	ES	5	3	2	0	4
PRACTICAL								
6.	BS7161	Basic Sciences Laboratory	BS	4	0	0	4	2
7.	GE7162	Engineering Practices Laboratory	ES	4	0	0	4	2
			TOTAL	**27**	**17**	**2**	**8**	**22**

SEMESTER II

S. No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	HS7251	Technical English	HS	4	4	0	0	4
2.	MA7251	Mathematics-II	BS	4	4	0	0	4
3.	PH7251	Materials Science	BS	3	3	0	0	3
4.	GE7151	Computing Techniques	ES	3	3	0	0	3
5.	PR7251	Production Processes	ES	3	3	0	0	3
6.	GE7153	Engineering Mechanics	ES	4	4	0	0	4
PRACTICAL								
7.	PR7261	Production Processess Laboratory	ES	4	0	0	4	2
8.	GE7161	Computer Practices Laboratory	ES	4	0	0	4	2
			TOTAL	**29**	**21**	**0**	**8**	**25**

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SEMESTER III

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	AE7301	Aero Engineering Thermodynamics	ES	3	3	0	0	3
2.	AE7302	Principles of Flight	PC	3	3	0	0	3
3.	AE7351	Engineering Fluid Mechanics and Machinery	ES	3	3	0	0	3
4.	AE7353	Solid Mechanics	ES	3	3	0	0	3
5.	EE7151	Basic Electrical and Electronics Engineering	ES	3	3	0	0	3
6.	MA7354	Numerical Methods	BS	4	4	0	0	4
PRACTICAL								
7.	EE7261	Electrical and Electronics Engineering Laboratory	ES	4	0	0	4	2
8.	ME7362	Mechanical Sciences Laboratory	ES	4	0	0	4	2
			TOTAL	**27**	**19**	**0**	**8**	**23**

SEMESTER IV

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	AE7401	Aerodynamics - I	PC	3	3	0	0	3
2.	AE7402	Aircraft Structures - I	PC	3	3	0	0	3
3.	AE7403	Aircraft Systems and Instruments	PC	3	3	0	0	3
4.	AE7404	Propulsion - I	PC	3	3	0	0	3
5.	MA7358	Transform Techniques and Partial Differential Equations	BS	4	4	0	0	4
6.	PR7451	Kinematics and Dynamics of Machines	PC	4	4	0	0	4
PRACTICAL								
7.	AE7411	Aerodynamics Laboratory	PC	4	0	0	4	2
8.	AE7412	Aircraft Component Drawing Laboratory	PC	4	0	0	4	2
			TOTAL	**28**	**20**	**0**	**8**	**24**

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SEMESTER V

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	AE7501	Aerodynamics - II	PC	3	3	0	0	3
2.	AE7502	Aircraft Structures-II	PC	3	3	0	0	3
3.	AE7503	Flight Mechanics	PC	3	3	0	0	3
4.	AE7504	Propulsion - II	PC	3	3	0	0	3
5.		Professional Elective-I	PE	3	3	0	0	3
6.		Professional Elective-II	PE	3	3	0	0	3
PRACTICAL								
7.	AE7511	Aircraft Structures Laboratory	PC	4	0	0	4	2
8.	AE7512	Propulsion Laboratory	PC	4	0	0	4	2
			TOTAL	**26**	**18**	**0**	**8**	**22**

SEMESTER VI

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	AE7601	Aircraft Stability and Control	PC	4	4	0	0	4
2.	AE7602	Computational Fluid Dynamics	PC	3	3	0	0	3
3.	AE7603	Finite Element Methods	PC	3	3	0	0	3
4.	GE7251	Environmental Science and Engineering	HS	3	3	0	0	3
5.		Professional Elective-III	PE	3	3	0	0	3
6.		Professional Elective-IV	PE	3	3	0	0	3
PRACTICAL								
7.	AE7611	Aeromodelling	EEC	4	0	0	4	2
8.	AE7612	Aircraft Design Project – I	EEC	4	0	0	4	2
			TOTAL	**27**	**19**	**0**	**8**	**23**

SEMESTER VII

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	AE7701	Composite Materials and Structures	PC	3	3	0	0	3
2.	AE7702	Experimental Aerodynamics	PC	3	3	0	0	3
3.	AE7703	Heat Transfer	PC	3	3	0	0	3
4.	AE7704	Rockets and Launch Vehicles	PC	3	3	0	0	3
5.		Professional Elective-V	PE	3	3	0	0	3
6.		Open Elective - I*	OE	3	3	0	0	3
PRACTICAL								
7.	AE7711	Aircraft Design Project-II	EEC	4	0	0	4	2
8.	HS7561	Communication Skills and Soft Skills	HS	3	1	0	2	2
			TOTAL	**25**	**19**	**0**	**6**	**22**

SEMESTER VIII

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.		Professional Elective-VI	PE	3	3	0	0	3
2.		Open Elective-II*	OE	3	3	0	0	3
PRACTICAL								
3.	AE7811	Experiments in flight Laboratory	EEC	4	0	0	4	2
4.	AE7812	Project Work	EEC	20	0	0	20	10
			TOTAL	**30**	**6**	**0**	**24**	**18**

TOTAL NO. OF CREDITS: 179

***Course from the curriculum of other UG Programmes**

HUMANITIES AND SOCIALSCIENCES (HS)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	HS7151	Foundational English	HS	4	4	0	0	4
2.	HS7251	Technical English	HS	4	4	0	0	4
3.	GE7251	Environmental science and Engineering	HS	3	3	0	0	3
4.	HS7561	Communication Skills and Soft Skills	HS	3	1	0	2	2

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BASIC SCIENCES (BS)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	MA7151	Mathematics-I	BS	4	4	0	0	4
2.	PH7151	Engineering Physics	BS	3	3	0	0	3
3.	CY7151	Engineering Chemistry	BS	3	3	0	0	3
4.	BS7161	Basic Sciences Laboratory	BS	4	0	0	4	2
5.	MA7251	Mathematics-II	BS	4	4	0	0	4
6.	PH7251	Materials Science	BS	3	3	0	0	3
7.	MA7354	Numerical Methods	BS	4	4	0	0	4
8.	MA7358	Transform Techniques and Partial Differential Equations	BS	4	4	0	0	4

ENGINEERING SCIENCES (ES)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	GE7152	Engineering Graphics	ES	5	3	2	0	4
2.	GE7162	Engineering Practices Laboratory	ES	4	0	0	4	2
3.	GE7151	Computing Techniques	ES	3	3	0	0	3
4.	PR7251	Production Processes	ES	3	3	0	0	3
5.	GE7153	Engineering Mechanics	ES	4	4	0	0	4
6.	PR7261	Production Processes Laboratory	ES	4	0	0	4	2
7.	GE7161	Computer Practices Laboratory	ES	4	0	0	4	2
8.	AE7351	Engineering Fluid Mechanics and Machinery	ES	3	3	0	0	3
9.	AE7301	Aero Engineering Thermodynamics	ES	3	3	0	0	3
10.	AE7353	Solid Mechanics	ES	3	3	0	0	3
11.	EE7151	Basic Electrical and Electronics Engineering	ES	3	3	0	0	3
12.	EE7261	Electrical and Electronics Engineering Laboratory	ES	4	0	0	4	2
13.	ME7362	Mechanical Sciences Laboratory	ES	4	0	0	4	2

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PROFESSIONAL CORE (PC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	AE7302	Principles of Flight	PC	3	3	0	0	3
2.	AE7403	Aircraft Systems and Instruments	PC	3	3	0	0	3
3.	AE7401	Aerodynamics-I	PC	3	3	0	0	3
4.	AE7404	Propulsion-I	PC	3	3	0	0	3
5.	AE7402	Aircraft Structures-I	PC	3	3	0	0	3
6.	PR7451	Kinematics and Dynamics of Machines	PC	4	4	0	0	4
7.	AE7411	Aerodynamics Laboratory	PC	4	0	0	4	2
8.	AE7412	Aircraft Component Drawing Laboratory	PC	4	0	0	4	2
9.	AE7503	Flight Mechanics	PC	3	3	0	0	3
10.	AE7501	Aerodynamics-II	PC	3	3	0	0	3
11.	AE7504	Propulsion-II	PC	3	3	0	0	3
12.	AE7502	Aircraft Structures-II	PC	3	3	0	0	3
13.	AE7512	Propulsion Laboratory	PC	4	0	0	4	2
14.	AE7511	Aircraft structures Laboratory	PC	4	0	0	4	2
15.	AE7601	Aircraft Stability and Control	PC	4	4	0	0	4
16.	AE7602	Computational Fluid Dynamics	PC	3	3	0	0	3
17.	AE7603	Finite Element Methods	PC	3	3	0	0	3
18.	AE7702	Experimental Aerodynamics	PC	3	3	0	0	3
19.	AE7703	Heat Transfer	PC	3	3	0	0	3
20.	AE7701	Composite Materials and Structures	PC	3	3	0	0	3
21.	AE7704	Rockets and Launch Vehicles	PC	3	3	0	0	3

PROFESSIONAL ELECTIVES (PE)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	AE7001	Aero Elasticity	PE	3	3	0	0	3
2.	AE7002	Aerospace Materials	PE	3	3	0	0	3
3.	AE7003	Aircraft Design	PE	3	3	0	0	3

4.	AE7004	Aircraft Engine Repairs and Maintenance	PE	3	3	0	0	3
5.	AE7005	Aircraft Rules and Regulations CAR I & II	PE	3	3	0	0	3
6.	AE7006	Aircraft Systems Engineering	PE	3	3	0	0	3
7.	AE7007	Airframe Repair and Maintenance	PE	3	3	0	0	3
8.	AE7008	Approximate Methods in Structural Mechanics	PE	3	3	0	0	3
9.	AE7009	Avionics	PE	3	3	0	0	3
10.	AE7010	Boundary Layer Theory	PE	3	3	0	0	3
11.	AE7011	Combustion in Aerospace Vehicles	PE	3	3	0	0	3
12.	AE7012	Design of Gas Turbine Engine Components	PE	3	3	0	0	3
13.	AE7013	Fatigue and Fracture Mechanics	PE	3	3	0	0	3
14.	AE7014	Fundamentals of Control Engineering	PE	3	3	0	0	3
15.	AE7015	Helicopter Aerodynamics	PE	3	3	0	0	3
16.	AE7016	Hypersonic Aerodynamics	PE	3	3	0	0	3
17.	AE7017	Missile Aerodynamics	PE	3	3	0	0	3
18.	AE7018	Numerical Heat Transfer	PE	3	3	0	0	3
19.	AE7019	Satellite Technology	PE	3	3	0	0	3
20.	AE7020	Space Mechanics	PE	3	3	0	0	3
21.	AE7021	Structural Dynamics	PE	3	3	0	0	3
22.	AE7022	Theory of Elasticity	PE	3	3	0	0	3
23.	AE7023	Theory of Plates and Shells	PE	3	3	0	0	3
24.	AE7024	Theory of Vibrations	PE	3	3	0	0	3
25.	AE7025	UAV System Design	PE	3	3	0	0	3
26.	AE7026	Wind Engineering	PE	3	3	0	0	3
27.	AE7027	Wind Tunnel Techniques	PE	3	3	0	0	3
28.	AE7071	Experimental Stress Analysis	PE	3	3	0	0	3
29.	GE7071	Disaster Management	PE	3	3	0	0	3
30.	GE7073	Fundamentals of Nanoscience	PE	3	3	0	0	3
31.	GE7074	Human Rights	PE	3	3	0	0	3
32.	GE7072	Foundation Skills in Integrated Product Development	PE	3	3	0	0	3

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EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S.No	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	AE7611	Aeromodelling	EEC	4	0	0	4	2
2.	AE7612	Aircraft Design Project-I	EEC	4	0	0	4	2
3.	AE7711	Aircraft Design Project-II	EEC	4	0	0	4	2
4.	AE7811	Experiments in Flight Laboratory	EEC	4	0	0	4	2
5.	AE7812	Project Work	EEC	20	0	0	20	10

S.NO.	SUBJECT AREA	CREDITS AS PER SEMESTER								CREDITS TOTAL
		I	II	III	IV	V	VI	VII	VIII	

SUMMARY

1.	**HS**	04	04	00	00	00	03	02	00	**11**
2.	**BS**	12	07	04	04	00	00	00	00	**27**
3.	**ES**	06	14	16	00	00	00	00	00	**36**
4.	**PC**	00	00	03	20	16	10	12	00	**61**
5.	**PE**	00	00	00	00	06	06	03	03	**18**
6.	**OE**	00	00	00	00	00	00	03	03	**6**
7.	**EEC**	00	00	00	00	00	04	02	12	**20**
	Total	**22**	**25**	**23**	**24**	**22**	**23**	**22**	**18**	**179**
8.	**Non Credit / Mandatory**									

HS7151 **FOUNDATIONAL ENGLISH** **L T P C**
4 0 0 4

COURSE DESCRIPTION:
This course aims at developing the language skills necessary for the first year students of Engineering and Technology.

OBJECTIVES:
- To develop the four language skills – Listening, Speaking, Reading and Writing.
- To improve the students' communicative competence in English.
- To teach students the various aspects of English language usage.

CONTENTS

UNIT I GREETING AND INTRODUCING ONESELF 12
Listening- Types of listening – Listening to short talks, conversations; **Speaking** – Speaking about one's place, important festivals etc. – Introducing oneself, one's family/ friend;**Reading** – Skimming a passage– Scanning for specific information;**Writing**- Guided writing - Free writing on any given topic (My favourite place/ Hobbies/ School life, writing about one's leisure time activities, hometown, etc.); **Grammar** – Tenses (present and present continuous) -Question types - Regular and irregular verbs; **Vocabulary –** Synonyms and Antonyms.

UNIT II GIVING INSTRUCTIONS AND DIRECTIONS 12
Listening – Listening and responding to instructions; **Speaking** – Telephone etiquette - Giving oral instructions/ Describing a process – Asking and answering questions; **Reading** – Reading and finding key information in a given text - Critical reading - **Writing –**Process description(non-technical)- **Grammar** – Tense (simple past& past continuous) - Use of imperatives – Subject – verb agreement – Active and passive voice; - **Vocabulary** – Compound words – Word formation – Word expansion (root words).

UNIT III READING AND UNDERSTANDING VISUAL MATERIAL 12
Listening- Listening to lectures/ talks and completing a task; **Speaking** –Role play/ Simulation – Group interaction; **Reading** – Reading and interpreting visual material;**Writing**- Jumbled sentences – Discourse markers and Cohesive devices – Essay writing (cause & effect/ narrative);**Grammar** – Tenses (perfect), Conditional clauses –Modal verbs; **Vocabulary** –Cause and effect words; Phrasal verbs in context.

UNIT IV CRITICAL READING AND WRITING 12
Listening- Watching videos/ documentaries and responding to questions based on them; **Speaking** Informal and formal conversation; **Reading** –Critical reading (prediction & inference);**Writing**–Essay writing (compare & contrast/ analytical) – Interpretation of visual materials;**Grammar** – Tenses (future time reference);**Vocabulary** – One word substitutes (with meanings) – Use of abbreviations & acronyms – Idioms in sentences.

UNIT V LETTER WRITING AND SENDING E-MAILS 12
Listening- Listening to programmes/broadcast/ telecast/ podcast;**Speaking** – Giving impromptu talks, Making presentations on given topics- Discussion on the presentation;**Reading** –Extensive reading;**Writing**- Poster making – Letter writing (Formal and E-mail) ;**Grammar** – Direct and Indirect speech – Combining sentences using connectives; **Vocabulary** –Collocation;

TEACHING METHODS:
Interactive sessions for the speaking module.
Use of audio – visual aids for the various listening activities.
Contextual Grammar Teaching.

EVALUATION PATTERN:
Internals – 50%
End Semester – 50%

TOTAL:60 PERIODS

OUTCOMES:
- Students will improve their reading and writing skills
- Students will become fluent and proficient in communicative English
- Students will be able to improve their interpersonal communication

TEXTBOOK:
1. Richards, Jack.C with Jonathan Hull and Susan Proctor **New Interchange : English for International Communication. (level2, Student's Book)** Cambridge University Press,New Delhi: 2010.

REFERENCES:
1. Bailey, Stephen. **Academic Writing: A practical guide for students**. New York: Rutledge,2011.
2. Morgan, David and Nicholas Regan. **Take-Off: Technical English for Engineering**. London: Garnet Publishing Limited, 2008.
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 Skillsfor Business English.** Cambridge University Press, Cambridge: Reprint 2011.

MA7151	**MATHEMATICS – I (Common to all branches of B.E. / B.Tech. Programmes in I Semester)**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

OBJECTIVES:
- The goal of this course is for students to gain proficiency in calculus computations. In calculus, we use three main tools for analyzing and describing the behavior of functions: limits, derivatives, and integrals. Students will use these tools to solve application problems in a variety of settings ranging from physics and biology to business and economics.
- To make the student acquire sound knowledge of techniques in solving ordinary differential equations that model engineering problems.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their usage.

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UNIT I DIFFERENTIAL CALCULUS 12

Representation of functions - New functions from old functions - Limit of a function - Limits at infinity - Continuity - Derivatives - Differentiation rules - Polar coordinate system - Differentiation in polar coordinates - Maxima and Minima of functions of one variable.

UNIT II FUNCTIONS OF SEVERAL VARIABLES 12

Partial derivatives – Homogeneous functions and Euler's theorem – Total derivative – Differentiation of implicit functions – Change of variables – Jacobians – Partial differentiation of implicit functions – Taylor's series for functions of two variables – Errors and approximations – 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

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

TOTAL: 60 PERIODS

OUTCOMES:

- Understanding of the ideas of limits and continuity and an ability to calculate with them and apply them.
- Improved facility in algebraic manipulation.
- Fluency in differentiation.
- Fluency in integration using standard methods, including the ability to find an appropriate method for a given integral.
- Understanding the ideas of differential equations and facility in solving simple standard examples.

TEXTBOOKS:

1. James Stewart, "Calculus with Early Transcendental Functions", Cengage Learning, New Delhi, 2008.
2. Narayanan S. and Manicavachagom Pillai T. K., "Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2007.
3. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 9th Edition, New Delhi, 2014.
4. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.

REFERENCES:

1. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., New Delhi, 11th Reprint, 2010.

2. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, New Delhi, 3rd Edition, 2007.
3. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
4. Greenberg M.D., "Advanced Engineering Mathematics", Pearson Education, New Delhi, 2nd Edition, 5th Reprint, 2009. Aircraft design
5. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi, 2007.

PH7151 ENGINEERING PHYSICS L T P C
(Common to all branches of B.E / B.Tech programmes) 3 0 0 3

OBJECTIVE:

- To introduce the concept and different ways to determine moduli of elasticity and applications.
- To instill the concept of sound, reverberation, noise cancellation, and ultrasonic generation, detection and applications
- To inculcate an idea of thermal properties of materials, heat flow through materials and quantum physics
- To promote the basic understanding of interferometers, principles and applications of lasers, optical fibers and sensors
- To establish a sound grasp of knowledge on the basics, significance and growth of single crystals

UNIT I PROPERTIES OF MATTER 9

Elasticity – Poisson's ratio and relationship between moduli (qualitative) - stress-strain diagram for ductile and brittle materials, uses - factors affecting elastic modulus and tensile strength - bending of beams - cantilever - bending moment - Young's modulus determination - theory and experiment - uniform and non-uniform bending - I shaped girders - twisting couple - hollow cylinder - shaft - torsion pendulum - determination of rigidity modulus-moment of inertia of a body (regular and irregular).

UNIT II ACOUSTICS AND ULTRASONICS 9

Classification of sound - loudness and intensity - Weber-Fechner Law - standard intensity and intensity level - decibel - reverberation - reverberation time - calculation of reverberation time for different types of buildings – sound absorbing materials - factors affecting acoustics of buildings : focussing, interference, echo, echelon effect, resonance - noise and their remedies. Ultrasonics: production - magnetostriction and piezoelectric methods - detection of ultrasound - acoustic grating – ultrasonic interferometer - industrial applications – Non-destructive testing - ultrasonic method: scan modes and practice.

UNIT III THERMAL AND MODERN PHYSICS 9

Thermal expansion - thermal stress - expansion joints - bimetallic strips - thermal conductivity- heat conductions in solids – flow of heat through compound media - Forbe's and Lee's disc method: theory and experiment- Black body radiation – Planck's theory (derivation) – Compton effect – wave model of radiation and matter – Schrödinger's wave equation – time dependent and independent equations – Physical significance of wave function – particle in a one dimensional box.

UNIT IV APPLIED OPTICS 9

Interference - Michelson interferometer: construction, working, determination of wave length and thickness - anti-reflection coating - air wedge and its applications - Lasers – principle and applications – Einstein's coefficients – CO2 and Nd:YAG laser - semiconductor lasers: homo junction and hetro junction - construction and working – applications. Optical fibres - classification (index & mode based) - principle and propagation of light in optical fibres - acceptance angle and numerical aperture - fibre optic communication system - active and passive sensors.

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 - interplanar distance for a cubic crystal - coordination number and packing factor for SC, BCC, FCC, HCP and diamond structures - structure and significance of NaCl, CsCl, ZnS and graphite - crystal imperfections: point defects, line defects – Burger vectors, dislocations and stacking faults – Growth of single crystals: Bridgman and Czochralski methods.

TOTAL: 45 PERIODS

OUTCOME:

- The students will understand different moduli of elasticity, their determination and applications.
- The students will gain knowledge on the properties of sound, noise cancellation, and production, detection and applications of ultrasonics
- The students will acquire sound knowledge on thermal expansion and thermal conductivity of materials. Further they will gain an idea of quantum physics.
- The students will gain knowledge on interferometers, lasers and fiber optics
- The students will secure knowledge on the basics of crystal structures and their significance. Further they gain basic ideas of growing single crystals.

TEXTBOOKS:

1. Palanisamy P.K., "Engineering Physics", Scitech Publications (P) Ltd. (2006).
2. Arumugam M., "Engineering Physics", Anuradha Publications (2000)
3. Gaur R.K. and Gupta S.L., "Engineering Physics", Dhanpat Rai Publications (2013)

REFERENCES:

1. Serway R.A. and Jewett, J.W. "Physics for Scientists and Engineers with Modern Physics". Brooks/cole Publishing Co. (2010).
2. Tipler P.A. and Mosca, G.P., "Physics for Scientists and Engineers with Modern Physics". W.H.Freeman, (2007).
3. Markert J.T.,Ohanian, H. and Ohanian, M. "Physics for Engineers and Scientists". W.W.Norton & Co. (2007).

CY7151 ENGINEERING CHEMISTRY

L	T	P	C
3	0	0	3

OBJECTIVES:

- To develop an understanding about fundamentals of polymer chemistry.
- Brief elucidation on surface chemistry and catalysis.
- To develop sound knowledge photochemistry and spectroscopy.
- To impart basic knowledge on chemical thermodynamics.
- To understand the basic concepts of nano chemistry.

UNIT I POLYMER CHEMISTRY 9

Introduction: Functionality-degree of polymerization. Classification of polymers- natural and synthetic, thermoplastic and thermosetting. Types and mechanism of polymerization: addition (free radical, cationic, anionic and living); condensation and copolymerization. Properties of polymers: Tg, tacticity, molecular weight-weight average, number average and polydispersity index. Techniques of polymerization: Bulk, emulsion, solution and suspension.

UNIT II SURFACE CHEMISTRYAND CATALYSIS 9

Adsorption-Types of adsorption-adsorption of gases on solids- adsorption from solutions-Types of isotherms–Frendlich adsorption isotherm, Langmuir adsorption isotherm. Industrial applications of adsorption. Catalysis: Characteristics and types of catalysts-homogeneous and heterogeneous, auto catalysis. Enzyme catalysis -factors affecting enzyme catalysis, Michaelis- Menton equation. Industrial applications of catalysts.

UNIT III PHOTOCHEMISTRY AND SPECTROSCOPY 9

Photochemistry: Laws of photochemistry-Grotthuss-Draper law, Stark-Einstein law and Lambert-Beer Law. Photo processes-internal conversion, inter-system crossing, fluorescence, phosphorescence, chemiluminescence and photo-sensitization. Spectroscopy: Electromagnetic spectrum-absorption of radiation-electronic, vibrational and rotational transitions. Width and intensities of spectral lines.Spectrophotometric estimation of iron.UV-Vis and IR spectroscopy- principles, instrumentation (Block diagram) and applications.

UNIT IV CHEMICAL THERMODYNAMICS 9

Second law: Entropy-entropy change for an ideal gas, reversible and irreversible processes; entropy of phase transitions; Free energy and work function: Helmholtzand Gibbs free energy functions; Criteria of spontaneity; Gibbs-Helmholtz equation; Clausius Clapeyron equation; Maxwell relations-Van't Hoff isotherm and isochore. Chemical potential; Gibbs-Duhem equation- variation of chemical potential with temperature and pressure.

UNIT V NANOCHEMISTRY 9

Basics-distinction between molecules, nanoparticles and bulk materials; size-dependent properties. Preparation of nanoparticles – sol-gel and solvothermal. Preparation of carbon nanotube by chemical vapour deposition and laser ablation. Preparation of nanowires by VLS growth, electrochemical deposition and electro spinning. Properties and uses of nanoparticles, nanoclusters, nanorods, nanotubes and nanowires.

TOTAL: 45 PERIODS

OUTCOMES:

- Will be familiar with polymer chemistry, surface chemistry and catalysis.
- Will know the photochemistry, spectroscopy and chemical thermodynamics.
- Will know the fundamentals of nano chemistry.

TEXTBOOKS

1. Jain P. C. & Monica Jain., "Engineering Chemistry", DhanpatRai Publishing Company (P) Ltd, New Delhi, 2014.
2. Kannan P., Ravikrishnan A., "Engineering Chemistry", Sri Krishna Hitech Publishing Company Pvt. Ltd. Chennai, 2014

REFERENCES

1. Pahari A., Chauhan B., "Engineering Chemistry", Firewall Media, New Delhi, 2012.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3. AshimaSrivastava. Janhavi N N, Concepts of Engineering Chemistry", ACME Learning Private Limited., New Delhi., 2010.
4. Vairam S., Kalyani P., Suba Ramesh., "Engineering Chemistry", Wiley India Pvt Ltd., New Delhi., 2011.

GE7152 ENGINEERING GRAPHICS

L	T	P	C
3	2	0	4

OBJECTIVES

• To develop in students, graphic skills for communication of concepts, ideas and design of engineering products and 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 FREE HANDSKETCHING 14

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- Free hand sketching of multiple views from pictorial views of objects

UNIT II PROJECTION OF POINTS, LINES AND PLANE SURFACES 14

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 trapezoidal 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 14

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

UNIT IV PROJECTION OF SECTIONED SOLIDS AND DEVELOPMENT OF SURFACES **14**

Sectioning of 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. Development of lateral surfaces of solids with cut-outs and holes.

UNIT V ISOMETRIC AND PERSPECTIVE PROJECTIONS **15**

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 and miscellaneous problems.
Perspective projection of simple solids-Prisms pyramids and cylinders by visual ray method and vanishing point method.

COMPUTER AIDED DRAFTING (DEMONSTRATION ONLY) **3**

Introduction to drafting packages and demonstration of their use.

L=45+T=30, TOTAL: 75 PERIODS

OUTCOMES:

On Completion of the course the student will be able to

- Perform free hand sketching of basic geometrical shapes and multiple views of objects.
- Draw orthographic projections of lines, planes and solids
- Obtain development of surfaces.
- Prepare isometric and perspective views of simple solids.

TEXT BOOK:

1. N.D.Bhatt and V.M.Panchal, “Engineering Drawing”, Charotar Publishing House, 50th Edition, 2010.

REFERENCES:

1. K.R.Gopalakrishna., “Engineering Drawing” (Vol I&II combined) Subhas Stores, Bangalore, 2007
2. Luzzader, Warren.J., and Duff,John M.,,’’ Fundamentals of Engineering Drawing with an introduction to Interactive Computer Graphics for Design and Production”, Eastern Economy Edition, Prentice Hall of India Pvt Ltd, New Delhi, 2005
3. M.B.Shah and B.C.Rana, “Engineering Drawing”, Pearson, 2nd Edition, 2009
4. K.Venugopal and V.Prabhu Raja, “Engineering Graphics”, New Age International (P)Limited ,2008.
5. K. V.Natarajan, “A text book of Engineering Graphics”, 28th Edition, Dhanalakshmi Publishers, Chennai, 2015.
6. BasantAgarwal and Agarwal C.M., “Engineering Drawing”, Tata McGraw Hill Publishing Company Limited, New Delhi, 2008.
7. N.S Parthasarathy and Vela Murali, “ Engineering Drawing”, Oxford University Press, 2015

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.

BS7161 **BASIC SCIENCES LABORATORY** **L T P C**
(Common to all branches of B.E. / B.Tech Programmes) **0 0 4 2**

PHYSICS LABORATORY: (Any Seven Experiments)

OBJECTIVE:

- To inculcate experimental skills to test basic understanding of physics of materials including properties of matter, thermal and optical properties.
- To induce the students to familiarize with experimental determination of velocity of ultrasonic waves, band gap determination and viscosity of liquids.

1. Torsional pendulum - Determination of rigidity modulus of wire and moment of inertia of disc
2. Non-uniform bending - Determination of young's modulus
3. Uniform bending – Determination of young's modulus
4. Lee's disc Determination of thermal conductivity of a bad conductor
5. Potentiometer-Determination of thermo e.m.f of a thermocouple
6. Laser- Determination of the wave length of the laser using grating
7. Air wedge - Determination of thickness of a thin sheet/wire
8. a) Optical fibre -Determination of Numerical Aperture and acceptance angle
   b) Compact disc- Determination of width of the groove using laser.
9. Acoustic grating- Determination of velocity of ultrasonic waves in liquids.
10. Ultrasonic interferometer – determination of the velocity of sound and compressibility of liquids
11. Post office box -Determination of Band gap of a semiconductor.
12. Spectrometer- Determination of wavelength using gating.
13. Viscosity of liquids - Determination of co-efficient of viscosity of a liquid by Poiseuille‟s flow

OUTCOME:

- To determine various moduli of elasticity and also various thermal and optical properties of materials.
- To determine the velocity of ultrasonic waves, band gap determination and viscosity of liquids.

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CHEMISTRY LABORATORY:
(Minimum of 8 experiments to be conducted)

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 poly vinyl 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.

TOTAL: 60 PERIODS

TEXTBOOKS

1. Vogel's Textbook of Quantitative Chemical Analysis (8^{TH} edition, 2014)
2. Laboratory Manual- Department of Chemistry, CEGC, Anna University (2014).

GE7162	**ENGINEERING PRACTICES LABORATORY**	**L**	**T**	**P**	**C**
	(Common to all Branches of B.E. / B.Tech. Programmes)	**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 & ELECTRICAL)

1. CIVIL ENGINEERING PRACTICES **15**

PLUMBING

Basic pipe connections involving the fittings like valves, taps, coupling, unions, reducers, elbows and other components used in household fittings. Preparation of plumbing line sketches.

• Laying pipe connection to the suction side of a pump.
• Laying pipe connection to the delivery side of a pump.
• Practice in connecting pipes of different materials: Metal, plastic and flexible pipes used in household appliances.

WOOD WORK

Sawing, planing and making joints like T-Joint, Mortise and Tenon joint and Dovetail joint.

STUDY

• Study of joints in door panels and wooden furniture
• Study of common industrial trusses using models.

2. ELECTRICAL ENGINEERING PRACTICES **15**

- Basic household wiring using Switches, Fuse, Indicator and Lamp etc.,
- Stair case light wiring
- Tube – light wiring
- Preparation of wiring diagrams for a given situation.
- Study of Iron-Box, Fan Regulator and Emergency Lamp

GROUP – B (MECHANICAL AND ELECTRONICS) **15**

3. MECHANICAL ENGINEERING PRACTICES

WELDING

- Arc welding of Butt Joints, Lap Joints, and Tee Joints
- Gas welding Practice.
- Basic Machining - Simple turning, drilling and tapping operations..
- Study and assembling of the following:
  a. Centrifugal pump
  b. Mixie
  c. Air Conditioner.

DEMONSTRATION ON FOUNDRY OPERATIONS.

4. ELECTRONIC ENGINEERING PRACTICES **15**

- Soldering simple electronic circuits and checking continuity.
- Assembling electronic components on a small PCB and Testing.
- Study of Telephone, FM radio and Low Voltage Power supplies.

TOTAL: 60 PERIODS

OUTCOMES

- Ability to fabricate carpentry components and to lay pipe connections including plumbing works.
- Ability to use welding equipments to join the structures
- Ability to do wiring for electrical connections and to fabricate electronics circuits.

HS7251 **TECHNICAL ENGLISH** **L T P C**
4 0 0 4

OBJECTIVES

- To enable students acquire proficiency in technical communication.
- To enhance their reading and writing skills in a technical context.
- To teach various language learning strategies needed in a professional environment.

CONTENTS

UNIT I ANALYTICAL READING **12**

Listening- Listening to informal and formal conversations; **Speaking** – Conversation Skills(opening, turn taking, closing)-explaining how something works-describing technical functions and applications; **Reading** –Analytical reading, Deductive and inductive reasoning; **Writing**- vision statement–structuring paragraphs.

UNIT II SUMMARISING 12

Listening- Listening to lectures/ talks on Science & Technology; **Speaking** –Summarizing/ Oral Reporting, **Reading** – Reading Scientific and Technical articles; **Writing**- Extended definition –Lab Reports – Summary writing.

UNIT III DESCRIBING VISUAL MATERIAL 12

Listening- Listening to a panel discussion; **Speaking** – Speaking at formal situations; **Reading** – Reading journal articles - Speed reading; **Writing**-data commentary-describing visual material-writing problem-process- solution-the structure of problem-solution texts- writing critiques

UNIT IV WRITING/ E-MAILING THE JOB APPLICATION 12

Listening- Listening to/ Viewing model interviews; **Speaking** –Speaking at different types of interviews – Role play practice (mock interview); **Reading** – Reading job advertisements and profile of the company concerned; **Writing**- job application – cover letter –Résumé preparation.

UNIT V REPORT WRITING 12

Listening- Viewing a model group discussion; **Speaking** –Participating in a discussion - Presentation; **Reading** – Case study - analyse -evaluate – arrive at a solution; **Writing**– Recommendations- Types of reports (feasibility report)- designing and reporting surveys- – Report format.- writing discursive essays.

TEACHING METHODS:

Practice writing
Conduct model and mock interview and group discussion.
Use of audio – visual aids to facilitate understanding of various forms of technical communication.
Interactive sessions.

EVALUATION PATTERN:

Internals – 50%
End Semester – 50%

TOTAL:60 PERIODS

OUTCOMES

- Students will learn the structure and organization of various forms of technical communication.
- Students will be able to listen and respond to technical content.
- Students will be able to use different forms of communication in their respective fields.

TEXTBOOK:

1. Craig,Thaine**. Cambridge Academic English: An integrated skills course for EAP(Student's Book)Level: Intermediate** Cambridge University Press, New Delhi: 2012

REFERENCES:

1. Laws, Anne. **Presentations.** Hyderabad: Orient Blackswan, 2011.
2. Ibbotson, Mark. **Cambridge English for Engineering**. Cambridge University Press, Cambridge,New Delhi: 2008
3. Naterop, Jean B. and Rod Revell. **Telephoning in English**. Cambridge: Cambridge University Press, 2004.
4. Rutherford, Andrea J. **Basic Communication Skills for Technology**. New Delhi: Pearson Education, 2001.
5. Bailey, Stephen. **Academic Writing A practical Guide for Students**. Routledge, London: 2004

6. Hewings, Martin**. Cambridge Academic English: An integrated skills course for EAP(Student's Book)Level: Intermediate** Cambridge University Press, New Delhi: 2012.

MA7251	MATHEMATICS - II (Common to all branches of B.E. / B.Tech. Programmes in II Semester)	L	T	P	C
		4	0	0	4

OBJECTIVES:

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To acquaint the student with the concepts of vector calculus, needed for problems in all engineering disciplines.
- To develop an understanding of the standard techniques of complex variable theory so as to enable the student to apply them with confidence, in application areas such as heat conduction, elasticity, fluid dynamics and flow of the electric current.
- To make the student appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.

UNIT I MATRICES 12

Eigenvalues and Eigenvectors of a real matrix – Characteristic equation – Properties of eigenvalues 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 – 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 FUNCTION 12

Analytic functions – Necessary and sufficient conditions for analyticity - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions - Bilinear

Error! Objects cannot be created from editing field codes.

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 with no pole on real axis.

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 ordinary differential equations with constant coefficients.

TOTAL: 60 PERIODS

OUTCOMES:

- Upon successful completion of the course, students should be able to:
- Evaluate real and complex integrals using the Cauchy integral formula and the residue theorem
- Appreciate how complex methods can be used to prove some important theoretical results.
- Evaluate line, surface and volume integrals in simple coordinate systems
- Calculate grad, div and curl in Cartesian and other simple coordinate systems, and establish identities connecting these quantities
- Use Gauss, Stokes and Greens theorems to simplify calculations of integrals and prove simple results.

TEXTBOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 9th Edition, New Delhi, 2014.
2. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, New Delhi, 43rd Edition, 2014.

REFERENCES:

1. Ramana, B.V. “Higher Engineering Mathematics”, Tata McGraw Hill, New Delhi, 2010.
2. Glyn James, “Advanced Modern Engineering Mathematics”, Pearson Education, New Delhi, 2007.
3. Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”, Narosa Publications, New Delhi, 3rd Edition, 2007.
4. Bali N., Goyal M. and Watkins C., “Advanced Engineering Mathematics”, Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
5. Peter V. O’Neil , “Advanced Engineering Mathematics”, Cengage Learning India Pvt., Ltd, New Delhi, 2007.

PH7251 MATERIALS SCIENCE L T P C

(Common to Manufacturing, Industrial, Mining, Aeronautical, Automobile and Production Engineering) **3 0 0 3**

OBJECTIVE:

- To impart knowledge on the basics of binary phase diagrams and their applications
- To learn the phase diagram, effect of alloying elements and various transformations in the Fe-C system, and also the heat treatment of steels.
- To introduce various strengthening methods of materials, and also various mechanical properties and their measurement
- To instill the types, properties and applications of magnetic, dielectric and superconducting materials.
- To introduce the preparation, properties and applications of various new materials.

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 AND HEAT TREATMENT 9

The iron-carbon equilibrium diagram - phases, invariant reactions - microstructue of slowly cooled steels - eutectoid steel, hypo and hypereutectoid steels - effect of alloying elements on the Fe-C system - diffusion in solids - Fick's law - phase transformations - T-T-T-diagram for eutectoid steel – pearlitic, baintic and martensitic transformations - tempering of martensite - heat treatment of steels - annealing - normalizing - quenching and tempering - case hardening - induction, flame and laser hardening - carburizing, cyaniding, carbonitriding and nitriding.

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, properties, types and applications.

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 – Inoue criteria – melt spinning process – applications - Shape memory alloys – phases, shape memory effect, pseudoelastic effect – NiTi alloy – applications- Nanomaterials – preparation: ball milling and chemical vapour deposition - properties and applications – carbon nanotubes - Biomaterials.

TOTAL: 45 PERIODS

OUTCOME:

Upon completion of this course, the students will

- gain knowledge on the basics of binary phase diagrams and the use of lever rule
- learn about the Fe-C phase diagram, effect of alloying elements, TTT in the Fe-C system, and also the heat treatment of steels.
- understand the significance of dislocations, strengthening mechanisms, and tensile, creep, hardness and fracture behavior of materials
- acquire knowledge on the types, properties and applications of magnetic, dielectric and superconducting materials.
- get adequate understanding on the preparation, properties and applications of ceramics, composites, metallic glasses, shape-memory alloys and nanomaterials.

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

TEXTBOOKS:

1. Raghavan, V. “Physical Metallurgy: Principles and Practice”, Phi Learning (2009).
2. Balasubramaniam, R. “Callister's Materials Science and Engineering”, Wiley India Pvt. Ltd. (2014).
3. Palanisamy P.K., “Materials Science”, Scitech (2013).

REFERENCES:

1. Raghavan, V. “Materials Science and Engineering”, Printice Hall of India (2007).
2. Shackelford, J.F. “Introduction to Materials Science for Engineers”. Pearson India (2006).
3. Donald Askeland. “Materials Science and Engineering”, Brooks/Cole (2010).
4. Smith, W.F., Hashemi, J. and R.Prakash. “Materials Science and Engineering”,Tata Mcgraw Hill Education Private Limited (2014).

GE7151	COMPUTING TECHNIQUES	L	T	P	C
	(Common to all branches of Engineering and Technology)	**3**	**0**	**0**	**3**

OBJECTIVES:

- To learn programming using a structured programming language.
- To provide C programming exposure.
- To introduce foundational concepts of computer programming to students of different branches of Engineering and Technology.

UNIT I INTRODUCTION 9

Introduction to Computers – Computer Software – Computer Networks and Internet - Need for logical thinking – Problem formulation and development of simple programs - Pseudo code - Flow Chart and Algorithms.

UNIT II C PROGRAMMING BASICS 9

Introduction to C programming – Fundamentals – Structure of a C program – Compilation and linking processes - Constants, Variables – Data Types – Expressions - Operators –Decision Making and Branching – Looping statements – Solving Simple Scientific and Statistical Problems.

UNIT III ARRAYS AND STRINGS 9

Arrays – Initialization – Declaration – One dimensional and two dimensional arrays - Strings- String operations – String Arrays - simple programs- sorting- searching – matrix operations.

UNIT IV POINTERS 9

Macros - Storage classes –Basic concepts of Pointers– Pointer arithmetic - Example Problems - Basic file operations

UNIT V FUNCTIONS AND USER DEFINED DATA TYPES 9

Function – definition of function – Declaration of function – Pass by value – Pass by reference – Recursion –Enumerators – Structures - Unions

TOTAL : 45 PERIODS

Attested

DIRECTOR
Centre For Academic Courses
Anna University, Chennai-600 025.

OUTCOMES:

At the end of the course, the student should be able to:

- Write C program for simple applications
- Formulate algorithm for simple problems
- Analyze different data types and arrays
- Perform simple search and sort**.**
- Use programming language to solve problems.

TEXTBOOKS:

1. Pradip Dey, Manas Ghosh, "Computer Fundamentals and Programming in C", Second Edition, Oxford University Press, 2013.
2. Ashok N. Kamthane, "Computer programming", Pearson Education, 2007.
3. Yashavant P. Kanetkar. "Let Us C", BPB Publications, 2011.

REFERENCES:

1. Kernighan,B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2006 .
2. Byron S Gottfried, "Programming with C", Schaums Outlines, Second Edition, Tata McGraw-Hill, 2006.
3. R.G. Dromey, "How to Solve it by Computer", Pearson Education, Fourth Reprint, 2007.

PR7251	PRODUCTION PROCESSES (Common to Aero/Auto/Rubber and Plastics)	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To impart the knowledge about the various production processes available
- To expose the student on the principle and applications of the processes
- To make a decision on a relevant process based on the merits and demerits.

UNIT I CASTING PROCESSES 10

Methods of production processes – comparison – sand casting – mould, pattern, die – pattern allowances – materials – types – 2 and 3 box moulding process – steps involved – core function and core making – runner, riser, gate-purpose – construction, principle, merits, demerits and applications of die casting, shell moulding, investment casting, centrifugal casting, continuous casting squeeze casting.

UNIT II METAL FORMING PROCESSES 8

Definition and companion of hot and cold forming – Principle, construction, types, merits, demerits and application of forging, rolling, extrusion, spinning processes – sheet metal operations – Types of dies used – Principle of powder metallurgy – steps involved – merits, demerits and applications.

UNIT III MACHINING PROCESSES 9

Machine and machine tool – construction, types operations in the following machines with block diagrams – Lathe, Milling, Drilling and Grinding – Concept of NC/CNC machines – Comparison of CNC with conventional machines – sample manual part programming for CNC Lathe and milling.

UNIT IV WELDING PROCESSES 9

Types of joining – soldering, brazing, welding, Chemical and mechanical – Fusion welding process – Gas welding – flame types – applications = Arc welding – types of joint – electrode – power supply – edge preparation – weld symbol – filler material – flux/ shielding gases – arc theory – Construction and applications of types of arc welding – Manual, GTAW, GMAW, SAW, ESW – Thermit welding, Pressure welding – resistance welding – spot, seam, projection and flash butt welding – stud welding – friction stir welding – diffusion bonding.

UNIT V UNCONVENTIONAL MACHINING PROCESSES 9

Need for unconventional – Construction, working principle merits, demerits and applications with block diagram only for AJM, AWJM, USM, CHM, ECM, EDM, EBM, LBM, PAM and IBM.

TOTAL: 45 PERIODS

OUTCOMES:

- Has enough knowledge on the various processes available to make a part.
- Confident to select the process to based on cost of time and quantities.
- Can determine processes for new materials.

TEXT BOOKS

1. Serope Kalpakjian, Steven R. Schmid, Manufacturing Engineering and Technology - Anna University, 4/e, Pearson Education, 2014
2. P.C. Sharma, “A Text Book of Production Technology”, S.Chand and Co. Ltd., New Delhi, 2010.

REFERENCES:

1. B.H.Amstead, Phillip F.Ostwald, L.Begemon, “Manufacturing Processes”, John Wiley and Sons, 8th Edition, 1998.
2. De Garmo, “Materials and Processes in Manufacturing”, Prentice Hall of India, 8th Edition, 2008.
3. P.N.Rao, “Manufacturing Technology – I and II”, Tata McGraw Hill Publishing Co., New Delhi – 2013.
4. Amitabha Ghosh, Asok Kumar Mallik, Manufacturing Science, EWP Pvt. Ltd, 2007

GE7153	ENGINEERING MECHANICS	L	T	P	C
		4	0	0	4

OBJECTIVE :

- The objective of this course is to inculcate in the student the ability to analyze any problem in a simple and logical manner and to predict the physical phenomena and thus lay the foundation for engineering applications.

UNIT I STATICS OF PARTICLES **12**

Fundamental Concepts and Principles, Systems of Units, Method of Problem Solutions, Statics of Particles -Forces in a Plane, Resultant of Forces, Resolution of a Force into Components, Rectangular Components of a Force, Unit Vectors.

Equilibrium of a Particle- Newton's First Law of Motion, Space and Free-Body Diagrams, Forces in Space, Equilibrium of a Particle in Space.

UNIT II EQUILIBRIUM OF RIGID BODIES **12**

Principle of Transmissibility, Equivalent Forces, Vector Product of Two Vectors, Moment of a Force about a Point ,Varignon's Theorem, Rectangular Components of the Moment of a Force, Scalar Product of Two Vectors, Mixed Triple Product of Three Vectors, Moment of a Force about an Axis, Couple - Moment of a Couple, Equivalent Couples, Addition of Couples, Resolution of a Given Force into a Force -Couple system, Further Reduction of a System of Forces, Equilibrium in Two and Three Dimensions - Reactions at Supports and Connections.

UNIT III DISTRIBUTED FORCES **16**

Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration , Theorems of Pappus-Guldinus, Distributed Loads on Beams, Center of Gravity of a Three-Dimensional Body, Centroid of a Volume, Composite Bodies , Determination of Centroids of Volumes by Integration.

Moments of Inertia of Areas and Mass - Determination of the Moment of Inertia of an Area by Integration , Polar Moment of Inertia , Radius of Gyration of an Area , Parallel-Axis Theorem , Moments of Inertia of Composite Areas, Moments of Inertia of a Mass - Moments of Inertia of Thin Plates , Determination of the Moment of Inertia of a Three-Dimensional Body by Integration.

UNIT IV FRICTION **8**

The Laws of Dry Friction. Coefficients of Friction, Angles of Friction, Wedges, Wheel Friction. Rolling Resistance , Ladder friction.

UNIT V DYNAMICS OF PARTICLES **12**

Kinematics - Rectilinear Motion and Curvilinear Motion of Particles.

Kinetics- Newton's Second Law of Motion -Equations of Motions , Dynamic Equilibrium, Energy and Momentum Methods - Work of a Force , Kinetic Energy of a Particle, Principle of Work and Energy, Principle of Impulse and Momentum, Impact, Method of Virtual Work - Work of a Force, Potential Energy, Potential Energy and Equilibrium.

L – 45 + T – 15 TOTAL: 60 PERIODS

OUTCOME:

- Upon completion of this course, students will be able to construct meaningful mathematical models of physical problems and solve them.

TEXT BOOK

1. Beer,F.P and Johnson Jr. E.R, "Vector Mechanics for Engineers", McGraw-Hill Education (India) Pvt. Ltd. 10th Edition, 2013.

REFERENCES

1. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
2. J.L. Meriam & L.G. Karige, Engineering Mechanics: Statics (Volume I) and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.
3. P. Boresi & J. Schmidt, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
4. Irving H. Shames, G. Krishna Mohana Rao, Engineering Mechanics - Statics and Dynamics, Fourth Edition – PHI / Pearson Education Asia Pvt. Ltd., 2006.
5. Vela Murali, “Engineering Mechanics”, Oxford University Press (2010)

PR7261	PRODUCTION PROCESSESS LABORATORY (Common to Aero/Auto/Rubber and Plastics)	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To get hands on experience in the machines for production
- To prepare the process planning sheets for all the operations and then follow the sequence during the machining processes.

LIST OF EXPERIMENTS:

1. Study of all the machining tools- identification of parts/mechanisms and position of tool and work piece.
2. Facing, plain turning/step turning operations in Lathe.
3. Tape Turning/Threading and knurling operations in Lathe.
4. Multi-start Threading/Burnishing operations in Lathe.
5. Machining to make a cube using shaper
6. Machining to make a V-block using shaper.
7. Counter sinking, counter Boring and Tapping operations in a drilling machine.
8. Surfacing/pocket milling in a vertical milling machine.
9. Polygonal shape milling in a horizontal milling machine
10. Flat surface grinding and cylindrical grinding operations
11. Machining an internal spline in slotting machine.
12. To machine the given part drawing using Lathe and milling machines.

TOTAL: 60PERIODS

OUTCOMES:

- Enough experience to operate machines and processes commonly used in production of components.
- Enable interpretation of process plan sheets to be followed for the machining of products.

GE7161 COMPUTER PRACTICES LABORATORY

L	T	P	C
0	0	4	2

OBJECTIVES:

- To understand the basic programming constructs and articulate how they are used to develop a program with a desired runtime execution flow.
- To articulate where computer programs fit in the provision of computer-based solutions to real world problems.
- To learn to use user defined data structures.

LIST OF EXPERIMENTS

1. Search, generate, manipulate data using MS office/ Open Office
2. Presentation and Visualization – graphs, charts, 2D, 3D
3. Problem formulation, Problem Solving and Flowcharts
4. C Programming using Simple statements and expressions
5. Scientific problem solving using decision making and looping.
6. Simple programming for one dimensional and two dimensional arrays.
7. Solving problems using String functions
8. Programs with user defined functions
9. Program using Recursive Function
10. Program using structures and unions.

TOTAL: 60 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

- Write and compile programs using C programs.
- Write program with the concept of Structured Programming
- Identify suitable data structure for solving a problem
- Demonstrate the use of conditional statement.

LABORATORY REQUIREMENTS FOR BATCH OF 30 STUDENTS

30 Systems with C compiler

AE7301 AERO ENGINEERING THERMODYNAMICS

L	T	P	C
3	0	0	3

OBJECTIVE:

- To introduce fundamental concepts in thermodynamics, heat transfer, and refrigeration and air conditioning. Apply Mathematical foundations, principles in solving thermodynamics problems.

UNIT I FIRST LAW OF THERMODYNAMICS 9

Concept of continuum-Macroscopic approach-thermodynamic systems-properties-state, path and process, quasi-static process- work and heat-zeroth law and first law of thermodynamics-internal energy-enthalpy- applications of first law of thermodynamics to closed and open system.

UNIT II SECOND LAW OF THERMODYNAMICS 10

Second law of thermodynamics-Kelvin's and Clausius statements of second law-reversibility and irreversibility-carnot theorem-carnot cycle- reversed carnot cycle- clausius inequality-concept of entropy-principle of energy-availability and unavailability-Exergy for closed and an open systems.

UNIT III PROPERTIES OF PURE SUBSTANCES AND POWER CYCLE 8

Properties of pure substances-Thermodynamic properties of pure substances in solid, liquid and vapour phases, phase rule, P-V, P-T, T-V, H-S diagrams, PVT surfaces thermodynamics properties of steam, calculations of work done and heat transfer in non-flow and flow processes. Standard Rankine cycle, Reheat and Regeneration cycle.

UNIT IV AIR STANDARD CYLCES AND IC ENGINES 9

Cycle-air standard efficiency-Otto cycle-diesel cycle- dual cycle- Brayton cycle-components of IC engines-Two stroke and four stroke cycle engine-performance of IC engine-supercharging.

UNIT V REFRIGERATION, AIR CONDITIONING AND PSYCHROMETRY 9

Concepts of psychrometry, Psychrometric relation and charts-processes-Refrigeration systems-Air-conditioning systems and its types- simple vapour compression system-vapour absorption system-Refrigerants.

TOTAL: 45 PERIODS

OUTCOME:

- This course provides the basic knowledge about thermodynamic laws and relations, and their application to various processes**.**

TEXT BOOKS:

1. Nag.P.K., "Engineering Thermodynamics", McGraw Hill Education (India) Private Limited; Fifth edition ,April 2013.
2. Rathakrishnan E, "Fundamentals of Engineering Thermodynamics", Prentice Hall India, 2 revised edition 2005.
3. Yunus A. Cengel and Michael A. Boles, "Thermodynamics: An Engineering Approach" McGraw-Hill Science/Engineering/Math; 7thedition 2010.

REFERENCES:

1. Ramalingam K.K. "Thermodynamics", Sci-Tech Publications, 2006
2. Holman.J.P., "Thermodynamics", 3rd Ed. McGraw-Hill, 2007.
3. Venwylen and Sontag, "Classical Thermodynamics", Wiley Eastern, 1987
4. Arora C.P, "Thermodynamics", Tata McGraw-Hill, New Delhi, 2003.
5. Merala C, Pother, Craig W, Somerton, "Thermodynamics for Engineers", Schaum Outline Series, Tata McGraw-Hill, New Delhi, 2004.

AE7302 PRINCIPLES OF FLIGHT L T P C
3 0 0 3

OBJECTIVE:

- To introduce the concepts of flying, International standard atmosphere, structural aspects of airplanes, brief description of systems of instruments used in airplanes and power plants used**.**

UNIT I HISTORY OF FLIGHT 8

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

UNIT II AIRCRAFT CONFIGURATIONS AND ITS CONTROLS 10

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

UNIT III BASICS OF AERODYNAMICS 9

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

UNIT IV BASICS OF PROPULSION 9

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

UNITV BASICS OF AIRCRAFT STRUCTURES 9

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

TOTAL : 45 PERIODS

OUTCOME:

- On completion of the course, the students will understand the basic concepts of Aerospace, their power plants and the Mechanics of its flight.

TEXT BOOKS

1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition , 2015
2. Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

REFERENCES

1. Kermode, A.C. Flight without Formulae, Pearson Education; Eleven edition, 2011

AE7351 ENGINEERING FLUID MECHANICS AND MACHINERY L T P C 3 0 0 3

OBJECTIVE:

- The student is introduced to the mechanics of fluids through a thorough understanding of the properties of the fluids. The dynamics of fluids is introduced through the control volume approach which gives an integrated understanding of the transport of mass, momentum and energy. The applications of the conservation laws to flow though pipes and hydraulics machines are studied.

UNIT I INTRODUCTION 8

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 9

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

UNIT III DIMENSIONAL ANALYSIS 8

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

UNIT IV TURBINES 10

Impact of jets - Euler's equation - Theory of roto-dynamic machines-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 –. Specific speed - unit quantities – performance curves for turbines .

UNIT V PUMPS 10

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.

TOTAL: 45 PERIODS

OUTCOME:

- On completion of the course, students will be familiar with all the basic concepts of fluids and fluid flow phenomenon, conservation equations and their applications to simple problems.

TEXT BOOKS:

1. Bansal, R.K., Fluid Mechanics and Hydraulics Machines, Laxmi Publications (P) Ltd., New Delhi, Ninth edition,2015.
2. Rathakrishnan. E, Fluid Mechanics, Prentice Hall of India (II Ed.), 2007.

REFERENCES:

1. Ramamurtham. S, Hydraulics, Fluid Mechanics and Fluid Machines, Dhanpat Rai Publishing Co Pvt., Ltd, 9th edition, 2012.
2. Kumar. K.L. Engineering Fluid Mechanics (VII Ed.) S Chand publishers Reprint Edition 2006 edition (1 December 2010)
3. Streeter. V. L., and Wylie, E.B., Fluid Mechanics, McGraw Hill, 1983.

AE7353 SOLID MECHANICS L T P C
3 0 0 3

OBJECTIVE:

- To introduce various behavior of structural components under various loading conditions. Also to introduce about the deflection of beams, stresses and strains in torsional members.

UNIT I STRESS-STRAIN – AXIAL LOADING 9

Definition of stress and strain- Stress-Strain relation- Relation between material constants.-Bar under axial loading- Statically determinate and indeterminate cases – Thermal stress-Impact Loading

UNIT II STRESSES IN BEAMS 9

Types of beams and loadings – Relation between shear force and bending moment - Shear force and bending moment diagrams – Euler beam theory - Bending stress in beams – Shear stress in beam – Composite beam.

UNIT III DEFLECTION OF BEAM 9

Various methods for statically determinate beams - Double integration method – Macaulay's method – Moment area method – Conjucate Beam method – Method of superposition

UNIT IV TORSION – SPRINGS 9

Shear stress and twist relation for circular section – Comparison of hollow shaft and solid shaft – Compound shaft – Power transmission by circular shafts – Springs – Deflection expression for close coiled helical spring – Stress in springs.

UNIT V BIAXIAL STRESS 9

Thin walled cylinder under internal pressure – Principal stresses for general biaxial stress field – Mohr's circle - Stresses in combined loading

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course

- Students will be familiarizing with the fundamentals of deformation, stresses, and strains in structural elements and pressure vessels.
- Students will be familiarizing the beam of different cross sections for shear force, bending moment, slope and deflection.

TEXT BOOKS:

1. Timoshenko and young, 'Elements of strength of Materials', Vol I & II, Van Nostrand Reinhold Company; 5th Revised edition,1968.
2. William Nash, Strength of Materials, McGraw-Hill Education; 6th edition , 2013.
3. 'Mechanics of Materials' by James M. Gere & Barry J Goodno, cengage Learning Custom Publishing, 8th edition, 2012.

REFERENCES:

1. Clive L. Dym , Irving H. Shames, "Solid Mechanics : A Variational Approach, Augmented Edition", Springer publishers, 2013.
2. Stephen Timoshenko, 'Strength of Materials',Vol I & II, CBS Publishers and Distributors, 3rd edition, 2004.
3. R.K.Rajput, 'Strength of Materials', S Chand; 4th Rev. Edition 2007.

EE7151 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To impart the knowledge on basic concepts of electrical circuits and electrical machines.
- To impart the knowledge on basic concepts of electronic components, devices and circuits

UNIT I BASIC CONCEPTS AND DC CIRCUITS 9

Ohm's law - Electrical resistance - Series /Parallel resistive circuits - Star/Delta transformations - Kirchoff's law - Node and Mesh analysis - Thevenin's and Norton's theorem.

UNIT II A.C.CIRCUITS 9

RMS and average value of periodic waves - Form factor - Phase and Phase difference - Simple RC.RL and RLC circuits - series and parallel resonance - power and power factor - introduction to three phase systems – power measurement in 3 phase system.

UNIT III D.C. MACHINES 10

Construction details of DC machines - principle of operation of DC generator - EMF equation - principle of DC motor - Back EMF - Voltage and torque equation - Principle of transformer - construction and type - EMF equation - Tests on transformer - Equivalent circuit - Induction motor - Construction and basic principle of operation - Starting and Running torques.

UNIT IV ELECTRONIC COMPONENTS AND DEVICES 9

Operating principle and characteristics of Simple PN Junction Diodes, Zener diode, Bipolar Junction transistor - Field Effect Transistors – UJT – SCR.

UNIT V ANALOG CIRCUITS 8

Rectifier and Power Supply Circuits, clipper, clamper using diodes, Operational Amplifiers (Ideal) - properties and typical circuits like differentiator, integrator, summer, comparator.

TOTAL: 45 PERIODS

OUTCOME:

- Ability to use the various electrical machines like AC/ DC, electronic components and applications of analog circuits

REFERENCES:

1. Theraja, B.L., “A Text Books of Electrical Technology ", S.S. Chand and Co., New Delhi, 1998.
2. Edminister J.A., “Theory and Problems on Electric circuits ", McGraw Hill International Edition, 1994.
3. Kosow, I.L., “Electrical Machinery and Transformers ", 4th Edition, Prentice Hall of India, 1991.
4. Nagrath I.J. and Kothari D.P., "Theory and Problems of Basic Electrical Engineering", Prentice Hall of India, 1998.
5. Millman.J. and Grabel.S, Integrated Electronics, Tata McGraw Hill, 1995.
6. Horowits.P. and Hill.W, The Art of Electronics, McGraw Hill, 1995.

MA7354 NUMERICAL METHODS L T P C
4 0 0 4

OBJECTIVES:

- To provide the mathematical foundations of numerical techniques for solving linear system, Eigen value problems, interpolation, numerical differentiation and integration and the errors associated with them;
- To demonstrate the utility of numerical techniques of ordinary and partial differential equations in solving engineering problems where analytical solutions are not readily available.

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 methods – Iterative methods of Gauss-Jacobi and Gauss-Seidel - Matrix Inversion by Gauss-Jordan method – Eigen values of a matrix by Power method and by Jacobi's method.

UNIT II INTERPOLATION AND APPROXIMATION 12

Interpolation with unequal intervals - Lagrange interpolation – Newton's divided difference interpolation – Cubic Splines - Interpolation with equal intervals - Newton's forward and backward difference formulae – Least square method - Linear curve fitting.

UNIT III NUMERICAL DIFFERENTATION AND INTEGRATION 12

Approximation of derivatives using interpolation polynomials - Numerical integration using Trapezoidal, Simpson's 1/3 and Simpson's 3/8 rules – Romberg's method - Two point and three point Gaussian quadrature formulae – Evaluation of double integrals by Trapezoidal and Simpson's 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 and second order equations - Multi-step methods - Milne's and Adams-Bashforth 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 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 completion of this course, the students will be able to:

- Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions.
- Apply numerical methods to obtain approximate solutions to mathematical problems.
- Derive numerical methods for various mathematical operations and tasks, such as interpolation, differentiation, integration, the solution of linear and nonlinear equations, and the solution of differential equations.
- Analyse and evaluate the accuracy of common numerical methods.

TEXT BOOKS:

1. Grewal, B.S. and Grewal,J.S., "Numerical methods in Engineering and Science", Khanna Publishers, New Delhi, 9th Edition, 2007.
2. Sankara Rao . K, "Numerical Methods for Scientists and Engineers" PHI Learning Pvt Ltd. New Delhi, 2007.

REFERENCES:

1. Brian Bradie, "A Friendly Introduction to Numerical Analysis", Pearson Education Asia, New Delhi, 1st Edition, 2007.

2. Gerald, C.F. and Wheatley, P.O., “Applied Numerical Analysis”, Pearson Education Asia, New Delhi, 6th Edition, 2006.
3. Laurene V. Fausett, “Applied Numerical Analysis using MATLAB”, Pearson Education, New Delhi, 1st print, 2nd Edition, 2009.
4. S. R. K. Iyengar, R. K. Jain, Mahinder Kumar Jain, "Numerical Methods for Scientific and Engineering Computation", 6th Edition, New Age International Publishers, New Delhi, 2012.

EE7261 ELECTRICAL AND ELECTRONICS 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 shunt generator
2. Load test on DC shunt moor
3. Load test on S Transformer
4. Load test on Induction motor
5. Regulation of 3 Alternator
6. Study of CRO
7. Logic gates
8. Operational amplifiers
9. Time constant of RC circuit
10. Characteristics of LVDT
11. Calibration of Rotometer
12. RTD and Thermistor
13. Flapper Nozzle system

TOTAL: 60 PERIODS

OUTCOMES:

- Ability to perform speed characteristic of different electrical machine
- Ability to use of diodes, transistors for rectifiers
- Ability to use of operational amplifiers

ME7362 MECHANICAL SCIENCES LABORATORY **L T P C 0 0 4 2**

OBJECTIVE:

- To train the students in testing and quantifying the mechanical properties of Engineering Materials, Engines.

LIST OF EXPERIMENTS:

Material Testing Lab

- Tension Test
- Torsion Test

- Testing of springs
- Impact test i) Izod, ii) Charpy
- Hardness test i) Vickers, ii) Brinell, iii) Rockwell, iv) Shore
- Deflection of Beams
- Dye Penetrant Test
- Tensile testing of polymers.
- Flex Fatigue test for Elastomers.
- Injection moulding machine operation.

IC Engines Lab

- Performance test on a 4 stroke engine
- Viscosity determination of the given fluid
- Moment of inertia of connecting rod
- Determination of Effectiveness of a parallel and counter flow heat exchangers.
- Valve timing of a 4 stroke engine and port timing of a 2 stroke engine.
- Determination of Flash point and Fire point of the given oil.

TOTAL: 60 PERIODS

OUTCOME:

- Upon completion of this course, the students can able to apply determine the strength materials and thermal properties.

AE7401 AERODYNAMICS - I L T P C
3 0 0 3

OBJECTIVES:

- To introduce the concepts of mass, momentum and energy conservation relating to Aerodynamics.
- To make the student understand the concept of vorticity, irrotationality, theory of airfoils and wing sections.
- Also to introduce the basics of viscous flow.

UNIT I REVIEW OF BASIC FLUID MECHANICS 10

System and Control volume approach, substantial, local and convective derivative, Continuity, momentum and energy equations, Inviscid flow, Euler equation, incompressible Bernoulli's Equation. Circulation and Vorticity, Green's Lemma and Stoke's Theorem, Barotropic Flow, Kelvin's theorem, Streamline, Stream Function, Irrotational flow, Potential Function, Equipontential Lines, Elementary Flows and their combinations.

UNIT II TWO DIMENSIONAL INVISCID INCOMPRESSIBLE FLOW 8

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

UNIT III AIRFOIL THEORY 9

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

UNIT IV SUBSONIC WING THEORY 8

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

UNIT V INTRODUCTION TO LAMINAR AND TURBULENT FLOW 10

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

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course students will have

- An ability to apply airfoil theory to predict air foil perform
- A knowledge of incompressible flow
- An explosive to Boundary layer theory

TEXTBOOKS:

1. E. L. Houghton & N. B. Carruthers, "Aerodynamics for Engineering students", Edward Arnold Publishers Ltd., London, 1989.
2. Anderson, J.D., Fundamentals of Aerodynamics, McGraw-Hill Education; 5th edition, 2010.

REFERENCES:

1. Milne Thomson, L.H., Theoretical Aerodynamics, Macmillan, 1985.
2. John J Bertin., Aerodynamics for Engineers, Prentice Hall publishers6th edition, 2013.
3. Clancy, L J., Aerodynamics, Shroff publishers2006

AE7402 AIRCRAFT STRUCTURES – I L T P C
3 0 0 3

OBJECTIVES:

- To provide the students an understanding on the linear static analysis of determinate and indeterminate aircraft structural components.
- To provide the design process using different failure theories.

UNIT I ANALYSIS OF TRUSSES AND BEAMS 9

Plane truss analysis, plane frame analysis, analysis of a 3-D truss, analysis of continuous beams using Clapeyron's 3-moment equation.

UNIT II ENERGY METHODS OF ANALYSIS 9

Energy expression for various loadings and its application to statically determinate and indeterminate beams, trusses, frames and rings.

UNIT III BUCKLING OF COLUMNS 9

Buckling of Long column and short column- inelastic buckling- columns with different end conditions, empirical methods, the Southwell plot, use of Energy methods, imperfections in columns, stresses and deflections in a beam-column.

UNIT IV FAILURE ANALYSIS 9

Failure of Ductile and brittle materials, Theories of failure and their Failure envelopes, Introduction to fatigue failure and fracture mechanics of materials.

UNIT V DESIGN OF JOINTS 9

Types of joints and rivets. Failure of joints. Design of bolted joints. Stresses in bolts and nuts due to various loadings - Axial load, shear load and combined loading. Types of welded joints. Strength of welded joints for various loadings

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to perform linear static analysis of determinate and indeterminate aircraft structural components.
- Ability to design the component using different theories of failure

TEXT BOOKS:

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

REFERENCES:

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

AE7403 AIRCRAFT SYSTEMS AND INSTRUMENTS L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge of the hydraulic and pneumatic systems components and types of instruments and its operation including navigational instruments to the students

UNITI AIRCRAFT SYSTEMS 9

Hydraulic systems – Study of typical systems – components – Hydraulic systems controllers – Modes of operation – Pneumatic systems – Working principles – Typical Pneumatic Power system – Brake system – Components, Landing Gear Systems – Classification – Shock absorbers – Retractive mechanism.

UNITII AIRPLANE CONTROL SYSTEMS 10

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

UNITIII ENGINE SYSTEMS 9

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

UNITIV AIRCONDITIONING AND PRESSURIZING SYSTEM 8

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

UNITV AIRCRAFT INSTRUMENTS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

- Know the operation of airplane control system, Engine system, Air conditioning and pressing system.
- Know the operation of air data Instruments system.

TEXT BOOKS

1. Mekinley, J.L. and R.D. Bent, Aircraft Power Plants, McGraw Hill 1993.
2. Pallet, E.H.J. Aircraft Instruments & Principles, Pitman & Co 1993.

REFERENCES

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

AE7404 PROPULSION- I L T P C
3 0 0 3

OBJECTIVE:

- To understand the principles of operation and design of aircraft powerplants. Also to introduce about the types, operation and performance of various parts of the aircraft engines.

UNIT I FUNDAMENTALS OF GAS TURBINE ENGINES 8

Illustration of working of gas turbine engine – The thrust equation – Factors affecting thrust – Effect of pressure, velocity and temperature changes of air entering compressor – Methods of thrust augmentation – Characteristics of turboprop, turbofan and turbojet – Performance characteristics.

UNIT II INLETS 9

Internal flow and Stall in subsonic inlets – Boundary layer separation – Major features of external flow near a subsonic inlet – Relation between minimum area ratio and eternal deceleration ratio – Diffuser performance – Supersonic inlets – Starting problem on supersonic inlets – Shock swallowing by area variation – External declaration – Models of inlet operation.

UNIT III COMBUSTION CHAMBERS 9

Classification of combustion chambers – Important factors affecting combustion chamber design – Combustion process – Combustion chamber performance – Effect of operating variables on

performance – Flame tube cooling – Flame stabilization – Use of flame holders – Numerical problems.

UNIT IV NOZZLES 9

Theory of flow in isentropic nozzles – Convergent nozzles and nozzle choking –Nozzle throat conditions – Nozzle efficiency – Losses in nozzles – Over expanded and under – expanded nozzles – Ejector and variable area nozzles – Interaction of nozzle flow with adjacent surfaces – Thrust reversal.

UNIT V COMPRESSORS 10

Principle of operation of centrifugal compressor – Work done and pressure rise – Velocity diagrams – Diffuser vane design considerations – Concept of prewhirl – Rotation stall – Elementary theory of axial flow compressor – Velocity triangles – degree of reaction – Three dimensional – Air angle distributions for free vortex and constant reaction designs – Compressor blade design – Centrifugal and Axial compressor performance characteristics.

TOTAL: 45 PERIODS

OUTCOME:

- Upon completion of the course, the students will have the Ability to identify the engine components of jet propelled engines. Also the gain knowledge in the operation and performance of the engine parts.

TEXT BOOKS:

1. Hill, P.G. & Peterson, C.R. “Mechanics & Thermodynamics of Propulsion” Pearson education (2009)

REFERENCES:

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

MA7358 TRANSFORM TECHNIQUES AND PARTIAL DIFFERENTIAL EQUATIONS L T P C
4 0 0 4

OBJECTIVES:

- To introduce the effective mathematical tools for the solutions of partial differential equations that model physical processes;
- 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 transform techniques used in wide variety of situations in which the functions used are not periodic;
- To develop Z- transform techniques which will perform the same task for discrete time systems as Laplace Transform, a valuable aid in analysis of continuous time systems.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 12

Formation – Solutions of first order equations – Standard types and Equations reducible to standard types – Singular solutions – Lagrange's Linear equation – Integral surface passing through a given curve – Classification of partial differential equations - Solution of linear equations of higher order with constant coefficients – Linear non-homogeneous partial differential equations.

UNIT II FOURIER SERIES 12

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

UNIT III APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATION 12

Method of separation of variables – Solutions of one dimensional wave equation and one-dimensional heat equation – Steady state solution of two-dimensional heat equation – Fourier series solutions in cartesian coordinates.

UNIT IV FOURIER TRANSFORM 12

Fourier integral theorem – Fourier transform pair - Sine and cosine transforms – Properties – Transform of elementary functions – Convolution theorem – Parseval's identity.

UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS 12

Z-transform – Elementary properties – Inverse Z-transform – Convolution theorem – Initial and final value theorems – Formation of difference equation – Solution of difference equation using Z - transform.

TOTAL: 60 PERIODS

OUTCOME:

- The students can able to solve the partial differential equations, find the Fourier series analysis and solve the problems by using Fourier transform and Z transform techniques.

TEXTBOOKS:

1. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, New Delhi, 43rd Edition, 2014.
2. Erwin kreyszig, "Advanced Engineering Mathematics",John Wiley & Sons, 9th Edition, , New Delhi, 2014

REFERENCES:

1. Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, New Delhi, 2007.
2. Ramana, B.V. "Higher Engineering Mathematics", Tata McGraw Hill, New Delhi, 11thReprint , 2010.
3. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), New Delhi, 7th Edition, 2009.
4. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, New Delhi, 2007.

Attested

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PR7451 KINEMATICS AND DYNAMICS OF MACHINES L T P C
4 0 0 4

OBJECTIVE:

- To understand the basic concepts of mechanisms and machinery.

UNIT I MECHANISMS 12

Definition – Machine and Structure – Kinematic link, pair and chain – classification of Kinematic pairs – Constraint and motion – Degrees of freedom - Slider crank – single and double – Crank rocker mechanisms – Inversions, applications – Introduction to Kinematic analysis and synthesis of simple mechanisms – Determination of velocity and acceleration of simple mechanisms.

UNIT II FRICTION 12

Types of friction – friction in screw and nut – screw jack – pivot, collar and thrust bearings – plate and cone clutch – belt (Flat and V) and rope drives – creep in belts – open and crossed belt drives – Ratio of tensions – Effect of centrifugal and initial tensions – condition for maximum power transmission.

UNIT III GEARS AND CAMS 12

Gear – Types and profile – nomenclature of spur and helical gears – laws of gearing – interference – requirement of minimum number of teeth in gears – gear trains – simple, compound and reverted gear trains – determination of speed and torque in epicyclic gear trains – cams different types of followers – Cam – Types of cams and followers – Cam design for different follower motions.

UNIT IV VIBRATION 12

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.

UNIT V BALANCING 12

Static and dynamic balancing – single and several masses in different planes – primary and secondary balancing of reciprocating masses – Balancing of single and multi cylinder engines – Governors and Gyroscopic effects.

TOTAL:60 PERIODS

OUTCOME:

- The student shall be able to apply the kinematics and dynamics of machinery in design and analysis of engineering problems.

TEXT BOOKS:

1. Bansal R.K., “Theory of Machines”, Laxmi Publications Pvt Ltd., New Delhi, 20th edition 2009.
2. Rattan S.S., “Theory of machines”, Tata McGraw Hill publishing Co., New Delhi, 2nd edition 2011.

REFERENCES:

1. Rao J.S. and Dukkipati R.V., “Mechanism and Machine Theory”, Second Edition, Wiley Eastern Limited, 2006.
2. Malhotra D.R. and Gupta H.C , “The Theory of machines”, Satya Prakasam, Tech. India Publications, 2008.
3. Gosh A and Mallick A.K., “Theory of Machines and Mechanisms”, Affiliated East West press, 2009.
4. Shigley J.E. and Uicker J.J., “Theory of Machines and Mechanisms”, McGraw Hill, 2006.

AE7411 **AERODYNAMICS LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES:

- To predict different aerodynamic propulsion used in aero application
- To make the student familiarize with the experiments in aerodynamics on wings, bodies and calibration of supersonic wind tunnel.

LIST OF EXPERIMENTS

1. Calibration of a Subsonic Wind tunnel
2. Pressure distribution over a circular cylinder.
3. Pressure distribution over a cambered aerofoil.
4. Flow visualization studies in subsonic flows.
5. Pressure distribution over a finite wing of cambered aerofoil section
6. Pressure distribution over a Nose cone model.
7. Determination of Base drags of a missile model.
8. Determination of profile drag of bodies by wake survey method.
9. Study of flow field over a backward facing step
10. Calibration of Supersonic Wind Tunnel.
11. Flow visualization studies in supersonic flows.
12. Force measurements on Aircraft models

Only 10 experiments will be conducted

TOTAL: 60 PERIODS

OUTCOMES:

At the end of the course students will be able

- To use the fundamental dynamic principle in aircraft application
- To calibrate subsonic and supersonic wind tunnel
- The students will be able to determine lift for the given airfoil sections.
- The students will be able to identify of pressure distribution over the various bodies.
- They will have a practical exposure on flow visualization techniques pertaining to subsonic

AE7412 **AIRCRAFT COMPONENT DRAWING LABORATORY** **L T P C**
0 0 4 2

OBJECTIVE:

- To introduce the concept of design of basic aircraft structural components and to draft both manually. Also to get hands on training in designing the structural components using modeling package.

LIST OF EXPERIMENTS:

1. Design of riveted joints (Lap joint).
2. Design of riveted joints (Butt joint with single and double straps).
3. Design of welded joints.
4. Design of bolted joints.
5. Design of empennage.
6. Computer aided modeling of typical aircraft wing.

7. Computer aided modeling of typical fuselage structure.
8. Computer aided modeling of landing gear
9. Three view diagram of a typical aircraft
10. Layout of control systems.

TOTAL: 60 PERIODS

OUTCOME:

- At the end of the course, students will be familiarize with the basic aircraft and its components, 3-Dimensional Design of typical aircraft & its components, assembly of aircraft components

AE7501 AERODYNAMICS-II L T P C
3 0 0 3

OBJECTIVE:

- To introduce the concepts of compressibility, to make the student understand the theory behind the formation of shocks and expansion fans in Supersonic flows. To introduce the methodology of measurements in Supersonic flows.

UNIT I FUNDAMENTAL ASPECTS OF COMPRESSIBLE FLOW 8

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

UNIT II SHOCK AND EXPANSION WAVES 12

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

UNIT III TWO DIMENSIONAL COMPRESSIBLE FLOW 9

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

UNIT IV HIGH SPEED FLOW OVER AIRFOILS, WINGS AND AIRPLANE CONFIGURATION 8

Critical Mach number, Drag divergence Mach number, Shock Stall, Supercritical Airfoil Sections, Transonic area rule, Swept wing, Airfoils for supersonic flows, Lift, drag, Pitching moment and Centre of pressure for supersonic profiles, Shock expansion theory, wave drag, supersonic wings, Design considerations for supersonic aircrafts.

UNIT V CHARACTERIZATION OF HIGH SPEED FLOWS 8

Shock-Boundary layer interaction, Wind tunnels for transonic, Supersonic and hypersonic flows, shock tube, Gun tunnels, Supersonic flow visualization, Introduction to Hypersonic Flows.

TOTAL: 45 PERIODS

OUTCOMES:

Understanding characteristics of fluid flows

- Knowledge gained in shock phenomenon and fluid waves.
- Understanding fluid flow characteristics over wings airfoils and airplanes.
- Usage of wind tunnels for evaluating flow behaviors.

TEXTBOOKS:

1. Anderson, J. D, Modern Compressible Flow: With Historical Perspective McGraw-Hill Education; 3rd edition, 2002.
2. Rathakrishnan. E, Gas Dynamics, Prentice-Hall of India Pvt.,Ltd, 2008.

REFERENCES:

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

AE7502 AIRCRAFT STRUCTURES – II L T P C

3 0 0 3

OBJECTIVES:

- To provide the students various methods for analysis of aircraft wings and fuselage.
- To provide the behavior of major aircraft structural components

UNIT I UNSYMMETRICAL BENDING OF BEAMS 9

Unsymmetrical bending of beams – different methods of analysis (neutral axis method, ‘k’ method, and the principal axis method), stresses and deflections in beams under unsymmetrical bending.

UNIT II SHEAR FLOW IN OPEN SECTIONS 9

Definition and expression for shear flow due to bending, shear flow in thin-walled Open sections with and without stiffening elements, torsion of thin-walled Open sections, the shear center of symmetric and unsymmetrical open sections, structural idealization.

UNIT III SHEAR FLOW IN CLOSED SECTIONS 9

Shear flow due to bending and torsion in single-cell and multi-cell structures, the shear center of symmetric and unsymmetrical closed sections, effect of structural idealization, shear flow in a tapered beam, stress analysis of thin-webbed beams using Wagner’s theory.

UNIT IV BUCKLING OF PLATES 9

Behaviour of a rectangular plate under compression, governing equation for plate buckling, buckling analysis of sheets and stiffened panel under compression, concept of the effective sheet width, buckling due to shear and combined loading, crippling.

UNIT V AIRCRAFT STRESS ANALYSIS 9

Loading and analysis of aircraft wing, fuselage, and tail unit. Use of V-n diagram for sizing the aircraft wing, fuselage, and tail unit.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to analyse the aircraft wings and fuselage
- Ability to demonstrate the behavior of major aircraft structural components.

TEXT BOOKS:

1. Megson T M G, 'Aircraft Structures for Engineering Students', Butterworth-Heinemann; 5 edition,2012.
2. Bruhn. E.H., 'Analysis and Design of Flight Vehicles Structures', Tri-state off-set company, USA, 1985.
3. Howard D Curtis, 'Fundamentals of Aircraft Structural Analysis', WCB-McGraw Hill, 1997

REFEENCES

1. Rivello, R.M., Theory and Analysis of Flight Structures, McGraw Hill, 1993.
2. Peery, D.J., and Azar, J.J., Aircraft Structures, 2nd edition, McGraw – Hill, N.Y., 1999

AE7503 FLIGHT MECHANICS L T P C
3 0 0 3

OBJECTIVE:

- To make the student understand the performance of airplanes under various flight conditions like take off, cruise, landing, climbing, gliding, turning and other maneuvers.

UNIT I GENERAL CONCEPTS 9

International Standard atmosphere, IAS, EAS, TAS, Propeller theory- Froude momentum and blade element theories, Propeller co-efficients, Use of propeller charts, Performance of fixed and variable pitch propellers, High lift devices, Thrust augmentation

UNIT II DRAG OF BODIES 8

Streamlined and bluff body, Types of drag, Effect of Reynold's number on skin friction and pressure drag, Drag reduction of airplanes, Drag polar, Effect of Mach number on drag polar. Concept of sweep- effect of sweep on drag.

UNIT III STEADY LEVEL FLIGHT 10

General equation of motion of an airplane. Steady level flight, Thrust required and Power required, Thrust available and Power available for propeller driven and jet powered aircraft, Effect of altitude, maximum level flight speed, conditions for minimum drag and minimum power required, Effect of

drag divergence on maximum velocity, Range and Endurance of Propeller and Jet aircrafts. Effect of wind on range and endurance.

UNIT IV GLIDING AND CLIMBING FLIGHT 9

Shallow and steep angles of climb, Rate of climb, Climb hodograph, Maximum Climb angle and Maximum Rate of climb- Effect of design parameters for propeller jet and glider aircrafts, Absolute and service ceiling, Cruise climb, Gliding flight, Glide hodograph

UNIT V ACCELERATED FLIGHT 9

Estimation of take-off and landing distances, Methods of reducing landing distance, level turn, minimum turn radius, maximum turn rate, bank angle and load factor, Constraints on load factor, SST and MSTR. Pull up and pull down maneuvers, V-n diagram.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

- Understand concepts of take-off, climb, cruise, turn, descent and landing performance.
- understand the performance characteristics of the different types of power plants
- Understand and predict the behavior of fixed wing aircraft undertaking a typical flight profile
- Understand the factors that influence aircraft design and limit aircraft performance.

TEXT BOOKS:

1. Houghton,E.L. and Carruthers, N.B. Aerodynamics for engineering students, Edward Arnold Publishers, 1988.
2. Anderson, Jr., J.D. Aircraft Performance and Design, McGraw-Hill International Edition, 1999

REFERENCES:

1. Kuethe, A.M. and Chow, C.Y., Foundations of Aerodynamics, John Wiley & Sons; 5th Edition, 1997.
2. John J Bertin., Aerodynamics for Engineers, Prentice Hall; 6th edition, 2013.
3. Clancy, L J., Aerodynamics, Shroff publishers (2006)
4. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition , 2015

AE7504 PROPULSION – II L T P C
3 0 0 3

OBJECTIVE:

- To introduce basic concepts and salient features of engine components of jet propelled engines which are operated in atmosphere to students. This course is also aimed at making students familiarize with advanced jet propulsion methods like hypersonic propulsion.

UNIT I TURBINES FOR JET ENGINES 8

Principle of operation of axial flow turbines – work done and pressure rise – degree of reaction – types of design of turbines – turbine blade cooling- velocity diagrams- limitations of radial flow turbines- compressor & turbine matching – materials for turbine blades.

UNIT II RAMJET PROPULSION 8

Operating principle of ramjet engine – various components of ramjet engines and their efficiencies – Combustion in ramjet engine – critical, subcritical and supercritical modes of operation -ramjet engine and its performance characteristics – sample ramjet design calculations – flame stability problems in ramjet combustors –integral ram rockets.

UNIT III HYPERSONIC AIRBREATHING PROPULSION 10

Introduction to hypersonic air breathing propulsion, hypersonic vehicles and supersonic combustion- need for supersonic combustion for hypersonic propulsion – salient features of scramjet engine and its applications for hypersonic vehicles – problems associated with supersonic combustion – engine/airframe integration aspects of hypersonic vehicles – various types scramjet combustors – fuel injection schemes in scramjet combustors – one dimensional models for supersonic combustion using method of influence coefficients.

UNIT IV CHEMICAL ROCKET PROPULSION 11

Operating principle – specific impulse of a rocket – internal ballistics – rocket performance considerations – solid propellant rockets – selection criteria of solid propellants – propellant grain design considerations – erosive burning in solid rockets – liquid propellant rockets – selection of liquid propellants – various feed systems for liquid rockets -thrust control in liquid rockets – cooling in liquid rockets and the associated heat transfer problems – advantages of liquid rockets over solid rockets - introduction to hybrid propulsion – advantages and limitations of hybrid propulsion - static testing of rockets and safety considerations.

UNIT V ADVANCED PROPULSION TECHNIQUES 8

Introduction to nozzleless propulsion and basic concepts - Electric rocket propulsion – Ion propulsion – Nuclear rocket – comparison of performance of these propulsion systems with chemical rocket propulsion systems - Solar sail.

TOTAL: 45 PERIODS

OUTCOMES:

Understanding various propulsion systems

- Knowledge in rocket propulsion systems
- Knowing the applications and principles of liquid and solid-liquid propulsion systems
- Application of nuclear propulsion in rocketry

TEXT BOOKS:

1. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons; 8th Edition 2010.
2. Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors, Delhi, 2nd edition 2014.

REFERENCES:

1. David H. Heiser and David T. Pratt., “Hypersonic Air breathing Propulsion”, AIAA Education Series, 1999.

AE7511 AIRCRAFT STRUCTURES LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To enable the students understand the behavior of aircraft structural components under different loading conditions.
- To provide the Principle involved in photo elasticity and its applications in stress analysis

for composite laminates.

LIST OF EXPERIMENTS

1. Determination of Flexural strength of materials.
2. Deflection of Beams
3. Verification of Maxwell's Reciprocal Theorem
4. Buckling Load estimation of Slender Eccentric Columns
5. Acoustic emission techniques for composites specimen.
6. Unsymmetrical Bending of a Cantilever Beam
7. Combined bending and Torsion of a Hollow Circular Tube
8. Experiment using Photo elastic setup
9. Shear Centre of a Channel Section
10. Shear centre for unsymmetrical section.
11. Fabrication of a Composite Laminate.
12. Determination of characteristics for a Composite Specimen.

Only 10 experiments will be conducted.

TOTAL: 60 PERIODS

OUTCOMES:

At the end of the course

- students can understand the behavior of materials subjected to various types of loadings
- Students will be in a position to fabricate a composite laminates.

AE7512 PROPULSION LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To familiarize students and to expose them practically to various aircraft piston and gas turbine engines.
- To give practical exposure to various testing methods of variable area ducts, propellants, jet engine components and rockets.
- To practically determine flow behavior of jets.

LIST OF EXPERIMENTS

1. Study of aircraft piston engines and gas turbine engines
2. Velocity profiles of free jets
3. Velocity profiles of wall jets
4. Wall pressure measurements of a turbine blade passage
5. Burn rate measurements of solid propellants
6. Cascade testing of compressor blades
7. Prediction of potential core length in co-axial jets
8. Flow visualization of secondary injection in a supersonic cross flow
9. Wall pressure distribution in subsonic diffusers
10. Wall pressure measurements in supersonic nozzles

TOTAL: 60 PERIODS

OUTCOMES:

- Ability to understand details of piston and gas turbine engine
- Ability to perform various testing on ducts, propellants, jet engine components

AE7601 AIRCRAFT STABILITY AND CONTROL L T P C
4 0 0 4

OBJECTIVE:

- To make the student understand the concepts of stable and nonstable configuration of airplanes. Also to introduce the concepts of control of airplanes under various operating conditions.

UNIT I STATIC LONGITUDINAL STABILITY AND CONTROL 15

General concepts-Degrees of freedom of a rigid body, Static and dynamic stability, Need for stability in an airplane, inherently and marginally stable airplanes, Stability and Controllability, Requirements of control surfaces, criteria for longitudinal static stability, contribution to stability by wing, tail, fuselage, wing fuselage combination, Total longitudinal stability, Neutral point-Stick fixed and Stick free aspects, Free elevator factor, static margin, Hinge moment, Power effects on stability-propeller and jet aircrafts, longitudinal control, Movement of centre of gravity, elevator control effectiveness, elevator control power, elevator angle to trim, elevator angle per g, maneuver point, Stick force gradient and stick force per g, Aerodynamic balancing

UNIT II STATIC DIRECTIONAL STABILITY AND CONTROL 12

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

UNIT III STATIC LATERAL STABILTY AND CONTROL 12

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

UNIT IV DYNAMIC LONGITUDINAL STABILITY 11

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

UNIT V DYNAMIC LATERAL AND DIRECTIONAL STABILITY 10

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

TOTAL: 60 PERIODS

OUTCOMES:

Students who successfully complete the course will demonstrate the following outcomes by tests, homework, and written reports:

- An understanding of the different types of motion following a disturbance
- Perform preliminary design computations to meet static stability and time requirements
- An understanding of the contribution to directional stability from various components of the airplane and the requirements of rudder
- An understanding of the dihedral effect, rolling power and control effectiveness of aileron

- Analyze dynamic flight conditions using the non-linear equations of motion
- To get familiarized with the longitudinal, directional and lateral dynamics of the airplane
- To get familiarized with writing down the equations of motion following a disturbance, solve them and investigate the stability of the disturbed motion
- Identify the lateral and longitudinal modes and relate the important physical influences of aircraft properties on these modes.

TEXT BOOKS:

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

REFERENCES:

1. McCormick, B.W. Aerodynamics, Aeronautics & Flight Mechanics John Wiley, 1995.
2. Babister, A.W. Aircraft Stability and response, Pergamon Press, 1980
3. Etkin, B., Dynamics of Flight Stability and Control, Wiley, third edition 1995.

4.Pamadi, B.N. Performance, Stability, Dynamics, and Control of Airplanes, AIAA Education Series, 2004.

AE7602 COMPUTATIONAL FLUID DYNAMICS L T P C
3 0 0 3

OBJECTIVE:

- To achieve an understanding of principles of Fluid Dynamics. Introduce various computational techniques applicable to fluid dynamic problems and understand the Finite Volume Methods.

UNIT I INTRODUCTION TO NUMERICAL METHODS IN FLUID DYNAMICS 9

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

UNIT II SOLUTION OF FLUID FLOW EQUATIONS 9

Introduction to boundary layer equations and their solution - Discretization of the boundary layer equations and illustration of solution– Solution methods for elliptic, parabolic and hyperbolic equations-velocity potential equation.

UNIT III GRID GENERATION 8

Introduction to grid generation in computational fluid dynamics - Structured grid generation techniques – algebraic methods, conformal mapping and methods using partial differential equations - Basic ideas in numerical grid generation and mapping - Boundary value problem of numerical grid generation- grid control functions- branch cut - The boundary conditions of first kind – orthogonality of grid lines- boundary point grid control.

UNIT IV TIME DEPENDENT METHODS 9

Introduction to time dependent methods - Explicit time dependent methods –Description of Lax-

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

UNIT V FINITE VOLUME METHOD 10

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

TOTAL: 45 PERIODS

OUTCOMES:

- The students will be able to do the numerical grid generation and having knowledge about the mapping techniques.
- The students will be able obtain the solution for boundary layer equations and transformation equations.
- The students will have wide ideas about the explicit time dependent methods and their factorization schemes
- The students will be able to do the stability analysis and linearization of the implicit methods.
- They had enough knowledge on the fundamental aspects of finite volume method and their application to fluid dynamics problem.

TEXT BOOKS:

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

REFERENCES:

1. John F Wendt (Ed.), "Computational Fluid Dynamics – An Introduction", Third Edition, Springer-Verlag, Berlin Heidelberg, 2009.
2. H.K. Versteeg and W. Malalsekera "An Introduction to Computational Fluid Dynamics, The Finite Volume Method", PHI; 2 edition 2007.
3. T. J. Chung, "Computational Fluid Dynamics", Cambridge University Press; 2 edition (27 September 2010)
4. C. Hirsch, "Numerical Computation of Internal and External Flows" Volume-2, John Wiley and Sons, 1994
5. Joel H. Ferziger & Milovan Peric, "Computational Methods for Fluid Dynamics" Springer; 3rd ed. 2002 edition 2001.

AE7603 FINITE ELEMENT METHODS L T P C
3 0 0 3

OBJECTIVE:

- To give exposure to 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 – Raleigh Ritz's, Galerkin and 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, truss analysis. Beam element with various loadings and boundary conditions - longitudinal and lateral vibration. Use of local and natural coordinates.

UNIT III CONTINUUM ELEMENTS 8

Plane stress, Plane strain and axisymmetric problems, constant and linear strain triangular elements, stiffness matrix, axisymmetric load vector.

UNIT IV ISOPARAMETRIC ELEMENTS 10

Definitions, Shape function for 4, 8 and 9 nodal quadrilateral elements, Stiffness matrix and consistent load vector, Gaussian integration

UNIT V FIELD PROBLEM 9

Heat transfer problems, Steady state fin problems, Derivation of element matrices for two dimensional problems, Torsion problems

TOTAL: 45PERIODS

OUTCOME:

- Upon completion of this course, the Students can able to understand different mathematical Techniques used in FEM analysis and use of them in Structural and thermal problem.

TEXT BOOKS:

1. Tirupathi.R. Chandrapatha and Ashok D. Belegundu – Introduction to Finite Elements in Engineering – Prentice Hall India, Third Edition, 2003.
2. Rao. S.S., The Finite Element Methods in Engineering, Butterworth and Heinemann, 5th edition, 2010.
3. Reddy J.N. – An Introduction to Finite Element Method – McGraw Hill, 3rd edition, 2005.
4. R.Dhanaraj and K.Prabhakaran Nair, “Finite Element Method “, Oxford university press, India, 2015.

REFERENCES:

1. Krishnamurthy, C.S., Finite Element Analysis, Tata McGraw Hill, 2nd edition, 2001.
2. Bathe K.J. and Wilson, E.L., Numerical Methods in Finite Elements Analysis, Prentice Hall of India, 1985.
3. Robert D Cook, David S Malkus, Michael E Plesha, ‘Concepts and Applications of Finite Element Analysis’, 4th edition, John Wiley and Sons, Inc., 2003.
4. 4. Larry J Segerlind, ‘Applied Finite Element Analysis’, Second Edition, John Wiley and Sons, Inc. 1985.

GE7251 ENVIRONMENTAL SCIENCE AND ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

To the study of nature and the facts about environment.

- To find and implement 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 – energyflowintheecosystem–ecologicalsuccession–foodchains,foodwebsandecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grass land ecosystem (c)desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity– bio geographical 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 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, etc.

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– soil waste management: causes, effects and control measures of municipal solid wastes – roleofanindividualinpreventionofpollution–pollutioncasestudies–disastermanagement: 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: Lands are source and 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. –waste land 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.

Attested

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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 environment at infant stage.
- Ignorance and incomplete knowledge has lead to misconceptions.
- Development and improvement in standard of living has lead to serious environmental disasters.

TEXT BOOKS:

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

REFERENCES:

1. R.K.Trivedi,' Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media.
2. Cunningham,W.P.Cooper,T.H.Gorhani,'EnvironmentalEncyclopedia',Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S.Sengar,' Environmental law', Prentice hall of India PVT LTD, New Delhi, 2007.
4. Rajagopalan, R,' Environmental Studies-From Crisisto Cure',Oxford University Press 2005.

AE7611 AERODELLING L T P C
0 0 4 2

OBJECTIVE:

- The objective of this laboratory is to learn and understand the low cost UAV systems which is suitable for generating variety of data's to verify and validate the different types of algorithms developed by the researchers and scientists working on MINIUAV's and MAV's.

LIST OF EXPERIMENTS:

1. Model Building and working with Materials such as balsa wood, Coro plast, foam.
2. Power system integration including setting of thrust line.
3. Command and control system procedure.
4. Basic RF Experiments.
5. Flight Simulator Training.
6. Simple flight stabilization system integration.
7. Quad rotor stabilization (rotary).

8. Integration and setting up of video systems both 5 V and 12 V variants.
9. Auto Pilot: FY 3 ZT integration with GCS.
10. Integration of Payload like Gimbal camera and its operations, sensors etc.
11. Build an UAV airframe of own design and integrate with Autopilot system.

TOTAL: 60 PERIODS

OUTCOME:

- On completion of Aeromodelling course, students will be in a position to design UAV's. Students will get hands on training in flying an UAV.

AE7612 AIRCRAFT DESIGN PROJECT I L T P C
0 0 4 2

OBJECTIVE:

- To make the student work in groups and understand the Concepts involved in Aerodynamic design, Performance analysis and stability aspects of airplanes assigned.

LIST OF EXPERIMENTS:

1. Comparative studies of different types of airplanes and their specifications and performance details with reference to the design work under taken.
2. Preliminary weight estimation, Selection of design parameters, power plant selection, aerofoil selection, fixing the geometry of Wing, tail, control surfaces Landing gear selection.
3. Preparation of layout drawing, construction of balance and three view diagrams of the airplane under consideration.
4. Drag estimation, Performance calculations, Stability analysis and V-n diagram.

TOTAL: 60 PERIODS

OUTCOME:

- On completion of Aircraft design project I the students are in a position to carry out the aerodynamic design of airplanes.

AE7701 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 – Fiber Volume ratio – Mass fraction – Density of composites. Effect of voids in Composites.

UNIT II MACROMECHANICS 10

Generalized Hooke's Law - Elastic constants for anisotropic, orthotropic and isotropic materials - Macro Mechanics – Stress-strain relations with respect to natural axis, arbitrary axis – Determination of In plane strengths of a lamina - Experimental characterization of lamina. Failure theories of a lamina. Hygrothermal effects on lamina.

UNIT III LAMINATED PLATE THEORY 10

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

UNIT IV FABRICATION PROCESS AND REPAIR METHODS 8

Various open and closed mould processes, Manufacture of fibers, Importance of repair and different types of repair techniques in Composites – Autoclave and non-autoclave methods.

UNIT V SANDWICH CONSTRUCTIONS 7

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

TOTAL: 45 PERIODS

OUTCOMES:

- Understanding the mechanics of composite materials.
- Ability to analyse the laminated composites for various loading eases.
- Knowledge gained in manufacture of composites.

TEXT BOOKS:

1. Isaac M. Daniel & Ori Ishai , "Mechanics of Composite Materials," OUP USA publishers, 2nd edition, 2005.
2. Autar K Kaw, 'Mechanics of Composite Materials', CRC Press, 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. Lubing, Handbook on Advanced Plastics and Fibre Glass, Von Nostran Reinhold Co., New York, 1989.
3. Calcote, L R. "The Analysis of laminated Composite Structures", Von – Nostrand Reinhold Company, New York 1998.
4. Allen Baker, Composite Materials for Aircraft Structures, AIAA Series, 2nd Edition, 2004.

AE7702 EXPERIMENTAL AERODYNAMICS L T P C
3 0 0 3

OBJECTIVE:

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

UNIT I BASIC MEASUREMENTS IN FLUID MECHANICS 7

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

UNIT II WIND TUNNEL MEASEUREMENTS 10

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

UNIT III FLOW VISUALIZATION AND ANALOGUE METHODS 9

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

UNIT IV PRESSURE, VELOCITY AND TEMPERATUREMEASUREMENTS 9

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

UNIT V SPECIAL FLOWS AND UNCERTAINTY ANALYSIS 10

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

TOTAL: 45 PERIODS

OUTCOMES:

- Knowledge on measurement techniques in aerodynamic flow.
- Acquiring basics of wind tunnel measurement systems
- Specific instruments for flow parameter measurement like pressure, velocity

TEXT BOOKS:

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

AE7703 HEAT TRANSFER L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge on various modes of heat transfer and methods of solving problems. Also to give exposure to numerical methods employed to solve heat transfer problems.

UNIT I CONDUCTION 8

Governing equation in Cartesian, cylindrical and spherical coordinates. 1-D steady state heat conduction with and without heat generation. Composite wall- Electrical analogy – Critical thickness of insulation – Heat transfer from extended surface – Effect of temperature on conductivity- 1-D Transient analysis

UNIT II CONVECTION 11

Review of basic equations of fluid flow – Dimensional analysis- Forced convection – Laminar flow over flat plate and flow through pipes-Flow across tube banks. Turbulent flow over flat plate and flow through pipes – Free convection – Heat transfer from vertical plate using integral method – Empirical relations - Types of heat exchangers – Overall heat transfer coefficient – LMTD and NTU methods of analysis.

UNIT III RADIATION 9

Basic definitions – Concept of black body - Laws of black body radiation-Radiation between black surfaces – Radiation heat exchange between grey surfaces – Radiation shielding – Shape factor-Electrical network analogy in thermal radiation systems.

UNIT IV NUMERICAL METHODS 10

1-D and 2-D steady and unsteady state heat conduction – composite walls-heat generation-variable thermal conductivity- extended surfaces analysis using finite difference method-Convective heat transfer- Stream function- vorticity method- Creeping flow analysis-convection-diffusion 1-D, 2-D analysis using finite difference approximation. Numerical methods applicable to radiation heat transfer.

UNIT V CASE STUDIES IN AEROSPACE ENGINEERING 7

Numerical treatment of heat transfer problems pertaining to Aerospace Engineering like in gas turbines, rocket thrust chambers, Aerodynamic heating and Ablative heat transfer in thermal protection systems.

TOTAL: 45 PERIODS

OUTCOME:

- At the end of the course, students can be able to understand and apply different heat transfer principles of different applications.

TEXT BOOKS:

1. Yunus,A.Cengel, Heat Transfer -A Practical Approach, Tata McGraw Hill, Second edition, 2003.
2. Holman,J.P., Heat Transfer, McGraw Hill Book Co.,Inc., New York, 8th Edition,1996.
3. Sachdeva,S.C., Fundamentals of Engineering Heat and Mass Transfer, new age publishers,2010.
4. Necati Ozisik, Finite Difference Method in Heat Transfer, CRC Press, second edition, 1994

REFERENCES:

1. John H. Lienhard IV & John H. Lienhard V, “A Heat Transfer Text Book, Prentice Hall Inc., 1981.
2. Sutton,G.P., Rocket Propulsion Elements, John Wiley & Sons; 8th Edition 2010.
3. Mathur,M.L. and Sharma,R.P,“Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors, Delhi, 2nd edition 2014.

AE7704 **ROCKETS AND LAUNCH VEHICLES** **L T P C**
3 0 0 3

OBJECTIVE:

- To give exposure on important topics like rocket aerodynamics and staging and control of rockets to students to enrich their knowledge in the area of launch vehicles.

UNITI CLASSIFICATION OF ROCKETS AND LAUNCH VEHICLES 9

Various methods of classification of missiles and rockets-Basic Aerodynamics characteristics of launch vehicle configurations-Examples of various Indian space launch vehicles-Current status of Indian rocket programme with respect to international scenario.

UNIT II AERODYNAMICS OF ROCKETS AND LAUNCH VEHICLES 10

Airframe components of rockets and Launch Vehicles – forces acting on a missile while passing through atmosphere – slender body aerodynamics - method of describing forces and moments – lift force and lateral moment –lateral aerodynamic damping moment – longitudinal moment – drag estimation-Rocket Dispersion.

UNITIII ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD 10

One dimensional and two-dimensional rocket motions in free space and homogeneous gravitational fields – description of vertical, inclined and gravity turn trajectories – determination of range and altitude – simple approximations to burn out velocity and altitude – estimation of culmination time and altitude.

UNITIV STAGING OF ROCKETS AND LAUNCH VEHICLES 8

Design philosophy behind multistaging of launch vehicles– multistage vehicle optimization – stage separation techniques in atmosphere and in space – stage separation dynamics and lateral separation characteristics.

UNITV CONTROL OF ROCKETS AND LAUNCH VEHICLES 8

Introduction to aerodynamic control and jet control methods- thrust control methods – various types of thrust vector control methods including secondary injection thrust vector control for launch vehicles.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course

- Knowledge in types of rockets and launch vehicles with respect to Indian & international scenario.
- Gaining information on aerodynamics of rocket and launch vehicles.
- Knowledge on stages and remote control of rockets.

TEXT BOOKS:

1. Cornelisse, J.W., “Rocket Propulsion and Space Dynamics”, J.W. Freeman & Co.,Ltd, London, 1982.
2. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons; 8th Edition 2010.

REFERENCE:

1. Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors, Delhi, 2nd edition 2014.

AE7711 AIRCRAFT DESIGN PROJECT II L T P C
0 0 4 2

OBJECTIVE:

Each group of students is assigned to continue the structural design part of the airplane.

LIST OF EXPERIMENTS

1. Preliminary design of an aircraft wing – Shrenck's curve, structural load distribution, shear force, bending moment and torque diagrams
2. Detailed design of an aircraft wing – Design of spars and stringers, bending stress and shear flow calculations – buckling analysis of wing panels
3. Preliminary design of an aircraft fuselage – load distribution on an aircraft fuselage
4. Detailed design of an aircraft fuselage – design of bulkheads and longerons – bending stress and shear flow calculations – buckling analysis of fuselage panels
5. Design of control surfaces - balancing and maneuvering loads on the tail plane and aileron, rudder loads
6. Design of wing-root attachment
7. Landing gear design
8. Preparation of a detailed design report with CAD drawings

TOTAL: 60 PERIODS

OUTCOME:

- On completion of Aircraft design project II the students are in a position to carry out the aerodynamics and structural design of Airplanes.

HS7561 COMMUNICATION SKILLS AND SOFT SKILLS L T P C
1 0 2 2

COURSE DESCRIPTION

This course aims to help engineering students acquire the employability skills necessary for the workplace. It also attempts to meet the expectations of the employers by giving special attention to presentation skills, group discussion skills and soft skills. This aim will be achieved through expert guidance and teaching activities focusing on the above listed skills and language skills in the Language Laboratory.

OBJECTIVES:

- To enhance the employability skills of students with a special focus on presentation skills, group discussion skills and interview skills and soft skills.
- To help them improve their writing skills necessary for the workplace situation.

CONTENTS

UNIT I WRITING SKILLS

Preparing job applications – writing the cover letter and resume – applying for jobs online – e-mail etiquette – writing reports – collecting, analyzing and interpreting data.

UNIT II SOFT SKILLS

Hard skills & soft skills – soft skills: self-management skills & people skills – training in soft skills – persuasive skills – sociability skills – interpersonal skills – team building skills – leadership skills – problem solving skills – adaptability – stress management – motivation techniques – life skills.

UNIT III PRESENTATION SKILLS

Preparing slides using the computer– structuring the content (parts of a presentation)- body language – answering questions – individual presentation practice –– mini presentation (practice sessions)

UNIT IV GROUP DISCUSSION SKILLS

Participating in group discussions – understanding group dynamics – brainstorming – questioning and clarifying – GD strategies (expressing opinions, accepting or refusing others opinions, turn taking) – activities to improve GD skills – viewing recorded GD – mock GD.

UNIT V INTERVIEW SKILLS

Interview etiquette–technical Interview/HR Interview/body language – mock interview – attending job interviews – Types of interviews- telephone/skype interview – stress interview, one to one/panel interview – FAQs related to job interview.

TOTAL: 45 PERIODS

OUTCOMES:

- Students will be able to make presentations and participate in group discussions with confidence.
- Students will be able to perform well in interviews.
- They will have adequate writing skills.

REFERENCES:

1. Downes, Colm. Cambridge English for Job Hunting. CUP, 2008
2. Corneilssen, Joep. How to Prepare for Group Discussion and Interview. New Delhi: Tata-McGraw-Hill, 2009.
3. Dabreo, Desmond A. Group Discussion and Team Building. Mumbai: Better Yourself Books, 2004.
4. Ramesh, Gopalswamy, and Mahadevan Ramesh. The ACE of soft skills. New Delhi: Pearson, 2010.
5. Gulati, Sarvesh. Corporate Soft skills. New Delhi: Rupa and Co. 2006.
6. Van Emden, Joan, and Lucinda Becker. Presentation Skills for Students. New York: Palgrave Macmillan, 2004.
7. Sarawati, V. and Revathi Vishwanathan, Soft Skills for Career Communication Preesat Publications, Chennai: 2011

EXTENSIVE READERS

1. Covey, Stephen R. The 7 Habits of Highly Effective People,New York: Free Press, 1989
2. Bagchi, Cubroto. The Professional. New Delhi: Penguin Books India, 2009.

WEB RESOURCES

1. www.humanresources.about.com
2. www.careerride.com
3. https://bemycareercoach.com/softskills

Attested

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AE7811 **EXPERIMENTS IN FLIGHT LABORATORY** **L T P C**
0 0 4 2

OBJECTIVE:

- To impart practical knowledge to students on various maneuvers of flight and different modes of stability such as dutch roll, phugoid motion etc.,

LIST OF EXPERIMENTS

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

TOTAL: 60 PERIODS

OUTCOME:

- Upon completion of the course students will be in a position to do carry out preliminary design of a simple mini aircraft. These experiments will be conducted by the students during the flight training programme at IIT- Kanpur and evaluation is also done by the faculty of IIT-Kanpur.

AE7812 **PROJECT WORK** **L T P C**
0 0 20 10

OBJECTIVE:

- Students in a group of three or four will be assigned a project involving – design fabrication - theoretical studies - experimental studies on some problem related to Aerospace Engineering.

Continuous internal assessment marks for the project will be given during project review meetings. The student has to prepare and present a detailed project report at the end of the semester and give a talk about the work done. End semester examination mark will be based on viva voce examination.

TOTAL: 300 PERIODS

OUTCOMES:

- The students will be able to think innovatively.
- The students will be able to works as team.
- They will be able to understand the concept of system engineering and product developments.
- They will be in a position to use the theoretical knowledge in the practical applications.
- They will be better placed to be practically exposed in the particular field of the domain, they work.

AE7001 **AERO ELASTICITY** **L T P C**
3 0 0 3

OBJECTIVE:

- To make the student understand the various aero elasticity phenomenon like divergence flutter and control reversal and its effects on airplane design.

UNIT I AERO ELASTICITY PHENOMENA 8

Vibration of beams due to coupling between bending and torsion - The aero-elastic triangle of forces - Stability versus response problems – Aeroelasticity in Aircraft Design – Vortex induced vibration – Introduction to aero servo elasticity.

UNIT II DIVERGENCE OF A LIFTING SURFACE 10

Simple two dimensional idealizations – Strip theory – Fredholm integral equation of the second kind – Exact solutions for simple rectangular wings – Semi rigid assumption and approximate solutions – Generalized coordinates – Successive approximations – Numerical approximations using matrix equations.

UNIT III STEADY STATE AEROELASTIC PROBLEMS 9

Loss and reversal of aileron control – Critical aileron reversal speed – Aileron efficiency – Semi rigid theory and successive approximations – Lift distributions – Rigid and elastic wings.

UNIT IV FLUTTER ANALYSIS 10

Non-dimensional parameters – Stiffness criteria Dynamic mass balancing – Model experiments – Dimensional similarity – Flutter analysis – Two dimensional thin airfoils in steady incompressible flow – Quasi steady aerodynamic derivatives – Galerkin's method for critical speed – Stability of distributed motion – Torsion flexure flutter – Solution of the flutter determinant – Methods of determining the critical flutter speeds – Flutter prevention and control.

UNIT V EXAMPLES OF AEROELASTIC PROBLEMS 8

Galloping of transmission lines and flow induced vibrations of tall slender structures and suspension bridges – Aircraft wing flutter- Vibrational problems in Helicopters.

TOTAL: 45 PERIODS

OUTCOMES:

Students who successfully complete this course will be able to:

- Understanding of the different aero elastic phenomenon and the methods of counteracting it
- Explain how the aeroelastic phenomena flutter, divergence and aileron reversal arise and how they affect aircraft performance
- Formulate aeroelastic equations of motion and use them to derive fundamental relations for aeroelastic analysis,
- Perform a preliminary aeroelastic analysis of a slender wing structure in low-speed airflow, and explain under what circumstances an aeroelastic analysis can be expected to produce useful results.
- Ability to estimate the critical divergence, reversal and flutter speeds of an airplane and to investigate the stability of the disturbed motion.
- Understand Aero servo and aero thermo elasticity.

TEXT BOOKS:

1. Fung, Y.C. An Introduction to the theory of Aeroelasticity, Dover Publications Inc., 2008

REFERENCES:

1. Bisplinghoff., R.L. Ashley, H., and Halfman, R.L, " Aeroelasticity" Addison Wesley Publishing Co., Inc. II ed. 1996.
2. Broadbent, E.G., Elementary Theory of Aeroelasticity, Bunhill Publications Ltd., 1986.
3. Scanlan, R.H. and Rosenbaum, R., Introduction to the Study of Aircraft Vibration and Flutter, Macmillan Co., N.Y., 1991.
4. Blevins R.D, "Flow induced vibrations", Krieger Pub Co; 2 Reprint edition, 2001.

AE7002 AEROSPACE MATERIALS L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge to students on the mechanical behaviors of various materials that are used in aircraft and it characteristics.

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 – cermets - 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:

- Upon completion of this course, students will understand the advanced concepts of aerospace materials to the engineers and to provide the necessary mathematical knowledge that are needed in understanding their significance and operation. The students will have an exposure on various topics such elements of aerospace materials, mechanical behavior of materials, ceramics and composites and will be able to deploy these skills effectively in the understanding of aerospace materials.

REFERENCES

1. Titterton.G., Aircraft Materials and Processes, V Edition, Pitman Publishing Co., 1995.
2. Martin, J.W., Engineering Materials, Their properties and Applications, Wykedham Publications (London) Ltd., 1987.
3. Van Vlack.L.H., Elements of Materials Science and Engineering Prentice Hall; publishers, 6th edition, 1989,
4. Raghavan.V., Materials Science and Engineering, Prentice Hall of India, New Delhi,5th edition, 2004.

AE7003 AIRCRAFT DESIGN L T P C
3 0 0 3

OBJECTIVE:

- To make the student understand the choice of the selection of design parameters, Fixing the geometry and to investigate the performance and stability characteristics of airplanes.

UNIT I INTRODUCTION 6

State of art in airplane design, Purpose and scope of airplane design, Classification of airplanes based on purpose and configuration. Factors affecting configuration, Merits of different plane layouts. Stages in Airplane design. Designing for manufacturability, Maintenance, Operational costs, Interactive designs.

UNIT II PRELIMINARY DESIGN PROCEDURE 9

Data collection and 3-view drawings,· their purpose, weight estimation, Weight equation method – Development & procedures for evaluation of component weights. Weight fractions for various segments of mission. Choice of wind loading and thrust. Loading .

UNIT III POWER PLANT SELECTION 10

Choices available, comparative merits, Location of power plants, Functions dictating the locations.

UNIT IV DESIGN OF WING, FUSELAGE AND EMPHANAGE 10

Selection of aerofoil. Selection of Wing parameters, selection of sweep, Effect of Aspect ratio, Wing Design and Airworthiness requirements, V-n diagram, loads, Structural features. Elements of fuselage design, Loads on fuselage, Fuselage Design. Fuselage and tail sizing. Determination of tail surface areas, Tail design, Structural features, Check for nose wheel lift off.

UNIT V DESIGN OF LANDING GEAR AND CONTROL SURFACE 10

Landing Gear Design, Loads on landing gear, Preliminary landing gear design. Elements of Computer Aided and Design, Special consideration in configuration lay-out, Performance estimation.Stability aspects on the design of control surface.

TOTAL: 45 PERIODS

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OUTCOMES:

Students will be able to

- Initiate the preliminary design of an aircraft starting from data collection to satisfy mission specifications;
- To get familiarized with the estimation of geometric and design parameters of an airplane
- Understanding the procedure involved in weight estimation, power plant selection, estimation of the performance parameters, stability aspects, design of structural components of the airplane, stability of structural elements, estimation of critical loads etc.
- Initiate the design of a system, component, or process to meet requirements for aircraft systems;
- Complete the design of an aircraft to a level of sufficient detail to demonstrate that it satisfies given mission specifications
- Work in a multidisciplinary environment involving the integration of engineering practices in such subjects as aerodynamics, structures, propulsion, and flight mechanics

TEXT BOOKS:

1. Torenbeck, E. Synthesis of Subsonic Airplane Design, Delft University Press, U.K. 1986.
2. Raymer, D.P. Aircraft conceptual Design, AIAA series, 5th edition, 2012.

.

REFERENCES:

1. Kuechemann, D, " The Aerodynamic Design of Aircraft, American Institute of Aeronautics publishers, 2012

AE7004 AIRCRAFT ENGINE REPAIRS AND MAINTENANCE L T P C
3 0 0 3

OBJECTIVES:

- To make the students to familiarize with the Aircraft engine maintenance procedure and practice.
- Must have knowledge of basics of Aeronautics and engine components

UNIT I 10

Classification of piston engines - Principles of operation - Function of components - Materials used - Details of starting the engines - carburetion and Fuel injection systems for small and large engines - Ignition system components - spark plug detail - Engine operating conditions at various altitudes – Engine power measurements – Classification of engine lubricants and fuels – Induction, Exhaust and cooling system - Maintenance and inspection check to be carried out. Inspection and maintenance and troubleshooting - Inspection of all engine components - Daily and routine checks - Overhaul procedures - Compression testing of cylinders - Special inspection schedules - Engine fuel, control and exhaust systems - Engine mount and super charger - Checks and inspection procedures.

UNIT II 9

Propeller theory - operation, construction assembly and installation -Pitch change mechanism- Propeller axially system- Damage and repair criteria - General Inspection procedures - Checks on constant speed propellers - Pitch setting, Propeller Balancing, Blade cuffs, Governor/Propeller operating conditions – Damage and repair criteria.

UNIT III **9**

Symptoms of failure - Fault diagnostics - Case studies of different engine systems - Rectification during testing equipments for overhaul: Tools and equipments requirements for various checks and alignment during overhauling - Tools for inspection - Tools for safety and for visual inspection - Methods and instruments for non destructive testing techniques - Equipment for replacement of parts and their repair. Engine testing: Engine testing procedures and schedule preparation - Online maintenance.

UNIT IV **10**

Types of jet engines – Fundamental principles – Bearings and seals - Inlets - compressors-turbines-exhaust section – classification and types of lubrication and fuels- Materials used - Details of control, starting around running and operating procedures – Inspection and Maintenance-permissible limits of damage and repair criteria of engine components- internal inspection of engines- compressor washing- field balancing of compressor fans- Component maintenance procedures - Systems maintenance procedures - use of instruments for online maintenance - Special inspection procedures-Foreign Object Damage - Blade damage .

UNIT V **7**

Engine Overhaul - Overhaul procedures - Inspections and cleaning of components - Repairs schedules for overhaul - Balancing of Gas turbine components. Trouble Shooting: Procedures for trouble shooting - Condition monitoring of the engine on ground and at altitude - engine health monitoring and corrective methods.

TOTAL: 45PERIODS

OUTCOMES:

Students who successfully complete this course will be able to:

- Inspect and safely perform maintenance and troubleshooting on aircraft cabin atmospheric control, ice and rain control, position and warning, fire protection, and fuel systems using the manufacturer service manuals, acceptable industry practices and applicable regulations.
- Demonstrate a working knowledge and mechanical ability to inspect, maintain, service and repair aircraft electrical, engine (piston and turbine), airframe structure, flight control, hydraulic, pneumatic, fuel, navigation and instrument systems and other aircraft components
- Identify, install, inspect, fabricate and repair aircraft sheet metal and synthetic material structures.
- Display proper behavior reflecting satisfactory work habits and ethics to fulfill
- program requirements and confidence to prepare for employment.

REFERENCES:

1. Kroes& Wild, "Aircraft Power plants ", 7th Edition - McGraw Hill, New York, 1994.
2. Turbomeca, "Gas Turbine Engines ", The English Book Store ", New Delhi, 1993.
3. United Technologies' Pratt & Whitney, " The Aircraft Gas turbine Engine and its Operation", The English Book Store, New Delhi.

AE7005 AIRCRAFT RULES AND REGULATIONS - CAR I AND II **L T P C**
3 0 0 3

OBJECTIVE:

- The most obvious objective of this course is to familiarize the students in Airworthiness and to ensure design levels of reliability and operating safety of civil registered aircraft through promulgation and enforcement of highest achievable standards of airworthiness.

UNIT I C.A.R SERIES 'A' - PROCEDURE FOR CIVIL AIR WORTHINESS REQUIREMENTS AND RESPONSIBILITY OPERATORS VIS-A-VIS AIRWORTHINESS DIRECTORATE 8

Responsibilities of operators / owners; Procedure of CAR issue, amendments etc., Objectives and targets of airworthiness directorate; Airworthiness regulations and safety oversight of engineering activities of operators.

C.A.R. SERIES 'B' - ISSUE APPROVAL OF COCKPIT CHECK LIST, MEL, CDL - Deficiency list (MEL & CDL); Preparation and use of cockpit check list and emergency list.

UNIT II C.A.R. SERIES 'C' - DEFECT RECORDING, MONITORING, INVESTIGATION AND REPORTING 7

Defect recording, reporting, investigation, rectification and analysis; Flight report; Reporting and rectification of defects observed on aircraft; Analytical study of in-fight readings & recordings; Maintenance control by reliability Method.

C.A.R. SERIES 'D' - AND AIRCRAFT MAINTENANCE PROGRAMMES

Reliability Programme (Engines); Aircraft maintenance programme& their approval; On condition maintenance of reciprocating engines; TBO - Revision programme - Maintenance of fuel and oil uplift and consumption records - Light aircraft engines; Fixing routine maintenance periods and component TBOs - Initial & revisions.

UNIT III C.A.R. SERIES 'E' - APPROVAL OF ORGANISATIONS 10

Approval of organizations in categories A, B, C, D, E, F, & G; Requirements of infrastructure at stations other than parent base.C.A.R. SERIES 'F' - AIR WORTHINESS AND CONTINUED AIR WORTHINESS:Procedure relating to registration of aircraft; Procedure for issue / revalidation of Type Certificate of aircraft and its engines / propeller; Issue / revalidation of Certificate of Airworthiness; Requirements for renewal of Certificate of Airworthiness.

UNIT IV C.A.R. SERIES 'L' - AIRCRAFT MAINTENANCE ENGINEER - LICENSING 8

Issue of AME Licence, its classification and experience requirements, Complete Series 'L'.C.A.R. SERIES 'M' MANDATORY MODIFICATIONS AND INSPECTIONS:

Mandatory Modifications / Inspections.

UNIT V C.A.R. SERIES 'T' - FLIGHT TESTING OF AIRCRAFT 12

Flight testing of (Series) aircraft for issue of C of A; Fight testing of aircraft for which C or A had been previously issued. C.A.R. SERIES 'X' - MISCELLANEOUS REQUIREMENTS: Registration Markings of aircraft; Weight and balance control of an aircraft; Provision of first aid kits & Physician's kit in an aircraft; Use furnishing materials in an aircraft; Concessions; Aircraft log books; Document to be carried on board on Indian registered aircraft; Procedure for issue of taxy permit; Procedure for issue of type approval of aircraft components and equipment including instruments.

TOTAL: 45 PERIODS

OUTCOMES:

- Knowledge of Airworthiness requirements for transport, military, gliders and micro light aircrafts.
- Understanding of Defect recording, reporting, investigation, rectification and analysis
- Knowledge of procedure for holding examinations, proficiency checks etc. for
- Defense personnel to fulfill the requirements for grant of civil licenses.
- Understanding of procedure relating to registration of aircraft
- Knowledge of Issue/validation and renewal of Certificate of Airworthiness
- Understanding of Airworthiness of ageing aircraft.

REFERENCES:

1. "Aircraft Manual (India) ", Volume - Latest Edition, The English Book Store, 17-1,Connaught Circus, New Delhi.
2. "Civil Aviation Requirements with latest Amendment (Section 2 Airworthiness) ", Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi.
3. "Aeronautical Information Circulars (relating to Airworthiness) ", from DGCA. Advisory Circulars ", form DGCA.

AE7006 AIRCRAFT SYSTEMS ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To make the students familiarise with the fundamental operating principles of aircraft flight instruments.
- To make the students understand functioning of the various subsystems of aircraft and the interaction of the subsystem.

UNIT I INTRODUCTION TO SYSTEMS ENGINEERING 9

Overview-Systems Definition and Concepts-Conceptual System Design- System Engineering Process- Everyday examples of systems-Aircraft systems

UNIT II DESIGN AND DEVELOPMENT PROCESS 9

Product Life Cycle –Concept Phase-Definition Phase-Design Phase-Build, Test, Operate and Disposal Phase-Whole Life Cycle Tasks-Systems Analysis- Design Drivers in the Project, Product, Operating Environment-Interfaces with the Subsystems

UNIT III SYSTEM ARCHITECTURES AND INTEGRATION 9

Systems Architectures-Modeling and Trade-Offs- Evolution of Avionics Architectures-Systems Integration Definition- Examples of Systems Integration-Integration Skills-Management of Systems Integration

UNIT IV PRACTICAL CONSIDERATIONS AND CONFIGURATION CONTROL 9

Stake holders-Communications-Criticism- Configuration Control Process-Portrayal of a System-Varying Systems Configurations- Compatibility-Factors Affecting Compatibility –Systems Evolution Considerations and Integration of Aircraft Systems.

UNIT V SYSTEMS RELIABILITY AND MAINTAINABILITY 9

Systems and Components-Analysis-Influence, Economics, Design for Reliability-Fault and Failure Analysis-Case Study-Maintenance Types-Program-Planning and Design.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

- Understand the basic working principle of hydraulic and pneumatic systems and their components.
- Identify the types of control systems namely conventional and modern systems and the need to choose them for specific aircraft application.
- Understand the different types of fuel system used for piston engine and jet engines

REFERENCES:

1. Peter.Sydenham , “Systems Approach to Engineering”, Artech house, Inc, London, 2004.
2. Aslaksen, Erik and Rod Belcher, “Systems Engineering”, Prentice Hall, 1992.
3. Allan G. Seabridge and Ian Moir, “Design and Development of Aircraft Systems: An Introduction “, (AIAA Education Series), 2004.
4. Andrew P. Sage, James E., Jr. Armstrong, "Introduction to Systems Engineering (Wiley Series in Systems Engineering and Management)”, 2000.

AE7007 AIRFRAME REPAIR AND MAINTENANCE L T P C

3 0 0 3

OBJECTIVE:

- To make the students to understand the Airframe components and the tools used to maintain the components. Defect investigation, methods to carry out investigation and the detailed maintenance and practice procedures.

UNIT I WELDING IN AIRCRAFT STRUCTURAL COMPONENTS 9

Equipments used in welding shop and their maintenance - Ensuring quality welds - Welding jigs and fixtures - Soldering and brazing.

SHEET METAL REPAIR AND MAINTENANCE:

Selection of materials; Repair schemes; Fabrication of replacement patches; Tools - power/hand; Repair techniques; Close tolerance fasteners; Sealing compounds; forming/shaping; Calculation of weight of completed repair; Effect of weight - change on surrounding structure. Sheet metal inspection - N.D.T. Testing. Riveted repair design - Damage investigation - Reverse engineering.

UNIT II PLASTICS AND COMPOSITES IN AIRCRAFT 9

PLASTICS IN AIRCRAFT: Review of types of plastics used in airplanes - Maintenance and repair of plastic components - Repair of cracks, holes etc., and various repairs schemes - Scopes.

ADVANCED COMPOSITES IN AIRCRAFT:

Cleaning of fibre reinforced plastic (FRP) materials prior to repair; Break test - Repair Schemes; FRP/honeycomb sandwich materials; laminated FRP structural members and skin panels; Tools/equipment; Vacuum-bag process. Special precautions – Autoclaves

UNIT III AIRCRAFT JACKING, ASSEMBLY AND RIGGING 9

Airplane jacking and weighing and C.G. Location. Balancing of control surfaces - Inspection maintenance. Helicopter flight controls. Tracking and balancing of main rotor.

UNIT IV REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM 10

Trouble shooting and maintenance practices - Service and inspection - Inspection and maintenance of landing gear systems. - Inspection and maintenance of air-conditioning and pressurization system, water and waste system. Installation and maintenance of Instruments - handling - Testing - Inspection. Inspection and maintenance of auxiliary systems - Fire protection systems - Ice protection system - Rain removal system -Position and warning system - Auxiliary Power Units (APUs).

UNIT V SAFETY PRACTICES 8

Hazardous materials storage and handling, Aircraft furnishing practices - Equipments. Trouble shooting.Theory and practices.

TOTAL: 45 PERIODS

OUTCOMES:

Students who successfully complete this course will be able to:

- Identify and apply the principles of function and safe operation to aircraft as per FAA
- Understand general airframe structural repairs, the structural repair manual and structural control programme.
- Understand the nature of airframe structural component inspection, corrosion repair and non-destructive inspection
- Understand aircraft component disassembly, reassembly and troubleshooting
- Know about aircraft adhesives, sealants, bonding techniques, repair procedures and the types and detection of defects in aircraft composite materials
- Identify, install, inspect, fabricate and repair aircraft sheet metal and synthetic, material structures.

TEXT BOOKS:

1. Kroes, Watkins, Delp, "Aircraft Maintenance and Repair ", McGraw Hill, New York, 1992.

REFERENCES:

1. Larry Reithmeir, “Aircraft Repair Manual ", Palamar Books, Marquette, 1992.
2. Brimm D.J. Bogges H.E., "Aircraft Maintenance ", Pitman Publishing corp., NewYork, 1940.
3. Delp. Bent and Mckinely “Aircraft Maintenance Repair”, McGraw Hill, New York,1987.

AE7008 APPROXIMATE METHODS IN STRUCTURAL MECHANICS L T P C
3 0 0 3

OBJECTIVE:

- To understand the various approximate methods for solving both boundary value and initial value problems involved in structural mechanics.

UNIT I ANALYTICAL AND NUMERICAL METHODS 7

Review of analytical methods for solving ordinary differential equations related to structural mechanics problems, boundary conditions, initial conditions, Need for approximate methods, different forms of approximate solution, Numerical integration, Elementary study on calculus of variation.

UNIT II APPROXIMATE METHODS 9

Weighted residual methods: Least square method, collocation method, sub-domain method, method of moments, basic Galerkin form and modified Galerkin form, Variational method: Rayleigh Ritz method.

UNIT III STATIC, DYNAMIC AND STABILITY ANALYSIS 11

Application to statically determinate and indeterminate structures: bar, beam, torsional member. Free vibration and stability analysis, Improvement of solution accuracy.

UNIT IV FINITE DIFFERENCE METHOD 11

Application to statically determinate and indeterminate structures: bar, beam, torsional member. Free vibration and stability analysis.

UNIT V CODE DEVELOPMENT 7

Numerical integration; Solution of simultaneous algebraic equations; Code generation for structural mechanics problems using approximate methods.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able

- To understand the definition and the need for the approximate methods.
- To understand the principle and procedure related to variational approach and weighted residual method and their applications.
- To do static and stability analysis of 1 -D problems,
- To apply numerical methods like finite difference scheme and finite element approach.
- To develop code related to the implementation of the approximate methods.

TEXT BOOKS:

1. Szilard, R., Theory and Analysis of Plates – Classical and Numerical Methods, Prentice Hall, 1984.
2. Chajes, A., Principles of Structural Stability Theory, Prentice Hall. Inc., 1987.
3. Asghar Bhatti, M., Fundamental Finite Element Analysis and Applications: with Mathematica and *MATLAB* Computations, John Wiley & Sons Inc, 2005
4. Ansel C Ugural and Saul K Fenster, 'Advanced Strength and Applied Elasticity', 4th Edition, Prentice Hall, New Jersey, 2003.

REFERENCES:

1. Tauchert, T.R., Energy Principles in Structural Mechanics, McGraw Hill, International Student Edition, 1989.
2. Bathe, K.J., and Wilson, E. L., Numerical Methods in Finite Element Method, Prentice Hall (India) Ltd., 1985.
3. Chandrupatla R. Tirupathi, Belegundu D Ashok., Introduction to Finite Elements in Engineering, Prentice Hall (India) Ltd, 2007.
4. Reddy, J. N., An Introduction to the Finite Element Method, McGraw-Hill, 2004.

AE7009 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 built Digital avionics architecture
- Ability to Design Navigation system
- Ability to design and perform analysis on air system

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

AE7010 BOUNDARY LAYER THEORY L T P C
3 0 0 3

OBJECTIVE:

- To make the student understand the importance of viscosity and boundary layer in fluid flow. To introduce the theory behind laminar and turbulent boundary layers.

UNIT I FUNDAMENTAL EQUATIONS OF VISCOUS FLOW 8

Fundamental equations of viscous flow, Conservation of mass, Conservation of Momentum-Navier-Stokes equations, Energy equation, Mathematical character of basic equations, Dimensional parameters in viscous flow, Non-dimensionalising the basic equations and boundary conditions, vorticity considerations, creeping flow, boundary layer flow

UNIT II SOLUTIONS OF VISCOUS FLOW EQUATIONS 10

Solutions of viscous flow equations, Couette flows, Hagen-Poisuelle flow, Flow between rotating

concentric cylinders, Combined Couette-Poiseuille Flow between parallel plates, Creeping motion, Stokes solution for an immersed sphere, Development of boundary layer, Displacement thickness, momentum and energy thickness.

UNIT III LAMINAR BOUNDARY LAYER 10

Laminar boundary layer equations, Flat plate Integral analysis of Karman – Integral analysis of energy equation – Laminar boundary layer equations – boundary layer over a curved body-Flow separation- similarity solutions, Blasius solution for flat-plate flow, Falkner–Skan wedge flows, Boundary layer temperature profiles for constant plate temperature –Reynold's analogy, Integral equation of Boundary layer – Pohlhausen method – Thermal boundary layer calculations

UNIT IV TURBULENT BOUNDARY LAYER 10

Turbulence-physical and mathematical description, Two-dimensional turbulent boundary layer equations — Velocity profiles – The law of the wall – The law of the wake – Turbulent flow in pipes and channels – Turbulent boundary layer on a flat plate – Boundary layers with pressure gradient, Eddy Viscosity, mixing length , Turbulence modelling

UNIT V BOUNDARY LAYER CONTROL 7

Boundary layer control in laminar flow-Methods of Boundary layer control: Motion of the solid wall-Acceleration of the boundary layer-Suction- Injection of different gas-Prevention of transition-Cooling of the wall-Boundary layer suction-Injection of a different gas.

TOTAL: 45 PERIODS

OUTCOMES:

- To introduce the fundamental equations of the viscous flow and practical examples.
- To expose students to solve methods of the viscous flow.
- To make the students to understand the importance of viscosity and shear flow adjacent to the airframe of the aerospace vehicles.
- To demonstrate the laminar boundary layer concepts and solution methods.
- To make the students to understand the importance of turbulence boundary layer in an aerospace engineering problem.

TEXT BOOKS:

1. White, F. M., Viscous Fluid Flow, McGraw-Hill Education; 3rd edition, 2005.

REFERENCES:

1. Schlichting, H., Boundary Layer Theory, Springer publishers, 8th edition, 2000.
2. Reynolds, A, J., Turbulent Flows Engineering, John Wiley and Sons, 1980.

AE7011 COMBUSTION IN AEROSPACE VEHICLES L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge to students in the combustion mechanism of various aircraft engines including piston and gas turbine engines. Advanced concepts like supersonic combustion will be helpful in understanding hypersonic propulsion.
- Combustion mechanism of rockets will be useful for the study of rocket propulsion

UNIT I FUNDAMENTAL CONCEPTS IN COMBUSTION, CHEMICAL KINETICS AND FLAMES 9

Thermochemical equations – heat of reaction- first, second and third order reactions – premixed flames – diffusion flames – laminar and turbulent flames - measurement of burning velocity – various methods – effect of various parameters on burning velocity – flame stability – deflagration – detonation – Rankine-Hugoniot curves – radiation by flames

UNIT II COMBUSTION IN AIRCRAFT PISTON ENGINES 9

Introduction to combustion in aircraft piston engines – various factors affecting the combustion efficiency - fuels used for combustion in aircraft piston engines and their selection – detonation in piston engine combustion and the methods to prevent the detonation

UNIT III COMBUSTION IN GAS TURBINE AND RAMJET ENGINES 9

Combustion in gas turbine combustion chambers - recirculation – combustion efficiency, factors affecting combustion efficiency, estimation of adiabatic flame temperature in gas turbine combustion chambers – combustion stability –differences between the design of combustion chambers of ramjet and gas turbine engines - various types of flame holders for combustion chambers – salient features of after-burners

UNIT IV SUPERSONIC COMBUSTION 9

Introduction to supersonic combustion – supersonic combustion controlled by diffusion, mixing and heat convection – analysis of reactions and mixing processes - supersonic burning with detonation shocks - various types of supersonic combustors – high intensity combustors.

UNIT V COMBUSTION IN SOLID, LIQUID AND HYBRID ROCKETS 9

Solid propellant combustion - double and composite propellant combustion – various combustion models – combustion in liquid rocket engines – single fuel droplet combustion model – combustion models for hybrid rockets

TOTAL: 45 PERIODS

OUTCOMES:

- The student will be in a position to understand the detailed mechanism of Aerospace Vehicles and Aircraft Engines.
- The student will be able to analyse and impart the combustion processes that occur in Aircraft Engines and Rocket Vehicles.

TEXT BOOKS:

1. Sharma, S.P., and Chandra Mohan, “Fuels and Combustion”, Tata Mc. Graw Hill Publishing Co., Ltd., New Delhi, 1987.
2. Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors, Delhi, 2nd edition 2014.

REFERENCES:

1. Loh, W.H.T., “Jet, Rocket, Nuclear, Ion and Electric Propulsion: Theory and Design(Applied Physics and Engineering)”, Springer Verlag, New York, 2012.
2. Beer, J.M., and Chegar, N.A. “Combustion Aerodynamics”, Applied Science Publishers Ltd., London, 1981.
3. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons; 8th Edition 2010.

AE7012 DESIGN OF GAS TURBINE ENGINE COMPONENTS L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge to students on what constitutes the design, how the gas turbine engine components namely inlets, compressor, combustion chamber, turbine and nozzles are designed.

UNIT I GAS TURBINE ENGINE DESIGN FUNDAMENTALS 8

Design Process- compressible flow relationship; Constrain Analysis- Concept-Design tools-preliminary estimates; Mission analysis-Concept- design tools-Aircraft weight and fuel consumption data-Example problems on Constrain analysis, Mission analysis

UNIT II ON DESIGN AND OFF-DESING PARAMETRIC ANALYSIS 9

Total and static properties-corrected mass flow rate-Engine Cycle Design- One-Dimensional Through flow Area-Flow path force on components- aircraft constraint analysis, aircraft mission analysis, engine parametric (design point) analysis, engine performance (off-design) analysis, engine installation drag and sizing

UNIT III DESIGN OF ROTATING COMPONENTS 10

Engine Component Design-Fan and Compressor Aerodynamics-Diffusion factor-Aerofoil geometry-Flow path dimension-Radial variation-Turbine Aerodynamics- Constant axial velocity-adiabatic-selected Mach number-Mean line stage Design-stage pressure ratio-Airfoil geometry-radial variation-turbine cooling-range of turbine parameter-Engine life-Design Example –fan-compressor-turbine.

UNIT IV COMBUSTION CHAMBER DESIGN 9

Engine Component Design: Combustion system components- Combustion- Chemical reactor theory. Combustor Stability map-Stirring and mixing-Total pressure loss-Fuels-Ignition-Combustion Systems of Main Burner Design: Air partitioning- Main burner component Design: Diffuser-types of burner-inner and outer casing Design-Fuel- nozzle-Dome and liner-Primary zone- swirler-Secondary holes-Dilution holes-Transition duct-Example Design calculation: Design of Afterburners-Design parameters-Components-Diffuser-Fuel injection-Ignition-Flame stabilization-Flame spread and after burner length-Examples design calculation.

UNIT V INLET AND NOZZLE DESIGN 9

Inlets and Exhaust Nozzles Design: Elements of a Successful Inlet-Engine Integration Program-Definition of Subsonic Inlet-Engine Operational Requirements- Definition of Supersonic Inlet-Engine Operational Requirements- Engine Impact on Inlet Design- Inlet Impact on Engine Design-Validation of Inlet-Engine System-Exhaust nozzle design-Nozzle types and their design -Jet control methods for reduction of infrared signature-Simple design problem on dimensional nozzle flow

TOTAL: 45 PERIODS

OUTCOMES:

Upon successful completion of the course,

- The student will be able to perform design calculations of a Gas Turbine Engine from System Engineering point of view.
- The student will be able to match performances of a various sub systems of a Gas Turbine Engine.
- The student will be able to complete the preliminary design of an axial flow Jet Engine.

TEXT BOOKS:

1. Aircraft Engine Design, Second Edition, by J.D. Mattingly, W.H. Heiser, and D.T. Pratt, 2002, AIAA Education Series, AIAA
2. Aircraft Propulsion Systems Technology and Design, by G.C. Oates (ed.), 1989, AIAA Education Series, AIAA
3. H.I.H. Saravanamuttoo , G.F.C. Rogers, "Gas Turbine Technology", Pearson Education Canada; 6th edition, 2008.

REFERENCES:

1. High-Speed Flight Propulsion Systems, by S.N. Murthy and E.T. Curran (eds.), 1991, Volume 137, Progress in Astronautics and Aeronautics, AIAA
2. N. Cumpsty , "Jet Propulsion: A Simple Guide to the Aerodynamics and Thermodynamics Design and Performance of Jet Engines" , Cambridge University Press; 2 edition, 2003
3. Applied Gas Dynamics, by E.Rathakrishnan, John Wiley & Sons (Asia) Pvt Ltd, 2010.
4. Aircraft Gas Turbine Engine Technology, 3rd ed., by I.E. Treager, 1995, Glencoe McGraw-Hill, Inc.

AE7013 FATIGUE AND FRACTURE MECHANICS L T P C
3 0 0 3

OBJECTIVE:

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

UNIT I FATIGUE OF STRUCTURES 7

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

UNIT II STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR 10

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

UNIT III PHYSICAL ASPECTS OF FATIGUE 10

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

UNIT IV FRACTURE MECHANICS 10

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

UNIT V FATIGUE DESIGN AND TESTING 8

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

TOTAL: 45 PERIODS

Attested

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Centre For Academic Courses
Anna University, Chennai-600 025.

OUTCOMES:

- Ability to apply mathematical knowledge to define fatigue behaviors
- Ability to perform fatigue design
- Ability to analyse the fracture due to fatigue

TEXT BOOKS:

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

REFERENCES:

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

AE7014 FUNDAMENTALS OF CONTROL ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

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

UNIT I INTRODUCTION 9

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

UNIT II OPEN AND CLOSED LOOP SYSTEMS 9

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

UNIT III CHARACTERISTIC EQUATION AND FUNCTIONS 9

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

UNIT IV CONCEPT OF STABILITY 12

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

UNIT V SAMPLED DATA SYSTEMS 6

Z-Transforms Introduction to digital control system, Digital Controllers and Digital PID controllers

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to apply mathematical knowledge to model the systems and analyse the frequency domain.
- Ability to check the stability of the both time and frequency domain

TEXT BOOKS:

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

REFERENCES:

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

AE7015 HELICOPTER AERODYNAMICS L T P C
3 0 0 3

OBJECTIVE:

- To impart knowledge to the students and fundamental aspects of helicopter aerodynamics, performance of helicopters, stability and control aspects and also to expose them basic and aerodynamic design aspects

UNIT I INTRODUCTION 9

Helicopter as an aircraft, Basic features, Layout, Generation of lift, Main rotor, Gearbox, tail rotor, power plant, considerations on blade, flapping and feathering, Rotor controls and various types of rotor, Blade loading, Effect of solidity, profile drag, compressibility etc., Blade area required, number of Blades, Blade form, Power losses, Rotor efficiency.

UNIT II AERODYNAMICS OF ROTOR BLADE 9

Aerofoil characteristics in forward flight, Hovering and Vortex ring state, Blade stall, maximum lift of the helicopter calculation of Induced Power, High speed limitations; parasite drag, power loading, ground effect.

UNIT III POWER PLANTS AND FLIGHT PERFORMANCE 9

Piston engines, Gas turbines, Ramjet principle, Comparative performance, Horsepower required, Range and Endurance, Rate of Climb, Best Climbing speed, Ceiling in vertical climb, Autorotation.

UNIT IV STABILITY AND CONTROL 9

Physical description of effects of disturbances, Stick fixed Longitudinal and lateral dynamic stability, lateral stability characteristics, control response. Differences between stability and control of airplane and helicopter.

UNIT V ROTOR VIBRATIONS 9

Dynamic model of the rotor, Motion of the rigid blades, flapping motion, lagging motion, feathering motion, Properties of vibrating system, phenomenon of vibration, fuselage response, vibration

absorbers, Measurement of vibration in flight. Rotor Blade Design: General considerations, Airfoil selection, Blade construction, Materials, Factors affecting weight and cost, Design conditions, Stress analysis.

TOTAL: 45 PERIODS

OUTCOMES:

- To perform the Aerodynamics calculation of Rotor blade.
- To perform stability and control characteristics of Helicopter
- To perform and control Rotor vibration

TEXT BOOKS:

1. John Fay, Helicopter: history, piloting and How It Flies, Himalayan Books 1995.
2. Lalit Gupta, Helicopter Engineering; Himalayan Books New Delhi 1996.

REFERENCES:

1. Joseph Schafer, Basic Helicopter Maintenance (Aviation Technician Training Course-JS312642), Jeppesen 1980.
2. R W Prouty, Helicopter Aerodynamics, Phillips Pub Co, 1993.

AE7016 HYPERSONIC AERODYNAMICS L T P C
3 0 0 3

OBJECTIVE:

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

UNIT I FUNDAMENTALS OF HYPERSONIC AERODYNAMICS 9

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

UNIT II SIMPLE SOLUTION METHODS FOR HYPERSONIC INVISCID FLOWS 9

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

UNIT III VISCOUS HYPERSONIC FLOW THEORY 9

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

UNIT IV VISCOUS INTERACTIONS IN HYPERSONIC FLOWS 9

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

UNIT V HIGH TEMPERATURE EFFECTS IN HYPERSONIC FLOWS 9

Nature of high temperature flows – chemical effects in air – real and perfect gases – Gibb's free

energy and entropy - chemically reacting boundary layers – recombination and dissociation.

TOTAL: 45 PERIODS

OUTCOMES:

- Knowledge in basics of hypersonic and supersonic aerodynamics.
- Acquiring knowledge in theory of hypersonic flow.
- Understanding of boundary layers of hypersonic flow and viscous interaction.
- Role of chemical and temperature effects in hypersonic flow.

TEXT BOOKS:

1. John D. Anderson. Jr., "Hypersonic and High Temperature Gas Dynamics", AIAA; 2nd Edition, 2006

REFERENCES:

1. John D. Anderson. Jr., "Modern Compressible flow with historical Perspective", McGraw Hill Publishing Company, 3rd edition,, 2002.
2. John T. Bertin, "Hypersonic Aerothermodynamics", published by AIAA Inc., Washington. D.C., 1994.

AE7017 MISSILE AERODYNAMICS L T P C
3 0 0 3

OBJECTIVE:

- Upon completion of the course, Students will learn the concept of high speed aerodynamics and Configurations of missiles.

UNIT I BASICS ASPECTS OF MISSILE AERODYNAMICS 9

Classification of missiles-Aerodynamics characteristics and requirements of air to air missiles, air to surface missiles and surface to air missiles-Missile trajectories-fundamental aspects of hypersonic aerodynamics.

UNIT II MISSILE 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 III 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 IV 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- Wind tunnel tests – Comparison with CFD Analysis.

UNITV STABILITY AND CONTROL OF MISSILES 9

Forces and moments acting on missiles-Lateral, rolling and longitudinal moments-missile dispersion-stability aspects of missile configuration-Aerodynamic control methods-Jet control methods-Stability derivatives.

TOTAL: 45 PERIODS

OUTCOME:

- On completion of the course, students will be able to understand the aerodynamics of slender and blunt bodies, various aspects of launching phase and stability & control of missiles.

REFERENCES:

1. Anderson, J.D., "Fundamentals of Aerodynamics", McGraw-Hill Book Co., New York, 1985.
2. Chin SS, Missile Configuration Design, McGraw Hill, New York, 1961.
3. John D. Anderson. Jr., "Hypersonic and High Temperature Gas Dynamics", AIAA; 2nd edition, 2006
4. Nielsen, Jack N, Stever, Gutford, "Missile Aerodynamics", McGraw Hill, New York, 1960.
5. John D. Anderson. Jr., "Modern Compressible flow with historical Perspective", McGraw Hill Publishing Company, 3rd edition, 2002.

AE7018 NUMERICAL HEAT TRANSFER L T P C

3 0 0 3

OBJECTIVE:

- Students will learn the concepts of various computation methods that are applicable to conduction, convection and radiation problems.

UNIT I INTRODUCTION 9

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

UNIT II CONDUCTIVE HEAT TRANSFER 9

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

UNIT III TRANSIENT HEAT CONDUCTION 9

Introduction to Implicit, explicit Schemes and crank-Nicolson Schemes Computation(FDM) of One – dimensional un-steady heat conduction –with heat Generation-without Heat generation - 2D-transient heat conduction problem with different boundary conditions using Implicit, explicit Schemes. Importance of Courant number. Analysis for I-D,2-D transient heat Conduction problems.

UNIT IV CONVECTIVE HEAT TRANSFER 9

Convection- Numerical treatment (FDM) of steady and unsteady 1 -D and 2-d heat convection-diffusion steady-unsteady problems- Computation of thermal and Velocity boundary layer flows. Upwind scheme.Stream function-vorticity approach-Creeping flow.

UNIT V RADIATIVE HEAT TRANSFER 9

Radiation fundamentals-Shape factor calculation-Radiosity method- Absorption Method – Montacalro method-Introduction to Finite Volume Method- Numerical treatment of radiation enclosures using finite Volume method. Developing a numerical code for 1D, 2D heat transfer problems.

TOTAL: 45 PERIODS

OUTCOME:

- Upon completion of the course, students will learn the concepts of computation applicable to heat transfer for practical applications.

REFERENCES:

1. Necati Ozisik, Finite Difference Method in Heat Transfer, CRC Press, second edition, 1994.
2. Yogesh Jaluria, Kenneth E Torrence, Computational Heat transfer, CRC Press, second edition, 2002.
3. Pradip Majumdar, Computational Methods for Heat & Mass Transfer, CRC Press, 2005
4. Yunus A. Cengel, Heat Transfer – A Practical Approach Tata McGraw Hill Edition, 2003.
5. Sachdeva,S.C., Fundamentals of Engineering Heat and Mass Transfer, NEW AGE publishers,2010.
6. John D. Anderson, JR" Computational Fluid Dynamics", McGraw-Hill Book Co., Inc., New York, 1995.
7. T.J. Chung, Computational Fluid Dynamics, Cambridge University Press, 2002.

AE7019 SATELLITE TECHNOLOGY L T P C
3 0 0 3

OBJECTIVE:

- To understand the concept of orbital mechanics, satellite system, their configuration and control and make the students eligible to enter into R&D organization

UNIT I INTRODUCTION TO SATELLITE SYSTEMS 9

Common satellite applications and missions – Typical spacecraft orbits – Definitions of spin the three axis stabilization-Space environment – Launch vehicles – Satellite system and their functions (structure, thermal, mechanisms, power, propulsion, guidance and control, bus electronics).

UNIT II ORBITAL MECHANICS 9

Fundamental of flight dynamics – Time and coordinate systems – Orbit determination and prediction – Orbital maneuvers – GPS systems and application for satellite/orbit determination – Ground station network requirements.

UNIT III SATELLITE STRUCTURES & THERMAL CONTROL 9

Satellite mechanical and structural configuration: Satellite configuration choices, launch loads, separation induced loads, deployment requirements – Design and analysis of satellite structures – Structural materials and fabrication – The need of thermal control: externally induced thermal environment – Internally induced thermal environment - Heat transfer mechanism: internal to the spacecraft and external heat load variations – Thermal control systems: active and passive methods.

UNIT IV SPACECRAFT CONTROL 9

Control requirements: attitude control and station keeping functions, type of control maneuvers – Stabilization schemes: spin stabilization, gravity gradient methods, 3 axis stabilization – Commonly

used control systems: mass expulsion systems, momentum exchange systems, gyro and magnetic torque - Sensors star and sun sensors, earth sensor, magnetometers and inertial sensors

UNIT V POWER SYSTEM AND BUS ELECTRONICS 9

Solar panels: Silicon and Ga-As cells, power generation capacity, efficiency – Space battery systems – battery types, characteristics and efficiency parameters – Power electronics. Telemetry and telecommand systems: Tm & TC functions, generally employed communication bands (UHF/VHF, S, L, Ku, Kaetc), their characteristics and applications- Coding Systems – Onboard computer- Ground checkout Systems.

TOTAL:45 PERIODS

OUTCOMES:

- Aware of the mission, configuration and applications of satellites.
- Understand the concepts of Orbits and their mechanics.
- Understand the concepts of Bus electronics and power subsystem.
- Understand the concepts of structural design, analyzing techniques and various types of loads in satellite structural subsystem.
- Understand the importance of thermal control subsystem and its design studies.
- Understand the concepts of satellite sensors and actuators that needed for Attitude control subsystem development.
- Acquired the knowledge of satellite attitude as well as orbital dynamics in order to design the satellite control subsystem.
- Graduate will able to understand the concepts of Space Research and have interest to do research in R&D organizations.

TEXT BOOKS:

1. Analysis and Design of Flight Vehicle Structures, Tri-State off set company, USA, 1980.
2. Space Systems Engineering Rilay, FF, McGraw Hill, 1982.
3. Principles of Astronautics Vertregt.M.,Elsevier Publishing Company, 1985.
4. Introduction Space Flight, Francis J. Hale Prentice Hall, 1994.
5. Space Vehicle Design, Michael D. Griffin and James R. French, AIAA Education Series, 1991.

REFERENCES:

1. Spacecraft Thermal Control, Hand Book, Aerospace Press, 2002.
2. Structural Design of Missiles & Space Craft Lewis H. Abraham, McGraw Hill, 92.
3. Space Communications Systems, Richard.F, Filipowsky Eugen I Muehllorf, Prentice Hall, 1995.
4. Hughes, P.C. Spacecraft Altitude Dynamics, Wilsey, 1986.

AE7020 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 - the many body problem - Lagrange-Jacobi identity – the circular restricted three body problem – libration points – the 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 – the ballistic phase – trajectory geometry – optimal flights – time of flight – re-entry phase – the 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.

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.

REFERENCES:

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons; 8th Edition 2010.

AE7021 STRUCTURAL DYNAMICS L T P C
3 0 0 3

OBJECTIVE:

- To study the effect of periodic and aperiodic forces on mechanical systems with matrix approach and also to get the natural characteristics of large sized problems using approximate methods.

UNIT I FORCE DEFLECTION PROPERTIES OF STRUCTURES 9

Constraints and Generalized coordinates – Virtual work and generalized forces – Force – Deflection influence functions – stiffness and flexibility methods.

UNIT II PRINCIPLES OF DYNAMICS 9

Free and forced vibrations of systems with finite degrees of freedom – Response to periodic excitation – Impulse Response Function – Convolution Integral

UNIT III NATURAL MODES OF VIBRATION 9

Equations of motion for Multi degree of freedom Systems - Solution of Eigen value problems – Normal coordinates and orthogonality Conditions. Modal Analysis.

UNIT IV ENERGY METHODS 9

Rayleigh's principle – Rayleigh – Ritz method – Coupled natural modes – Effect of rotary inertia and shear on lateral vibrations of beams – Natural vibrations of plates.

UNIT V APPROXIMATE METHODS 9

Approximate methods of evaluating the Eigen frequencies and Eigen vectors by reduced, subspace, Lanczos, Power, Matrix condensation and QR methods.

TOTAL: 45 PERIODS

OUTCOMES:

- Knowing various options of mathematical modeling of structures.
- Method of evaluating the response of structures under various dynamically loaded conditions
- Knowledge in natural modes of vibration of structures.
- Gaining knowledge in numerical and approximate methods of evaluating natural modes of vibration.

TEXT BOOKS:

1. F.S. Tse, I.E. Morse and H.T. Hinkle, "Mechanical Vibrations: Theory and Applications" , Prentice Hall of India Pvt. Ltd, New Delhi, 2004.
2. W.C. Hurty and M.F. Rubinstein, "Dynamics of Structures", Prentice Hall of India Pvt. Ltd., New Delhi 1987.

REFERENCES:

1. R.K. Vierck, "Vibration Analysis", 2nd Edition, Thomas Y. Crowell & Co Harper &Row Publishers, New York, U.S.A. 1989.
2. S.P. Timoshenko ad D.H. Young, "Vibration Problems in Engineering", John Willey& Sons Inc., 1984.
3. V.Ramamurthi, "Mechanical Vibration Practice and Noise Control" Narosa Publishing House Pvt. Ltd, 2008.

AE7022 THEORY OF ELASTICITY L T P C
3 0 0 3

OBJECTIVE:

- To make the student understand the elastic behavior of different structural components under various loadings and boundary conditions.

UNIT I BASIC EQUATIONS OF ELASTICITY 9

Definition of Stress and Strain: Stress - Strain relationships - Equations of Equilibrium, Compatibility equations, Boundary Conditions, Saint Venant's principle - Principal Stresses, Stress Ellipsoid - Stress invariants.

UNIT II PLANE STRESS AND PLANE STRAIN PROBLEMS 9

Airy's stress function, Bi-harmonic equations, Polynomial solutions, Simple two dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams.

UNIT III POLAR COORDINATES 9

Equations of equilibrium, Strain - displacement relations, Stress – strain relations, Airy's stress function, Axi – symmetric problems, Introduction to Dunder's table, Curved beam analysis, Lame's, Kirsch, Michell's and Boussinesque problems – Rotating discs.

UNIT IV TORSION 9

Navier's theory, St. Venant's theory, Prandtl's theory on torsion, semi- inverse method and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections. Membrane Analogy.

UNIT V INTRODUCTION TO THEORY OF PLATES AND SHELLS 9

Classical plate theory – Assumptions – Governing equations – Boundary conditions – Navier's method of solution for simply supported rectangular plates – Levy's method of solution for rectangular plates under different boundary conditions.

TOTAL: 45 PERIODS

OUTCOME:

- Ability to use mathematical knowledge to solve problem related to structural elasticity

TEXT BOOKS:

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

REFERENCES:

1. Wang, C. T., Applied Elasticity, McGraw – Hill Co., New York, 1993.
2. Sokolnikoff, I. S., Mathematical Theory of Elasticity, McGraw – Hill, New York, 1978.
3. Volterra& J.H. Caines, Advanced Strength of Materials, Prentice Hall, New Jersey, 1991
4. Barber, J. R., Elasticity (Solid Mechanics and Its Applications), Springer publishers, 3rd edition,2010.

AE7023 THEORY OF PLATES AND SHELLS L T P C
3 0 0 3

OBJECTIVE:

- Gives exposure to formulation of governing equations, various types of analyses plate problems and the methods of solution.

UNIT I CLASSICAL PLATE THEORY 8

Assumptions – Governing Equation – Boundary Conditions – Methods of Solution

UNIT II RECTANGULAR PLATES 10

Navier's Method of Solution for Simply Supported Rectangular Plates – Levy's Method of Solution for Rectangular Plates under Different Boundary Conditions and loadings.

UNIT III CIRCULAR PLATES 9

Governing equation. Boundary conditions. Bending of circular and annular plates for different support conditions and loading cases.

UNIT IV STABILITY AND FREE VIBRATION ANALYSIS 8

Governing equation for buckling of plates. Buckling analysis of simply supported plates for different loadings. Governing equation for free vibration of rectangular plates. Natural frequency for rectangular plates for different boundary conditions.

UNIT V APPROXIMATE METHODS 10

Rayleigh – Ritz, Galerkin Methods– Finite Difference Method – Application to Rectangular Plates for Static, Free Vibration and Stability Analysis.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

- Understand the basic theory related to the analysis of plate.
- Apply various exact methods used for the static analysis of rectangular plates.
- Use governing equation and solution to circular plate bending problems.
- Comprehend stability and basic dynamic analysis of plates.
- Understand the use of various approximate methods for solving plate bending problems.

TEXT BOOKS:

1. Timoshenko, S.P. Winowsky. S., and Kreger, Theory of Plates and Shells, McGraw Hill Book Co., 1990.
2. Ansel Ugural, Stresses in Plates & Shells, McGraw Hill, 1981
3. Varadhan.T.K. & Bhaskar.K., "Analysis of Plates – Theory and Problems", Narosa Publishing House, 2000

REFERENCES:

1. Flugge, W. Stresses in Shells, Springer – Verlag, 1985.
2. Timoshenko, S.P. and Gere, J.M., Theory of Elastic Stability, Dover Publications Inc.; 2nd Revised edition, 2009
3. Harry Kraus, 'Thin Elastic Shells', John Wiley and Sons, 1987.
4. Lloyd Hamilton, Donald, "Beams, Plates and Shells", McGraw Hill, 1976.
5. Reddy.J.N., "Theory & Analysis of Elastic Plates and Shells (Series in Systems and Control)", CRC press, 2nd Edition, 2006

AE7024 THEORY OF VIBRATIONS 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 DEGREES OF FREEDOM SYSTEMS 10

Two degrees of freedom systems - Static and Dynamic couplings - vibration absorber- 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 an d Torsional vibrations.

UNIT IV APPROXIMATE METHODS 9

Approximate methods - Rayleigh's method - Dunkerlay's method – Rayleigh-Ritz method, Matrix Iteration method.

UNIT V ELEMENTS OF AEROELASTICITY 8

Coupled flexural–Torsional oscillation of beam- 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.

TEXT BOOKS:

1. Leonard Meirovitch, 'Elements of Vibration Analysis' – McGraw Hill International Edition,2007
2. G.K.Grover, "Mechanical Vibrations", 7th Edition, Nem Chand Brothers, Roorkee, India, 2009
3. William T. Thomson & Marie Dillon Dahleh, 'Theory of Vibration with Application", Prentice Hall publishers, 5th edition, 1997.

REFERENCES:

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

AE7025 UAV SYSTEM DESIGN L T P C
3 0 0 3

OBJECTIVE:

- The objective of this course is to learn and understand the low cost UAV SYSTEMS which is suitable for generating variety of datas' to verify and validate the different types of algorithms developed by the researchers and Scientists working on MINI UAV's and MAV's.

UNIT I INTRODUCTION TO UAV 9

History of UAV –classification – Introduction to Unmanned Aircraft Systems--models and prototypes – System Composition-applications

UNIT II THE DESIGN OF UAV SYSTEMS 9

Introduction to Design and Selection of the System- Aerodynamics and Airframe Configurations-Characteristics of Aircraft Types- Design Standards and Regulatory Aspects-UK,USA and Europe-Design for Stealth--control surfaces-specifications.

UNIT III AVIONICS HARDWARE 9

Autopilot –AGL-pressure sensors-servos-accelerometer –gyros-actuators- power supply-processor, integration, installation, configuration, and testing

UNIT IV COMMUNICATION PAYLOADS AND CONTROLS 9

Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequency range –modems-memory system-simulation-ground test-analysis-trouble shooting

UNIT V DEVELOPMENT OF UAV SYSTEMS 9

Waypoints navigation-ground control software- System Ground Testing- System In-flight Testing-Future Prospects and Challenges-Case Studies – Mini and Micro UAVs.

TOTAL: 45 PERIODS

OUTCOMES:

- Ability to design UAV system
- Ability to identify different hardware for UAV

REFERENCES:

1. Reg Austin “unmanned aircraft systems UAV design, development and deployment”, Wiley, 2010.
2. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.
3. Kimon P. Valavanis, “Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy”, Springer, 2007
4. Paul G Fahlstrom, Thomas J Gleason, “Introduction to UAV Systems”, UAV Systems, Inc, 1998,
5. Dr. Armand J. Chaput, “Design of Unmanned Air Vehicle Systems”,Lockheed Martin Aeronautics Company, 2001

AE7026 WIND ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- Apply fundamental principles of wind engineering theory to determine wind effects on civil engineering structures.
- Apply wind loading codes for structural design.
- Apply experimental methods for determining wind effects on buildings and structures

UNIT I THE ATMOSPHERE 6

Atmospheric Circulation - Stability of atmospheres -definitions & implications - Effects of friction - atmospheric motion - Local winds, Building codes, Terrains different types.

UNIT II ATMOSPHERIC BOUNDARY LAYER 9

Governing Equations - Mean velocity profiles, Power law, logarithmic law wind speeds, Atmospheric Turbulence profiles - Spectral density function -. Length scale of turbulence, .Roughness parameters simulation techniques in wind tunnels.

UNIT III BLUFF BODY AERODYNAMICS 10

Governing equations Boundary layers and separations - Wake and Vortex formation two dimensional- StroUhal Numbers, Reynolds numbers-Separation and Reattachments Oscillatory Flow.patterns Vortex shedding flows -Time varying forces to Wind velocity in turbulent flow - Structures in three dimensional

UNIT IV WIND LOADING: 10

Introduction, Analysis and synthesis. Loading coefficients, local• & global coefficients pressure shear stress coefficients, force and moment coefficients - Assessment methods - Quasi steady method - Peak factor method - Extreme value method.

UNIT V AERO ELASTIC PHENOMENA: 10

Vortex shedding and lock in phenomena in turbulent flows, across wind' galloping wake galloping Torsional divergence, along wind galloping of circular cables, cross wind galloping of circular dibble's', Wind loads &. Turbulent effects on tall. Structure - Launch vehicles.

TOTAL: 45 PERIODS

OUTCOMES:

- Upon completion of the course the student will be in a position to design wind turbines for production of wind power on alternative energy source.
- Also the student will be able to carry out structural analysis of various industrial structural units which are subjected to wind loads.

TEXT BOOKS:

1. Emil Simiu & Robert H Scanlan, 'Wind effects of structures fundamentals and applications to design; John Wiley & Sons INC New York, 3rd edition, 1996.

REFERENCES:

1. Tom Lawson, "Building Aerodynamics",Imperial College Press London, 1st edition, 2001.
2. Cook N J, Design Guides to wind loading of buildings structures. Part I & II, Burterworths, London, 1990 .

AE7027 WIND TUNNEL TECHNIQUES L T P C
3 0 0 3

OBJECTIVE:

- The students are exposed to various types and techniques of Aerodynamic data generation on aerospace vehicle configurations in the aerospace industry.

UNIT I PRINCIPLES OF MODEL TESTING 6

Buckingham Theorem – Non dimensional numbers – Scale effect – Geometric Kinematic and Dynamic similarities.

UNIT II TYPES AND FUNCTIONS OF WIND TUNNELS 6

Classification and types – special problems of testing in subsonic, transonic, supersonic and hypersonic speed regions – Layouts – sizing and design parameters.

UNIT III CALIBRATION OF WIND TUNNELS 9

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

UNIT IV CONVENTIONAL MEASUREMENT TECHNIQUES 12

Force measurements and measuring systems – Multi component internal and external balances – Pressure measurement system - Steady and Unsteady Pressure- single and multiple measurements - Velocity measurements – Intrusive and Non-intrusive methods – Flow visualization techniques- surface flow, oil and tuft - flow field visualization, smoke and other optical and nonintrusive techniques

UNIT V SPECIAL WIND TUNNEL TECHNIQUES 12

Intake tests – store carriage and separation tests - Unsteady force and pressure measurements – wind tunnel model design

TOTAL: 45 PERIODS

OUTCOME:

- Ability to use various techniques of Aerodynamic data generation.

TEXT BOOKS:

1. Rae, W.H. and Pope, A., Low Speed Wind Tunnel Testing, John Wiley Publication, 1984.
2. NAL-UNI Lecture Series 12: Experimental Aerodynamics, NAL SP 98 01April , 1998

REFERENCES:

1. Pope, A., and Goin, L., High Speed Wind Tunnel Testing, John Wiley, 1985.
2. Bradsaw Experimental Fluid Mechanics. Short term course on Flow visualization techniques, NAL , 2009
3. Lecture course on Advanced Flow diagnostic techniques 17-19 September 2008 NAL, Bangalore

AE7071 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.
- Knowledge in NDT in stress analysis.

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, 2009.

REFERENCES:

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

GE7071 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 etc - Classification, Causes, Impacts including social, economic, political, environmental, health, psychosocial, etc.- 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 Processess 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 etc.- 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, Scenarious in the Indian context, Disaster damage assessment and management.

TEXTBOOKS:

1. Singhal J.P. "Disaster Management", Laxmi Publications, 2010. ISBN-10: 9380386427 ISBN-13: 978-9380386423

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

REFERENCES

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

GE7073 FUNDAMENTALS OF NANO SCIENCE 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, 92 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, TiO_2,MgO, ZrO_2, NiO, nanoalumina, CaO, $AgTiO_2$, 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:

Upon completing this course, the students

- 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 edition, Weinheim Cambridge, Wiley-VCH, 2000

REFERENCES

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

GE7074 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. Kapoor S.K., “Human Rights under International law and Indian Laws”, Central Law Agency, Allahabad, 2014.
2. Chandra U., “Human Rights”, Allahabad Law Agency, Allahabad, 2014.
3. Upendra Baxi, the Future of Human Rights, Oxford University Press, New Delhi.

GE7072	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, analyze and arrive at requirements for new product development and convert them in to design specification
- To understand system modeling 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 Edition, 2011.
3. John W Newstorm and Keith Davis, "Organizational Behavior", Tata McGraw Hill, Eleventh Edition, 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 Edition, Prentice Hall, 2003.
4. Mark S Sanders and Ernest J McCormick, "Human Factors in Engineering and Design", McGraw Hill Education, Seventh Edition, 2013