ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

REGULATIONS – 2019

CHOICE BASED CREDIT SYSTEM

B.E. AERONAUTICAL ENGINEERING

THE VISION OF THE DEPARTMENT OF AEROSPACE ENGINEERING

The Department of Aerospace Engineering shall strive to be a globally known department, committed for its academic excellence, professionalism and societal expectations. The Department aims to impart state of the art technical knowledge, practical skills, leadership qualities, team spirit, ethical values and entrepreneurial skill to make all the students capable of taking up any task relevant to the area of Aerospace Engineering.

THE MISSION OF THE DEPARTMENT OF AEROSPACE ENGINEERING

The Mission of the Department of Aerospace Engineering is to

- Prepare the students to have a very good fundamental knowledge to meet the present and future needs of industries.
- Improve the technical knowledge of the students in tune with the current requirements through collaboration with industries and research organization.
- Make the students gain enough knowledge in various aspects of system integration.
- Motivate the students to take up jobs in national laboratories and aerospace industries of our country.
- Take up inter and multidisciplinary research, sponsored and consultancy projects with industries and research establishments.
- Encourage the faculty members and students to do research and to update with the latest developments in the area of Aerospace Engineering.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS)

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

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

PEO III: Motivation for Higher Studies: Graduates of the programme will have motivation to pursue higher studies and acquire masters and research degrees

PEO IV: 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 V: 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.

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PROGRAMME OUTCOMES (POs)

After going through the four years of study, Aeronautical Engineering Graduates will exhibit the following.

PO	Graduate Attribute	Programme outcome
1.	Engineering Knowledge	a. Graduate will demonstrate strong basics in mathematics, science and engineering.
2.	Problem Analysis	b. Graduate will demonstrate the ability to design, analyse and conduct experiments, as well as to interpret data.
3.	Design/Development of solutions	c. Graduate will demonstrate the ability to design a system or a component to meet the design requirements and other professional fields.
4.	Conduct of Investigations of Complex problems	d. Graduate will acquire the capability to identify, formulate and solve complex engineering problems of Aeronautical Engineering and aerospace subsystems.
5.	Modern tool usage	e. Graduate will become familiar with modern engineering tools and analyze the problems within the domains of Aeronautical Engineering as a member of multidisciplinary teams.
6.	The Engineer and Society	f. Graduates will be able to contribute to society by way of becoming good academicians or scientists/engineers in aircraft and aerospace industry for the development of aircraft and aerospace systems that are less noisy, produce less pollution and cheaper transport.
7.	Environment and sustainability	g. 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 and aerospace industry.
8.	Ethics	h. 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.
9.	Individual and Team work	i. Graduate will be trained towards developing and understanding the importance of design and development of Airplanes from system integration point of view.
10.	Communication	j. Graduate will be able to communicate effectively both in verbal and non-verbal forms. Graduates 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.
11.	Project Management and Finance	k. Graduates will be capable of developing cost effective solutions for development of aircraft and aerospace subsystems.
12.	Lifelong Learning	l. Graduate will be capable of understanding the value for life-long learning. Graduate will be capable of doing higher studies and research in inter and multidisciplinary areas.

Mapping PEO with POs:

PEO/PO	1	2	3	4	5	6	7	8	9	10	11	12
I	√	√	√	√	√	√	√	√	√	√	√	
II	√	√	√	√	√		√	√	√	√		√
III	√	√	√	√	√	√					√	√
IV			√	√	√	√	√		√	√		
V	√	√	√	√	√		√		√	√		√

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MAPPING OF COURSE OUTCOMES WITH PROGRAMME OUTCOMES:

Subjects/PO	Category	Sem/Year	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
Technical English	HSMC	I/I												
Engineering Mathematics-I	BSC	I/I												
Engineering Physics	BSC	I/I												
Engineering Chemistry	BSC	I/I												
Engineering Graphics	ESC	I/I	√		√		√					√		√
Basic Sciences Laboratory	BSC	I/I												
Workshop Practices Laboratory	ESC	I/I	√	√	√	√								
Professional Communication	HSMC	II/I												
Engineering Mathematics-II	BSC	II/I												
Materials Science	BSC	II/I												
Problem Solving and Python Programming	ESC	II/I	√	√	√	√	√			√	√			√
Basics of Electrical and Electronics Engineering	ESC	II/I	√	√	√	√	√							
Engineering Mechanics	ESC	II/I	√	√	√	√		√	√				√	√
Problem Solving and Python Programming Laboratory	ESC	II/I	√	√	√	√	√			√	√			√
Electrical and Electronics Engineering Laboratory	ESC	II/I	√	√	√	√					√		√	
Subjects/PO	**Category**	**Sem/Year**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Transform Techniques and Partial Differential Equations	BSC	III/II												
Elective – Humanities I	HSMC	III/II												
Aero Engineering Thermodynamics	PCC	III/II	√	√	√	√							√	√
Solid Mechanics	PCC	III/II	√	√	√	√							√	√
Fluid Mechanics and Fluid Machines	PCC	III/II	√	√	√	√	√	√						√
Elements of Aeronautical Engineering	PCC	III/II	√	√	√	√	√	√						√
Thermodynamics and Strength of Materials Laboratory	PCC	III/II	√	√	√	√	√	√	√		√		√	√
Fluid Mechanics Laboratory	PCC	III/II	√	√	√	√	√	√	√		√		√	√
Elective – Humanities II	HSMC	IV/II												
Environmental Science	PCC	IV/II		√	√						√			
Low Speed Aerodynamics	PCC	IV/II	√	√	√	√	√	√					√	√
Air breathing Propulsion	PCC	IV/II		√	√	√	√	√	√		√		√	√
Aircraft Performance	PCC	IV/II		√	√	√	√	√	√				√	√

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Advanced Solid Mechanics	PCC	IV/II	√	√	√	√	√		√				√	√
Propulsion Laboratory	PCC	IV/II	√	√	√	√	√		√		√		√	√
Aerodynamics laboratory	PCC	IV/II		√	√	√	√		√		√	√		√
Subjects/PO	**Category**	**Sem/Year**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Management Science	HSMC	IV/II		√	√	√	√	√	√	√	√	√		√
High Speed Aerodynamics	PCC	V/III	√	√	√	√	√	√	√				√	√
Rocket Propulsion	PCC	V/III		√	√	√	√	√	√				√	√
Aircraft Structures	PCC	V/III	√	√	√	√	√		√				√	√
Aircraft Structures Laboratory	PCC	V/III		√	√		√		√					√
Industrial Training/Internship*	EEC	V/III		√	√	√	√		√					√
Aircraft Stability and Control	PCC	VI/III	√	√	√	√	√				√		√	√
Computational Fluid Dynamics	PCC	VI/III	√	√	√	√	√	√			√		√	√
Composite Materials and Structures	PCC	VI/III		√	√	√	√		√				√	√
Aircraft Design Project –I	PCC	VI/III		√	√	√	√				√			
Flight Training Laboratory	EEC	VI/III	√	√	√	√	√	√	√		√			√
Subjects/PO	**Category**	**Sem/Year**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Experimental Aerodynamics	PCC	VII/IV	√	√	√	√	√	√			√		√	√
Finite Element Method	PCC	VII/IV	√	√	√	√	√						√	√
Rockets and Missiles	PCC	VII/IV	√	√	√	√	√	√	√				√	√
Aircraft Design Project-II	PCC	VII/IV		√	√	√	√		√		√			√
Project I	EEC	VII/IV	√	√	√	√	√		√		√	√	√	√
Project II	EEC	VII.IV	√	√	√	√	√		√		√	√	√	√
PROFESSIONAL ELECTIVE COURSES														
Subjects/PO	**Category**	**Sem/Year**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
Aircraft Rules and Regulations CAR I & II	PEC I	V/III	√	√			√	√	√	√	√	√	√	√
Elements of Heat Transfer			√	√	√	√	√	√	√				√	√
Experimental Stress Analysis				√	√	√	√		√					√
Mechanics of Machines			√	√	√	√	√		√		√		√	√
Wind Engineering			√	√	√	√	√	√	√				√	√
Aircraft Engine Repairs and Maintenance	PEC II	VI/III	√	√			√	√	√	√	√	√	√	√
Boundary Layer Theory			√	√	√	√	√	√	√				√	√
Design of Gas Turbine Engine Components			√	√	√	√	√				√		√	√
Manufacturing Processes				√	√	√	√	√	√		√			√

Theory of Elasticity			√	√	√	√	√		√					√
Advanced Aerospace Materials				√	√	√	√		√					√
Aircraft Design	PEC III		√	√	√	√	√		√		√	√	√	√
Fundamentals of Control Engineering				√	√	√	√		√			√	√	
Theory of Vibration			√	√	√	√	√		√				√	√
Principles and Applications of Total Quality Management				√	√	√	√		√		√			√
Aero Elasticity	PEC IV	VII/IV		√	√	√	√		√					√
Airframe Repair and Maintenance			√	√		√	√	√	√	√	√	√		√
Missile Aerodynamics			√	√	√	√	√				√		√	√
Numerical Heat Transfer				√	√	√	√	√	√				√	√
Structural Dynamics			√	√	√	√	√		√				√	√
Aircraft Systems Engineering	PEC V		√	√				√	√	√	√	√	√	√
Avionics Systems				√	√	√	√		√		√			√
Fatigue and Fracture Mechanics			√	√	√	√	√		√					√
Helicopter Engineering			√	√	√	√	√	√	√		√		√	
Space Mechanics			√	√	√	√	√	√			√		√	√
Approximate Methods in Structural Mechanics	PEC VI	VIII/IV		√	√	√	√		√					√
Combustion in Aerospace Vehicles			√	√	√	√	√		√				√	√
Hypersonic Aerodynamics			√	√	√	√	√	√	√				√	√
Satellite Technology			√	√	√	√	√	√			√		√	√
UAV System Design				√	√	√	√		√					√
Operations Research	PEC VII		√	√	√	√	√	√	√		√	√	√	√
Helicopter Maintenance			√	√	√	√						√		√
Smart Materials and Structures			√	√	√	√	√		√					√
Non-conventional Energy Resources			√	√	√	√	√		√				√	√

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PROGRAMME SPECIFIC OUTCOMES

1. **Strong Foundation Knowledge**
   After completing the course, the graduate will have strong basics in aeronautical sciences which will help him/her to pursue either higher studies or seek employment in aeronautical or allied fields. The strong foundation knowledge will help the graduate to become a brilliant academician, a successful engineer/scientist or even an entrepreneur.

2. **Useful Deliverables to Society**
   The graduate will have the ability to help society by way of his participation in delivering useful products and services to society through his/her work in industry, research organisation, educational institution, business organisation etc as he/she has strong basic knowledge in aeronautical engineering& ethics and is environmentally conscious.

3. **Desire to have Lifelong Learning**
   The curriculum and syllabus have been framed in such a way to impart desire to the graduate to acquire knowledge, on continuous basis even after completing the programme. This would help the graduate to excel in the line of profession he/she has chosen.

4. **Ability to work as Team Member**
   Graduate will be able to work as a team member which will be a main requirement in industry or research organisation or in any business enterprise. This will pave the way for successful career for the graduate and also play a role for the success of the organisation in which the graduate is employed.

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ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

B.E. AERONAUTICAL ENGINEERING

REGULATIONS – 2019

CHOICE BASED CREDIT SYSTEM

CURRICULA AND SYLLABI FOR I - VIII SEMESTERS

SEMESTER I

SL. No.	Course Code	Course Title	Category	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.	HS5151	Technical English	HSMC	4	0	0	4	4
2.	MA5158	Engineering Mathematics - I	BSC	3	1	0	4	4
3.	PH5151	Engineering Physics	BSC	3	0	0	3	3
4.	CY5151	Engineering Chemistry	BSC	3	0	0	3	3
5.	GE5151	Engineering Graphics	ESC	1	0	4	5	3
PRACTICALS								
6.	BS5161	Basic Sciences Laboratory	BSC	0	0	4	4	2
7.	GE5162	Workshop Practices Laboratory	ESC	0	0	4	4	2
			Total	**14**	**1**	**12**	**27**	**21**

SEMESTER II

SL. No.	Course Code	Course Title	Category	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.	HS5251	Professional Communication	HSMC	4	0	0	4	4
2.	MA5252	Engineering Mathematics II	BSC	3	1	0	4	4
3.	GE5153	Problem Solving and Python Programming	ESC	3	0	0	3	3
4.	EE5251	Basics of Electrical and Electronics Engineering	ESC	3	0	0	3	3
5.	GE5152	Engineering Mechanics	ESC	3	1	0	4	4
6.	PH5251	Materials Science	BSC	3	0	0	3	3
PRACTICALS								
7.	GE5161	Problem Solving and Python Programming Laboratory	ESC	0	0	4	4	2
8.	EE5261	Electrical and Electronics Engineering Laboratory	ESC	0	0	4	4	2
			Total	**19**	**2**	**8**	**29**	**25**

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SEMESTER III

S.No.	Course Code	Course Title	Category	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.		Elective - Humanities I	HSMC	3	0	0	3	3
2.	MA5355	Transform Techniques and Partial Differential Equations	BSC	3	1	0	4	4
3.	AE5301	Aero Engineering Thermodynamics	PCC	3	0	0	3	3
4.	AE5302	Solid Mechanics	PCC	3	0	0	3	3
5.	AE5351	Fluid Mechanics and Fluid Machines	PCC	3	0	0	3	3
6.	AE5303	Elements of Aeronautical Engineering	PCC	3	0	0	3	3
PRACTICALS								
7.	AE5311	Thermodynamics and Strength of Materials Laboratory	PCC	0	0	4	4	2
8.	AE5312	Fluid Mechanics Laboratory	PCC	0	0	2	2	1
			TOTAL	**18**	**1**	**6**	**25**	**22**

SEMESTER IV

S.No.	Course Code	Course Title	Category	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.		Elective – Humanities II	HSMC	3	0	0	3	3
2.	GE5251	Environmental Sciences	BSC	3	0	0	3	3
3.	AE5401	Low Speed Aerodynamics	PCC	3	0	0	3	3
4.	AE5402	Advanced Solid Mechanics	PCC	3	0	0	3	3
5.	AE5403	Air breathing Propulsion	PCC	3	0	0	3	3
6.	AE5404	Aircraft Performance	PCC	3	0	0	3	3
7.		Audit Course – I*	AC	3	0	0	3	0
PRACTICALS								
8.	AE5411	Aerodynamics Laboratory	PCC	0	0	4	4	2
9.	AE5412	Propulsion Laboratory	PCC	0	0	4	4	2
			Total	**21**	**0**	**8**	**29**	**22**

*****Audit Course is optional.

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SEMESTER V

S.No.	Course Code	Course Title	Category	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.	HM5503	Management Science	HSMC	3	0	0	3	3
2.	AE5501	High Speed Aerodynamics	PCC	3	0	0	3	3
3.	AE5502	Aircraft Structures	PCC	3	0	0	3	3
4.	AE5503	Rocket Propulsion	PCC	3	0	0	3	3
5.		Professional Elective I	PEC	3	0	0	3	3
6.		Audit Course – II*	AC	3	0	0	3	0
PRACTICALS								
7.	AE5511	Aircraft Structures Laboratory	PCC	0	0	4	4	2
8.	AE5512	Industrial Training/Internship**	EEC	0	0	4	4	2
			Total	**18**	**0**	**8**	**26**	**19**

***Audit Course is optional.

** The students will undergo industrial training / Internship during previous vacation

SEMESTER VI

S.No.	Course Code	Course Title	Category	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.	AE5601	Aircraft Stability and Control	PCC	3	0	0	3	3
2.	AE5602	Composite Materials and Structures	PCC	3	0	0	3	3
3.	AE5603	Computational Fluid Dynamics	PCC	3	0	0	3	3
4.		Professional Elective II	PEC	3	0	0	3	3
5.		Professional Elective III	PEC	3	0	0	3	3
6.		Open Elective I	OEC	3	0	0	3	3
PRACTICALS								
7.	AE5611	Aircraft Design Project I	PCC	0	0	4	4	2
8.	AE5612	Flight Training Laboratory	PCC	0	0	4	4	2
			Total	**18**	**0**	**8**	**26**	**22**

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SEMESTER VII

S.No.	Course Code	Course Title	Category	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.	AE5701	Finite Element Method	PCC	3	0	0	3	3
2.	AE5702	Rockets and Missiles	PCC	3	0	0	3	3
3.	AE5703	Experimental Aerodynamics	PCC	3	0	0	3	3
4.		Professional Elective IV	PEC	3	0	0	3	3
5.		Professional Elective V	PEC	3	0	0	3	3
6.		Open Elective II	OEC	3	0	0	3	3
PRACTICALS								
7.	AE5711	Aircraft Design Project II	PCC	0	0	4	4	2
8.	AE5712	Project I	EEC	0	0	6	6	3
			Total	**18**	**0**	**10**	**28**	**23**

SEMESTER VIII

S.No.	Course Code	Course Title	Category	Periods per week			Total contact periods	Credits
				L	T	P		
THEORY								
1.		Professional Elective VI	PEC	3	0	0	3	3
2.		Professional Elective VII	PEC	3	0	0	3	3
PRACTICALS								
3.	AE5811	Project II	EEC	0	0	16	16	8
			Total	**6**	**0**	**16**	**22**	**14**

TOTAL NUMBER OF CREDITS: 168

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HUMANITIES AND SOCIAL SCIENCES (HSMC) – MANAGEMENT AND OTHERS

Sl. No	Course Code	Course Title	Periods per week			Total Contact Periods	Credits
			L	T	P		
1.	HS5151	Technical English	4	0	0	4	4
2.	HS5251	Professional Communication	4	0	0	4	4
3.	HM5503	Management Science	3	0	0	3	3

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HSMC– ELECTIVES – HUMANITIES I (ODD SEMESTER)

Sl. No	Course Code	Course Title	Periods per week			Credits
			Lecture	Tutorial	Practical	
1.	HU5171	Language and Communication	3	0	0	3
2.	HU5172	Values and Ethics	3	0	0	3
3.	HU5173	Human Relations at Work	3	0	0	3
4.	HU5174	Psychological Processes	3	0	0	3
5.	HU5175	Education, Technology and Society	3	0	0	3
6.	HU5176	Philosophy	3	0	0	3
7.	HU5177	Applications of Psychology in Everyday Life	3	0	0	3

HSMC– ELECTIVES – HUMANITIES II (EVEN SEMESTER)

Sl. No	Course Code	Course Title	Periods per week			Credits
			Lecture	**Tutorial**	**Practical**	
1.	HU5271	Gender Culture and Development	3	0	0	3
2.	HU5272	Ethics and Holistic Life	3	0	0	3
3.	HU5273	Law and Engineering	3	0	0	3
4.	HU5274	Film Appreciation	3	0	0	3
5.	HU5275	Fundamentals of Language and Linguistics	3	0	0	3
6.	HU5276	Understanding Society and Culture through Literature	3	0	0	3

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BASIC SCIENCE COURSE [BSC]

Sl. No	Course Code	Course Title	Periods per week			Total Contact Periods	Credits
			L	T	P		
1.	MA5158	Engineering Mathematics - I	3	1	0	4	4
2.	PH5151	Engineering Physics	3	0	0	3	3
3.	CY5151	Engineering Chemistry	3	0	0	3	3
4.	BS5161	Basic Sciences Laboratory	0	0	4	4	2
5.	MA5252	Engineering Mathematics - II	3	1	0	4	4
6.	PH5251	Materials Science	3	0	0	3	3
7.	MA5355	Transform Techniques and Partial Differential Equations	3	1	0	4	4
8.	GE5251	Environmental Sciences	3	0	0	3	4

ENGINEERING SCIENCE COURSE [ESC]

Sl. No	Course Code	Course Title	Periods per week			Total Contact Periods	Credits
			L	T	P		
1.	GE5151	Engineering Graphics	1	0	4	5	3
2.	GE5162	Workshop Practices Laboratory	0	0	4	4	2
3.	GE5161	Problem Solving and Python programming	3	0	0	3	3
4.	EE5251	Basics of Electrical and Electronics Engineering	3	0	0	3	3
5.	GE5152	Engineering Mechanics	3	1	0	4	4
6.	EE5261	Electrical and Electronics Engineering Laboratory	0	0	4	4	2
7.	GE5161	Problem Solving and Python Programming Laboratory	0	0	4	4	2

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

Sl. No	Course Code	Course Title	Periods per week			Total Contact Periods	Credits
			L	T	P		
1.	AD5091	Constitution of India	3	0	0	3	0
2.	AD5092	Value Education	3	0	0	3	0
3.	AD5093	Pedagogy Studies	3	0	0	3	0
4.	AD5094	Stress Management by Yoga	3	0	0	3	0
5.	AD5095	Personality Development Through Life Enlightenment Skills	3	0	0	3	0
6.	AD5096	Unnat Bharat Abhiyan	3	0	0	3	0
7.	AD5097	Essence of Indian Knowledge Tradition	3	0	0	3	0
8.	AD5098	Sanga Tamil Literature Appreciation	3	0	0	3	0

Attested

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PROFESSIONAL CORE COURSES [PCC]

Sl. No	Course Code	Course Title	Periods per week			Credits	Semester
			Lecture	Tutorial	Practical		
1	AE5301	Aero Engineering Thermodynamics	3	0	0	3	3
2	AE5302	Solid Mechanics	3	0	0	3	3
3	AE5351	Fluid Mechanics and Fluid Machines	3	0	0	3	3
4	AE5303	Elements of Aeronautical Engineering	3	0	0	3	3
5	AE5311	Thermodynamics and Strength of Materials Laboratory	0	0	4	4	3
6	AE5312	Fluid Mechanics Laboratory	0	0	2	1	3
7	AE5401	Low Speed Aerodynamics	3	0	0	3	4
8	AE5402	Advanced Solid Mechanics	3	0	0	3	4
9	AE5403	Air breathing Propulsion	3	0	0	3	4
10	AE5404	Aircraft Performance	3	0	0	3	4
11	AE5411	Aerodynamics Laboratory	0	0	4	2	4
12	AE5412	Propulsion Laboratory	0	0	4	2	4
13	AE5501	High Speed Aerodynamics	3	0	0	3	5
14	AE5502	Aircraft Structures	3	0	0	3	5
15	AE5503	Rocket Propulsion	3	0	0	3	5
16	AE5511	Aircraft Structures Laboratory	0	0	4	2	5
17	AE5601	Aircraft Stability and Control	3	0	0	3	6
18	AE5602	Composite Materials and Structures	3	0	0	3	6
19	AE5603	Computational Fluid Dynamics	3	0	0	3	6
20	AE5611	Aircraft Design Project I	0	0	4	2	6
21	AE5612	Flight Training Laboratory	0	0	4	2	6
22	AE5701	Finite Element Method	3	0	0	3	7
23	AE5702	Rockets and Missiles	3	0	0	3	7
24	AE5703	Experimental Aerodynamics	3	0	0	3	7
25	AE5711	Aircraft Design Project II	0	0	4	2	7

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PROFESSIONAL ELECTIVES COURSES

SEMESTER V, ELECTIVE – I

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1.	AE5001	Aircraft Rules and Regulations CAR I & II	PEC	3	0	0	3	3
2.	AE5002	Elements of Heat Transfer	PEC	3	0	0	3	3
3.	AE5003	Experimental Stress Analysis	PEC	3	0	0	3	3
4.	ME5452	Mechanics of Machines	PEC	3	0	0	3	3
5.	AE5004	Wind Engineering	PEC	3	0	0	3	3

SEMESTER VI, ELECTIVE – II

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1.	AE5005	Aircraft Engine Repairs and Maintenance	PEC	3	0	0	3	3
2.	AE5006	Boundary Layer Theory	PEC	3	0	0	3	3
3.	AE5007	Design of Gas Turbine Engine Components	PEC	3	0	0	3	3
4.	ME5251	Manufacturing Processes	PEC	3	0	0	3	3
5.	AE5008	Theory of Elasticity	PEC	3	0	0	3	3

SEMESTER VI, ELECTIVE – III

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1.	AE5009	Advanced Aerospace Materials	PEC	3	0	0	3	3
2.	AE5010	Aircraft Design	PEC	3	0	0	3	3
3.	AE5011	Fundamentals of Control Engineering	PEC	3	0	0	3	3
4.	AE5012	Theory of Vibration	PEC	3	0	0	3	3
5.	AE5013	Principles and Applications of Total Quality Management	PEC	3	0	0	3	3

SEMESTER VII, ELECTIVE – IV

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1.	AE5014	Airframe Repair and Maintenance	PEC	3	0	0	3	3
2.	AE5015	Aero Elasticity	PEC	3	0	0	3	3
3.	AE5016	Missile Aerodynamics	PEC	3	0	0	3	3
4.	AE5017	Numerical Heat Transfer	PEC	3	0	0	3	3
5.	AE5018	Structural Dynamics	PEC	3	0	0	3	3

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SEMESTER VII, ELECTIVE – V

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1.	AE5071	Aircraft Systems Engineering	PEC	3	0	0	3	3
2.	AE5072	Avionics Systems	PEC	3	0	0	3	3
3.	AE5019	Fatigue and Fracture Mechanics	PEC	3	0	0	3	3
4.	AE5020	Helicopter Engineering	PEC	3	0	0	3	3
5.	AE5021	Space Mechanics	PEC	3	0	0	3	3

SEMESTER VIII, ELECTIVE – VI

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1.	AE5022	Approximate Methods in Structural Mechanics	PEC	3	0	0	3	3
2.	AE5023	Combustion in Aerospace Vehicles	PEC	3	0	0	3	3
3.	AE5024	Hypersonic Aerodynamics	PEC	3	0	0	3	3
4.	AE5025	Satellite Technology	PEC	3	0	0	3	3
5.	AE5026	UAV System Design	PEC	3	0	0	3	3

SEMESTER VIII, ELECTIVE – VII

Sl. No.	Course Code	Course Title	Category	Periods Per week			Total Contact Periods	Credits
				L	T	P		
1.	IE5552	Operations Research	PEC	3	0	0	3	3
2.	AE5027	Helicopter Maintenance	PEC	3	0	0	3	3
3.	AE5028	Smart Materials and Structures	PEC	3	0	0	3	3
4.	AE5029	Non-conventional Energy Resources	PEC	3	0	0	3	3

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

Sl. No.	Course Code	Course Title	Periods per week			Credits	Semester
			Lecture	Tutorial	Practical		
1	AE5512	Industrial Training / Internship*	0	0	4	2	5
2	AE5712	Project I	0	0	6	3	7
3	AE5811	Project II	0	0	16	8	8

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SUMMARY

B.E.(AERONAUTICAL ENGINEERING)										
Sl.No	Subject Area	Credits per Semester								Credits Total
		I	II	III	IV	V	VI	VII	VIII	
1	HSMC	4	4	3	3	3	-	-	-	17
2	BSC	12	7	4	3	0	-	-	-	23
3	ESC	5	14	-	-	0	-	-	-	19
4	PCC	-	-	15	16	11	13	11		66
5	PEC	-	-	-	-	3	6	6	6	21
6	OEC	-	-	-	-	0	3	3	-	6
7	EEC	-	-	-	-	2	0	3	8	13
8	AC	-	-	-	-	0	0	-	-	0
	Total	**21**	**25**	**22**	**22**	**19**	**22**	**23**	**14**	**168**

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HS5151 **TECHNICAL ENGLISH** **L T P C**
4 0 0 4

COURSE OBJECTIVES:

The first semester English course entitled 'Technical English' aims to,

- Familiarise first year students of engineering and technology with the fundamental aspects of technical English.
- Develop all the four language skills by giving sufficient practice in the use of the skills in real life contexts.
- Enhance the linguistic and communicative competence of first year engineering and technology students.

UNIT I INTRODUCING ONESELF 12

Listening: Listening and filling a form, listening to speeches by specialists from various branches of engineering and completing activities such as answering questions, identifying the main ideas of the listening text, style of the speaker (tone and tenor) – **Speaking**: Introducing oneself –introducing friend/ family - **Reading:** Descriptive passages (from newspapers / magazines)- **Writing**: Writing a paragraph (native place, school life)- **Grammar:** Simple present, present continuous – **Vocabulary Development**: One word substitution

UNIT II DIALOGUE WRITING 12

Listening: Listening to conversations (asking for and giving directions) –**Speaking:** making conversation using (asking for directions, making an enquiry), Role plays-dialogues- **Reading:** Reading a print interview and answering comprehension questions-**Writing**: Writing a checklist, Dialogue writing- **Grammar**: Simple past – question formation (Wh- questions, Yes or No questions, Tag questions) - **Vocabulary Development**: Stress shift, lexical items related to the theme of the given unit.

UNIT III FORMAL LETTER WRITING 12

Listening: Listening to speeches by famous people and identifying the central message of the speech – answering multiple-choice questions)-**Speaking:** Giving short talks on a given topic-**Reading:** Reading motivational essays on famous engineers and technologists (answering open-ended and closed questions)- **Writing:** Writing formal letters/ emails (Complaint letters)-**Grammar**: Future Tense forms of verbs, subject and verb agreement-**Vocabulary Development**: Collocations – Fixed expressions

UNIT IV WRITING COMPLAINT LETTERS 12

Listening: Listening to short talks (5 minutes duration and fill a table, gap-filling exercise) note taking/note making- **Speaking:** Small group discussion, giving recommendations-**Reading:** Reading problem – solution articles/essays drawn from various sources- **Writing:** Making recommendations – Writing a letter/ sending an email to the Editor- note making- **Grammar:** Modals – Phrasal verbs – cause and effect sentences- **Vocabulary Development**: Connectives, use of cohesive devices in writing, technical vocabulary.

UNIT V WRITING DEFINITIONS AND PRODUCT DESCRIPTION 12

Listening: Listening to a product description (labeling and gap filling) exercises- **Speaking:** Describing a product and comparing and contrasting it with other products- **Reading**: Reading graphical material for comparison (advertisements)-**Writing:** Writing Definitions (short and long) – compare and contrast paragraphs- **Grammar:** Adjectives – Degrees of comparison - compound nouns- **Vocabulary Development**: Use of discourse markers – suffixes (adjectival endings).

Attested

TOTAL : 60 PERIODS

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LEARNING OUTCOMES

At the end of the course the students will have gained,

- Exposure to basic aspects of technical English.
- The confidence to communicate effectively I various academic situations.
- Learnt the use of basic features of Technical English.

TEXT BOOK:

1. Revised Edition of 'English for Engineers and Technologists' Volume 1 published by Orient Black Swan Limited 2019.

ASSESSMENT PATTERN

- Assessments will assess all the four skills through both pen and paper and computer based tests.
- Assessments can be pen and paper based, quizzes.

MA5158	ENGINEERING MATHEMATICS – I (Common to all branches of B.E. / B.Tech. Programmes in I Semester)	L 3	T 1	P 0	C 4

COURSE OBJECTIVES:

- To develop the use of matrix algebra techniques that is needed by engineers for practical applications.
- To familiarize the students with differential calculus.
- To familiarize the student with functions of several variables. This is needed in many branches of engineering.
- To make the students understand various techniques of integration.
- To acquaint the student with mathematical tools needed in evaluating multiple integrals and their applications.

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 DIFFERENTIAL CALCULUS 12

Limit of function – One sided limit – Limit Laws – Continuity – left and right continuity – types of discontinuities – Intermediate Value Theorem – Derivatives of a function - Differentiation rules – Chain rule – Implicit differentiation – logarithmic differentiation – Maxima and minima – Mean value theorem – (Optional: Polar coordinate system – Differentiation in polar coordinates).

UNIT III 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 IV 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 V 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.

TOTAL :60 PERIODS

COURSE OUTCOMES:

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

- Use the matrix algebra methods for solving practical problems.
- Apply differential calculus tools in solving various application problems.
- Able to use differential calculus ideas on several variable functions.
- Apply different methods of integration in solving practical problems.
- Apply multiple integral ideas in solving areas, volumes and other practical problems.

TEXT BOOKS:

1. Grewal B.S., “Higher Engineering Mathematics”, Khanna Publishers, 44th Edition, New Delhi, 2017.
2. James Stewart, "Calculus with Early Transcendental Functions", Cengage Learning, 6th Edition, New Delhi,2013.
3. Joel Hass, Christopher Heil and Maurice D.Weir, "Thomas' Calculus", Pearson, 14th Edition, New Delhi, 2018.
4. Narayanan S. and Manicavachagom Pillai T. K., “Calculus" Volume I and II, S. Viswanathan Publishers Pvt. Ltd., Chennai, 2009.

REFERENCES:

1. Bali N., Goyal M. and Watkins C., “Advanced Engineering Mathematics”, Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), 7th Edition, New Delhi, 2009.
2. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2015.
3. Greenberg M.D., “Advanced Engineering Mathematics”, Pearson Education2nd Edition, 5th Reprint, Delhi, 2009.
4. Jain R.K. and Iyengar S.R.K., “Advanced Engineering Mathematics”,Narosa Publications, 5th Edition, New Delhi, 2017.
5. Peter V.O’Neil, “Advanced Engineering Mathematics”, Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi , 2012.
6. Ramana B.V., “Higher Engineering Mathematics”, Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

PH5151	ENGINEERING PHYSICS	L T P C
	(Common to all branches of B.E / B.Tech programmes)	3 0 0 3

COURSE OBJECTIVES:

- To make the students in understanding the importance of mechanics.
- To equip the students on the knowledge of electromagnetic waves.
- To introduce the basics of oscillations, optics and lasers.
- To enable the students in understanding the importance of quantum physics.
- To elucidate the application of quantum mechanics towards the formation of energy bands in crystalline materials.

UNIT I MECHANICS 9

Moment of inertia (M.I) - Radius of gyration - Theorems of M .I - M.I of circular disc, solid cylinder , hollow cylinder , solid sphere and hollow sphere - K.E of a rotating body – M.I of a diatomic molecule – Rotational energy state of a rigid diatomic molecule - centre of mass – conservation of linear momentum – Relation between Torque and angular momentum - Torsional pendulum.

UNIT II ELECTROMAGNETIC WAVES 9

Gauss's law – Faraday's law - Ampere's law - The Maxwell's equations - wave equation; Plane electromagnetic waves in vacuum, Conditions on the wave field - properties of electromagnetic waves: speed, amplitude, phase, orientation and waves in matter - polarization - Producing electromagnetic waves - Energy and momentum in EM waves: Intensity, waves from localized sources, momentum and radiation pressure - Cell-phone reception. Reflection and transmission of electromagnetic waves from a non-conducting medium-vacuum interface for normal incidence.

UNIT III OSCILLATIONS, OPTICS AND LASERS 9

Simple harmonic motion - resonance - waves on a string - standing waves - traveling waves - Energy transfer of a wave - sound waves - Doppler effect - reflection and refraction of light waves - total internal reflection - interference - interferometers - air wedge experiment. Theory of laser - characteristics - Spontaneous and stimulated emission - Einstein's coefficients - population inversion - Nd-YAG laser, CO_2 laser, semiconductor laser - applications.

UNIT IV BASIC QUANTUM MECHANICS 9

Photons and light waves - Electrons and matter waves - The Schrodinger equation (Time dependent and time independent forms) - meaning of wave function - Normalization - Particle in a infinite potential well - Normalization, probabilities and the correspondence principle.

UNIT V APPLIED QUANTUM MECHANICS 9

The harmonic oscillator - Barrier penetration and quantum tunneling - Tunneling microscope - Resonant diode - Finite potential wells - particle in a three dimensional box - Bloch's theorem for particles in a periodic potential, Kronig-Penney model and origin of energy bands.

TOTAL: 45 PERIODS

COURSE OUTCOMES

After completion of this course, the students should able to

- Understanding the importance of mechanics.
- Express the knowledge of electromagnetic waves.
- Know the basics of oscillations, optics and lasers.
- Understanding the importance of quantum physics.
- Apply quantum mechanical principles towards the formation of energy bands in crystalline materials.

TEXT BOOKS

1. D.Kleppner and R.Kolenkow. An Introduction to Mechanics. McGraw Hill Education, 2017.
2. D.Halliday, R.Resnick and J.Walker. Principles of Physics. John Wiley & Sons, 2015.
3. N.Garcia, A.Damask and S.Schwarz. Physics for Computer Science Students. Springer-Verlag, 2012.

REFERENCES

1. R.Wolfson. Essential University Physics. Volume 1 & 2. Pearson, 2016.
2. D.J.Griffiths. Introduction to Electrodynamics. Pearson Education, 2015
3. K.Thyagarajan and A.Ghatak. Lasers: Fundamentals and Applications. Springer, 2012.

CY5151 ENGINEERING CHEMISTRY (COMMON TO ALL BRANCHES) **L T P C 3 0 0 3**

COURSE OBJECTIVES:

- To introduce the basic concepts of polymers, their properties and some of the important applications.
- To impart knowledge on the basic principles and preparatory methods of nanomaterials.
- To facilitate the understanding of the laws of photochemistry, photoprocesses and instrumentation & applications of spectroscopic techniques.
- To familiarize the operating principles and applications of energy conversion, its processes and storage devices.
- To inculcate sound understanding of water quality parameters and water treatment techniques.

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. Structure, Properties and uses of: PE, PVC, PC, PTFE, PP, Nylon 6, Nylon 66, Bakelite, Epoxy; Conducting polymers – polyaniline and polypyrrole.

UNIT II NANOCHEMISTRY 9

Basics-distinction between molecules, nanomaterials and bulk materials; size-dependent properties. Types –nanoparticle, nanocluster, nanorod, nanowire and nanotube. Preparation of nanomaterials: sol-gel, solvothermal, laser ablation, chemical vapour deposition, electrochemical deposition and electro spinning. Characterization - Scanning Electron Microscope and Transmission Electron Microscope - Principle and instrumentation (block diagram). Properties (optical, electrical, mechanical and magnetic) and Applications of nanomaterials - medicine, agriculture, electronics and catalysis.

UNIT III PHOTOCHEMISTRY AND SPECTROSCOPY 9

Photochemistry: Laws of photochemistry - Grotthuss-Draper law, Stark-Einstein law and Lambert-Beer Law (derivation and problems). Photo physical processes – Jablonski diagram. Chemiluminescence, photo-sensitization and photoquenching – mechanism and examples. Spectroscopy: Electromagnetic spectrum - absorption of radiation - electronic, vibrational and rotational transitions. Width and intensities of spectral lines. Atomic absorption spectroscopy, UV-Vis and IR spectroscopy- principles, instrumentation (Block diagram) and applications.

UNIT IV ENERGY CONVERSIONS AND STORAGE 9

Nuclear fission - controlled nuclear fission - nuclear fusion - differences between nuclear fission and fusion - nuclear chain reactions - nuclear energy - light water nuclear power plant – fast breeder reactor. Solar energy conversion - solar cells. Wind energy. Batteries - types of batteries – primary battery (dry cell), secondary battery (lead acid, nickel-cadmium and lithium-ion-battery). Fuel cells – H_2-O_2 and microbial fuel cell. Explosives – classification, examples: TNT, RDX, Dynamite; Rocket fuels and propellants – definition and uses.

UNIT V WATER TECHNOLOGY 9

Water – sources and impurities – water quality parameters: colour, odour, pH, hardness, alkalinity, TDS, COD and BOD. Boiler feed water – requirement – troubles (scale & sludge, caustic embrittlement, boiler corrosion and priming & foaming. Internal conditioning – phosphate, calgon and carbonate treatment. External conditioning - zeolite (permutit) and ion exchange demineralization. Municipal water treatment process – primary (screening, sedimentation and coagulation), secondary (activated sludge process and trickling filter process) and tertiary (ozonolysis, UV treatment, chlorination, reverse osmosis).

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- To recognize and apply basic knowledge on different types of polymeric materials, their general preparation methods and applications to futuristic material fabrication needs.
- To identify and apply basic concepts of nanoscience and nanotechnology in designing the synthesis of nanomaterials for engineering and technology applications.
- To identify and apply suitable spectroscopic technique for material analysis and study different forms of photochemical reactions.
- To recognize different forms of energy resources and apply them for suitable applications in energy sectors.
- To demonstrate the knowledge of water and their quality in using at different industries.

TEXT BOOKS:

1. Jain P. C. & Monica Jain., “Engineering Chemistry”, 16th Edition, Dhanpat Rai Publishing Company (P) Ltd, New Delhi, 2015.
2. Sivasankar B., “Engineering Chemistry”, Tata McGraw-Hill Publishing Company Ltd, New Delhi, 2012.
3. S.S.Dara, “A text book of Engineering Chemistry”, Chand Publications, 2014.

REFERENCES:

1. Schdeva M V, “Basics of Nano Chemistry”, Anmol Publications Pvt Ltd
2. B.Sivasankar, “Instrumental Methods of Analysis”, Oxford University Press. 2012.
3. Friedrich Emich, “Engineering Chemistry”, Scientific International Ltd.
4. V RGowariker, N V Viswanathan and Jayadev Sreedhar, “Polymer Science” New AGE International Publishers, 2009.

GE5151 **ENGINEERING GRAPHICS** **L T P C**
1 0 4 3

COURSE OBJECTIVES:

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

1. Drawing free hand sketches of basic geometrical shapes and multiple views of objects.
2. Drawing orthographic projections of lines and planes.
3. Drawing orthographic projections of solids.
4. Drawing development of the surfaces of objects.
5. Drawing isometric and perspective views of simple solids.

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 different methods – 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 **15**

Orthographic projection- principles-Principle 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 **15**

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 **15**

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 **12**

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

TOTAL (L: 15 + P: 60)=75 PERIODS

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COURSE OUTCOMES:

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

1. Draw free hand sketching of basic geometrical shapes and multiple views of objects.
2. Draw orthographic projections of lines and planes
3. Draw orthographic projections of solids
4. Draw development of the surfaces of objects
5. Draw isometric and perspective views of simple solids.

TEXT BOOKS:

1. Bhatt, N. D.,Panchal V M and Pramod R. Ingle, "Engineering Drawing", Charotar Publishing House, 53rd Edition, 2014.
2. Parthasarathy, N. S. and Vela Murali, "Engineering Drawing", Oxford University Press, 2015

REFERENCES:

1. Agrawal, B. and Agrawal C.M., "Engineering Drawing", Tata McGraw, N.Delhi, 2008.
2. Gopalakrishna, K. R., "Engineering Drawing", Subhas Stores, Bangalore, 2007.
3. Natarajan, K. V., "A text book of Engineering Graphics", 28thEd., Dhanalakshmi Publishers, Chennai, 2015.
4. Shah, M. B., and Rana, B. C., "Engineering Drawing", Pearson, 2ndEd., 2009.
5. Venugopal, K. and Prabhu Raja, V., "Engineering Graphics", New Age,2008.

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.
4. The students will be permitted to use appropriate scale to fit solution within A3 size.
5. The examination will be conducted in appropriate sessions on the same day.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9				0.9					0.6		0.6	0.6	0.9	0.6
2	0.9									0.6		0.6	0.6	0.6	
3	0.9				0.9					0.6		0.6	0.6	0.6	
4	0.9		0.6		0.9					0.6		0.6	0.6	0.6	
5	0.9		0.9		0.9					0.6		0.6	0.6	0.6	

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BS5161	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)

COURSE OBJECTIVES:

- 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 and band gap determination.

LIST OF EXPERIMENTS

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. Photoelectric effect
14. Michelson Interferometer.
15. Estimation of laser parameters.
16. Melde's string experiment

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, the students will be able

- 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

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

COURSE OBJECTIVES:

- To inculcate experimental skills to test basic understanding of water quality parameters, such as, acidity, alkalinity, hardness, DO, chloride and copper.
- To induce the students to familiarize with electroanalytical techniques such as, pH metry, potentiometry and conductometry in the determination of impurities in aqueous solutions.
- To demonstrate the analysis of metals and polymers by spectroscopy and viscometry methods.

LIST OF EXPERIMENTS:

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 polyvinylalcohol using Ostwald viscometer.
12. Pseudo first order kinetics-ester hydrolysis.
13. Corrosion experiment-weight loss method.
14. Phase change in a solid.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

- To analyse the quality of water samples with respect to their acidity, alkalinity, hardness and DO.
- To determine the amount of metal ions through volumetric and spectroscopic techniques
- To determine the molecular weight of polymers by viscometric method.
- To quantitatively analyse the impurities in solution by electroanalytical techniques
- To design and analyse the kinetics of reactions and corrosion of metals

TEXT BOOKS:

1. Laboratory Manual- Department of Chemistry, CEGC, Anna University (2014).
2. Vogel‟s Textbook of Quantitative Chemical Analysis (8th edition, 2014).

GE5162	WORKSHOP PRACTICES LABORATORY	L	T	P	C
	(Common to all Branches of B.E. / B.Tech. Programmes)	0	0	4	2

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

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

GROUP – A (CIVIL & ELECTRICAL)

PART I CIVIL ENGINEERING PRACTICES 15

PLUMBING WORK:

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

WOOD WORK:

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

Wood Work Study:

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

PART II ELECTRICAL ENGINEERING PRACTICES 15

WIRING WORK:

a) Wiring Switches, Fuse, Indicator and Lamp etc. such as in basic household,
b) Wiring Stair case light.
c) Wiring tube – light.
d) Preparing wiring diagrams for a given situation.

Wiring Study:

a) Studying an Iron-Box wiring.
b) Studying a Fan Regulator wiring.
c) Studying an Emergency Lamp wiring.

GROUP – B (MECHANICAL AND ELECTRONICS)

PART III MECHANICAL ENGINEERING PRACTICES 15

WELDING WORK:

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

BASIC MACHINING WORK:

a) (simple)Turning.
b) (simple)Drilling.
c) (simple)Tapping.

ASSEMBLY WORK:

a) Assembling a centrifugal pump.
b) Assembling a household mixer.
c) Assembling an air conditioner.

SHEET METAL WORK:

a) Making of a square tray

FOUNDRY WORK:

a) Demonstrating basic foundry operations.

PART IV ELECTRONIC ENGINEERING PRACTICES 15

SOLDERING WORK:

a) Soldering simple electronic circuits and checking continuity.

ELECTRONIC ASSEMBLY AND TESTING WORK:

a) Assembling and testing electronic components on a small PCB.

ELECTRONIC EQUIPMENT STUDY:

a) Studying a FM radio.
b) Studying an electronic telephone.

TOTAL = 60 PERIODS

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

1. Draw pipe line plan; lay and connect various pipe fittings used in common household plumbing work; Saw; plan; make joints in wood materials used in common household wood work.
2. Wire various electrical joints in common household electrical wire work.
3. Weld various joints in steel plates using arc welding work; Machine various simple processes like turning, drilling, tapping in parts; Assemble simple mechanical assembly of common household equipments; Make a tray out of metal sheet using sheet metal work.
4. Solder and test simple electronic circuits; Assemble and test simple electronic components on PCB.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.6	0.3											0.3	0.3	
2		0.6	0.6											0.6	
3		0.6	0.3										0.6	0.6	
4		0.6	0.6	0.3										0.6	

HS5251 PROFESSIONAL COMMUNICATION L T P C
4 0 0 4

COURSE OBJECTIVES

The course entitles 'Professional Communication' aims to,

- Improve the relevant language skills necessary for professional communication.
- Develop linguistic and strategic competence in workplace context.
- Enhance language proficiency and thereby the employability of budding engineers and technologists.

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UNIT I TECHNICAL COMMUNICATION 12

Listening: Listening to telephone conversations (intent of the speaker and note taking exercises)-Speaking: Role play exercises based on workplace contexts, introducing oneself-Reading: Reading the interview of an achiever and completing exercises (skimming, scanning and predicting)- Writing: Writing a short biography of an achiever based on given hints-Grammar: Asking and answering questions, punctuation in writing, prepositional phrases-Vocabulary Development: use of adjectives.

UNIT II SUMMARY WRITING 12

Listening: Listening to talks/lectures both general and technical and summarizing the main points- Speaking: Participating in debates- Reading: Reading technical essays/ articles and answering comprehension questions-Writing: Summary writing-Grammar: Participle forms, relative clauses- Vocabulary Development: Use of compound words, abbreviations and acronyms.

UNIT III PROCESS DESCRIPTION 12

Listening: Listening to a process description and drawing a flowchart-Speaking: Participating in Group Discussions, giving instructions- Reading: Reading instruction manuals- Writing: Writing process descriptions- Writing instructions- Grammar: Use of imperatives, active and passive voice, sequence words- Vocabulary Development: Technical jargon

UNIT IV REPORT WRITING 12

Listening: Listening to a presentation and completing gap-filling exercises- Speaking: Making formal presentations- Reading: Reading and interpreting charts/tables and diagrams- Writing: Interpreting charts/tables and diagrams, writing a report- Grammar: Direct into indirect speech, use of phrases- Vocabulary Development: reporting words

UNIT V WRITING JOB APPLICATIONS 12

Listening: Listening to a job interview and completing gap=filling exercises- Speaking: Mock interview, telephone interviews- Reading: Reading a job interview, SOP, company profile and completing comprehension exercises- Writing: job applications and resumes and SOPs-Grammar: Present perfect and continuous tenses- Vocabulary Development: Technical vocabulary.

TOTAL : 60 PERIODS

LEARNING OUTCOMES

At the end of the second semester the learners should be able to,

- Read and comprehend technical texts effortlessly.
- Write reports of a technical kind.
- Speak with confidence in interviews and thereby gain employability

TEXT BOOK

1. Revised Edition of 'English for Engineers and Technologists' Volume 1 published by Orient Black Swan Limited 2019.

ASSESSMENT PATTERN

- Assessments will assess all the four skills through both pen and paper and computer based tests.
- Assessments can be pen and paper based, quizzes.

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MA5252	ENGINEERING MATHEMATICS – II (Common to all branches of B.E. / B.Tech. Programmes in II Semester)	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

- To acquaint the students with the concepts of vector calculus which naturally arises in many engineering problems.
- To develop an understanding of the standard techniques of complex variable theory in particular analytic function and its mapping property.
- To familiarize the students with complex integration techniques and contour integration techniques which can be used in real integrals.
- To acquaint the students with Differential Equations which are significantly used in Engineering problems.
- To make the students appreciate the purpose of using transforms to create a new domain in which it is easier to handle the problem that is being investigated.

UNIT I VECTOR CALCULUS **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 theorem, Stoke's theorem and Gauss divergence theorem – Verification and application in evaluating line, surface and volume integrals.

UNIT II ANALYTIC FUNCTION **12**

Analytic functions – Necessary and sufficient conditions for analyticity - Properties – Harmonic conjugates – Construction of analytic function - Conformal mapping – Mapping by functions - Bilinear transformation $w = c + z,\ az,\ 1/z,\ z^2$.

UNIT III 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 IV DIFFERENTIAL EQUATIONS **12**

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

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

COURSE OUTCOMES:

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

- Calculate grad, div and curl and use Gauss, Stokes and Greens theorems to simplify calculations of integrals.
- Construct analytic functions and use their conformal mapping property in application problems.
- Evaluate real and complex integrals using the Cauchy's integral formula and residue theorem.
- Apply various methods of solving differential equation which arise in many application problems.
- Apply Laplace transform methods for solving linear differential equations.

TEXT BOOKS:

1. Erwin Kreyszig, "Advanced Engineering Mathematics", John Wiley and Sons, 10th Edition, New Delhi, 2015.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, New Delhi, 2017.

REFERENCES:

1. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), 7th Edition, New Delhi, 2009.
2. Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, 4th Edition, New Delhi, 2011.
3. Jain R.K. and Iyengar S.R.K., "Advanced Engineering Mathematics", Narosa Publications, 5th Edition, New Delhi, 2017.
4. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi, 2012.
5. Ramana B.V., "Higher Engineering Mathematics", Tata McGraw Hill Co. Ltd., 11th Reprint, New Delhi, 2010.

GE5153 PROBLEM SOLVING AND PYTHON PROGRAMMING L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I INTRODUCTION TO COMPUTING AND PROBLEM SOLVING 9

Fundamentals of Computing – Computing Devices – Identification of Computational Problems – Pseudocodes and Flowcharts – Instructions – Algorithms – Building Blocks of Algorithms – Introduction to Python Programming – Python Interpreter and Interactive Mode – Variables and Identifiers – Arithmetic Operators– Values and Types – Statements.

SUGGESTED ACTIVITIES:

- Developing Pseudocodes and flowcharts for real life activities such as railway ticket booking using IRCTC, admission process to undergraduate course, academic schedules during a semester etc.
- Developing algorithms for basic mathematical expressions using arithmetic operations.
- Installing Python.
- Simple programs on print statements, arithmetic operations.

SUGGESTED EVALUATION METHODS:

- Assignments on pseudocodes and flowcharts.
- Tutorials on Python programs.

UNIT II CONDITIONALS AND FUNCTIONS 9

Operators – Boolean Values – Operator Precedence – Expression – Conditionals: If-Else Constructs – Loop Structures/Iterative Statements – While Loop – For Loop – Break Statement – Function Call and Returning Values – Parameter Passing – Local and Global Scope – Recursive Functions.

SUGGESTED ACTIVITIES:

- Simple Python program implementation using Operators, Conditionals, Iterative Constructs and Functions.
- Implementation of a simple calculator.
- Developing simple applications like calendar, phone directory, to-do lists etc.
- Flow charts for GCD, Exponent Functions, Fibonacci Series using conditionals and iterative statements.
- External learning - Recursion vs. Iteration.

SUGGESTED EVALUATION METHODS:

- Tutorials on the above activities.
- Group discussion on external learning.

UNIT III SIMPLE DATA STRUCTURES IN PYTHON 10

Introduction to Data Structures – List – Adding Items to a List – Finding and Updating an Item – Nested Lists – Cloning Lists – Looping Through a List – Sorting a List – List Concatenation – List Slices – List Methods – List Loop – Mutability – Aliasing – Tuples: Creation, Accessing, Updating, Deleting Elements in a Tuple, Tuple Assignment, Tuple as Return Value, Nested Tuples, Basic Tuple Operations – Sets.

SUGGESTED ACTIVITIES:

- Implementing python program using lists, tuples, sets for the following scenario:
  - Simple sorting techniques
  - Student Examination Report
  - Billing Scheme during shopping.
- External learning - List vs. Tuple vs. Set – Implementing any application using all the three data structures.

SUGGESTED EVALUATION METHODS:

- Tutorials on the above activities.
- Group Discussion on external learning component.

UNIT IV STRINGS, DICTIONARIES, MODULES 10

Strings: Introduction, Indexing, Traversing, Concatenating, Appending, Multiplying, Formatting, Slicing, Comparing, Iterating – Basic Built-In String Functions – Dictionary: Creating, Accessing, Adding Items, Modifying, Deleting, Sorting, Looping, Nested Dictionaries Built-in Dictionary Function – Finding Key and Value in a Dictionary – Modules – Module Loading and Execution – Packages – Python Standard Libraries.

SUGGESTED ACTIVITIES:

- Implementing Python program by importing Time module, Math package etc.
- Creation of any package (student's choice) and importing into the application.

SUGGESTED EVALUATION METHODS:

- Tutorials on the above activities.

UNIT V FILE HANDLING AND EXCEPTION HANDLING 7

Introduction to Files – File Path – Opening and Closing Files – Reading and Writing Files – File Position – Exception: Errors and Exceptions, Exception Handling, Multiple Exceptions.

SUGGESTED ACTIVITIES:

- Developing modules using Python to handle files and apply various operations on files.
- Usage of exceptions, multiple except blocks - for applications that use delimiters like age, range of numerals etc.
- Implementing Python program to open a non-existent file using exceptions.

SUGGESTED EVALUATION METHODS:

- Tutorials on the above activities.
- Case Studies.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓									✓
CO2	✓		✓		✓							✓
CO3	✓	✓	✓									✓
CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
CO6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

TEXT BOOKS:

1. Reema Thareja, “Python Programming: Using Problem Solving Approach”, Oxford University Press, 2017.
2. Allen B. Downey, “Think Python: How to Think Like a Computer Scientist”, Second Edition, Shroff/O‘Reilly Publishers, 2016. (http://greenteapress.com/wp/thinkpython/).

REFERENCES:

1. Guido van Rossum, Fred L. Drake Jr., “An Introduction to Python – Revised and Updated for Python 3.2”, Network Theory Ltd., 2011.
2. John V Guttag, “Introduction to Computation and Programming Using Python”, Revised and Expanded Edition, MIT Press , 2013
3. Charles Dierbach, “Introduction to Computer Science using Python”, Wiley India Edition, 2016.
4. Timothy A. Budd, “Exploring Python”, Mc-Graw Hill Education (India) Private Ltd., 2015.
5. Kenneth A. Lambert, “Fundamentals of Python: First Programs”, Cengage Learning, 2012.

EE5251 BASICS OF ELECTRICAL AND ELECTRONICS ENGINEERING **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- To understand the basic concepts of electric circuits, magnetic circuits and wiring.
- To understand the operation of AC and DC machines.
- To understand the working principle of electronic devices and circuits.

UNIT I BASIC CIRCUITS AND DOMESTIC WIRING **9**

Electrical circuit elements (R, L and C)-Dependent and independent sources – Ohm's Law-Kirchhoff's laws - mesh current and node voltage methods (Analysis with only independent source) - Phasors – RMS-Average values-sinusoidal steady state response of simple RLC circuits. Types of wiring- Domestic wiring - Specification of Wires-Earthing-Methods-Protective devices.

UNIT II THREE PHASE CIRCUITS AND MAGNETIC CIRCUITS **9**

Three phase supply – Star connection – Delta connection –Balanced and Unbalanced Loads-Power in three-phase systems – Comparison of star and delta connections – Advantages-Magnetic circuits-Definitions-MMF, Flux, Reluctance, Magnetic field intensity, Flux density, Fringing, self and mutual inductances-simple problems.

UNIT III ELECTRICAL MACHINES **9**

Working principle of DC generator, motor-EMF and Torque equation-Types –Shunt, Series and Compound-Applications. Working principle of transformer-EMF equation-Operating principles of three phase and single phase induction motor-Applications. Working principles of alternator-EMF equation-Operating principles of Synchronous motor, stepper motor-Applications.

UNIT IV BASICS OF ELECTRONICS **9**

Intrinsic semiconductors, Extrinsic semiconductors – P-type and N-type, P-N junction, VI Characteristics of PN junction diode, Zener effect, Zener diode, Zener diode Characteristics-Rectifier circuits-Wave shaping.

UNIT V CURRENT CONTROLLED AND VOLTAGE CONTROLLED DEVICES **9**

Working principle and characteristics - BJT, SCR, JFET, MOSFET.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1 To be able to understand the concepts related with electrical circuits and wiring.
CO2 To be able to study the different three phase connections and the concepts of magnetic circuits.
CO3 Capable of understanding the operating principle of AC and DC machines.
CO4 To be able to understand the working principle of electronic devices such as diode and zener diode.
CO 5 To be able to understand the characteristics and working of current controlled and voltage controlled devices.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							
CO2	✓	✓	✓	✓	✓						✓	
CO3	✓	✓	✓	✓	✓						✓	✓
CO4	✓	✓	✓	✓	✓						✓	✓
CO5	✓		✓	✓	✓						✓	✓

Attested

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TEXT BOOKS:

1. Kothari DP and I.J Nagrath, “Basic Electrical and Electronics Engineering”, McGraw Hill Education, 2014
2. Del Toro, “Electrical Engineering Fundamentals”, Second edition, Pearson Education, New Delhi, 1989.
3. John Bird, “Electrical Circuit theory and technology”, Routledge; 5th edition, 2013

REFERENCES:

1. Thomas L. Floyd, ‘Electronic Devices’, 10th Edition, Pearson Education, 2018.
2. Albert Malvino, David Bates, ‘Electronic Principles, McGraw Hill Education; 7th edition, 2017
3 Kothari DP and I.J Nagrath, “Basic Electrical Engineering”, McGraw Hill, 2010.
4 Muhammad H.Rashid, “Spice for Circuits and electronics”, 4th ed., Cengage India,2019.

GE5152 ENGINEERING MECHANICS L T P C
3 1 0 4

COURSE OBJECTIVES:

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

1. Applying the various methods to determine the resultant forces and its equilibrium acting on a particle in 2D and 3D.
2. Applying the concept of reaction forces (non-concurrent coplanar and noncoplanar forces) and moment of various support systems with rigid bodies in 2D and 3D in equilibrium. Reducing the force, moment, and couple to an equivalent force - couple system acting on rigid bodies in 2D and 3D.
3. Applying the concepts of locating centroids/center of gravity of various sections / volumes and to find out area moments of inertia for the sections and mass moment of inertia of solids.
4. Applying the concepts of frictional forces at the contact surfaces of various engineering systems.
5. Applying the various methods of evaluating kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

UNIT I STATICS OF PARTICLES (9+3)

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 (9+3)

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 (9+3)

Centroids of lines and areas – symmetrical and unsymmetrical shapes, Determination of Centroids by Integration , Theorems of Pappus-Guldinus, Distributed Loads on Beams, Centre 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 (9+3)

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

UNITV DYNAMICS OF PARTICLES (9+3)

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.

TOTAL (L: 45 + T: 15)=60 PERIODS

COURSE OUTCOMES:

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

1. Apply the various methods to determine the resultant forces and its equilibrium acting on a particle in 2D and 3D.
2. Apply the concept of reaction forces (non-concurrent coplanar and noncoplanar forces) and moment of various support systems with rigid bodies in 2D and 3D in equilibrium. Reducing the force, moment, and couple to an equivalent force - couple system acting on rigid bodies in 2D and 3D.
3. Apply the concepts of locating centroids / center of gravity of various sections / volumes and to find out area moments of inertia for the sections and mass moment of inertia of solids.
4. Apply the concepts of frictional forces at the contact surfaces of various engineering systems.
5. Apply the various methods of evaluating kinetic and kinematic parameters of the rigid bodies subjected to concurrent coplanar forces.

TEXT BOOKS:

1. Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, SanjeevSanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 11thEdition, 2017.
2. Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018.

REFERENCES:

1. Boresi P and Schmidt J, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
2. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th edition, Prentice Hall, 2013.
3. Irving H. Shames, Krishna Mohana Rao G, Engineering Mechanics – Statics and Dynamics, 4thEdition, Pearson Education Asia Pvt. Ltd., 2005.
4. Meriam J L and Kraige L G, Engineering Mechanics: Statics and Engineering Mechanics: Dynamics, 7th edition, Wiley student edition, 2013.
5. Timoshenko S, Young D H, Rao J V and Sukumar Pati, Engineering Mechanics, 5thEdition, McGraw Hill Higher Education, 2013.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9	0.6	0.6	0.3								0.6	0.9	0.3	0.3
2	0.9	0.6	0.6	0.3								0.6	0.9	0.3	0.3
3	0.9	0.6	0.9	0.3								0.6	0.9	0.3	0.6
4	0.9	0.6	0.9	0.3								0.6	0.9	0.3	0.6
5	0.9	0.6	0.9	0.3								0.6	0.9	0.3	0.6

PH5251 **MATERIALS SCIENCE** **L T P C**

(Common to Mechanical, Manufacturing, Industrial, Mining, Aeronautical, Automobile and Production Engineering & Rubber and Plastics Technology) **3 0 0 3**

COURSE OBJECTIVES

- To make the students to understand the basics of crystallography and crystal imperfections.
- To introduce various strengthening methods of materials, and also various mechanical properties and their measurement.
- To impart knowledge on the basics of phase diagrams and their applications.
- To learn about iron-carbon system, and about various ferrous and non-ferrous alloys.
- To introduce the preparation, properties and applications of ceramics, composites and nanomaterials.

UNIT I CRYSTALLOGRAPHY 9

Crystallographic directions and planes – metallic crystal structures: BCC, FCC and HCP – linear and planar densities – crystal imperfections- edge and screw dislocations, Burgers vector and elastic strain energy- surface imperfections – grain and twin boundaries – Polymorphism – phase changes – nucleation and growth – homogeneous and heterogeneous nucleation.

UNIT II MECHANICAL PROPERTIES 9

Tensile test - plastic deformation by slip – slip systems – mechanisms of strengthening in metals: strain hardening, grain size reduction, solid solution strengthening, precipitation hardening – Creep: creep curves, stress and temperature effects, mechanisms of creep, creep-resistant materials – Fracture: ductile and brittle fractures - the Griffith criterion – fracture toughness - Fatigue failure: the S-N curve – factors that affect fatigue life – Hardness: Rockwell and Brinell hardness tests, Knoop and Vickers microhardness tests.

UNIT III PHASE DIAGRAMS 9

Basic concepts - Gibbs phase rule – Unary phase diagram (iron) - Binary phase diagrams: isomorphous systems (Cu-Ni) – determination of phase composition and phase amounts – tie line and lever rule - binary eutectic diagram with no solid solution and limited solid solution (Pb-Sn) – eutectoid and peritectic reactions - other invariant reactions – micro structural development during the slow cooling: eutectic, hypereutectic and hypoeutectic compositions.

UNIT IV FERROUS AND NONFERROUS ALLOYS 9

The Fe-Fe_3C phase diagram: phases, invariant reactions, development of microstructure in eutectoid, hypoeutectoid and hypereutectoid alloys – influence of other alloying elements in the Fe-C system - phase transformations – isothermal transformation diagram for eutectoid iron-carbon alloy – microstructures: pearlite, bainite, spheroidite and martensite – steels, stainless steels and cast irons – copper alloys – aluminum alloys – titanium alloys.

UNIT V CERAMICS, COMPOSITES AND NANO MATERIALS 9

Ceramics – types and applications- refractories, abrasives and cements – Composites: classification, role of matrix and reinforcement - Fiber reinforced composites – carbon-carbon composites – Nanomaterials: types, physical, chemical and mechanical properties - carbon nanotubes: properties and applications - synthesis of nanomaterials: sonochemical, molecular epitaxy, physical vapor deposition (PVD) and chemical vapor deposition (CVD). Characterization: Transmission electron microscopy - scanning electron microscopy - Atomic force microscopy - X-ray powder diffraction - Nanoparticle size calculation.

TOTAL: 45 PERIODS

COURSE OUTCOMES

Upon completion of this course, the students will

- understand the basics of crystallography and its importance in materials properties
- understand the significance of dislocations, strengthening mechanisms, and tensile, creep, hardness and fracture behavior of materials
- gain knowledge on binary phase diagrams, and also will be able to determine the phase composition and phase amount.
- understand about the Fe-C system and various microstructures in it, and also about various ferrous and non-ferrous alloys.
- get adequate understanding on the preparation, properties and applications of ceramics, composites and nanomaterials.

REFERENCES

1. W.D.Callitser and D.G.Rethwish. Materials Science and Engineering. John Wiley & Sons, 2014.
2. V.Raghavan. Materials Science and Engineering: A First Course. PHI Learning, 2015.
3. M.F.Ashby, P.J.Ferreira and D.L.Schodek. Nanomaterials, Nanotechnologies and Design: An Introduction for Engineers, 2011.
4. J.F.Shackelford. Introduction to Materials Science for Engineers. Pearson, 2015.
5. D.R. Askeland and W.J.Wright. Essentials of Materials Science and Engineering, Cengage Learning, 2013.
6. W.F.Smith, J.Hashemi and R.Prakash. Materials Science and Engineering. McGraw Hill Education, 2017.

GE5161 PROBLEM SOLVING AND PYTHON PROGRAMMING LABORATORY

L	T	P	C
0	0	4	2

COURSE OBJECTIVES:

- To understand the problem solving approaches.
- To learn the basic programming constructs in Python.
- To articulate where computing strategies support in providing Python-based solutions to real world problems.
- To use Python data structures - lists, tuples, dictionaries.
- To do input/output with files in Python.

EXPERIMENTS:

1. Identification and solving of simple real life or scientific or technical problems, and developing flow charts for the same.
2. Python programming using simple statements and expressions.
3. Scientific problems using Conditionals and Iterative loops.
4. Implementing real-time/technical applications using Lists, Tuples.
5. Implementing real-time/technical applications using Sets, Dictionaries.
6. Implementing programs using Functions.
7. Implementing programs using Strings.
8. Implementing programs using written modules and Python Standard Libraries.
9. Implementing real-time/technical applications using File handling.
10. Implementing real-time/technical applications using Exception handling.
11. Exploring Pygame tool.
12. Developing a game activity using Pygame like bouncing ball, car race etc.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

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

CO1: Develop algorithmic solutions to simple computational problems

CO2: Develop and execute simple Python programs.

CO3: Structure simple Python programs for solving problems.

CO4: Decompose a Python program into functions.

CO5: Represent compound data using Python data structures.

CO6: Apply Python features in developing software applications.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓									✓
CO2	✓		✓		✓							✓
CO3	✓	✓	✓									✓
CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓	✓	✓	✓	✓			✓	✓	✓	✓
CO6	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

EE5261ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY **L T P C**

0 0 4 2

COURSE OBJECTIVES

1. To impart hands on experience in verification of circuit laws and measurement of circuit parameters
2. To train the students in performing various tests on electrical motors.
3. It also gives practical exposure to the usage of CRO, power sources & function generators

LIST OF EXPERIMENTS

1. Verification of Kirchhoff's Law.
2. Steady state response of AC and DC circuits (Mesh, Node Analysis)
3. Frequency response of RLC circuits.
4. Measurement power in three phase circuits by two-watt meter method.
5. Regulation of single phase transformer.
6. Performance characteristics of DC shunt generator.
7. Performance characteristics of single phase induction motor.
8. Characteristics of PN diode and Zener diode
9. Characteristics of Zener diode
10. Half wave and full wave Rectifiers
11. Application of Zener diode as shunt regulator.
12. Characteristics of BJT and JFET

TOTAL: 60 PERIODS

COURSE OUTCOMES:

1. To become familiar with the basic circuit components and know how to connect them to make a real electrical circuit;
2. Ability to perform speed characteristic of different electrical machines
3. Ability to use logic gates and Flip flops

Attested

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MA5355 TRANSFORM TECHNIQUES AND PARTIAL DIFFERENTIAL EQUATIONS **L T P C 3 1 0 4**

COURSE 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
- To develop the analytic solutions for partial differential equations used in engineering by Fourier series;
- 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 – Lagrange's Linear equation – 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

Classification of partial differential equations- 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

COURSE OUTCOMES :

At the end of the course, students will be able to

- Solve partial differential equations which arise in application problems.
- Analyze the functions as an infinite series involving sine and cosine functions.
- Obtain the solutions of the partial differential equations using Fourier series.
- Obtain Fourier transforms for the functions which are needed for solving application problems.
- Manipulate discrete data sequences using Z transform techniques.

TEXT BOOKS:

1. Erwin kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 10th Edition, New Delhi, 2015.
2. Grewal B.S., "Higher Engineering Mathematics", Khanna Publishers, 44th Edition, New Delhi, 2017.

REFERENCES:

1. Bali N., Goyal M. and Watkins C., "Advanced Engineering Mathematics", Firewall Media (An imprint of Lakshmi Publications Pvt., Ltd.,), 7th Edition, New Delhi, 2009.
2. Glyn James, "Advanced Modern Engineering Mathematics", Pearson Education, 4th Edition, New Delhi, 2011.
3. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage Learning India Pvt., Ltd, 7th Edition, New Delhi, 2012.
4. Ramana, B.V. "Higher Engineering Mathematics", Tata McGraw Hill, 11th Reprint, New Delhi, 2010.

AE5301 AERO ENGINEERING THERMODYNAMICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

Of this course are

1. To impart basic knowledge on the fundamental concepts of thermodynamics.
2. To apply first and second law of thermodynamics to closed and open systems.
3. To gain basic knowledge on the concept of entropy and the types of energy for closed and open systems.
4. To 42nalyse and compare the performance of various IC engines.
5. To get exposure on the basic concepts of psychrometry and its relations.

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 9

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 9

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

COURSE OUTCOMES:

Upon completion of the course, Students will be able to

CO1: Apply different laws and basics of thermodynamic process.

CO2: Classify Types of basic air standard cycles and the working principle of compressor.

CO3: Apply the steam power generation and jet propulsion principles.

CO4: Relate theoretical knowledge with different machines.

CO5: Gain knowledge which is the prerequisite for heat transfer.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							✓
CO2	✓	✓	✓	✓	✓							✓
CO3		✓	✓	✓	✓	✓	✓					
CO4	✓	✓	✓	✓	✓	✓	✓					✓
CO5	✓	✓	✓	✓	✓	✓	✓					✓

TEXT BOOKS:

1. Nag.P.K., "Engineering Thermodynamics", McGraw Hill Education (India) Private Limited; 5th edition ,April 2013.
2. Rathakrishnan E, "Fundamentals of Engineering Thermodynamics", Prentice Hall India, Second revised edition 2005.
3. Yunus A. Cengel and Michael A. Boles, "Thermodynamics: An Engineering Approach" McGraw-Hill Science/Engineering/Math; 7thedition 2010.

REFERENCES:

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

AE5302 SOLID MECHANICS L T P C
3 0 0 3

COURSE OBJECTIVES:

Of this course are

1. To enable understanding of the behaviour and response of materials.
2. To allow the student to carry out easy and moderate level structural analysis of basic structural members.
3. To familiarise with the different methods used for beam deflection analysis.
4. To impart knowledge to the students on how structural elements are sized.
5. To enable the student to gain knowledge in how stresses are developed and distributed internally.

UNIT I BASIC CONCEPTS & AXIAL LOADING 9

Normal Stress and Strain – Mechanical Properties of Materials – Material Constants – Study of Stress-strain Curves of Different Materials – Elasticity & Plasticity – Hooke's Law – Shear Stress and Strain – Allowable Stresses and Allowable Loads – Design for Axial Loads – Impact Loading – Thermal Stresses in Bars – Strain Energy in a Bar – Tapered Bar Subject to Axial Load.

UNIT II STRESSES IN BEAMS 9

Types of Beams, Loads, and Support Reactions – Relationships Between Load, Shear Force, and Bending Moments – Shear-Force and Bending-Moment Diagrams – Curvature of a Beam – Normal Stresses in Beams - Design of Beams for Bending Stress – Shear Stresses in Beams of Rectangular & Circular Cross Sections – The I-Section Beam – Built-up Beams – Application Problems.

UNIT III DEFLECTION OF BEAMS 9

The Euler-Bernoulli Beam Theory – Differential Equation of the Deflection Curve – Deflections by Integration of the Bending-Moment Equation – Deflections by Integration of the Shear-Force and Load Equations – Method of Superposition – Moment-Area Theorems and Application – Macaulay's Method – Strain Energy in Beams – Non-Prismatic Beams.

UNIT IV TORSION 9

Torsional Deformations of Circular Bars of Linearly Elastic Materials – Non-uniform Torsion – Stresses and Strains in Pure Shear – Angle of Twist & Torsional Rigidity – Transmission of Power by Circular Shafts – Statically Indeterminate Torsional Members – Stress Analysis of a Close-Coil Helical Spring – Stress Concentration in Torsion – Shaft Design Principle.

UNIT V BASIC CONCEPTS IN APPLIED STRESS ANALYSIS 9

Plane Stress – Principal Stresses and Maximum Shear Stresses – Mohr's Circle for Plane Stress – Hooke's Law for Plane Stress – Triaxial Stress – Spherical Pressure Vessels – Cylindrical Pressure Vessels –Maximum Stresses in Beams – Stress Concentration in Bending – Combined Loadings – Sketch of Stress Elements – Stresses in Inclined Planes & Transformation Equations.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, Students will be able to

CO1: Clear understanding of mechanical behaviour of materials.
CO2: Knowledge of different structural members and load types.
CO3: Design members under axial loading.
CO4: Design member under torsion loading.
CO5: Calculate beams deflections.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓							✓	✓
CO2	✓	✓	✓	✓							✓	✓
CO3	✓	✓	✓	✓							✓	✓
CO4	✓	✓	✓	✓							✓	✓
CO5	✓	✓	✓	✓							✓	✓

TEXT BOOKS:

1. James M. Gere, "Mechanics of Materials", 8th Edition, 2013.

REFERENCES:

1. David Roylance ,'Mechanics of Materials,Wiley; 1st edition,1995
2. Hibbeler R.C,'Mechanics of Materials', 10th Edition, Pearson College Div, 2016
3. Rajput R.K, 'Strength of Materials', S.Chand Ltd, 4th Edition, 2006.

Attested

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AE5351 FLUID MECHANICS AND FLUID MACHINES

L T P C
3 0 0 3

COURSE OBJECTIVES:

Of this course are

1. To learn about the basic properties of fluids.
2. To introduce the concept of incompressible and viscous flows.
3. To have a thorough knowledge on dimensional analysis and model studies.
4. To study the applications of conservation laws to flow through pipes and hydraulic machines.
5. To learn the basics of water turbines, their classification and working principles.

UNIT I BASIC EQUATIONS 9

Definition of fluid, Newton's law of viscosity, Units and dimensions-Properties of fluids, mass density, specific volume, specific gravity, viscosity, compressibility and surface tension, Control volume- application of continuity equation and momentum equation, Incompressible flow, Bernoulli's equation and its applications.

UNIT II INCOMPRESSIBLE VISCOUS FLOW 9

Exact flow solutions in channels and ducts, Couette and Poisuielle flow, laminar flow through circular conduits and circular annuli- concept of boundary layer – measures of boundary layer thickness – Darcy Weisbach equation, friction factor, Moody's diagram.

UNIT III DIMENSIONAL ANALYSIS AND MODEL STUDIES 9

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

UNIT IV PUMPS 9

Euler's equation – Theory of Roto dynamic machines – various efficiencies – velocity components at entry and exit of the rotor, velocity triangles – Centrifugal pumps, working principle, work done by the impeller, performance curves – Cavitation in pumps- Reciprocating pump–working principle.

UNIT V TURBINES 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, Students will be able to

CO1: Exhibit the basic understanding on fluid properties and fluid statics.
CO2: Demonstrate the understanding in fluid kinematics and governing equations.
CO3: Use the governing equations for fluid flow problems and understand the elementary plane flows.
CO4: Analyse laminar and turbulent flow problems.
CO5: Acquire knowledge on the various types of fluid machines.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							✓
CO2	✓	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓	✓	✓						✓
CO4	✓	✓	✓	✓	✓	✓					✓	✓
CO5	✓	✓	✓	✓	✓	✓					✓	✓

TEXT BOOKS:

1. Ojha C.S.P, Berndtsson R and Chadramouli P. N., Oxford University Press, 2010
2. Rathakrishnan. E, Fluid Mechanics, Prentice Hall of India,2nd Edition, 2007
3. Subramanya K,' Theory and Applications of Fluid Mechanics',Tata McGraw Hill,1993.
4. Yunus A.Cengel and John M.Cimbala, Fluid Mechanics, McGraw Hill, 2nd, Edition, 2013.

REFERENCES:

1. Bansal, R.K., Fluid Mechanics and Hydraulics Machines, Laxmi Publications (P) Ltd., New Delhi, 9th edition,2015.
2. Kumar. K.L. Engineering Fluid Mechanics (VII Ed.) S Chand publishers 2006 edition Reprint Edition (1 December 2010).
3. Ramamurtham. S, Hydraulics, Fluid Mechanics and Fluid Machines, Dhanpat Rai Publishing Co Pvt., Ltd, 9th edition, 2012.

AE5303 ELEMENTS OF AERONAUTICAL ENGINEERING

L	T	P	C
3	0	0	3

COURSE OBJECTIVES: Of this course are

1. To introduce the concepts of flying.
2. To impart knowledge about the different layers in International standard atmosphere.
3. To provide important design principles of airplane structures.
4. To describe about various systems and instruments used in airplanes.
5. To provide adequate knowledge on the control systems and navigational instruments used on airplanes.

UNIT I BASICS OF AERONAUTICS 9

History of flight – Classification of flight vehicles-Components of an airplane and their functions-lift generation – airfoil nomenclature – International Standard Atmosphere- Types and working principles of aircraft engines.

UNIT II BASICS OF AIRCRAFT STRUCTURES 9

General types of aircraft construction, Monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure. Use of Aluminium alloy, titanium, stainless steel and composite materials.

UNIT III AIRCRAFT SYSTEMS 9

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

UNIT IV AIRCRAFT CONTROL SYSTEMS 9

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

UNIT V AIRCRAFT INSTRUMENTS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, Students will be able to

CO1 Determine the properties of atmosphere at a given altitude in ISA.
CO2 Demonstrate different types of construction and materials used for aircraft structures.
CO3 Explain the operating principle of various systems used on airplanes.
CO4 Differentiate power assisted and power operated flight control systems.
CO5 Explain the working of various instruments used for aircraft navigation.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓			✓	✓					✓
CO2	✓	✓	✓	✓	✓	✓	✓					✓
CO3	✓	✓	✓	✓	✓							✓
CO4		✓	✓	✓	✓						✓	✓
CO5	✓	✓	✓	✓	✓							✓

TEXT BOOKS:

1. Anderson, J.D., Introduction to Flight, McGraw-Hill; 8th edition , 2015
2. Handbooks of Airframe and Power plant Mechanics, US dept. of Transportation, Federal, Aviation Administration, the English Book Store, New Delhi, 1995.
3. Mekinley, J.L. and R.D. Bent, Aircraft Power Plants, McGraw Hill 1993.
4. Pallet, E.H.J. Aircraft Instruments & Principles, Pitman & Co 1993.
5 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; 11th edition, 2011.
2. McKinley, J.L. and Bent R.D. Aircraft Maintenance & Repair, McGraw Hill, 1993.

AE5311 THERMODYNAMICS AND STRENGTH OF MATERIALS LABORATORY

L T P C
0 0 4 2

COURSE OBJECTIVES:

This laboratory course will enable the students

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

Thermodynamics Laboratory:

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

Strength of Materials Laboratory:

1. Tension Test
2. Testing of springs
3. Impact test, Charpy mode
4. Deflection of Beams
5. Tensile testing of polymers.
6. Fatigue test for Elastomers

Any 10 experiments will be conducted from above 12 experiments

TOTAL: 60 PERIODS

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓		✓	✓	✓			✓	✓		✓
CO2	✓	✓	✓	✓		✓			✓		✓	✓
CO3	✓	✓		✓		✓	✓		✓		✓	✓
CO4	✓		✓		✓	✓	✓		✓		✓	✓
CO5	✓			✓	✓	✓	✓		✓		✓	✓

AE5312 FLUID MECHANICS LABORATORY

L T P C
0 0 2 1

COURSE OBJECTIVES: This laboratory course will enable the students

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

LIST OF EXPERIMENTS

1. Study of Pressure Measuring Devices
2. Stability of Floating Body
3. Hydrostatics Force on Flat Surfaces/Curved Surfaces
4. Verification of Bernoulli's Theorem
5. Venturimeter Characteristics
6. Orifice meter Characteristics
7. Impacts of jets on solid surfaces
8. Velocity distribution in pipes
9. Laminar Flow Characteristics
10. Measurement of Coefficient of Discharge of given Orifice and Venturi meters
11. Determination of the density & viscosity of an oil and friction factor of oil flow in a pipe
12. Determination of the performance characteristics of a centrifugal pump

Any 10 experiments will be conducted from above 12 experiments

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, Students will be able to

CO1: Explain and apply the basic principles of buoyancy.

CO2: Determine discharge characteristics of flow meters.

CO3: Acquire knowledge on the impact characteristics of jets.

CO4: Measure physical properties of fluids and characterize the performance of fluid machinery.

CO5: Distinguish between laminar and turbulent flows.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓		✓	✓		✓			✓
CO2	✓	✓	✓	✓	✓				✓		✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓		✓			✓
CO4	✓	✓	✓	✓	✓		✓		✓		✓	✓
CO5	✓	✓	✓	✓		✓	✓		✓		✓	✓

GE5251 ENVIRONMENTAL SCIENCES L T P C
3 0 0 3

OBJECTIVES:

- To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize on the biodiversity of India and its conservation.
- To impart knowledge on the causes, effects and control or prevention measures of environmental pollution and natural disasters.
- To facilitate the understanding of global and Indian scenario of renewable and non-renewable resources, causes of their degradation and measures to preserve them.
- To familiarize the influence of societal use of resources on the environment and introduce the legal provisions, National and International laws and conventions for environmental protection.
- To inculcate the effect of population dynamics on human and environmental health and inform about human right, value education and role of technology in monitoring human and environmental issues.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 14

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – 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 a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity. Field study of common plants, insects, birds Field study of simple ecosystems – pond, river, hill slopes, 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 – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides. Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land 47 degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization-environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment protection act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

- To recognize and understand the functions of environment, ecosystems and biodiversity and their conservation.
- To identify the causes, effects and environmental pollution and natural disasters and contribute to the preventive measures in the immediate society.
- To identify and apply the understanding of renewable and non-renewable resources and contribute to the sustainable measures to preserve them for future generations.
- To recognize different forms of energy and apply them for suitable applications in for technological advancement and societal development.
- To demonstrate the knowledge of societal activity on the long and short term environmental issues and abide by the legal provisions, National and International laws and conventions in professional and personal activities and to identify and analyse effect of population dynamics on human value education, consumerism and role of technology in environmental issues.

TEXT BOOKS:

1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 6th Edition, New Age International Publishers (2018).
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, (2016).
3. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education (2004).

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, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press (2005).
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. (2013).

AE5401 LOW SPEED AERODYNAMICS

L T P C
3 0 0 3

COURSE OBJECTIVES:

Of this course are

1. To learn the concepts of mass, momentum and energy conservation equations relate to Aerodynamics.
2. To acquire knowledge about the concept of 2-D inviscid flows
3. To learn the methodology of conformal transformation and theory of airfoils.
4. To know the concepts of subsonic wing theory.
5. To learn the basics of viscous flow theory.

UNIT I REVIEW OF BASIC FLUID MECHANICS 9

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, Equipotential Lines, Elementary Flows and their combinations.

UNIT II TWO DIMENSIONAL INVISCID INCOMPRESSIBLE FLOW 9

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

UNIT III AIRFOIL THEORY 9

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

UNIT IV SUBSONIC WING THEORY 9

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

UNIT V INTRODUCTION TO LAMINAR AND TURBULENT FLOW 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, Students will be able to

CO1: Apply the fundamental concepts of mass, momentum, energy conservation equations for aerodynamic applications.
CO2: Solve the problems related to the concepts of vorticity, irrotational and circulation.
CO3: Acquire knowledge about ideal and real flow over the bluff and slender bodies.
CO4: Gain insights into thin airfoil theory.
CO5: Analyze and determine velocity profiles in the laminar and turbulent boundary layer.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓						✓	✓
CO2	✓	✓	✓	✓	✓		✓				✓	✓
CO3	✓	✓	✓	✓	✓	✓					✓	✓
CO4		✓	✓	✓	✓	✓					✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓				✓	✓

TEXT BOOKS:

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

REFERENCES:

1. Clancy, L J., Aerodynamics, Shroff publishers 2006.
2. John J Bertin., Aerodynamics for Engineers, Prentice Hall publishers, 6th edition, 2013.
3. Milne Thomson, L.H., Theoretical Aerodynamics, Macmillan, 1985.

AE5402 ADVANCED SOLID MECHANICS L T P C
3 0 0 3

COURSE OBJECTIVES:

Of this course are

1. To provide the students an understanding of linear static analysis of determinate and indeterminate aircraft structural components.
2. To introduce the advanced concepts in the stress analysis of beams.
3. To impart knowledge and enable the student work out a variety of problems in structural analysis applying energy principles.
4. To impart knowledge on column theory and practical column design.
5. To allow the student to differentiate between various failures theories and appropriately apply a failure theory in design.

Attested

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UNIT I BEAM & TRUSS ANALYSIS 9

Built-Up Beams – Composite Beams – Transformed-Section Method – Types of Statically Indeterminate Beams – Use of The Principle of Superposition – Analysis of Continuous Beams – Clapeyron's 3-Moment equation – Plane Frame Analysis – Truss Analysis in 2-D & 3-D.

UNIT II ENERGY METHODS 9

Energy methods – Determination of Strain Energy and Complementary Energy in a Structural Member – Castigliano's Theorems – Unit Load Method – Dummy Load Method – Application to Deflection Problems in Statically Determinate and Statically Indeterminate Systems – Beams, Trusses, Frames and Rings.

UNIT III BUCKLING OF COLUMNS 9

Buckling and Stability – Columns with Pinned Ends – Columns with Other Support Conditions – Euler's Curve – Columns with Eccentric Axial Loads – The Secant Formula for Columns – Elastic and Inelastic Column Behavior – Inelastic Buckling – Design Formulas for Columns – Ideal Column Section.

UNIT IV FAILURE ANALYSIS 9

Failure of Ductile and Brittle Materials – Theories of Failure – Maximum Normal Stress & Maximum Shear Stress Failure Envelopes – Distortion Energy Failure Theory – Octahedral Shear Stress Failure Theory – Material Fatigue – Introduction to Fatigue Failure and Fracture – Repeated Loading – The S-N Curve

UNIT V DESIGN OF JOINTS 9

Type of Joints – Bolted Joints – Determination of Stresses & Design of a Bolted Joint for Axial, Shear, and Combined Loading – Basic Design of a Welded Joint – Strength of Welding – Different Types of Rivets and Riveted Joints – Loading on a Riveted Joint – Failure Modes – Strength and Efficiency of Joints.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, Students will be able to

CO1: Solve problems in Beam & Frame Analysis.
CO2: Solve problems using Energy Methods.
CO3: Solve problems in column buckling and carry out stability analysis.
CO4: Use appropriate failure theories for structural mechanics problems.
CO5: Design different types of Joint under different loading conditions.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓		✓				✓	✓
CO2	✓	✓	✓	✓	✓		✓				✓	✓
CO3	✓	✓	✓	✓	✓		✓				✓	✓
CO4	✓	✓	✓	✓	✓		✓				✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓				✓	✓

TEXT BOOKS:

1. Peery, D.J., and Azar, J.J., Aircraft Structures, 2nd edition, McGraw – Hill, N.Y., 1999.
2. R.K. Rajput 'Strength of Materials', S.Chand Ltd, 4th, Edition, 2006.

REFERENCES:

01. Bruhn E F, 'Analysis and Design of Flight Vehicle Structures', Tri-State Off-set Company, USA, 1985.
02. Donaldson, B.K., 'Analysis of Aircraft Structures – An Introduction' Cambridge University Press publishers, 2nd edition, 2008.

AE5403 **AIR BREATHING PROPULSION**

L T P C
3 0 0 3

COURSE OBJECTIVES:

Of this course are

1. To make the students learn thermodynamics principle of cycles of various jet propulsion engines and their performance characteristics.
2. To impart knowledge on subsonic and supersonic inlet operating characteristics to students.
3. To make the students familiarize with the combustion processes in gas turbine engine and nozzle performance characteristics.
4. To give exposure on various types of air compressor, operating characteristics and various design parameter of compressor to students.
5. To make the students learn the principle of operation of turbine and turbine design parameter along with matching of compressor and turbine.

UNIT I FUNDAMENTALS OF GAS TURBINE ENGINES 9

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

UNIT II 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 AND NOZZLE 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.
Isentropic flow through nozzles – Nozzle efficiency – Ejector and variable area nozzles – Interaction of nozzle flows with adjacent surfaces – Thrust reversal – Numerical problems.

UNIT IV COMPRESSORS 9

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.

UNIT V TURBINE 9

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.

TOTAL: 45 PERIODS

Attested

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COURSE OUTCOMES:

Upon completion of the course, Students will be able to

CO1: Predict performance characteristics of jet engines based upon the cycle operation.

CO2: Acquire knowledge on the operation of subsonic inlets and various methods of supersonic inlet starting and their operating characteristics.

CO3: Get exposure the combustion processes inside combustion chamber and uses of after burner engines and they can solve nozzle performance variation due to altitude change.

CO4: Explain the working of compressor and preliminary design calculation of compressor blades.

CO5: Acquire knowledge on the working of turbine, turbine blade cooling method and matching of compressor and turbines.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓				✓	✓
CO2		✓	✓	✓	✓	✓					✓	✓
CO3		✓	✓	✓	✓	✓					✓	✓
CO4		✓	✓	✓	✓	✓	✓		✓		✓	✓
CO5		✓	✓	✓	✓	✓	✓		✓		✓	✓

TEXT BOOKS:

01. Ahmed F. El – Sayed, “Aircraft Propulsion and Gas turbine engines”, CRC Press Taylor and Francis group, Second Edition 2017.
02. Hill, P.G. & Peterson, C.R. “Mechanics & Thermodynamics of Propulsion” Pearson education, 2009.

REFERENCES:

01. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H. “Gas Turbine Theory”, Pearson Education Canada; 6th edition, 2008.
02. Ganesan. V “ Gas turbine”, third edition,Mc Graw Hill Education Private Ltd, New delhi.
03. Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”,standard Publishers & Distributors, Delhi, 2nd edition 2014.
04. Oates, G.C., “Aero thermodynamics of Aircraft Engine Components”, AIAA Education Series, New York, 1985.

AE5404 AIRCRAFT PERFORMANCE

L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

1. To impart knowledge on the concepts of EAS, TAS and ISA.
2. To provide the basic equations governing the steady performance of airplanes.
3. To describe the gliding and climbing flights and the parameters that decide those performances.
4. To provide the methods to calculate the approximate total takeoff and landing distance.
5. To introduce the concept of load factor and provides necessary equations to assess the turn performance of an airplane.

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 9

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 9

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

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

CO1: Prepare the drag polar diagram and associated equations for subsonic airplanes.

CO2: Calculate the range and endurance of jet and propeller airplanes under given operating conditions.

CO3: Assess the performance of airplanes during steady glide and climb.

CO4: Decide the factors for takeoff and landing distance of airplanes.

CO5: Draw the flight envelope of given aircraft.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓	✓	✓	✓				✓	✓
CO2		✓	✓	✓	✓	✓	✓				✓	
CO3			✓	✓	✓	✓	✓				✓	
CO4			✓	✓	✓	✓	✓				✓	✓
CO5		✓	✓	✓	✓	✓	✓				✓	✓

TEXT BOOKS:

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

REFERENCES:

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

AE5411 **AERODYNAMICS LABORATORY** **L T P C**
0 0 4 2

COURSE OBJECTIVES:

Of this laboratory course are

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

LIST OF EXPERIMENTS

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

Any 10 experiments will be conducted from above 12 experiments

TOTAL: 60 PERIODS

COURSE OUTCOMES: Upon completion of this course, Students will be able to

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

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

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

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

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓				✓	✓		✓
CO2		✓	✓		✓	✓	✓		✓		✓	✓
CO3				✓	✓	✓	✓		✓	✓		✓
CO4	✓	✓			✓					✓		✓
CO5		✓	✓	✓	✓		✓		✓			✓

Attested

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Centre for Academic Courses
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AE5412 **PROPULSION LABORATORY** **L T P C**
0 0 4 2

COURSE OBJECTIVES:

Of this laboratory course are

01. To determine the flow behaviour of free and wall jets.
02. To visualize the shock pattern in scramjet combustor model.
03. To provide an idea of wall pressure distribution on subsonic and supersonic inlets and nozzles.
04. To perform testing on compressor blades and basic knowledge on cold flow studies.
05. To develop the ability to analyze and interpret the experimental data using software.

LIST OF EXPERIMENTS

1. Velocity profiles of coaxial jets
2. Velocity profiles of free jets
3. Velocity profiles of wall jets
4. Wall pressure measurements of a turbine blade passage
5. Flow visualization in a scramjet combustion model
6. Cascade testing of compressor blades
7. Measurement of potential core length in supersonic 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

COURSE OUTCOMES:

Upon completion of this course, Students will be able to

CO1: Explain the basic fundamental concepts in jet propulsion.

CO2: Get hands on experience on jet engine combustion.

CO3: Demonstrate the fundamental concepts of low speed and high speed jets and experimental techniques pertain to measurements.

CO4: Get practical exposures on flow visualization techniques pertaining to supersonic flows.

CO5: Conduct the experiments pertaining to solid propellant combustion.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓			✓	✓		✓		✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓		✓		✓	
CO4	✓	✓			✓	✓	✓		✓		✓	
CO5	✓	✓	✓	✓	✓	✓			✓			✓

Attested

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HM5503 **MANAGEMENT SCIENCE**

L T P C
3 0 0 3

OBJECTIVES: Of this course are

1. To introduce fundamental concepts of management and organisation to students.
2. To impart knowledge to students on various aspects of marketing, quality control and marketing strategies.
3. To make students familiarize with the concepts of human resources management.
4. To acquaint students with the concepts of project management and cost analysis.
5. To make students familiarize with the concepts of planning process and business strategies.

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANISATION 9

Concepts of Management and organization- nature, importance and Functions of Management, Systems Approach to Management - Taylor's Scientific Management Theory- Fayal's Principles of Management- Maslow's theory of Hierarchy of Human Needs- Douglas McGregor's Theory X and Theory Y - Hertzberg Two Factor Theory of Motivation - Leadership Styles, Social responsibilities of Management, Designing Organisational Structures: Basic concepts related to Organisation - Departmentation and Decentralisation.

UNIT II OPERATIONS AND MARKETING MANAGEMENT 9

Principles and Types of Plant Layout-Methods of Production(Job, batch and Mass Production), Work Study - Basic procedure involved in Method Study and Work Measurement - Business Process Reengineering(BPR)- Statistical Quality Control: control charts for Variables and Attributes (simple Problems) and Acceptance Sampling, Objectives of Inventory control, EOQ, ABC Analysis, Purchase Procedure, Stores Management and Store Records - JIT System, Supply Chain Management, Functions of Marketing, Marketing Mix, and Marketing Strategies based on Product Life Cycle.

UNIT III HUMAN RESOURCES MANAGEMENT 9

Concepts of HRM, HRD and Personnel Management and Industrial Relations (PMIR), HRM vs PMIR, Basic functions of HR Manager: Manpower planning, Recruitment, Selection, Training and Development, Wage and Salary Administration, Promotion, Transfer, Performance Appraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating - Capability Maturity Model (CMM) Levels.

UNIT IV PROJECT MANAGEMENT 9

Network Analysis, Programme Evaluation and Review Technique (PERT), Critical Path Method (CPM), identifying critical path, Probability of Completing the project within given time, Project Cost Analysis, Project Crashing (simple problems).

UNIT V STRATEGIC MANAGEMENT AND CONTEMPORARY STRATEGIC ISSUES 9

Mission, Goals, Objectives, Policy, Strategy, Programmes, Elements of Corporate Planning Process, Environmental Scanning, Value Chain Analysis, SWOT Analysis, Steps in Strategy Formulation and Implementation, Generic Strategy alternatives. Bench Marking and Balanced Score Card as Contemporary Business Strategies.

TOTAL: 45 PERIODS

Attested

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Centre for Academic Courses
Anna University, Chennai-600 025

COURSE OUTCOMES:

Upon completion of the course, Students will be able to

CO1: Plan an organizational structure for a given context in the organisation to carry out production operations through Work-study.

CO2: Survey the markets, customers and competition better and price the given products appropriately.

CO3: Ensure quality for a given product or service.

CO4: Plan, schedule and control projects through PERT and CPM.

CO5: Evolve a strategy for a business or service organisation.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓			✓	✓	✓		✓	✓	✓	
CO2		✓			✓	✓	✓		✓	✓	✓	
CO3		✓			✓	✓	✓		✓	✓	✓	
CO4		✓			✓	✓	✓		✓	✓	✓	
CO5		✓			✓	✓	✓		✓	✓	✓	

TEXT BOOKS:

01. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2007.
02. Stoner, Freeman, Gilbert, Management, 6th Ed, Pearson Education, New Delhi, 2004.
03. Thomas N.Duening & John M.Ivancevich Management—Principles and Guidelines, Biztantra,2007.
04. P. Vijay Kumar, N. Appa Rao and Ashnab, Chnalill, Cengage Learning India, 2012.

REFERENCES:

01. Kotler Philip and Keller Kevin Lane: Marketing Management, Pearson, 2012.
02. Koontz and Weihrich: Essentials of Management, McGraw Hill, 2012.
03. Lawrence R Jauch, R. Gupta and William F. Glueck: Business Policy and Strategic Management Science, McGraw Hill, 2012.
04. Samuel C. Certo: Modern Management, 2012.

AE5501 HIGH SPEED AERODYNAMICS

L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

01. To get insight into the basic aspects of compressible flow.
02. To arrive at the shock wave and expansion wave relations.
03. To get exposure on potential equation for 2-dimensionla compressible flow.
04. To get knowledge on high speed flow over airfoils, wings and airplane configuration.
05. To gain basic knowledge on low and high speed wind tunnels.

UNIT I FUNDAMENTAL ASPECTS OF COMPRESSIBLE FLOW 9

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

UNIT II SHOCK AND EXPANSION WAVES 9

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

UNIT III TWO DIMENSIONAL COMPRESSIBLE FLOW 9

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

UNIT IV HIGH SPEED FLOW OVER AIRFOILS, WINGS AND AIRPLANE CONFIGURATION 9

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

UNIT V CHARACTERIZATION OF HIGH SPEED FLOWS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, Students will be able to

CO1: Acquire knowledge on the effect of compressibility at high-speeds and to make intelligent design decisions based on this understanding. .

CO2: Gain insights on shock formation and dynamics and the ability to estimate the shock location.

CO3: Estimate drag and lift forces on basic aerodynamic (lifting) shapes travelling at high-speed.

CO4: Determine the full high-speed flow field on thin airfoils, wedges, and in nozzles.

CO5: Apply the concepts of aerodynamics to the design of aerospace systems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓				✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓				✓	✓
CO3		✓	✓	✓	✓	✓	✓				✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓				✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓				✓	✓

TEXT BOOKS:

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

REFERENCES:

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

AE5502 **AIRCRAFT STRUCTURES**

L T P C
3 0 0 3

OBJECTIVES: Of this course are

01. To familiarise the student, the generalized theory of pure bending and work out problems in the calculation of bending stress involving different methods.
02. To gain knowledge in the concept of shear flow in thin-walled sections.
03. To carry out shear flow analysis involving different types of sections.
04. To Impart theoretical knowledge on the behaviour of thin plates and thin-walled columns.
05. To carry out basic stress analysis procedures involving 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

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

CO1: Analyse and investigate the normal stress variation on unsymmetrical sections subjected to bending moments.

CO2: Determine the shear flow variation in thin walled open sections with skin effective and ineffective in bending. Also to find out the shear centre of sections.

CO3: Calculate the shear flow variation in single cell and multicell tubes subjected to shear and torque loads

CO4: Investigate the behaviour of buckling of simply supported plates and also to know the effective width of sheet stringers combination.

CO5: Analyse the shear and bending moment variation of aircraft wing and fuselage and also to know the characteristics of thin webbed beams.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓		✓					✓
CO2	✓	✓	✓	✓	✓		✓				✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓				✓	✓
CO4	✓	✓	✓	✓	✓		✓				✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓				✓	✓

TEXT BOOKS:

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

REFERENCES:

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

AE5503 ROCKET PROPULSION

L T P C
3 0 0 3

OBJECTIVES: Of this course are

01. To introduce the basic concepts of jet propulsion.
02. To make students learn the operating and performance characteristics of ramjet engines.
03. To impart knowledge on the needs, various challenges in scramjet combustion and the applications of scramjet to hypersonic vehicle operations.
04. To give exposure to the students on the various kinds of propellants and internal ballistics of solid rocket motor.
05. To make the students familiarize with the various subsystems of liquid, hybrid rockets and importance aspects of advanced propulsion systems.

UNIT I RAMJET PROPULSION 9

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

UNIT II SCRAMJET PROPULSION 9

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 III SOLID ROCKET MOTOR 9

Type of rockets – specific impulse of a rocket– rocket performance – Real and ideal nozzle - solid propellants– selection criteria of solid propellants – – internal ballistics – burning rate - propellant grain design considerations – erosive burning in solid rockets – Igniters – types of igniters.

UNIT IV LIQUID AND HYBRID ROCKET ENGINES 9

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 9

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

COURSE OUTCOMES:

Upon completion of this course, Students will be able to

CO1: Predict, analyse and design model ramjet engines.

CO2: Acquire knowledge in field of supersonic combustion process and their difficulties involved.

CO3: Predict the internal ballistic properties based on mission requirements.

CO4: Determine operational and performance characteristics of liquid and hybrid rockets.

CO5: Acquire knowledge in the field of advance propulsive systems and their futuristic applications.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓				✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓				✓	✓
CO3		✓	✓	✓	✓	✓	✓				✓	
CO4		✓	✓	✓	✓		✓				✓	✓
CO5		✓	✓	✓	✓	✓				✓	✓	✓

TEXT BOOKS:

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

REFERENCES:

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

AE5511 **AIRCRAFT STRUCTURES LABORATORY**

L T P C
0 0 4 2

COURSE OBJECTIVES: Of this laboratory course are

01. To enable the students understand the behaviour of aircraft structural components under different loading conditions.

02. To provide an exposure to photo elasticity and its applications in stress analysis

03. To familiarize with unsymmetrical bending of beams and shafts

04. To familiarize with the fabrication of composite laminates.

05. To impart knowledge in non destructive evaluation

LIST OF EXPERIMENTS

1. Verification of the Superposition Principle & Maxwell's Reciprocal Theorem
2. Unsymmetrical Bending of Beams
3. Installation and Performance of Electrical Resistance Strain Gauges
4. Strain Measurement Using Electrical Resistance Strain Gauges
5. Shear Center Position of a Thin-Walled Beam
6. Experiments in Photoelasticity
7. Calibration of a Photoelastic Specimen
8. Fabrication of a Composite Laminate
9. Flexure Tests of Composite Specimens
10. Experimental Determination of the Buckling Load of Columns
11. Thin –Walled Column Strength
12. Acoustic & Ultrasonic Testing of Composites
13. Free Vibration Studies with Beams
14. Forced Vibration Testing

Any 10 experiments will be conducted from above 14 experiments

TOTAL: 60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, Students will be able to

CO1: Practical behaviour of aircraft structural Components Under different loading conditions.

CO2: Student will have hands-on experience in the area of testing of structural components.

CO3: Student will able to demonstrate the basics experimental techniques in photoelasticity.

CO4: Student will have an exposure to data interpretation/analysis of vibration measuring instruments.

CO5: Student will have practical knowledge in the field of fabrication and testing of Composite material specimens.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓				✓		✓	
CO2	✓	✓	✓		✓		✓		✓		✓	
CO3	✓	✓	✓		✓				✓		✓	
CO4	✓	✓	✓		✓				✓		✓	
CO5	✓	✓	✓		✓		✓		✓		✓	

Attested

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AE5512 INDUSTRIAL TRAINING/INTERNSHIP

L T P C
0 0 4 2

COURSE OBJECTIVE:

This course is aimed to provide more weightage for project work. The project work could be done in the form of a summer project or internship in the industry or even a minor practical project in the college. Participation in any technical event/ competition to fabricate and demonstrate an innovative machine or product could be encouraged under this course.

TOTAL = 60 PERIODS

AE5601 AIRCRAFT STABILITY AND CONTROL L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

01. To impart knowledge on the criteria for longitudinally stable configuration.
02. To provide the aspects of weathercock stability and requirements of rudder.
03. To impart knowledge on dihedral effect and aileron control power.
04. To provide the methodology to obtain the characteristic modes of an airplane in longitudinal motion.
05. To impart knowledge on autorotation and spin and Dutch roll motions of airplanes.

UNIT I STATIC LONGITUDINAL STABILITY AND CONTROL 9

General concepts-Degrees of freedom of a rigid body, Static and dynamic stability, Need for stability in an airplane, inherently and marginally stable airplanes, Stability and Controllability, Requirements of control surfaces, criteria for longitudinal static stability, contribution to stability by wing, tail, fuselage, wing fuselage combination, Total longitudinal stability, Neutral point-Stick fixed and Stick free aspects, Free elevator factor, static margin, Hinge moment, Power effects on stability-propeller and jet aircrafts, longitudinal control, 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 9

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

UNIT III STATIC LATERAL STABILTY AND CONTROL 9

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

Attested

UNIT IV DYNAMIC LONGITUDINAL STABILITY 9

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

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UNIT V DYNAMIC LATERAL AND DIRECTIONAL STABILITY 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, Students will be able to

CO1: Obtain static margin of airplane in stick fixed and free aspects.

CO2: Successfully design the rudder by considering the critical situations that demand the use of rudder.

CO3: Estimate total lateral stability of an airplane.

CO4: Determine the natural frequency and damping ratio of phugoid and short period motions.

CO5: Explain the recovery procedure of an airplane from dangerous situations like autorotation and spin.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓			✓			✓
CO2	✓	✓	✓	✓	✓				✓		✓	✓
CO3	✓	✓	✓	✓	✓				✓		✓	✓
CO4	✓	✓	✓	✓	✓	✓			✓			✓
CO5		✓	✓	✓	✓				✓		✓	✓

TEXT BOOKS:

01. Nelson, R.C. Flight Stability & Automatic Control, McGraw Hill, 1998.
02. Perkins C.D. & Hage R.E. Airplane performance, stability and control, John Wiley & Sons 1967.

REFERENCES:

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

AE5602 COMPOSITE MATERIALS AND STRUCTURES

L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

1. To impart knowledge in the mechanical behaviour of anisotropic materials and how they differ from classical construction materials.
2. To familiarize with the classical lamination theory to analyse the stiffness and strength of composite laminates
3. To impart knowledge to Design a composite laminate with given requirements.
4. To familiarize the methods for more advanced tools of composites analysis and design including failure theories and their implementation, the effect of holes and cracks, fatigue.
5. To familiarize with the different manufacturing process available to manufacture composite structures.

UNIT I INTRODUCTION & MICROMECHANICS 9

Introduction – Aerospace Application of Composite Materials – Types of Reinforcements and Matrices – Classification of Composite Materials – Micromechanics – Mechanics of Materials Approach – Elasticity Approach – Prediction of Elastic Constants – Effect of Voids in Composites – Load Sharing – Longitudinal Strength of a Uni-directional Lamina – Minimum & Critical Volume Fractions.

UNIT II MACROMECHANICS APPROACH 9

Generalized Hooke's Law – Elastic Constants for Anisotropic, Orthotropic and Isotropic Materials – Experimental Determination of Lamina Properties – Lamina Stiffness Matrix – Stress-strain Relations with Respect to Natural & Arbitrary Axis – Determination of Lamina Properties & Lamina Strength – Failure Theories For an Orthotropic Lamina – Hygrothermal effects on a Lamina.

UNIT III LAMINATED PLATE THEORY 9

Governing differential equation for a Laminate – Classical Lamination Theory – Stress – Strain Relations For a laminate – In plane and Flexural constants of a laminate – Response and Behaviour of Different Laminate Types – Determination of Laminate Stiffness Matrix – Hygrothermal Stresses and Strains – Failure analysis of a laminate – Laminate Impact resistance and Interlaminar Stresses.

UNIT IV FABRICATION PROCESS AND REPAIR METHODS 9

Various Open and Closed Mould Processes – Manufacture of Fibers – Importance of Repair and Different Types of Repair Techniques in Composites – Autoclave and Other Methods for the Production of Composite Parts – Non-destructive Evaluation of Composite Parts.

UNIT V SANDWICH CONSTRUCTION 9

Basic Design Concepts of Sandwich Construction – Materials Used for Sandwich Construction – Failure Modes of Sandwich Panels – Bending and Shear Stress in Sandwich Beams – Fabrication of Sandwich Panels – Testing of Sandwich Materials – Use of Sandwich Construction in Aircraft and Space Structures.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, Students will be able to

CO1: Classify the different composite material based on fibre and matrix factors.

CO2: Solve problems related to micromechanics of composite laminas.

CO3: Analyse and apply the different failure theories.

CO4: Impart knowledge on the Behaviour and Response of Laminated Plates

CO5: Demonstrates the different production processes of composite structures.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓	✓		✓				✓	✓
CO2		✓	✓	✓	✓		✓				✓	✓
CO3		✓	✓	✓	✓		✓				✓	✓
CO4		✓	✓	✓	✓		✓				✓	✓
CO5		✓	✓	✓	✓		✓				✓	✓

Attested

TEXT BOOKS:

01. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites," John Wiley & Sons, 3rd edition, July 2006.

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REFERENCES:

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

AE5603 COMPUTATIONAL FLUID DYNAMICS L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

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

UNIT I INTRODUCTION TO NUMERICAL METHODS IN FLUID DYNAMICS 9

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

UNIT II GRID GENERATION 9

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

UNIT III TIME DEPENDENT METHODS 9

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

UNIT IV FINITE VOLUME METHOD 9

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

UNIT V SOLUTION OF FLUID FLOW EQUATIONS & CFD FOR INDUSTRIAL APPLICATIONS **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.

Various levels of approximation of flow equations, turbulence modelling for viscous flows, verification and validation of CFD codes, application of CFD tools to 3D configurations. Introduction to commercial CFD software for aerospace applications. High performance computing for CFD applications – Parallelization of codes – Domain decomposition.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, Students will be able to

CO1: Acquire knowledge on the mathematical nature of fluid dynamic equations and to specify boundary conditions.

CO2: Generate grid by using numerical methods.

CO3: Apply time dependant methods for 1-Dand 2-Dflow problems.

CO4: Acquire knowledge on various flux evaluation schemes and on pressure- velocity coupling procedure.

CO5: Gain insights on performance computing and parallelization of complex codes.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓	✓	✓	✓				✓	✓
CO2	✓	✓	✓		✓				✓		✓	✓
CO3		✓	✓	✓	✓	✓			✓		✓	✓
CO4	✓	✓	✓	✓	✓	✓			✓		✓	✓
CO5		✓	✓	✓	✓	✓	✓		✓		✓	✓

TEXT BOOKS:

01. Fletcher C.A.J. , “Computational Techniques for Fluid Dynamics 1” Springer Verlag, 1996.
02. Fletcher C.A.J., “Computational Techniques for Fluid Dynamics 2”, Springer Verlag, 1995.

REFERENCES:

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

AE5611 **AIRCRAFT DESIGN PROJECT I** **L T P C**
0 0 4 2

COURSE OBJECTIVES: Of this course are

01. To familiarise with data collections of different airplanes.
02. To get hands on experience in weight estimations
03. To finalize the geometric parameters of airplanes.
04. To familiarise with the performance characteristics of airplanes.
05. To investigate the stability of the system when subjected to disturbance.

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

COURSE OUTCOMES:

Upon completion of the course, Students will be able to

CO1: Do preliminary design of an aircraft starting from data collection to satisfy mission specifications.

CO2: Get familiarized with the estimation of geometric and design parameters of an airplane.

CO3: Carry out the procedure involved in weight estimation, power plant selection, and estimation of the performance parameters.

CO4: Initiate the design of a system, component, or process to meet requirements for aircraft systems.

CO5: Work in a multidisciplinary environment involving the integration of engineering practices in such subjects as aerodynamics, structures, propulsion, and flight mechanics.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓	✓		✓		✓			
CO2		✓	✓	✓	✓				✓			
CO3		✓	✓	✓	✓		✓		✓			
CO4		✓	✓	✓	✓				✓			
CO5		✓	✓	✓	✓				✓			

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AE5612 **FLIGHT TRAINING LABORATORY**

L T P C
0 0 4 2

COURSE OBJECTIVES: Of this course are

01. To make students learn the steps involved in CG determination.
02. To introduce the methods of calibrating various flight instruments.
03. To impart practical knowledge to students on determining various performance parameters.
04. To find the neutral points and maneuver points in an aircraft.
05. To impart practical knowledge to students about different modes of stability such as Dutch roll, phugoid motion etc.

- The 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.

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

COURSE OUTCOMES:

Upon completion of this course, Students will be able to

CO1: Acquire flying experience on a trainer aircraft.
CO2: Determine the C.G position of an airplane.
CO3: Calculate the performance parameters such as rate of climb, climb angle etc.
CO4: Compute the stability parameters such as stick fixed neutral point, stick free neutral point and control parameters such as stick fixed manoeuvre point, stick free manoeuvre point.
CO5: Get practical experience of Dutch roll and phugoid motion.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					✓	✓	✓	✓	✓	✓		✓
CO2	✓	✓			✓	✓	✓		✓			✓
CO3	✓	✓			✓	✓	✓		✓			✓
CO4	✓	✓			✓	✓	✓		✓			✓
CO5		✓	✓	✓	✓		✓		✓			✓

Attested

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AE5701 **FINITE ELEMENT METHOD**

L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

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

UNIT I INTRODUCTION **9**

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 **9**

Bar elements, uniform sections, 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 **9**

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

UNIT IV ISOPARAMETRIC ELEMENTS **9**

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: 45 PERIODS

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

CO1: Have overall understanding of various approximate methods used for solving structural mechanics problems. Be able to understand the formulation of governing equation for the finite element method, convergence criteria and advantage over other approximate methods.

CO2: Have the capability to solve 1-D problems related to static analysis of structural members.

CO3: Formulate the elemental matrices for 2-D problems.

CO4: Get an exposure to isoparametric element formulations and importance of numerical integration.

CO5: Solve Eigen value problems and scalar field problems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓							✓
CO2	✓	✓	✓	✓	✓							✓
CO3	✓	✓	✓	✓	✓							✓
CO4	✓	✓	✓	✓	✓							✓
CO5	✓	✓	✓	✓	✓							✓

TEXT BOOKS:

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

REFERENCES:

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

AE5702 ROCKETS AND MISSILES

L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

01. To impart knowledge on the aerodynamic characteristics of different classes of missiles.
02. To provide the methodology to estimate the drag on a subsonic/supersonic missile.
03. To introduce the 1D and 2D motion of rockets in free space and in homogeneous gravitational field.
04. To explore the need for multi staging in rockets.
05. To introduce the various types control techniques used on missiles and rockets.

UNIT I CLASSIFICATION OF ROCKETS AND LAUNCH VEHICLES 9

Various methods of classification of missiles and rockets-Basic Aerodynamic 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 9

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.

UNIT III ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD **9**

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 burnout velocity and altitude – estimation of culmination time and altitude – Ballistic trajectories.

UNIT IV STAGING OF ROCKETS AND LAUNCH VEHICLES **9**

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

UNIT V CONTROL OF ROCKETS AND LAUNCH VEHICLES **9**

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, Students will be able to

CO1: Classify missiles based on different aspects.
CO2: Calculate the forces and moments that act on a missile in atmosphere.
CO3: Perform the calculations pertaining to altitude and range covered by rockets in homogeneous gravitational field.
CO4: Optimize a multi stage rocket based on given constraint.
CO5: Demonstrate the principles and the practical complications involved in aerodynamic and jet control of missiles.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓			✓	✓				✓	✓
CO2	✓	✓	✓		✓						✓	✓
CO3	✓	✓	✓		✓						✓	✓
CO4		✓	✓	✓	✓	✓	✓		✓		✓	
CO5		✓	✓	✓	✓	✓	✓		✓		✓	

TEXT BOOKS:

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

REFERENCES:

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

AE5703 EXPERIMENTAL AERODYNAMICS

L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

01.To learn the basic measurements involved in fluid mechanics

02. To analyze and compare the performance of various low and high speed wind tunnels.

03. To visualize incompressible and compressible flows using various techniques.

04. To measure flow filed variables using pitot-static-probes, transducers and anemometers.

05.To gain basic knowledge on special flows and to perform uncertainty analysis for their experiments

UNIT I BASIC MEASUREMENTS IN FLUID MECHANICS 9

Objective of experimental studies –– Measuring instruments – Performance terms associated with measurement systems –– Components of measuring systems - Data acquisition and processing – Signal conditioning – Flow similarity – Model design and construction.

UNIT II WIND TUNNEL MEASEUREMENTS 9

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

UNIT III FLOW VISUALIZATION AND ANALOGUE METHODS 9

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

UNIT IV PRESSURE, VELOCITY AND TEMPERATURE MEASUREMENTS 9

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

UNIT V SPECIAL FLOWS AND UNCERTAINTY ANALYSIS 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, Students will be able to

CO1: Determine the performance parameters of the various measuring instruments.

CO2: Acquire knowledge on the practical elements of experimental aerodynamics and to develop an appreciation for how aerodynamic data are acquired.

CO3: Have the ability to apply modern instrumentation and measurement techniques to the acquisition of aerodynamic data and understand the inherent limitations of each technique.

CO4: Estimate experimental uncertainty.

CO5: Demonstrate the principles of three component and six component balances associated with wind tunnels.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓				✓		✓	✓
CO2	✓	✓	✓	✓	✓	✓					✓	
CO3	✓	✓	✓	✓	✓	✓			✓		✓	✓
CO4		✓	✓	✓	✓	✓			✓		✓	✓
CO5		✓	✓	✓	✓	✓			✓		✓	✓

TEXT BOOKS:

01. Jewel B. Barlow,William H. Rae, Jr.Alan Pope,“ Low-Speed WindTunnel Testing”, 3rd Edition,John Wiley & Sons, Inc,1999.
02. Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", John Wiley, 1978.

REFERENCES:

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

AE5711 AIRCRAFT DESIGN PROJECT II L T P C

0 0 4 2

COURSE OBJECTIVES:

Of this course are

1. To familiarize with Lift distribution and structural load distribution in aircraft wing
2. To gain knowledge in drawing the sheer force and bending moment diagram for wing structure.
3. Enable the student to design the load carrying members such as spars, ribs and stringers in wing.
4. To gain knowledge in plotting the shear flow for wing box
5. To familiarize with the bulkhead design and enable the student to design the Oleo strut used in landing gears.

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 drawing.

TOTAL: 60 PERIODS

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COURSE OUTCOMES:

Upon completion of this course, Students will be able to

CO1: Analyse the lift distribution on an aircraft wing.

CO2: Design the structural load carrying members of wing.

CO3: Design the fuselage structure.

CO4: Investigate the shear flow on wing and fuselage structures.

CO5: Design oleo strut used in landing gears.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓		✓		✓		✓	✓
CO2	✓	✓	✓	✓	✓				✓		✓	✓
CO3	✓	✓	✓	✓	✓		✓		✓		✓	✓
CO4	✓	✓	✓	✓	✓				✓		✓	✓
CO5	✓	✓	✓	✓	✓				✓		✓	✓

AE5712 **PROJECT I**

L T P C
0 0 6 3

COURSE OBJECTIVE:

It is intended to start the project work early in the seventh semester and carry out both design and fabrication of required models or components whose working can be demonstrated. The design is expected to be completed in the seventh semester and the fabrication and demonstration will be carried out in the eighth semester.

AE5811 **PROJECT II**

L T P C
0 0 16 8

COURSE OBJECTIVE:

After the completion of design in the previous semester, the fabrication and demonstration will be carried out in the eighth semester. Students are expected to conduct experiments and interpret the data by plotting and analysing.

AE5001 AIRCRAFT RULES AND REGULATIONS - CAR I AND II L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

1. To acquaint students with airworthiness regulations and civil air worthiness requirements.
2. To familiarize students with analytical study of in- flight readings and engine reliability programmes and aircraft maintenance programmes
3. To impart knowledge on procedures relating to registration of aircraft, issue and renewal of air worthiness certificates to aircraft.
4. To acquaint students with aircraft maintenance engineer licensing procedures.
5. To make the students learn weight and balance control of an aircraft and material and documents to be carried on board for Indian registered aircraft.

UNIT I C.A.R SERIES 'A' - PROCEDURE FOR CIVIL AIR WORTHINESS REQUIREMENTS AND RESPONSIBILITY OPERATORS VIS-A-VIS AIRWORTHINESS DIRECTORATE 9

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 9

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

C.A.R. SERIES 'D' - AND AIRCRAFT MAINTENANCE PROGRAMMES: Reliability Programme (Engines); Aircraft maintenance programme& their approval; On condition maintenance of reciprocating engines; TBO - Revision programme - Maintenance of fuel and oil uplift and consumption records - Light aircraft engines; Fixing routine maintenance periods and component TBOs - Initial & revisions.

UNIT III C.A.R. SERIES 'E' - APPROVAL OF ORGANISATIONS 9

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

UNIT IV C.A.R. SERIES 'L' - AIRCRAFT MAINTENANCE ENGINEER – LICENSING 9

Issue of AME 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 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, Students will be able to

CO1: Acquire knowledge of Airworthiness requirements for transport, military, gliders and micro light aircrafts.

CO2: Perform defect recording, reporting, investigation, rectification and analysis.

CO3: Acquire Knowledge of procedure for holding examinations, proficiency checks etc.

CO4: Perform procedure relating to registration of aircraft and fulfil the requirements for grant of civil licenses.

CO5: Acquire Knowledge of Issue/validation and renewal of Certificate of Airworthiness and to determine airworthiness of ageing aircraft.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓	✓	✓	✓	✓	✓		✓
CO2	✓	✓			✓	✓	✓	✓	✓	✓	✓	
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
CO4	✓	✓			✓	✓	✓	✓	✓	✓		
CO5	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓

REFERENCES:

01. "Aircraft Manual (India) ", Volume - Latest Edition ,The English Book Store, 17-1,Connaught Circus, New Delhi.(Old Edition 2003)
02. "Aeronautical Information Circulars (relating to Airworthiness) ", from DGCA. Advisory Circulars ", form DGCA.
03. "Civil Aviation Requirements with latest Amendment (Section 2 Airworthiness) ", Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi.1993.

AE5002 ELEMENTS OF HEAT TRANSFER L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

01. To impart knowledge to students in the fundamentals of conductive heat transfer both steady and unsteady with practical examples.
02. To acquaint students with laminar and turbulent convective heat transfer analysis and its application to heat exchanger.
03. To make students learn the basis of radiative heat transfer and its importance in thermal radiation systems.
04. To make the students capable of obtaining numerical solutions of conductive convective and radioactive heat transfer problems with finite difference methods.
05. To make students familiarize with aerospace heat transfer problem and numerical analysis of such problems.

UNIT I CONDUCTION 9

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 9

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 9

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 9

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

COURSE OUTCOMES: Upon completion of this course, Students will be able to

CO1: Apply the basic concepts of heat conduction for engineering problems.

CO2: Distinguish between the basic differences pertaining to heat conduction and convection.

CO3: Acquire knowledge on the unique behaviour of heat transfer process by radiation.

CO4: Acquire skills to apply numerical methods for heat transfer solutions.

CO5: Apply the numerical methods as well as analytical methods for heat transfer problem solutions.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓	✓	✓					✓
CO2	✓	✓			✓	✓	✓				✓	✓
CO3			✓	✓	✓	✓	✓				✓	
CO4		✓	✓	✓	✓				✓		✓	✓
CO5	✓	✓	✓	✓	✓	✓					✓	✓

TEXT BOOKS:

01. Sachdeva,S.C., Fundamentals of Engineering Heat and Mass Transfer, NEW AGE publishers,2010.
02. Yunus A. Cengel, Heat Transfer – A Practical Approach Tata McGraw Hill, 4th Edition, 2009.

REFERENCES:

01. NecatiOzisik, Finite Difference Method in Heat Transfer, CRC Press, 2nd edition, 2017.
02. Pradip Majumdar, Computational Methods for Heat & Mass Transfer, CRC Press, 2005.
03. YogeshJaluria, Kenneth E Torrence, Computational Heat transfer, CRC Press, 3rd Edition, 2017.

AE5003 **EXPERIMENTAL STRESS ANALYSIS**

L T P C
3 0 0 3

COURSE OBJECTIVES:

Of this course are

01. Be able to understand the various experimental techniques involved for measuring displacements, stresses, strains in structural components.

02. To familiarize with the different types of strain gages used.

03. To familiarize with the instrumentation system used for strain gauges.

04. Be able to use photo elasticity techniques and methods for stress analysis.

05. Be able to familiarize with the different NDT techniques.

UNIT I BASICS OF MECHANICAL MEASUREMENTS 9

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

UNIT II ELECTRICAL-RESISTANCE STRAIN GAUGES 9

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

UNIT III STRAIN-GAUGE CIRCUITS & INSTRUMENTATION 9

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

UNIT IV PHOTOELASTIC METHODS OF STRESS ANALYSIS 9

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

UNIT V NON-DESTRUCTIVE TESTING 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, Students will be able to

CO1: Analyse the performance of measuring instrumentation.

CO2: Impart knowledge on different methods of strain measurement.

CO3: Design different strain gauge circuits.

CO4: Use photoelasticity for stress analysis.

CO5: Exposure the different types of non-destructive testing methods.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓		✓					✓
CO2	✓	✓	✓	✓	✓		✓					✓
CO3		✓	✓	✓	✓		✓					✓
CO4	✓	✓	✓	✓	✓		✓					✓
CO5	✓	✓	✓	✓	✓		✓					✓

TEXT BOOKS:

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

REFERENCES:

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

ME5452 MECHANICS OF MACHINES L T P C
3 0 0 3

COURSE OBJECTIVES:

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

UNIT I KINEMATIC ANALYSIS IN SIMPLE MECHANISMS AND CAMS 9

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

UNIT II TOOTHED GEARING AND GEAR TRAINS 9

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

UNIT III FRICTION ASPECTS IN MACHINE COMPONENTS 9

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

UNIT IV STATIC AND DYNAMIC FORCE ANALYSIS 9

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

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UNIT V BALANCING OF ROTATING MASSES AND VIBRATION 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

1. Design the linkages and the cam mechanisms for specified output motions.
2. Determine the gear parameters of toothed gearing and speeds of gear trains in various applications.
3. Evaluate the frictional torque in screw threads, clutches, brakes and belt drives.
4. Determine the forces on members of mechanisms during static and dynamic equilibrium conditions.
5. Determine the balancing masses on rotating machineries and the natural frequencies of free and forced vibratory systems.

TEXT BOOK

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

REFERENCES

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

AE5004 WIND ENGINEERING

L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

01. To introduce fundamental aspects of atmospheric air motions and different types of terrain to students.
02. To make students familiarize with properties of atmospheric boundary layer and turbulence effects in atmosphere on structures.
03. To make students knowledgeable on boundary layer separation effects, wake and vortex formations and three-dimensional flow structures.
04. To acquaint students with wind loading analysis and different assessment methods.
05. To elucidate students with basic concepts of aero elastic phenomena and their relevance to wind loaded structures.

UNIT I THE ATMOSPHERE 8

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

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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 9

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: 9

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

COURSE OUTCOMES: Upon completion of this course, Students will be able to

CO1: Design wind turbines for production of wind power on alternative energy source.

CO2: Carry out structural analysis of various industrial structural units which are subjected to wind load.

CO3: Use the principles of atmospheric boundary layer in industrial aerodynamics and separation and reattachment concepts of oscillatory flows.

CO4: Apply the effects of turbulent wind on tall structures.

CO5: Acquire knowledge in vortex shedding and lock in turbulent force.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓		✓	✓	✓		✓		✓	✓
CO2		✓	✓	✓	✓	✓	✓		✓		✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓
CO4	✓	✓	✓		✓	✓	✓		✓			✓
CO5	✓	✓	✓		✓	✓	✓		✓			✓

TEXT BOOKS:

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

REFERENCES:

01. Cook N J, Design Guides to wind loading of buildings structures. Part I & II, Butterworths, don, 1990.

02. Tom Lawson, "Building Aerodynamics", Imperial College Press London, 1st edition, 2001.

Attested

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AE5005 AIRCRAFT ENGINE REPAIRS AND MAINTENANCE L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

01.To introduce fundamental aspects of piston engine maintenance and inspection procedures to students
02.To acquaint students with damage assessment and balancing procedures of propeller
03.To impart knowledge on various tools requirements and testing procedures of piston engine to students
04.To familiarize students with jet engine maintenance, component inspection and damage criteria of engine components
05.To impart knowledge on overhaul procedures and condition monitoring of the engine at various altitudes to students

UNIT I BASIC OF PISTON ENGINE INSPECTION AND MAINTENANCE 9

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 PROPELLER INSPECTION AND REPAIR 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 ENGINE INSPECTION, TESTING AND REPAIR 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 JET ENGINE INSPECTION AND MAINTENANCE 9

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

UNIT V ENGINE OVERHAUL AND TROUBLE SHOOTING 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, Students will be able to

CO1: 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.

CO2: 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.

CO3: Identify, install, inspect, fabricate and repair aircraft sheet metal and synthetic material structures.

CO4: Display proper behaviour reflecting satisfactory work habits and ethics to fulfil program requirements and confidence to prepare for employment.

CO5: Gain insights in balancing and troubleshooting of gas turbine engine components.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	
CO4	✓				✓	✓	✓	✓	✓	✓		✓
CO5	✓	✓	✓			✓	✓	✓	✓	✓		✓

TEXT BOOK:

01. Kroes & Wild, "Aircraft Power plants ", 7th Edition - McGraw Hill, New York, 1994.

REFERENCES:

01. Turbomeca, "Gas Turbine Engines ", The English Book Store ", New Delhi, 1993.
02. United Technologies' Pratt & Whitney, " The Aircraft Gas turbine Engine and its Operation", The English Book Store, New Delhi.

AE5006 **BOUNDARY LAYER THEORY** **L T P C**
3 0 0 3

COURSE OBJECTIVES: Of this course are

01. To acquaint students with the fundamental concepts in boundary layer flow and with the governing equations of viscous flow

02. To make students familiarize with obtaining analytical solutions for low speed viscous flow problems commonly found in engineering applications

03. To introduce the basic concepts in laminar boundary layer theory and its applications in engineering to students

04. To elucidate students on the complex phenomenon in turbulent boundary layer theory and turbulence modelling

05. To make students knowledgeable on the techniques used for boundary layer control.

UNIT I **FUNDAMENTAL EQUATIONS OF VISCOUS FLOW** **9**

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

UNIT II SOLUTIONS OF VISCOUS FLOW EQUATIONS 9

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

UNIT III LAMINAR BOUNDARY LAYER 9

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

UNIT IV TURBULENT BOUNDARY LAYER 9

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

UNIT V BOUNDARY LAYER CONTROL 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, Students will be able to

CO1: Use fundamental equations of the viscous flow for practical examples.

CO2: Solve viscous flow problems for solutions.

CO3: Appreciate the importance of viscosity and shear flow adjacent to the airframe of the aerospace vehicles.

CO4: Gain knowledge on the laminar boundary layer concepts and solution methods.

CO5: Gain insights on the importance of turbulence boundary layer in an aerospace engineering problem.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓				✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓				✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓				✓	✓
CO4	✓	✓	✓	✓	✓	✓	✓				✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓				✓	✓

TEXT BOOKS:

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

REFERENCES:

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

AE5007 DESIGN OF GAS TURBINE ENGINE COMPONENTS L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

01. To introduce basic design concepts of jet engine and estimation of required thrust to students.

02. To make students familiarize with the design parameter and off design calculations.

03. To give the students adequate exposure to design procedure to the rotating components of engine such as compressor and turbine along with staging.

04. To make the students learn the aspects of combustion processes, flame stabilization issue, igniters design and NOx controls.

05. To make students familiarize with the concept of design inlet and nozzle for various on - off design conditions.

UNIT I GAS TURBINE ENGINE DESIGN FUNDAMENTALS 9

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

UNIT II ON DESIGN AND OFF-DESING PARAMETRIC ANALYSIS 9

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

UNIT III DESIGN OF ROTATING COMPONENTS 9

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

UNIT IV COMBUSTION CHAMBER DESIGN 9

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

UNIT V INLET AND NOZZLE DESIGN 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, Students will be able to

CO1: Do preliminary weight and fuel estimation for an aircraft mission.

CO2: Identify variation in parametric analysis of ON and OFF design calculations.

CO3: Explain the principle design of compressor and turbine and selection of suitable materials.

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CO4: Estimate the total pressure losses and able to predict ignition delay.

CO5: Determine the basic design factors affects ON and OFF design operation of inlets and nozzle on engine performance.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓		✓			✓
CO2	✓	✓	✓	✓	✓				✓		✓	
CO3	✓	✓	✓	✓	✓	✓	✓		✓		✓	
CO4	✓	✓	✓	✓	✓				✓		✓	
CO5	✓	✓	✓	✓	✓				✓		✓	

TEXT BOOKS:

01. Mattingly J.D., Heiser, W.H. and Pratt D.T, 'Aircraft Engine Design', 2nd Edition, AIAA Education Series, AIAA, 2002.
02. Oates G.C.,' Aircraft Propulsion Systems Technology and Design',1989, AIAA Education Series.
03. Saravanamuttoo H.I.H and Rogers, G.F.C. "Gas Turbine Technology", Pearson Education Canada; 6th edition, 2008.

REFERENCES:

01. Cumpsty N., "Jet Propulsion: A Simple Guide to the Aerodynamics and Thermodynamics Design and Performance of Jet Engines" , Cambridge University Press; 2nd edition, 2003
02. Murthy S.N. and Curran E.T.,' High-Speed Flight Propulsion Systems', Volume 137, Progress in Astronautics and Aeronautics, AIAA,1991.
03. Rathakrishnan E, 'Applied Gas Dynamics, John Wiley & Sons (Asia) Pvt Ltd, 2010.
04. Treage I.E, Aircraft Gas Turbine Engine Technology, 3rd edition, Glencoe McGraw-Hill, Inc. 1995

ME5251 MANUFACTURING PROCESSES **L T P C**
3 0 0 3

COURSE OBJECTIVES:

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

1. Applying the working principles of various metal casting processes.
2. Applying the working principles of various metal joining processes.
3. Analyzing the working principles of bulk deformation of metals.
4. Applying the working principles of sheet metal forming process.
5. Applying the working principles of plastics molding.

UNIT I METAL CASTING PROCESSES **9**

Sand Casting – Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Molding sand Properties and testing – Cores –Types and applications – Molding machines – Types and applications– Melting furnaces – Principle of special casting processes- Shell, investment – Ceramic mould – Pressure die casting – Centrifugal Casting - CO casting - Defects in Sand casting process – Stir casting - Defects in Sand casting.

UNIT II METAL JOINING PROCESSES 9

Fusion welding processes – Type of Gas welding – Flame characteristics – Filler and Flux materials – Arc welding, Electrodes, Coating and specifications – Principles and types of Resistance welding – Gas metal arc welding – Submerged arc welding – Electro slag welding – Gas Tungsten arc welding – Principle and application of special welding processes – Plasma arc welding – Thermit Welding – Electron beam welding – Friction welding – Friction stir welding – Diffusion welding – Weld defects – Brazing and soldering – methods and process capabilities – Adhesive bonding, Types and application

UNIT III BULK DEFORMATION PROCESSES 9

Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – Characteristics of the processes – Typical forging operations – rolling of metals – Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts – Principle of rod and wire drawing – Tube drawing – Principles of Extrusion – Types – Hot and Cold extrusion.

UNIT IV SHEET METAL PROCESSES 9

Sheet metal characteristics – Typical shearing, bending and drawing operations – Stretch forming operations – Formability of sheet metal – Test methods –special forming processes - Working principle and applications – Hydro forming – Rubber pad forming – Metal spinning – Introduction of Explosive forming, magnetic pulse forming, peen forming, Super plastic forming – Micro forming – Incremental forming.

UNIT V MANUFACTURE OF PLASTIC COMPONENTS 9

Types and characteristics of plastics – Molding of thermoplastics – working principles and typical applications – injection molding – Plunger and screw machines – Compression molding, Transfer Molding – Typical industrial applications – introduction to blow molding – Rotational molding – Film blowing – Extrusion – Thermoforming – Bonding of Thermoplastics.

TOTAL = 45 PERIODS

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

1. Apply the working principles of various metal casting processes.
2. Apply the working principles of various metal joining processes.
3. Analyze the working principles of bulk deformation of metals.
4. Apply the working principles of sheet metal forming process.
5. Apply the working principles of plastics molding.

TEXT BOOKS:

1. Kalpakjian. S, “Manufacturing Engineering and Technology”, Pearson Education India Edition, 2006.
2. Roy. A. Lindberg, Processes and materials of manufacture, PHI / Pearson education, 2006.

REFERENCES:

1. Gowri.S, P. Hariharan, A.SureshBabu, Manufacturing Technology I, Pearson Education, 2008.
2. HajraChouldhary S.K. and Hajra Choudhury. A. K., Elements of Workshop Technology, Volume I and II, Media Promoters and Publishers Private Limited, Mumbai, 1997.
3. Paul Degarma E., Black J.T. and Ronald A. Kosher, Materials and Processes, in Manufacturing, Eight Edition,Prentice Hall of India, 1997.
4. Rao. P. N., Manufacturing Technology Foundry, Forming and Welding, 2nd Ed.Tata McGraw Hill, 2003.
5. Sharma, P.C., A Textbook of Production Technology, S.Chand and Co. Ltd., 2004.

CO	PO												PSO		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
1	0.9						0.6					0.3	0.6	0.3	0.3
2	0.9						0.6					0.3	0.6	0.3	0.3
3	0.9						0.6					0.3	0.6	0.3	0.3
4	0.9						0.6					0.3	0.6	0.3	0.3
5	0.9						0.6					0.3	0.6	0.3	0.3

AE5008 **THEORY OF ELASTICITY**

L T P C
3 0 0 3

COURSE OBJECTIVES:

Of this course are

01. To improve the ability to use the principles of theory of elasticity in engineering problems.

02. To analyze some real problem and to formulate the conditions of theory of elasticity application.

03. To familiarize with the stress function approach in solving linear elasticity problems.

04. To execute a reasonable choice of parameters of the model (geometry, material properties, and boundary conditions).

05. To provide the foundation for pursuing other solid mechanics courses such as theory of plates and shells, elastic stability, composite structures and fracture mechanics.

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

OUTCOMES: Upon completion of this course, Students will be able to

CO1: have knowledge on the difference between Strength of Materials approach and Theory of Elasticity

CO2: Exhibit better understanding on the strain-displacement relation, stress-strain relations and stress ellipsoid

CO3: Demonstrate the knowledge on the classification of 2-D problems and the methods of solution.

CO4: Formulate of governing equations and solution for torsion of non-circular sections.

CO5: Solve the governing equation for plate bending.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓		✓					✓
CO2	✓	✓	✓	✓	✓		✓					✓
CO3	✓	✓	✓	✓	✓		✓					✓
CO4	✓	✓	✓	✓	✓		✓					✓
CO5	✓	✓	✓	✓	✓		✓					✓

TEXT BOOKS:

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

REFERENCES:

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

AE5009 **ADVANCED AEROSPACE MATERIALS** **L T P C**
3 0 0 3

COURSE OBJECTIVES: Of this course are

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

02. To familiarize with the high performance alloys used in aerospace applications.

03. To gain knowledge of the various high temperature materials and their characterisation methods.

04. To gain knowledge of the various thermal protection systems and coatings.

05. To familiarize with the smart materials used for aerospace applications.

UNIT I MECHANICAL BEHAVIOUR 9

Properties of Conventional Aircraft Materials – Linear and Non-Linear Behaviour – Yielding, Strain Hardening and Fracture – Design for Strength – General Requirements of Materials for Aerospace Applications – Principles of Stressed Skin Construction – Effect of Manufacturing Procedures on Material Behaviour – Micro-structural Influence of Mechanical Behaviour.

UNIT II HIGH PERFORMANCE ALLOYS 9

High Performance Alloys For Aerospace Application – Aluminium, Magnesium, and Titanium alloys – Comparison of Properties – Steel Quality & Effect of Carbon Content – Effect of Alloying & Heat Treatments – Properties of Advanced Alloys used in Aircraft – Effect of Corrosion on Mechanical properties – Stress Corrosion Cracking – Corrosion Resistance Materials – Heat Resistance Alloys – Effect of Alloying Elements & Ideal Percentage Composition.

UNIT III HIGH TEMPERATURE MATERIALS 9

Carbon/Carbon composites – Properties & Advantages – Fabrication Processes – Metal Matrix Composites – Mechanical Properties – Mechanical and Thermal Properties of Materials at Elevated Temperatures – Super Alloys – Ceramic Material Systems and Their Properties – Fabrication of Ceramic Composites – Cermet Tools – Application of These Materials in The Thermal Protection Systems of Aerospace Vehicles – Application of High Temperature Materials in an Aircraft.

UNIT IV CHARACTERIZATION OF MATERIAL STRUCTURE 9

X-Ray Diffraction And Their Applications **–** Absorption of X-rays and filters - X-ray – Diffraction Directions - Working Principles of Transmission Electron Microscopes – Image Formation – Resolving Power – Magnification & Depth of Focus – Advanced Chemical and Thermal analysis **–** Basic Principles & Practice – Augur Spectroscopy – Differential Thermal Analysis.

UNIT V SMART MATERIALS FOR AEROSPACE APPLICATION 9

Fundamentals of Piezoelectricity – Soft and Hard Piezoelectric Ceramics – Basic Piezoceramic Characteristics – Shape Memory Alloys - Fundamentals of Shape Memory Alloy (SMA) Behavior – Phase Transformation – Lattice Structure and Deformation Mechanism – Origin of the One-Way Shape Memory Effect – Stress Induced Martensite and Pseudoelasticity – Two-Way Shape Memory Effect.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, Students will be able to

- **CO1:** Demonstrate the mechanical behaviour of materials and ability to compare material performance.
- **CO2:** Suggest suitable material for specific applications.
- **CO3:** Investigate the influence of process parameters on material behaviour.
- **CO4:** Impart Knowledge on the state of the art techniques in material characterization.
- **CO5:** Explain the physical understanding of piezoelectric and SMA behaviour.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓	✓		✓					✓
CO2		✓	✓	✓	✓		✓					✓
CO3		✓	✓	✓	✓		✓					✓
CO4		✓	✓	✓	✓		✓					✓
CO5		✓	✓	✓	✓		✓					✓

TEXT BOOKS:

01. Adrian Mouritz,'AIAA Education Series – Introduction to Aerospace Materials, 2012.
02. Titterton.G., Aircraft Materials and Processes, V Edition, Pitman Publishing Co., 1995.

REFERENCES:

01. Martin, J.W., Engineering Materials, Their properties and Applications, Wykedham Publications (London) Ltd., 1987.
02. Prasad**,** N. Eswara**,** Wanhill, R. J. H Aerospace Materials and Material Technologies – Indian Institute of Metals Series, 2017.
03. Raghavan.V., Materials Science and Engineering, Prentice Hall of India, New Delhi, 5th edition, 2004.
04. Sam Zhang, 'Aerospace Materials Handbook (Advances in Materials Science and Engineering) 1st Edition, 2016.
05. Van Vlack.L.H., Elements of Materials Science and Engineering Prentice Hall; publishers, 6th edition, 1989

AE5010 **AIRCRAFT DESIGN** **L T P C**
3 0 0 3

COURSE OBJECTIVES: Of this course are

01. To familiarise with the various configurations of airplanes.
02. To familiarise with selection of proper power plant.
03. To gain knowledge in performance parameters of airplanes.
04. To expose the students with optimization of wing loading.
05. To impart knowledge in structural design of airplanes.

UNIT I REVIEW OF DEVELOPMENTS IN AIRPLANES 9

Categories and types of aircrafts – various configurations – Layouts and their relative merits – strength, stiffness, fail safe and fatigue requirements – Maneuvering load factors – Gust and maneuverability envelopes – Balancing and maneuvering loads on tail planes.

UNIT II POWER PLANT TYPES AND CHARACTERISTICS 9

Selection of power plants, Characteristics of different types of power plants – Propeller characteristics and selection – Relative merits of location of power plant.

UNIT III PRELIMINARY DESIGN 9

Selection of geometric and aerodynamic parameters – Weight estimation and balance diagram – Drag estimation of complete aircraft – Level flight, climb, takeoff and landing calculations – range and endurance – static and dynamic stability estimates – control requirements.

UNIT IV SPECIAL PROBLEMS 9

Layout peculiarities of subsonic and supersonic aircraft – optimization of wing loading to achieve desired performance – loads on undercarriages and design requirements.

UNIT V STRUCTURAL DESIGN 9

Estimation of loads on complete aircraft and components – Structural design of fuselage, wings and undercarriages, controls, connections and joints. Materials for modern aircraft – Methods of analysis, testing and fabrication.

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, Students will be able to

- **CO1:** Select proper airplane configuration for their design.
- **CO2:** Install the power plant in proper location to generate required thrust.
- **CO3:** Estimate complete performance and stability parameter such as range, endurance, static margin, centre of gravity of airplane etc.
- **CO4:** Carry out design of wing and fuselage.
- **CO5:** Demonstrate complete design procedure for an airplane.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓		✓		✓	✓	✓	
CO2	✓	✓	✓	✓	✓		✓		✓	✓	✓	
CO3	✓	✓	✓	✓	✓		✓		✓	✓	✓	
CO4	✓	✓	✓	✓	✓				✓	✓	✓	
CO5	✓	✓	✓	✓	✓				✓	✓	✓	

TEXT BOOKS:

01. D.P. Raymer, “Aircraft conceptual design”, AIAA Series, 1988
02. Mohammad H. Sadraey, “Aircraft Design a Systems Engineering Approach”, A John Wiley & Sons, Ltd., Publication, 1st edition. 2013.

REFERENCES:

01. G. Corning, “Supersonic & Subsonic Airplane Design”, II Edition, Edwards Brothers Inc.,Michigan, 1953.
02. E.F. Bruhn, “Analysis and Design of Flight Vehicle Structures”, Tristate Offset Co., U.S.A., 1980.
03. E. Torenbeek, “Synthesis of Subsonic Airplane Design”, Delft University Press, London, 1976.
04. H.N.Kota, Integrated design approach to Design fly by wire” Lecture notes Interline Pub. Bangalore, 1992.

AE5011 FUNDAMENTALS OF CONTROL ENGINEERING

L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

01. To introduce the mathematical modelling of systems, open loop and closed loop systems and analyses in time domain and frequency domain.
02. To introduce sampled data control system.
03. To impart the knowledge on the concept of stability.
04. To impart knowledge on the various methods to analyze stability in both time and frequency domain.
05. To introduce state models for linear continuous time systems.

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 9

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

UNIT V STATE VARIABLE ANALYSIS 9

Introduction – Concepts of state, state variables and state model – State models for linear continuous time systems – Solution of state equations – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course the student will be able to

CO1: The characteristics, uses and limitations of classical and modern feedback control methods.
CO2: Acquire knowledge on open and closed loop systems.
CO3: Distinguish between the responses of different order systems for various step inputs.
CO4: Apply the concepts of time response and frequency responses for the practical systems.
CO5: Acquire in-depth knowledge of PID control and state-space representation.

Attested

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓	✓					✓	✓	
CO2		✓	✓	✓	✓					✓	✓	
CO3		✓	✓	✓	✓					✓	✓	
CO4		✓	✓	✓	✓					✓	✓	
CO5		✓	✓	✓	✓					✓	✓	

TEXT BOOKS:

01. Kuo, B.C. Automatic control systems, Prentice-Hall of India Pvt. Ltd., New Delhi, 2017.
02. Naresh K Sinha, Control Systems, New Age International Publishers, New Delhi, 2008.

REFERENCES:

01. Nagrath I.J & Gopal M Control System Engineering, New Age International Publishers, 4th Edition, 2006.
02. OGATO, Modern Control Engineering, Prentice-Hall of India Pvt. Ltd., New Delhi, 5th Edition, 2010.

AE5012 THEORY OF VIBRATION

L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

01. To impart knowledge on the fundamentals of Vibration Theory.
02. To do mathematically model for real-world mechanical vibration problems.
03. To familiarize with the multi degree of freedom systems.
04. To impart knowledge to obtain a complete solution to mechanical vibration problems using mathematical or numerical techniques.
05. To familiarize with the different aeroelastic problems.

UNIT I SINGLE DEGREE OF FREEDOM SYSTEMS 9

Introduction to simple harmonic motion, D'Alembert's Principle, Free vibrations – Damped vibrations – Forced Vibrations, with and without damping – support excitation – Transmissibility - Vibration measuring instruments.

UNIT II MULTI DEGREES OF FREEDOM SYSTEMS 9

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 9

Vibration of elastic bodies - Vibration of strings – Longitudinal, Lateral and Torsional vibrations

UNIT IV APPROXIMATE METHODS 9

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

UNIT V ELEMENTS OF AEROELASTICITY 9

Coupled flexural–Torsional oscillation of beam- Aeroelastic problems - Collars triangle - Wing Divergence - Aileron Control reversal – Flutter – Buffeting. – Elements of servo elasticity.

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, Students will be able to

CO1: Solve problems in free, free damped and forced vibration characteristics of single degree of freedom systems.

CO2: Analyse the vibration characteristic of multi degree of freedom systems including orthogonality conditions.

CO3: Analyse the vibration characteristics of continuous system such as strings, bar, shafts and beams.

CO4: Calculate the fundamental frequency of multi degree of freedom systems using approximate methods.

CO5: Investigate the aero elastic effects of 2D wing.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓		✓				✓	✓
CO2	✓	✓	✓	✓	✓		✓				✓	✓
CO3	✓	✓	✓	✓	✓		✓				✓	✓
CO4	✓	✓	✓	✓	✓		✓				✓	✓
CO5	✓	✓	✓	✓	✓		✓				✓	✓

TEXT BOOKS:

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

REFERENCES:

01. Bisplinghoff R.L., Ashely H and Hogman R.L., Aero elasticity – Addison Wesley Publication, New York, 1983.
02. Den Hartog, 'Mechanical Vibrations' Crastre Press, 2008.
03. TSE. F.S., Morse, I.F., Hinkle, R.T., 'Mechanical Vibrations' – Prentice Hall, New York, 1984.
04. William Weaver, Stephen P. Timoshenko, Donovan H. Young, Donovan H. Young.'Vibration Problems in Engineering' – John Wiley and Sons, New York, 200.
05. William W Seto, 'Mechanical Vibrations' – McGraw Hill, Schaum Series, 1964.

AE5013 PRINCIPLES AND APPLICATIONS OF TOTAL QUALITY MANAGEMENT

L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

01. To learn about the evolution and the basic concepts of quality.
02. To understand the various principles, practices of TQM to achieve quality.
03. To learn the various statistical approaches for Quality control.
04. To understand the TQM tools for continuous process improvement.
05. To learn the importance of ISO and Quality systems.

UNIT I INTRODUCTION 9

Introduction – Need for quality – Evolution of quality – Definition of quality – Dimensions of product and service quality – Basic concepts of TQM – TQM Framework – Barriers to TQM Contributions of Quality Gurus —Deming's 14 point principles – Crosby's 14 point principles – Juran Triology.

UNIT II TQM PRINCIPLES 9

Quality statements – Customer focus –Customer orientation, Customer satisfaction, Customer complaints, Customer retention – Continuous process improvement – PDCA cycle, 5s, Kaizen –Supplier partnership – Partnering, Supplier selection, Supplier Rating.

UNIT III TOOLS & TECHNIQUES I 9

The seven traditional tools of quality- Histogram – Pareto diagram – Cause and effect diagram – Flow charts –Check sheet – Scatter diagram – Quality control charts – The seven new tools of quality – Why-why analysis – Affinity diagram – Interrelationship digraph – Tree diagram – Prioritization matrix – Process decision program chart – Activity network diagram.

UNIT IV TOOLS & TECHNIQUES II 9

Quality circles – Quality Function Deployment (QFD) – Taguchi methodology – Total Productive Maintenance –Concepts – Business Process Reengineering – Six-sigma – Concepts – case studies – Bench marking — Failure Mode and Effect Analysis – Stages, Types.

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000- ISO 9000-2000 Quality System – Elements, Documentation, Quality auditing QS 9000 – ISO 14000 – Concepts, Requirements and Benefits –Quality Council – Leadership, Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, Students will be able to

CO1: Apply basic concepts of quality gurus.
CO2: Gain and apply the knowledge of TQM principles.
CO3: Identify the appropriate the statistical tool to achieve the quality control.
CO4: Employ the principles of continuous process improvement tools.
CO5: Gain and apply the knowledge of quality systems.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓		✓		✓			✓	✓
CO2	✓	✓	✓	✓		✓		✓			✓	✓
CO3	✓	✓	✓	✓		✓		✓			✓	✓
CO4	✓	✓	✓	✓		✓		✓			✓	✓
CO5	✓	✓	✓	✓		✓		✓			✓	✓

TEXT BOOKS:

01. Dale H.Besterfield Carol Besterfield-Michna, Glen H.Besterfield, Mary Besterfied-Sacre, Hemant Urdhwareshe, Rashmi Urdhwareshe, "Total Quality Management, Pearson Publications, 3rd Edition, 2003.
02. Oakland, J.S. "TQM – Text with Cases", Butterworth – Heinemann Ltd., Oxford, 3rd Edition, 2003.

REFERENCES:

01. James R. Evans and William M. Lindsay, "The Management and Control of Quality", 6th Edition, South-Western (Thomson Learning), 2005.
02. Janakiraman,B and Gopal, R.K, "Total Quality Management – Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
03. Chapman and Hall, "Total Quality Management", 2nd Edition, 1995.
04. Mukherjee,P.N "Total Quality Management", Prentice- Hall iof India Private Limited, 2006.
05. Suganthi,L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.

AE5014 AIRFRAME REPAIR AND MAINTENANCE L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

01. To familiarise with various types of airframe repairs and inspection procedures.
02. To impart knowledge on the materials used for airframe components.
03. To assembly and disassembling of airframe components.
04. To familiarise with the hydraulic and pneumatic components of airplanes.
05. To make the students understand safety procedure followed for repairing of airplanes.

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 9

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

UNIT V SAFETY PRACTICES 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, Students will be able to

CO1: Identify and apply the principles of function and safe operation to aircraft as per FAA.
CO2: Demonstrate the general airframe structural repairs, the structural repair manual and structural control programme.
CO3: Perform airframe structural component inspection, corrosion repair and non-destructive inspection.
CO4: Do aircraft component disassembly, reassembly and troubleshooting.
CO5: Acquire knowledge on 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.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓	✓	✓	✓	✓	✓	✓		
CO2	✓	✓		✓	✓	✓	✓	✓	✓	✓		
CO3		✓		✓	✓	✓	✓	✓	✓	✓		
CO4	✓	✓		✓	✓	✓	✓	✓	✓	✓		
CO5	✓	✓		✓	✓	✓	✓	✓	✓	✓		

TEXT BOOKS:

01. Kroes, Watkins, Delp, "Aircraft Maintenance and Repair ", McGraw Hill, New York, 7th Edition, 2013.

REFERENCES:

01. Brimm D.J. Bogges H.E., "Aircraft Maintenance ", Pitman Publishing corp., NewYork, 2009.
02. Delp. Bent and Mckinely “Aircraft Maintenance Repair”, McGraw Hill, New York, 1987.
03. Larry Reithmeir, “Aircraft Repair Manual ", Palamar Books, Marquette, 1992.

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AE5015 **AERO ELASTICITY** **L T P C**
3 0 0 3

COURSE OBJECTIVES: Of this course are

1. Explain structural concepts such as elastic stiffness, inertia, influence coefficients, elastic axis, and shear center.
2. Describe structural dynamics of wings, including bending and torsion modes of vibration and their associated natural frequencies.
3. Apply aeroelastic concepts of divergence, flutter, lift and roll effectiveness, aileron reversal, and mode coalescence.
4. Knowledge to formulate and derive static and dynamic aeroelastic equations of motion.
5. To Apply Rayleigh-Ritz Method for Approximate continuous aeroelastic systems able to Interpret velocity-damping and velocity-frequency flutter diagrams.

UNIT I AERO ELASTICITY PHENOMENA 9

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 9

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 9

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 9

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

COURSE OUTCOMES: Upon completion of this course, Students will be able to

CO1: Investigate the different aero elastic phenomenon and the methods of counteracting it.

CO2: Explain how the aeroelastic phenomena flutter, divergence and aileron reversal arise and how they affect aircraft performance.

CO3: Formulate aeroelastic equations of motion and use them to derive fundamental relations for aeroelastic analysis.

CO4: 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.

CO5: Estimate the critical divergence, reversal and flutter speeds of an airplane and to investigate the stability of the disturbed motion.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓	✓							✓
CO2		✓	✓	✓	✓							✓
CO3		✓	✓	✓	✓							✓
CO4		✓	✓	✓	✓							✓
CO5		✓	✓	✓	✓							✓

TEXT BOOKS:

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

REFERENCES:

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

AE5016 MISSILE AERODYNAMICS L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

01. To introduce different classes of missiles and rockets to students.
02. To impart adequate knowledge on various airframe components of missiles and their functions to students.
03. To give exposure to analyse the various forms of drag and its estimations to students.
04. To make the students familiarize with the concepts of staging and stage separation methods.
05. To make students learn the stability and control aspects 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

Various configurations-components-forces on the vehicle during atmospheric flight-nose cone design and drag estimation-various types of drag and their origin–methods to minimize the drag types.

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.

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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.

UNIT V 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

COURSE OUTCOMES:

Upon completion of this course, Students will be able to

CO1: Acquire enough knowledge on various configurations of missiles and rockets.

CO2: Predict the aerodynamics characteristics of various airframes components.

CO3: Acquire knowledge on unsteady flow characterizes of launch vehicles.

CO4: Compare the aerodynamics performance of missiles determined form wind tunnel tests and CFD results.

CO5: Determine the stability characteristics of missiles and necessary forces required to control.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓		✓	✓			✓		✓	✓
CO2	✓	✓	✓	✓	✓				✓		✓	✓
CO3	✓	✓	✓	✓	✓		✓		✓		✓	✓
CO4	✓	✓	✓	✓	✓	✓			✓		✓	✓
CO5	✓	✓	✓	✓	✓				✓		✓	✓

TEXT BOOKS:

01. Chin SS, Missile Configuration Design, McGraw Hill, New York, 1961.
02. Nielsen, Jack N, Stever, Gutford, “Missile Aerodynamics”, McGraw Hill, New York, 1988.

REFERENCES:

01. Anderson, J.D., “Fundamentals of Aerodynamics”, McGraw-Hill Book Co., New York, 2011.
02. John D. Anderson. Jr., “Hypersonic and High Temperature Gas Dynamics”, AIAA; 2nd edition, 2006.
03. John D. Anderson. Jr., “Modern Compressible flow with historical Perspective”, McGraw Hill Publishing Company, 3rd edition, 2002.

AE5017 **NUMERICAL HEAT TRANSFER** **L T P C**
3 0 0 3

COURSE OBJECTIVES: Of this course are

01. To impart knowledge to students in the fundamental principles of various numerical methods which are useful to obtain numerical solutions to heat transfer problems.

02. To make the students learn numerical methods to obtain solution to 1-D, 2-D and 3-D conductive heat transfer problems.

03. To introduce both implicit and explicit methods for numerical solution of transient heat conduction problems to students.

04. To make the students familiarize with the numerical treatment of convective heat transfer problems to compute velocity and temperature profiles in boundary problems.

05. To acquaint students with the use of finite volume method in radiative heat transfer problems.

UNIT I INTRODUCTION 9

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

UNIT II CONDUCTIVE HEAT TRANSFER 9

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

UNIT III TRANSIENT HEAT CONDUCTION 9

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

UNIT IV CONVECTIVE HEAT TRANSFER 9

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

UNIT V RADIATIVE HEAT TRANSFER 9

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

TOTAL: 45 PERIODS

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COURSE OUTCOMES:

Upon completion of this course, Students will be able to

CO1: Acquire knowledge on the basic concepts on the applications of numerical methods for the heat transfer problem solutions.

CO2: Appreciate the role of boundary conditions in defining the complexities and the methodology for numerical solutions of heat transfer problems.

CO3: Use both implicit and explicit schemes for transient heat conduction problems.

CO4: Compute the temperature profiles in thermal boundary layer.

CO5: Apply finite volume methods for radiative heat transfer problems and the role of Montecarlo methods in radiative heat transfer.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓	✓					✓	✓
CO2	✓	✓	✓	✓	✓	✓	✓				✓	✓
CO3		✓	✓	✓	✓				✓		✓	✓
CO4		✓	✓	✓	✓		✓				✓	✓
CO5		✓	✓	✓	✓	✓	✓		✓		✓	

TEXT BOOKS:

01. Sachdeva,S.C., Fundamentals of Engineering Heat and Mass Transfer, NEW AGE publishers,2010.
02. Yunus A. Cengel, Heat Transfer – A Practical Approach Tata McGraw Hill 4th Edition, 2009.

REFERENCES:

01. NecatiOzisik, Finite Difference Method in Heat Transfer, CRC Press, 2nd edition, 2017.
02. Pradip Majumdar, Computational Methods for Heat & Mass Transfer, CRC Press, 2005.
03. YogeshJaluria, Kenneth E Torrence, Computational Heat transfer, CRC Press, 3rd Edition, 2017.

AE5018 STRUCTURAL DYNAMICS

L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

01. To study the effect of periodic and a periodic forces on mechanical systems and the significance of resonance.

02. To gain knowledge in force deflection properties of structures.

03. Impart to the student the theory and understanding of free and forced vibrations and system response.

04. To familiarise with the natural frequencies of a given physical system.

05. To gain knowledge in energy and approximate methods of analysis.

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

COURSE OUTCOMES: Upon completion of this course, Students will be able to

CO1: Demonstrate fundamental theory of dynamic equation of motion, analysis methods for dynamic systems.

CO2: Will be able to: apply knowledge of mathematics, science, and engineering by developing the equations of motion for vibratory systems and solving for the free and forced response.

CO3: Analyse the different energy methods used to investigate the vibration characteristics of plates and beams.

CO4: Investigate the natural modes of vibration of different structural components and Knowledge of mathematical modelling of structures.

CO5: Use approximate methods to investigate the natural modes of vibration of a system.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓		✓				✓	✓
CO2	✓	✓	✓	✓	✓		✓				✓	✓
CO3	✓	✓	✓	✓	✓		✓				✓	✓
CO4	✓	✓	✓	✓	✓		✓				✓	✓
CO5	✓	✓	✓	✓	✓		✓				✓	✓

TEXT BOOKS:

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

REFERENCES:

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

AE5071 AIRCRAFT SYSTEMS ENGINEERING

L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

01. To introduce basic concepts of systems engineering and their application to aircraft systems.

02. To acquaint students with design, build, test, operate and disposal phases of aircraft systems and aircraft operating environment system.

03. To impart knowledge on evolution of avionics architecture and arrangements of systems integration of aircraft.

04. To familiarise students with varying system configurations and their compatibility and system evolution considerations.

05. To impart knowledge on fault and failure analysis of aircraft systems and components and types of maintenance procedures

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

COURSE OUTCOMES:

Upon completion of this course, Students will be able to

CO1: Acquire knowledge on the basic working principle of hydraulic and pneumatic systems and their components.

CO2: Identify the types of control systems namely conventional and modern systems and the need to choose them for specific aircraft application.

CO3: Acquire knowledge on the different types of fuel system used for piston engine and jet engines.

CO4: Identify the different configurations of aircrafts and compatibility of various systems.

CO5: Acquire knowledge on the fault and failure analysis of aircraft systems.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓				✓	✓	✓	✓	✓	✓	✓	✓
CO2	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓				✓	✓	✓	✓	✓	✓	✓	✓
CO4	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓
CO5	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓

TEXT BOOKS:

01. Allan G. Seabridge and Ian Moir, “Design and Development of Aircraft Systems: An Introduction “, (AIAA Education Series), 2004.

REFERENCES:

01. Andrew P. Sage, James E., Jr. Armstrong, "Introduction to Systems Engineering (WileySeries in Systems Engineering and Management)”, 2000.
02. Aslaksen, Erik and Rod Belcher, “Systems Engineering”, Prentice Hall, 1992.
03. Peter.Sydenham , “Systems Approach to Engineering”, Artech house, Inc, London, 2004.

AE5072 AVIONICS SYSTEMS

L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

01. To introduce the basic of avionics and its need for civil and military aircrafts.
02. To impart knowledge about the avionic architecture and various avionics data buses.
03. To gain more knowledge on various avionics subsystems.
04. To impart knowledge on feedback systems.
05. To gain knowledge in field of navigation systems.

UNIT I INTRODUCTION TO AVIONICS 9

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

UNIT II DIGITAL AVIONICS ARCHITECTURE 9

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

UNIT III FLIGHT DECKS AND COCKPITS 9

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

UNIT IV INTRODUCTION TO NAVIGATION SYSTEMS 9

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

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UNIT V AIR DATA SYSTEMS AND AUTO PILOT 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, Students will be able to

CO1: Apply the basics of avionics subsystems architecture.

CO2: Distinguish between the needs of civil and military avionics systems.

CO3: Acquire knowledge on display technologies.

CO4: Build Digital avionics architecture.

CO5: Design navigation system and ability to design and perform analysis on air data system.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓	✓				✓		✓	✓
CO2		✓	✓	✓	✓				✓		✓	✓
CO3		✓	✓	✓	✓				✓		✓	✓
CO4		✓	✓	✓	✓				✓		✓	✓
CO5		✓	✓	✓	✓				✓		✓	✓

TEXT BOOKS:

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

REFERENCES:

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

AE5019 FATIGUE AND FRACTURE MECHANICS

L T P C
3 0 0 3

COURSE OBJECTIVES:

Of this course are

01. To impart knowledge in structural integrity in the context of fatigue failure.

02. To gain knowledge in statistical aspects of fatigue behaviour.

03. To impart knowledge in physical aspects of fatigue.

04. To familiarize the student with theoretical fracture mechanics and make him/her competent to carry out simple fracture analysis procedures

05. To enable the student to appreciate the different aspects of fatigue testing methods

UNIT I FATIGUE OF STRUCTURES 9

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

UNIT II STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR 9

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

UNIT III PHYSICAL ASPECTS OF FATIGUE 9

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

UNIT IV FRACTURE MECHANICS 9

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

UNIT V FATIGUE DESIGN AND TESTING 9

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

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, Students will be able to

- **CO1:** Develop a solid foundation in the theory, concepts and principles of fracture mechanics,
- **CO2:** Be able to use these solutions to guide a corresponding design, manufacture, or failure analysis
- **CO3:** Ability to investigate the life of a structure under dynamic loading conditions.
- **CO4:** Knowledge of fracture mechanics approach applicable to homogeneous and heterogeneous materials
- **CO5:** Knowledge of probalistic approach and development of mathematical models for life prediction of structures and knowledge of safe life and fail safe design.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓		✓					✓
CO2	✓	✓	✓	✓	✓		✓					✓
CO3	✓	✓	✓	✓	✓		✓					✓
CO4	✓	✓	✓	✓	✓		✓					✓
CO5	✓	✓	✓	✓	✓		✓					✓

TEXT BOOKS:

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

REFERENCES:

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

AE5020 **HELICOPTER ENGINEERING**

L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

01. To introduce fundamental aspects on helicopter rotor aerodynamics, generation of lift and rotor control & efficiency to students

02. To make students familiarize with the concepts like hovering and vortex ring state and calculation of induced power

03. To make students knowledgeable on helicopter flight performance calculations and on criteria for selection of power plants

04. To acquaint students with lateral and longitudinal stability characteristics of helicopter and the differences between stability and control

05. To elucidate students on the structural problems peculiar to helicopter rotor like rotor vibration

UNIT I INTRODUCTION **9**

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

UNIT II AERODYNAMICS OF ROTOR BLADE **9**

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

UNIT III POWER PLANTS AND FLIGHT PERFORMANCE **9**

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

UNIT IV STABILITY AND CONTROL **9**

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

UNIT V ROTOR VIBRATIONS **9**

Dynamic model of the rotor, Motion of the rigid blades, flapping motion, lagging motion, feathering motion, Properties of vibrating system, phenomenon of vibration, fuselage response, vibration.
absorbers, Measurement of vibration in flight. Rotor Blade Design: General considerations, Airfoil selection, Blade construction, Materials, Factors affecting weight and cost, Design conditions, Stress analysis.

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, Students will be able to

CO1: Perform the Aerodynamics calculation of Rotor blade.

CO2: Perform stability and control characteristics of Helicopter.

CO3: Perform and control Rotor vibration.

CO4: Explain the stability characteristics of a helicopter.

CO5: Demonstrates the role of rotor vibrations in helicopter design.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓	✓			✓		✓	✓
CO2	✓	✓	✓		✓	✓			✓		✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓		✓		✓	
CO4	✓	✓	✓	✓	✓	✓	✓		✓		✓	
CO5	✓	✓	✓	✓	✓	✓	✓		✓		✓	

TEXT BOOKS

01. John Fay, Helicopter: history, piloting and How It Flies, Himalayan Books 1995.
02. Lalit Gupta, Helicopter Engineering; Himalayan Books New Delhi 1996.
03. Rathakrishnan E,Helicopter Aerodynamics,PHI Learning Pvt Ltd,NewDelhi,2019.

REFERENCES:

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

AE5021 SPACE MECHANICS

L T P C
3 0 0 3

COURSE OBJECTIVES: Of this course are

01. To introduce special needs for manned space missions and precalculation of space environment to students.

02. To impart the knowledge on basis concepts of space mechanics like Newton's law of gravitation and its applications, reference co-ordinate systems and position vs time relationships of celestial bodies.

03. To acquaint students on the methodologies for computation of satellite orbit perturbations

04. To elucidate the concepts of space of influence and its purpose in computing interplanetary trajectories to students.

05. To impart knowledge of various phases of ballistic trajectories and special features of re-entry phase to students.

UNIT I SPACE ENVIRONMENT 9

Peculiarities of space environment and its description– effect of space environment on materials of spacecraft structure and astronauts- manned space missions – effect on satellite life time.

UNIT II BASIC CONCEPTS AND THE GENERAL N- BODY PROBLEM 9

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

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UNIT III SATELLITE INJECTION AND SATELLITE PERTURBATIONS 9

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 9

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

COURSE OUTCOMES: Upon completion of this course, Students will be able to

CO1: Acquire knowledge on the unique features of space environment and its effect on space craft and astronauts.

CO2: Compute position of bodies in orbits in terms of their coordinates with respect to time.

CO3: Gain insights on the intricate aspects of satellite injectors.

CO4: Determine and compute interplanetary trajectories.

CO5: Make calculations of all important phases of missile trajectories.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓		✓		✓	✓
CO2	✓	✓	✓	✓	✓				✓		✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓		✓		✓	
CO4	✓	✓	✓	✓	✓	✓			✓		✓	✓
CO5	✓	✓	✓	✓	✓	✓			✓		✓	✓

TEXT BOOKS:

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

REFERENCES:

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

AE5022 APPROXIMATE METHODS IN STRUCTURAL MECHANICS

L	T	P	C
3	0	0	3

COURSE OBJECTIVES: Of this course are

01. To gain knowledge in the various approximate methods available for solving both boundary value and initial value problems involved in structural mechanics.

02. To student must learn how to carry out static structural analysis of bars and beams using different solution techniques

03. To gain knowledge in problem solving using the Rayleigh-Ritz, Galerkin and finite difference method.

04. To familiarize with the estimation of the natural frequencies of continuous and multi-degree of freedom systems.

05. To exposure the different mathematical tools required in structural analysis.

UNIT I STATIC STRUCTURAL ANAYSIS 9

Review of analytical methods for the solution of ordinary differential equations in structural mechanics – Need for approximate methods – Introduction to matrix methods – Influence Coefficients, Stiffness and Flexibility Matrices – Analysis of beams using matrix methods – Determinate and Indeterminate Beam analysis – Truss Analysis.

UNIT II RAYLEIGH-RITZ & GALERKIN METHODS 9

Introduction to different weighted residual methods – Galerkin methods applied to the analysis of bars and beams – The Rayleigh-Ritz method – Application of the Rayleigh-Ritz method to static problems involving bars and beams – Variational principles – Stiffness matrix formulation.

UNIT III FINITE DIFFERENCE METHOD 9

Problem formulation using the finite difference technique – Bar under axial loads – Beams subject to bending – Uniform members under torsion – Stresses in thick-walled pressure vessels – Heat transfer problems using the finite difference method – Other practical problems.

UNIT IV VIBRATION PROBLEMS 9

Continuous systems – Formulation of governing differential equations – Modelling a continuous system into a multi-degree of freedom system – Methods of natural frequency determination – Rayleigh method – Holzer method – Other eigen-value problems in engineering.

UNIT V NUMERICAL METHODS 9

Numerical integration – Solution of simultaneous algebraic equations – Elementary studies on the calculus of variation – Laplace and Fourier transforms and their application – Simple coding with C++ / MATLAB – Numerical Integration for vibration problems

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, Students will be able to

CO1: Have knowledge on the difference between Strength of Materials approach and Theory of Elasticity

CO2: Exhibit better understanding on the strain-displacement relation, stress-strain relations and stress ellipsoid.

CO3: Demonstrate the knowledge on the classification of 2-D problems and the methods of solution.

CO4: Formulate the governing equations and solve problems in torsion of non-circular sections.

CO5: Acquire knowledge on the governing equation for plate bending and methods of solution.

Attested

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓	✓		✓					✓
CO2		✓	✓	✓	✓		✓					✓
CO3		✓	✓	✓	✓		✓					✓
CO4		✓	✓	✓	✓		✓					✓
CO5		✓	✓	✓	✓		✓					✓

TEXT BOOKS:

01. Ansel C Ugural and Saul K Fenster, 'Advanced Strength and Applied Elasticity', Fourth Edition, Prentice Hall, New Jersey, 2003.
02. AsgharBhatti, M., Fundamental Finite Element Analysis and Applications: with Mathematica and MATLAB Computations, John Wiley & Sons Inc, 2005.
03. Chajes, A., Principles of Structural Stability Theory, Prentice Hall. Inc., 1987.
04. Szilard, R., Theory and Analysis of Plates – Classical and Numerical Methods, Prentice Hall, 2004.

REFERENCES:

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

AE5023 COMBUSTION IN AEROSPACE VEHICLES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES: Of this course are

01. To introduce basic concept of combustion process and calculation of adiabatic flame temperature to students.
02. To make familiarize with basic laws of combustion and required kinetics of chemical reactions.
03. To impart knowledge on the different classes of flame and their physical and chemical characteristics to students.
04. To make the students familiarize with the combustion processes involved in various jet propulsion.
05. To give students exposure on the combustion mechanism of various propellants and the instability characteristics.

UNIT I THERMODYNAMICS OF COMBUSTION 9

Stoichiometry – absolute enthalpy- enthalpy of formation- enthalpy of combustion- laws of thermo chemistry- pressure and temperature effect on enthalpy of formation, adiabatic flame temperature, chemical and equilibrium products of combustion.

UNIT II PHYSICS AND CHEMISTRY OF COMBUSTION 9

Fundamental laws of transport phenomena, Conservations Equations, Transport in Turbulent Flow - Basic Reaction Kinetics, Elementary reactions, Chain reactions, Multistep reactions, simplification of reaction mechanism, Global kinetics.

UNIT III PREMIXED AND DIFFUSED FLAMES 9

One dimensional combustion wave, Laminar premixed flame, Burning velocity measurement methods, Effects of chemical and physical variables on Burning velocity, Flame extinction, Ignition, Flame stabilizations, Turbulent Premixed flame. Gaseous and diffusion flame – droplet combustion.

UNIT IV COMBUSTION IN GAS TURBINE, RAMJET AND SCRAMJET 9

Combustion in gas turbine chambers, recirculation, combustion efficiency, flame holders, subsonic combustion in ramjet, supersonic combustion in scramjet. Subsonic and supersonic combustion controlled by diffusion mixing and heat convection – peculiarities of supersonic combustion.

UNIT V COMBUSTION IN CHEMICAL ROCKETS 9

Combustion in liquid propellant rockets - Combustion of solid propellants- application of laminar flame theory to the burning of homogeneous propellants, Combustion in hybrid rockets-combustion instability in rockets.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, Students will be able to

CO1: Calculate adiabatic flame temperature and estimate equilibrium products of combustion.

CO2: Solve chemical kinetics and species conservation equations

CO3: Acquire knowledge in different flame structures and stability characteristics

CO4: Compare the performance of different combustors and design of flame holders.

CO5: Analyse the combustion mechanisms of different propellants.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓			✓	✓	✓				✓	✓
CO2	✓	✓			✓	✓	✓				✓	✓
CO3	✓	✓	✓	✓	✓		✓				✓	✓
CO4	✓	✓	✓	✓	✓		✓				✓	✓
CO5	✓	✓	✓	✓	✓				✓		✓	✓

TEXT BOOKS:

01. Kuo K.K. “Principles of Combustion” John Wiley and Sons, 2005.
02. Mathur, M.L. and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers & Distributors, Delhi, Second edition 2014.
03. Mishra D. P., “Fundamentals of Combustion”, Prentice Hall of India, New Delhi, 2008.
04. Mukunda H. S., “Understanding Combustion”, Second edition, Orient Blackswan, 2009.
05. Warren C. Strahle, “An Introduction to Combustion”, Taylor & Francis, 1993.

REFERENCES:

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

Attested

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AE5024 **HYPERSONIC AERODYNAMICS**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES: Of this course are

01. To introduce basic concepts of hypersonic aerodynamics

02. To give exposure on various solution methods available for hypersonic inviscid flows

03. To make the students familiar with viscous hypersonic flow theory.

04. To impart basic knowledge on hypersonic viscous interaction similarity parameter and to learn the basic aspects of shock wave boundary layer interactions.

05. To make the students familiar with the basic concepts of high temperature effects in hypersonic flows.

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

COURSE OUTCOMES: Upon completion of this course, Students will be able to

CO1: Gain knowledge in the peculiarities of hypersonic aerodynamics.

CO2: Determine shock and expansion wave propagation in hypersonic flows.

CO3: Gain insights in the use of approximate methods for hypersonic flow solution.

CO4: Acquire knowledge in shock wave boundary layer interaction.

CO5: Investigate the high temperature effects on hypersonic vehicles.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓	✓	✓				✓	
CO2	✓	✓	✓	✓	✓	✓	✓				✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓				✓	✓
CO4	✓	✓	✓	✓	✓	✓					✓	✓
CO5	✓	✓	✓	✓	✓	✓	✓				✓	✓

TEXT BOOKS:

01. John D. Anderson. Jr., "Hypersonic and High Temperature Gas Dynamics", AIAA; Second Edition, 2006.

REFERENCES:

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

AE5025 SATELLITE TECHNOLOGY

L	T	P	C
3	0	0	3

COURSE OBJECTIVES: Of this course are

01. To introduce basic aspects of satellite subsystems and their functions, peculiarities of space environment and types of satellite orbits to students.
02. To impart knowledge to students on orbit determination and manoeuvres and ground station network requirements.
03. To make students familiarize with satellite mechanical and structural configurations and satellite thermal control systems.
04. To acquaint students with satellite control requirements and type of control manoeuvres and sensors needed for control.
05. To impart knowledge to students on satellite power electronics telemetry and telecommand systems.

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, Ka etc), their characteristics and applications- Coding Systems – Onboard computer- Ground checkout Systems.

TOTAL: 45 PERIODS

COURSE OUTCOMES: Upon completion of this course, Students will be able to

CO1: Explain the concepts of Orbits and their mechanics.

CO2: Explain the concepts of structural design, analyzing techniques and various types of loads in satellite structural subsystem.

CO3: Acquire knowledge on the importance of thermal control subsystem and its design studies.

CO4: Explain the concepts of satellite sensors and actuators that needed for Attitude control subsystem development.

CO5: Acquire the knowledge of satellite attitude as well as orbital dynamics in order to design the satellite control subsystem.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓	✓		✓					✓
CO2		✓	✓	✓	✓		✓					✓
CO3		✓	✓	✓	✓		✓					✓
CO4		✓	✓	✓	✓							✓
CO5		✓	✓	✓	✓		✓					✓

TEXT BOOKS:

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

REFERENCES:

01. Craft Lewis H. Abraham Structural Design of Missiles & Space, McGraw Hill, 1992.
02. Hughes, P.C. Spacecraft Altitude Dynamics, Wilsey, 1986.
03. Richard.F, FilipowskyEugen I Muehllorf Space Communications Systems, , Prentice Hall, 1995.
04. Spacecraft Thermal Control, Hand Book, Aerospace Press, 2002.

Attested

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AE5026 **UAV SYSTEM DESIGN**

L	T	P	C
3	0	0	3

COURSE OBJECTIVES: Of this course are

01. To introduce the basic concepts of unmanned aerial vehicles.

02. To make students familiarise with the design aspects of UAV.

03. To impart knowledge on the hardware components and their application in the UAV systems.

04. To infer about the communication and control detail of UAV.

05. To introduce the basic operational futures of UAV systems.

UNIT I INTRODUCTION TO UAV 9

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

UNIT II THE DESIGN OF UAV SYSTEM 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

COURSE OUTCOMES:

Upon completion of this course, Students will be able to

CO1: Acquire knowledge on the importance of UAVs with respect to their applications.

CO2: Identify and distinguish between various subsystems and configurations of UAV.

CO3: Perform ground test and troubleshooting with respect to UAV operation.

CO4: Distinguish between needs of mini and micro UAVs.

CO5: Gain insights with design standards and regulatory aspects of UAVs.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓	✓		✓					
CO2		✓	✓	✓	✓		✓					✓
CO3		✓	✓	✓	✓		✓					✓
CO4		✓	✓	✓	✓		✓					✓
CO5		✓	✓	✓	✓		✓					✓

REFERENCES:

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

IE5552 OPERATIONS RESEARCH L T P C
3 0 0 3

COURSE OBJECTIVES:

- Provide knowledge of optimization techniques and approaches.
- Formulate a real-world problem as a mathematical programming model.
- Enable the students apply mathematical, computational and communication skills needed for the practical utility of Operations Research.
- Knowledge to solve networking problems.
- Knowledge to solve various inventory problems.
- Gain knowledge on solving different waiting line models .

UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method. Solutions to LPP using simplex algorithm – Two phase method – Big M method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Revised simplex method - primal dual relationships – Dual simplex algorithm – Sensitivity analysis – changes in RHS value – changes in Coefficient of constraint – Adding new constraint – Adding new variable.

UNIT III NETWORK ANALYSIS 9

Transportation problems: Northwest corner rule, least cost method, Vogel’s approximation method - stepping stone method - MODI method – Unbalanced transportation – Assignment problem – Hungarian algorithm –Project Management CPM & PERT. Minimum spanning tree problem: Prim’s algorithm, Kruskal’s algorithm - Shortest path problem: Dijkstra’s algorithms, Floyds algorithm - maximal flow problem: Maximal-flow minimum cut theorem - Maximal flow algorithm

UNIT IV INVENTORY MODELS 9

Purchase model with no shortages – Manufacturing model with no shortages - Model with price breaks - Reorder point model - Probabilistic inventory model

UNIT V QUEUING THEORY 9

Queuing theory terminology – Single server, multi server- limited and unlimited queue capacity-limited and unlimited population –limited and infinite queue length.

COURSE OUTCOMES:

CO1: Learned to translate a real-world problem, given in words, into a mathematical Formulation.

CO2: An understanding of the role of algorithmic thinking in the solution of operations research problems.

CO3: Be able to build and solve Transportation Models and Assignment Models, maximal flow problem, minimum spanning tree and shortest path problem.

CO4: Able to handle issues in various Inventory models.

CO5: The students acquire capability in applying and using of queuing models for day today Problem

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓		✓	✓							
CO2	✓	✓		✓	✓							
CO3	✓	✓	✓	✓	✓							
CO4	✓	✓	✓	✓	✓							
CO5	✓	✓	✓	✓	✓							

TEXT BOOKS:

1. Panneerselvam R, “Operations Research”, PHI, 2009.
2. Srinivasan G., “Operations Research Principles and Applications”, PHI, 2017.

REFERENCES:

1. Hamdy A Taha, “Operations Research – An Introduction”, Pearson, 2017.
2. Philips, Ravindran and Solberg, “Operations Research principle and practise”, John Wiley,2007
3. Ronald L Rardin, “Optimisation in Operations Research”, Pearson, 2018.

AE5027 HELICOPTER MAINTENANCE

L	T	P	C
3	0	0	3

COURSE OBJECTIVES: Of this course are

01. To impart knowledge on basic concepts of Head maintenance, Vibration tracking of helicopter blades, Flight control systems and Mast adjustment concepts.

02. To provide students with the fundamentals of Helicopter ground handling.

03. To make students learn the basic concept of main rotor transmission and importance of torque meter maintenance.

04. To give an understanding of power plants, tail rotor systems servicing of helicopters.

05. To make the students familiar with the Fuselage maintenance and Special purpose equipments of helicopters.

UNIT I INTRODUCTION **9**

Helicopter as an aircraft - Basic features - Evolution of helicopter - Helicopter configurations - rotor arrangements - Compound Helicopter - jet rotor-no tail rotor concepts - Basic directions – Ground handling - bearing – Gears.

UNIT II MAIN ROTOR ASSEMBLY 9

Head maintenance – blade alignment – Static main rotor balance – Vibration – Tracking – Span wise dynamic balance – Blade sweeping – Electronic balancing. Dampener maintenance – Counter weight adjustment – Auto rotation adjustments – Mast & Flight Control Rotor - Mast – Stabilizer, dampeners. Swash plate flight control systems collective – Cyclic – Push pull tubes – Torque tubes – Bell cranks. Mixer box – Gradient unit control boosts – Maintenance & Inspection control rigging.

UNIT III MAIN ROTOR TRANSMISSIONS 9

Engine transmission coupling – Drive shaft Maintenance - clutch – Freewheeling units – Spray clutch - Roller unit – Torque meter – Rotor brake Maintenance of these components - Vibrations – Mounting systems – Transmissions.

UNIT IV POWER PLANTS & TAIL ROTORS 9

Fixed wing power plant modifications – Installation - Different type of power plant maintenance - Tail rotor system – Servicing tail rotor track - System rigging.

UNIT V AIRFRAMES AND RELATED SYSTEMS 9

Rotary wing Fuselage structural construction - Tubular, sheet metal, Bonded - Bell 206, Hughes 500, Eurocopter BO - 105 Fuselage- Fuselage maintenance. Airframe Systems - Stress and loads on Airframe, Wheel and skid Gear, visibility. Structural components and materials, Special purpose equipment.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, Students will be able to

CO1: Appreciate the different configurations and basic elements of helicopters.
CO2: Perform maintenance of main rotor assembly of helicopters.
CO3: Identify the various sources of vibration and the solutions to effectively control the vibrations in helicopters.
CO4: Perform maintenance of helicopter power plants.
CO5: Investigate the vibrational problems in helicopter airframe.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓									✓
CO2	✓	✓	✓	✓								✓
CO3	✓	✓	✓	✓	✓				✓			
CO4	✓	✓	✓	✓					✓		✓	
CO5	✓	✓	✓	✓	✓				✓			✓

TEXT BOOKS:

01. Gupta. L “Helicopter Engineering”, Himalayan Books, 1996.
02. Jeppesen, “Helicopter Maintenance Hand Book”, Jeppesons and Sons Inc., 2000.

REFERENCES:

01. “Civil Aircraft Inspection Procedures”, Part I and II, CAA, English Book House, New Delhi, 1986.
02. LARRY REITHMIER, “Aircraft Repair Manual”, Palamar Books Marquette, 1992.

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AE5028 SMART MATERIALS AND STRUCTURES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES: Of this course are

01. To familiarize with the fundamentals of structural health monitoring.

02. To impart knowledge in the areas of Vibration based techniques in structural health monitoring, fiberoptics and Piezo electric sensors.

03. To familiarize with the fundamentals of fabrication, modelling, analysis, and design of smart materials and structures.

04. To enable the student to get exposed to the state of the art of smart materials and systems, spanning piezoelectrics, shape memory, alloys, electro active polymers.

05. To familiarize with artificial neural networks and image processing

UNIT I OVERVIEW AND INTRODUCTION 9

Piezoelectric Material Crystal Structure – Fundamentals of Piezoelectricity – Shape Memory Alloys – Fundamentals of Shape Memory Alloy (SMA) Behaviour – Phase Transformation – Lattice Structure and Deformation Mechanism – Electrostrictive Material Systems – ER and MR Fluids – Current Application – Aerospace Field – Machine Tools – Automotive Systems – Medical Systems – Electronics Equipment – Robots – Energy Harvesting Using Smart Materials.

UNIT II PIEZOELECTRIC THEORY 9

Electromechanical Constitutive Equations – Piezoceramic Actuator & Sensor Equations – Piezoelectric Coupling Coefficients – Actuator Performance and Load Line Analysis – Hysteresis and Nonlinearities in Piezoelectric Materials – Piezoceramic Actuators – Behavior under Static & Dynamic Excitation Fields – Depoling Behavior and Dielectric Breakdown – Curie Temperature – Power Consumption – Equivalent Circuits to Model Piezoceramic Actuators – The Bimorph Sensor.

UNIT III BEAM MODELLING WITH PIEZOELECTRIC MATERIAL 9

Basic Definitions of Stress, Strains and Displacements in Beams – Transverse Deflection of Uniform Isotropic Beams – Simple Blocked Force Beam Model (Pin Force Model) – Single Actuator Characteristics – Dual Actuators – Symmetric & Asymmetric Actuation with Differential Voltages – Uniform Strain Model – Euler-Bernoulli Beam Model – Dissimilar Actuators – Embedded Actuators – Testing of a Beam with Surface Mounted Piezoactuators.

UNIT IV UNDERSTANDING SHAPE MEMORY ALLOYS (SMA) 9

Low Temperature Stress-Strain Curve – Origin of the One-Way Shape Memory Effect – Stress Induced Martensite and Pseudoelasticity – Two-Way Shape Memory Effect – All-Round Shape Memory Effect – R-Phase Transformation – Porous SMA – Constrained Behavior of SMA – Free Recovery – Constrained Recovery – Effective Load-Lines of an SMA Wire Actuator – Sample Preparation – Transformation Temperatures under Zero Stress.

UNIT V CONSTITUTIVE MODELLING AND SMA BEHAVIOUR 9

Tanaka Model – Liang and Rogers Model – Brinson Model – Testing of SMA Wires –Variation of Transformation Temperatures with Stress – Stress-Strain Behavior at Constant Temperature – Stress-Temperature Behavior at Constant Strain – Heat Absorbed by the SMA Wire – Thermomechanical Energy EquilibriumPower Requirements for SMA Activation – Resistance Behavior of SMA Wires – Heat Dissipation – SMA Wire Damping Capacity.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, Students will be able to

CO1: Classify the various forms of functional materials.
CO2: Investigate the Piezoelectric material behaviour.
CO3: Investigate the behaviour of SMA material.
CO4: Model a beam with Piezoelectric patch.
CO5: Impart knowledge on modelling of SMA material.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓	✓	✓		✓					✓
CO2	✓		✓	✓	✓		✓					✓
CO3	✓	✓	✓	✓	✓		✓					✓
CO4	✓	✓	✓	✓	✓		✓					✓
CO5	✓		✓	✓	✓		✓					✓

TEXT BOOKS:

01. Inderjit Chopra and Jayant Sirohi,' Smart Structures Theory', Cambridge University Press, 2014.

REFERENCES:

01. Martin, J.W., Engineering Materials, Their properties and Applications, Wykedham Publications (London) Ltd., 1987.
02. Prasad**,** N. Eswara, Wanhill**,** R. J. H, 'Aerospace Materials and Material Technologies – Indian Institute of Metals Series, 2017.
03. Sam Zhang, 'Aerospace Materials Handbook (Advances in Materials Science and Engineering) 1st Edition , 2016.
04. Van Vlack.L.H., Elements of Materials Science and Engineering Prentice Hall; Publishers, Sixth edition, 1989.

AE5029 NON-CONVENTIONAL ENERGY RESOURCES

L	T	P	C
3	0	0	3

COURSE OBJECTIVES: Of this course are

01. To create awareness on alternate sources of energy – their availability and utility.
02. To make student understand the theory of solar energy tapping.
03. To make student understand the design aspects and durability of batteries, fuel cells and flywheels.
04. To impart knowledge the students on wind turbine aerodynamics.
05. To introduce basic design aspects of wind turbines.

UNIT I SOLAR ENERGY **9**

Introduction – Conventional sources of energy – Overview of non-conventional energy resources – Solar energy incident on earth – Solar spectrum – Overview of solar energy technologies – Solar thermal devices – Photovoltaic panels – Biomass – Performance and durability of solar devices.

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UNIT II BATTERIES AND FUEL CELLS 9

Battery basics – Different types of batteries – Testing and performance of batteries – Inverters – Fuel cell types – Fuel processing – Concept to product – Performance aspects – Design principles of fuel cells – Materials used – Efficiency calculations – Durability of the device – Current limitations.

UNIT III WIND ENERGY 9

History of wind turbines – Current use – Cost and other practical issues – Wind types – Physical principles –– Blade theory – Wind turbine aerodynamics – Betz limit – Wind power calculation – Power curve – Conversion of energy – Energy storage – Efficiency –Types of wind turbines.

UNIT IV WIND TURBINE DESIGN 9

Components of a wind turbine – Design loads for horizontal axis wind turbines – Extreme loading cases – Blade aerodynamics performance and blade design – Conceptual design of a horizontal axis wind turbine – Stresses in blades – Blade dynamic response – Load transfer to hub, shaft and nacelle.

UNIT V FLYWHEELS AND SUPERCAPACITORS 9

History and application of flywheels and super capacitors – Working principle – Material selection principle – Energy extraction and storage – Construction details – Device performance – Design principles – Electrical parameters in capacitor design – Current commercial application.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of this course, Students will be able to

CO1: Explain concept of various form conventional energy.
CO2: Demonstrate various types of batteries and their applications.
CO3: Analyse the performance of wind turbine blades.
CO4: Do preliminary design for the development of wind turbine.
CO5: Demonstrate concept of energy storing devices.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓	✓	✓		✓				✓	✓
CO2	✓	✓	✓	✓	✓		✓				✓	✓
CO3	✓	✓	✓	✓	✓		✓				✓	✓
CO4	✓	✓	✓	✓	✓						✓	✓
CO5	✓	✓	✓	✓	✓		✓				✓	✓

TEXT BOOKS:

01. Rajput R.K,'Non-Conventional Energy Sources and Utilisation (Energy Engineering) Paperback, 2014.

REFERENCES:

01. Fuel Cell Handbook (Seventh Edition) Paperback – Import, 8 May 2016 by EG&G Technical Services Inc. , U.S. Department of Energy.
02. Musa,S ' Solar Energy Handbook' (MLI Handbook Series) Hardcover – Import, 2018.
03. Thomas Reddy,' Linden's Handbook of Batteries', 4th Edition, Kindle Edition,2001
04. Tiwari, G. N. and Arvind Tiwari , 'Shyam Handbook of Solar Energy: Theory, Analysis and Applications (Energy Systems in Electrical Engineering) Paperback – Import, 14 Jun 2018.
05. Tony Burton , Nick Jenkins, David Sharpe and Ervin Bossanyi ,'Wind Energy Handbook', 2nd Edition,2012.

AD5091 **CONSTITUTION OF INDIA**

L T P C
3 0 0 0

COURSE OBJECTIVES:

- Teach history and philosophy of Indian Constitution.
- Describe the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- Summarize powers and functions of Indian government.
- Explain emergency rule.
- Explain structure and functions of local administration.

UNIT I INTRODUCTION **9**

History of Making of the Indian Constitution-Drafting Committee- (Composition & Working) - Philosophy of the Indian Constitution-Preamble-Salient Features

UNIT II CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES **9**

Fundamental Rights-Right to Equality-Right to Freedom-Right against Exploitation Right to Freedom of Religion-Cultural and Educational Rights-Right to Constitutional Remedies Directive Principles of State Policy-Fundamental Duties

UNIT III ORGANS OF GOVERNANCE **9**

Parliament-Composition-Qualifications and Disqualifications-Powers and Functions-Executive President-Governor-Council of Ministers-Judiciary, Appointment and Transfer of Judges, Qualifications Powers and Functions

UNIT IV EMERGENCY PROVISIONS **9**

Emergency Provisions - National Emergency, President Rule, Financial Emergency

UNIT V LOCAL ADMINISTRATION **9**

District's Administration head- Role and Importance-Municipalities- Introduction- Mayor and role of Elected Representative-CEO of Municipal Corporation-Pachayati raj- Introduction- PRI- Zila Pachayat-Elected officials and their roles- CEO ZilaPachayat- Position and role-Block level-Organizational Hierarchy (Different departments)-Village level- Role of Elected and Appointed officials-Importance of grass root democracy

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: Able to understand history and philosophy of Indian Constitution.
CO2: Able to understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
CO3: Able to understand powers and functions of Indian government.
CO4: Able to understand emergency rule.
CO5: Able to understand structure and functions of local administration.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									✓			✓
CO2									✓			✓
CO3									✓			✓
CO4									✓			✓
CO5									✓			✓

Attested

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TEXT BOOKS:

1. Basu D D, Introduction to the Constitution of India, Lexis Nexis, 2015.
2. Busi S N, Ambedkar B R framing of Indian Constitution, 1st Edition, 2015.
3. Jain M P, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. The Constitution of India (Bare Act), Government Publication,1950

AD5092 VALUE EDUCATION

L	T	P	C
3	0	0	0

COURSE OBJECTIVES:

- Develop knowledge of self-development
- Explain the importance of Human values
- Develop the overall personality through value education
- Overcome the self destructive habits with value education
- Interpret social empowerment with value education

UNIT I INTRODUCTION TO VALUE EDUCATION 9

Values and self-development –Social values and individual attitudes, Work ethics, Indian vision of humanism, Moral and non- moral valuation, Standards and principles, Value judgements

UNIT II IMPORTANCE OF VALUES 9

Importance of cultivation of values, Sense of duty, Devotion, Self-reliance, Confidence, Concentration, Truthfulness, Cleanliness. Honesty, Humanity, Power of faith, National Unity, Patriotism, Love for nature, Discipline

UNIT III INFLUENCE OF VALUE EDUCATION 9

Personality and Behaviour development - Soul and Scientific attitude. Positive Thinking, Integrity and discipline, Punctuality, Love and Kindness, Avoid fault Thinking, Free from anger, Dignity of labour, Universal brotherhood and religious tolerance, True friendship Happiness Vs suffering, love for truth.

UNIT IV REINCARNATION THROUGH VALUE EDUCATION 9

Aware of self-destructive habits, Association and Cooperation, Doing best for saving nature Character and Competence –Holy books vs Blind faith, Self-management and Good health, Science of reincarnation

UNIT V VALUE EDUCATION IN SOCIAL EMPOWERMENT 9

Equality, Non violence, Humility, Role of Women, All religions and same message, Mind your Mind, Self-control, Honesty, Studying effectively

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1 – Gain knowledge of self-development
CO2 – Learn the importance of Human values
CO3 – Develop the overall personality through value education
CO4 – Overcome the self destructive habits with value education
CO5 – Interpret social empowerment with value education

Attested

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							✓	✓				✓
CO2							✓	✓	✓			✓
CO3							✓	✓	✓			✓
CO4							✓	✓				✓
CO5							✓	✓				✓

REFERENCES:

1. Chakroborty , S.K. “Values and Ethics for organizations Theory and practice”, Oxford University Press ,New Delhi

AD5093 **PEDAGOGY STUDIES** **L T P C**
3 0 0 0

COURSE OBJECTIVES:

- Understand the methodology of pedagogy.
- Compare pedagogical practices used by teachers in formal and informal classrooms in developing countries.
- Infer how can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy.
- Illustrate the factors necessary for professional development.
- Identify the Research gaps in pedagogy.

UNIT I INTRODUCTION AND METHODOLOGY: 9

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW 9

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES 9

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers’ attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT 9

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS 9

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 45 PERIODS

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COURSE OUTCOMES:

- Understand the methodology of pedagogy.
- Understand Pedagogical practices used by teachers in formal and informal classrooms in developing countries.
- Find how can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy.
- Know the factors necessary for professional development.
- Identify the Research gaps in pedagogy.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

REFERENCES:

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.

AD5094 STRESS MANAGEMENT BY YOGA

L T P C
3 0 0 0

COURSE OBJECTIVES:

- Develop healthy mind in a healthy body thus improving social health also improve efficiency
- Invent Do's and Don't's in life through Yam
- Categorize Do's and Don't's in life through Niyam
- Develop a healthy mind and body through Yog Asans
- Invent breathing techniques through Pranayam

UNIT I INTRODUCTION TO YOGA **9**

Definitions of Eight parts of yog. (Ashtanga)

UNIT II YAM **9**

Do`s and Don't's in life.
Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT III NIYAM **9**

Do`s and Don't's in life.
Ahinsa, satya, astheya, bramhacharya and aparigraha

UNIT IV ASAN **9**

Various yog poses and their benefits for mind & body

UNIT V PRANAYAM **9**

Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1 – Develop healthy mind in a healthy body thus improving social health also improve efficiency
CO2 – Learn Do's and Don't's in life through Yam
CO3 – Learn Do's and Don't's in life through Niyam
CO4 – Develop a healthy mind and body through Yog Asans
CO5 – Learn breathing techniques through Pranayam

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1							✓	✓				✓
CO2							✓	✓				✓
CO3							✓	✓				✓
CO4							✓	✓				✓
CO5							✓	✓				✓

REFERENCES:

1. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata
2. 'Yogic Asanas for Group Tarining-Part-I" : Janardan Swami Yogabhyasi Mandal, Nagpur

AD5095 PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

L T P C
3 0 0 0

COURSE OBJECTIVES:

- Develop basic personality skills holistically
- Develop deep personality skills holistically to achieve happy goals
- Rewrite the responsibilities
- Reframe a person with stable mind, pleasing personality and determination
- Discover wisdom in students

UNIT I NEETISATAKAM-HOLISTIC DEVELOPMENT OF PERSONALITY - I **9**

Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue)

UNIT II NEETISATAKAM-HOLISTIC DEVELOPMENT OF PERSONALITY - II **9**

Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

UNIT III APPROACH TO DAY TO DAY WORK AND DUTIES **9**

Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48

UNIT IV STATEMENTS OF BASIC KNOWLEDGE – I **9**

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18

UNIT V PERSONALITY OF ROLE MODEL - SHRIMAD BHAGWADGEETA 9

Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 45 PERIODS

COURSE OUTCOMES:

CO1: To develop basic personality skills holistically
CO2: To develop deep personality skills holistically to achieve happy goals
CO3: To rewrite the responsibilities
CO4: To reframe a person with stable mind, pleasing personality and determination
CO5: To awaken wisdom in students

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1									✓			✓
CO2									✓			✓
CO3									✓			✓
CO4									✓			✓
CO5									✓			✓

REFERENCES:

1. Gopinath,Rashtriya Sanskrit Sansthanam P, Bhartrihari's ThreeSatakam , Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram,Publication Department, Kolkata,2016

AD5097 ESSENCE OF INDIAN KNOWLEDGE TRADITION L T P C
3 0 0 0

COURSE OBJECTIVES

The course will introduce the students to

- get a knowledge about Indian Culture
- Know Indian Languages and Literature religion and philosophy and the fine arts in India
- Explore the Science and Scientists of Ancient, Medieval and Modern India
- Understand education systems in India

UNIT I INTRODUCTION TO CULTURE 9

Culture, civilization, culture and heritage, general characteristics of culture, importance of culture in human literature, Indian Culture, Ancient India, Medieval India, Modern India.

UNIT II INDIAN LANGUAGES AND LITERATURE 9

Indian Languages and Literature – I: Languages and Literature of South India, – Indian Languages and Literature – II: Northern Indian Languages & Literature

UNIT III RELIGION AND PHILOSOPHY 9

Major religions practiced in India and Understanding their Philosophy – religious movements in Modern India (Selected movements only)

Annexed

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UNIT IV FINE ARTS IN INDIA (ART, TECHNOLOGY& ENGINEERING) 9

Indian Painting, Indian handicrafts, Music, divisions of Indian classic music, modern Indian music, Dance and Drama, Indian Architecture (ancient, medieval and modern), Science and Technology in India, development of science in ancient, medieval and modern India

UNIT V EDUCATION SYSTEM IN INDIA 9

Education in ancient, medieval and modern India, aims of education, subjects, languages, Science and Scientists of Ancient India, Science and Scientists of Medieval India, Scientists of Modern India

TOTAL: 45 PERIODS

COURSE OUTCOMES

After successful completion of the course the students will be able to

- Understand philosophy of Indian culture.
- Distinguish the Indian languages and literature.
- Learn the philosophy of ancient, medieval and modern India.
- Acquire the information about the fine arts in India.
- Know the contribution of scientists of different eras.
- Understand education systems in India

REFERENCES:

1. Kapil Kapoor, "Text and Interpretation: The India Tradition",ISBN: 81246033375, 2005
2. "Science in Samskrit", Samskrita Bharti Publisher, ISBN 13: 978-8187276333, 2007
3. NCERT, "Position paper on Arts, Music, Dance and Theatre", ISBN 81-7450 494-X, 200
4. Narain, "Examinations in ancient India", Arya Book Depot, 1993
5. Satya Prakash, "Founders of Sciences in Ancient India", Vijay Kumar Publisher, 1989
6. M. Hiriyanna, "Essentials of Indian Philosophy", Motilal Banarsidass Publishers, ISBN 13: 978- 8120810990, 2014

AD5098 SANGA TAMIL LITERATURE APPRECIATION L T P C
3 0 0 0

COURSE OBJECTIVES:

The main learning objective of this course is to make the students an appreciation for:

1. Introduction to Sanga Tamil Literature.
2. 'Agathinai' and 'Purathinai' in Sanga Tamil Literature.
3. 'Attruppadai' in Sanga Tamil Literature.
4. 'Puranaanuru' in Sanga Tamil Literature.
5. 'Pathitrupaththu' in Sanga Tamil Literature.

UNIT I SANGA TAMIL LITERATURE AN INTRODUCTION 9

Introduction to Tamil Sangam – History of Tamil Three Sangams – Introduction to Tamil Sangam Literature – Special Branches in Tamil Sangam Literature - Tamil Sangam Literature's Grammar - Tamil Sangam Literature's parables.

UNIT II 'AGATHINAI' AND 'PURATHINAI' 9

Tholkappiyar's Meaningful Verses – Three literature materials – Agathinai's message - History of Culture from Agathinai – Purathinai – Classification – Mesaage to Society from Purathinai.

UNIT III 'ATTRUPPADAI'. 9

Attruppadai Literature – Attruppadai in 'Puranaanuru' - Attruppadai in 'Pathitrupaththu' – Attruppadai in 'Paththupaattu'.

UNIT IV 'PURANAANURU' 9

Puranaanuru on Good Administration, Ruler and Subjects – Emotion & its Effect in Puranaanuru.

UNIT V 'PATHITRUPATHTHU' 9

Pathitrupaththu in 'Ettuthogai' – Pathitrupaththu's Parables – Tamil dynasty: Valor, Administration, Charity in Pathitrupaththu - Mesaage to Society from Pathitrupaththu.

TOTAL (L: 45) = 45 PERIODS

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

1. Appreciate and apply the messages in Sanga Tamil Literature in their life.
2. Differentiate 'Agathinai' and 'Purathinai' in their personal and societal life.
3. Appreciate and apply the messages in 'Attruppadai' in their personal and societal life.
4. Appreciate and apply the messages in 'Puranaanuru' in their personal and societal life.
5. Appreciate and apply the messages in 'Pathitrupaththu' in their personal and societal life.

REFERENCES:

1. Sivaraja Pillai, The Chronology of the Early Tamils, Sagwan Press, 2018.
2. Hank Heifetz and George L. Hart, The Purananuru, Penguin Books, 2002.
3. Kamil Zvelebil, The Smile of Murugan: On Tamil Literature of South India, Brill Academic Pub, 1997.
4. George L. Hart, Poets of the Tamil Anthologies: Ancient Poems of Love and War, Princeton University Press, 2015.
5. Xavier S. Thani Nayagam, Landscape and poetry: a study of nature in classical Tamil poetry, Asia Pub. House, 1967.

	P												PS		
CO	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**
1									0.9						0.6
2									0.9						0.6
3									0.9						0.6
4									0.9						0.6
5									0.9						0.6

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HSMC– ELECTIVES – HUMANITIES I (ODD SEMESTER)

HU5171 LANGUAGE AND COMMUNICATION LT P C
3 0 0 3

COURSE DESCRIPTION

This course offers an introduction to language and communication. The primary goal of this course is to familiarize students with key ideas related to communication using language as well as non verbal means. Ideas related to the use of language and the underlying power structures are also examined. The course also examines the role of media in communication and in the dissemination of ideas as well as opinions.

Objectives

- ✓ To familiarize students with the concept of communication using linguistic and non linguistic resources.
- ✓ To help students ask critical questions regarding facts and opinions.
- ✓ To provide students with the material to discuss issues such as language and power structures.
- ✓ To help students think critically about false propaganda and fake news.

Learning Outcomes

- ➢ Students will be able to use linguistic and non linguistic resources of language in an integrated manner for communication.
- ➢ Students will be able to analyse communication in terms of facts and opinions.
- ➢ Students will be able to discuss, analyse and argue about issues related to language and power.

UNIT I LINGUISTIC AND NON-LINGUISTIC RESOURCE OF COMMUNICATION: 9

a) Writing and Speech
b) Distinction between language structure and language use, form and function, acceptability and grammaticality
c) Gestures and Body language, pictures and symbols, cultural appropriacy
d) Communicative Competency, context and situation, combination of linguistic and non-linguistic elements of communication

UNIT II STRUCTURE OF WRITING/CONVERSATION: 9

a) Language skills and the communication cycle; speaking and listening, writing and reading
b) Initiating and closing conversations, intervention, turn taking
c) Writing for target reader, rhetorical devices and strategies
d) Coherence and Cohesion in speech and writing

UNIT III POWER STRUCTURE AND LANGUAGE USE: 9

a) Gender and language use
b) Politeness expressions and their use
c) Ethical dimensions of language use
d) Language rights as part of human rights

UNIT IV MEDIA COMMUNICATION: 9

a) Print media, electronic media, social media
b) Power of media
c) Manufacturing of opinion, fake news and hidden agendas

UNIT V PERSUASIVE COMMUNICATION AND MISCOMMUNICATION: 9

a) Fundamentals of persuasive communication
b) Persuasive strategies
c) Communication barriers

TOTAL : 45 PERIODS

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TEXT BOOKS:

1. Austin, 1962, J.L. How to do things with words. Oxford: Clarendon Press. Grice, P.1989. Studies in the way of words. Cambridge, M.A: Harvard University Press.
2. Chomsky, N.1966. Aspects of the theory of syntax, The MIT press, Cambridge. Chomsky, N.2006. Language and Mind, Cambridge University Press.
3. Hymes. D.N. 1972, On communication competence in J.B. Pride and J.Holmes (ed), Sociolinguistics, pp 269-293, London Penguin.
4. Gilbert, H.Harman, 1976. Psychological aspect of the theory of syntax in Journal of Philosophy, page 75-87.
5. Stephen. C. Levenson, 1983, Pragmatics, Cambridge University press.
6. Stangley, J. 2007. Language in Context. Clarendon press, Oxford. 7. Shannon, 1942. A Mathematical Theory of Communication. 8. Searle, J.R. 1969. Speech acts: An essay in the philosophy of language. Cambridge: Cambridge University Press.

HU5172 VALUES AND ETHICS

L	T	P	C
3	0	0	3

OBJECTIVES:

- Teach definition and classification of values.
- Explain Purusartha.
- Describe Sarvodaya idea.
- Summarize sustenance of life.
- Conclude views of hierarchy of values.

UNIT I DEFINITION AND CLASSIFICATION OF VALUES **9**

Extrinsic values- Universal and Situational values- Physical- Environmental-Sensuous-Economic-Social-Aesthetic-Moral and Religious values

UNIT II CONCEPTS RELATED TO VALUES **9**

Purusartha-Virtue- Right- duty- justice- Equality- Love and Good

UNIT III IDEOLOGY OF SARVODAYA **9**

Egoism- Altruism and universalism- The Ideal of Sarvodaya and Vasudhaiva Kutumbakam

UNIT IV SUSTENANCE OF LIFE **9**

The Problem of Sustenance of value in the process of Social, Political and Technological Changes

UNIT V VIEWS ON HIERARCHY OF VALUES **9**

The Problem of hierarchy of values and their choice, The views of Pt. Madan Mohan Malviya and Mahatma Gandhi

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Able to understand definition and classification of values.
CO2: Able to understand purusartha.
CO3: Able to understand sarvodaya idea.
CO4: Able to understand sustenance of life.
CO5: Able to understand views of hierarchy of values.

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	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								✓	✓			✓
CO2								✓	✓			✓
CO3								✓	✓			✓
CO4								✓	✓			✓
CO5								✓	✓			✓

TEXTBOOKS:

1. Awadesh Pradhan : Mahamanake Vichara. (B.H.U., Vanarasi-2007)
2. Little, William, : An Introduction of Ethics (Allied Publisher, Indian Reprint 1955)
3. William, K Frankena : Ethics (Prentice Hall of India, 1988)

HU5173 HUMAN RELATIONS AT WORK L T P C
3 0 0 3

OBJECTIVES:

- Illustrate human relations at work its relationship with self.
- Explain the importance of interacting with people at work to develop teamwork.
- Infer the importance of physical health in maintaining human relations at work.
- Describe the importance of staying psychologically healthy.
- Identify the essential qualities for progressing in career.

UNIT I UNDERSTANDING AND MANAGING YOURSELF 9

Human Relations and You: Self-Esteem and Self-Confidence: Self-Motivation and Goal Setting; Emotional Intelligence, Attitudes, and Happiness; Values and Ethics and Problem Solving and Creativity.

UNIT II DEALING EFFECTIVELY WITH PEOPLE 9

Communication in the Workplace; Specialized Tactics for Getting Along with Others in the Workplace; Managing Conflict; Becoming an Effective Leader; Motivating Others and Developing Teamwork; Diversity and Cross-Cultural Competence.

UNIT III STAYING PHYSICALLY HEALTHY 9

Yoga, Pranayam and Exercise: Aerobic and anaerobic.

UNIT IV STAYING PSYCHOLOGICALLY HEALTHY 9

Managing Stress and Personal Problems, Meditation.

UNIT V DEVELOPING CAREER THRUST 9

Getting Ahead in Your Career, Learning Strategies, Perception, Life Span Changes, and Developing Good Work Habits.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to

CO1: Understand the importance of self-management.
CO2: Know how to deal with people to develop teamwork.
CO3: Know the importance of staying healthy.
CO4: Know how to manage stress and personal problems.
CO5: Develop the personal qualities essential for career growth.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						✓		✓	✓			✓
CO2									✓	✓		✓
CO3						✓		✓	✓			✓
CO4								✓				✓
CO5								✓	✓	✓		✓

TEXT BOOK:

1. Dubrien, A. J. (2017). Human Relations for Career and Personal Success: Concepts, Applications, and Skills, 11th Ed. Upper Saddle River, NJ: Pearson.

REFERENCES:

1. Greenberg, J. S. (2017). Comprehensive stress management (14th edition), New York: McGraw Hill.
2. Udai, Y. (2015). Yogasanaurpranayam. New Delhi: N.S. Publications.

HU5174 PSYCHOLOGICAL PROCESSES L T P C
3 0 0 3

COURSE DESCRIPTION

Psychological Processes course is designed for students to be aware of the basic principles of psychology for the better understanding of people's psyche and behaviour around them. This course enables learners to use the optimal use of different forms of thinking skills and thereby results in effective communication in diverse situations. Every unit of the syllabus highlights the psychological process of people, the most powerful and constructive use of perceptions.

OBJECTIVES

The major objectives of this course is

- To develop students' awareness – on psychology, learning behavior and usage of perception effectively.
- To learn to use the various kinds of thinking in a formal context.
- To critically evaluate content and comprehend the message on the bases of perception, personality and intelligence.

UNIT I INTRODUCTION

What is psychology? - Why study psychology? - Psychology as science – Behavior and its role in human communication – socio-cultural bases of behaviour – Biological bases of behavior - Brain and its functions – Principles of Heredity – Cognition and its functions Fields of psychology – Cognitve and Perceptual – Industrial and Organizational.

UNIT II SENSORY & PERCEPTUAL PROCESSES

Some general properties of Senses: Visual system – the eye, colour vision – Auditory system – Hearing, listening, Sounds - Other senses - Selective attention; physiological correlates of attention; Internal influences on perception learning – set - motivation & emotion - cognitive styles; External influences on perception figure and ground separation – movement – organization – illusion; Internal- external interactions: Constancy - Depth Perception- Binocular & Monocular Perception; Perceptual defense & Perceptual vigilance; Sensory deprivation - Sensory bombardment; ESP - Social Perception.

UNIT III COGNITION & AFFECT

Learning and memory – philosophy of mind – concepts - words – images – semantic features – Association of words – Repetition – Retrieval – Chunking - Schemata - Emotion and motivation – nature and types of motivation – Biological & Psychosocial motivation – nature and types of emotions – physiological & cognitive bases of emotions – expressions of emotions – managing negative emotions - enhancing positive emotions.

UNIT IV THINKING, PROBLEM-SOLVING & DECISION MAKING

Thinking skills – Types of thinking skills – Concrete & Abstract thinking – Convergent & Divergent - Analytical & Creative thinking – Problem & Possibility thinking – Vertical & Lateral thinking – Problem solving skills – stages of problem solving skills – Decision making - intuition and reasoning skills - Thinking and language - The thinking process- concepts, problem solving, decision-making, creative thinking; language communication.

UNIT V PERSONALITY & INTELLIGENCE

Psychological phenomena & Attributes of humans - cognition, motivation, and behavior - thoughts, feelings, perceptions, and actions – personality dimensions, traits, patterns - Specialized knowledge, performance accomplishments, automaticity or ease of functioning, skilled performance under challenge - generative flexibility, and speed of learning or behavior change.

REFERENCES

1. Morgan, C.T.and King, R.A (1994) Introduction to Psychology, Tata McGraw Hill Co Ltd, New Delhi.
2. Robert A. Baron (2002), Psychology, 5th Edition, Prentice Hall, India.
3. Michael W.Passer, Ronald E.smith (2007), Psychology: The science of mind and Behavior,3rd Edition Tata McGraw-Hill Edition.
4. Robert S.Feldman (2004) Understanding Psychology 6th Edition Tata McGraw – Hill.
5. Endler, N. S., & Summerfeldt, L. J. (1995). Intelligence. personality. psychopathology. and adjustment. In D. H. Saklofske & M. Zeidner (Eds.). International handbook of personality and intelligence (pp. 249-284). New York: Plenum Press.
6. Ford, M. E. (1994). A living systems approach to the integration of personality and intelligence. In R. J. Sternberg. & P. Ruzgis (Eds.). Personality and intelligence (pp. 188-21 7). New York: Cambridge University Press.
7. De Bono, E (1990) Lateral Thinking, Harper Perennial, New York.

HU5175 EDUCATION, TECHNOLOGY AND SOCIETY L T P C
3 0 0 3

COURSE DESCRIPTION

This course introduces students to multidisciplinary studies in Education, Technology and Society. Students will get an understanding of the relationship between education, technology and society. They will also learn about the long lasting impact of good education in a technologically advanced society.

COURSE OBJECTIVES:

The course aims

- To help learners understand the basics of different types of technology utilised in the field of education
- To make them realize the impact of education in society
- To make them evolve as responsible citizen in a technologically advanced society

LEARNING OUTCOMES

By the end of the course, learners will be able to

- Understand the various apps of technology apps and use them to access, generate and present information effectively.
- Apply technology based resources and other media formats equitably, ethically and legally.
- Integrate their technical education for betterment of society as well as their personal life.

UNIT I INDIAN EDUCATION SYSTEM

Gurukul to ICT education – Teacher as facilitator – Macaulay's Minutes – English medium vs Regional medium – Importance of Education in Modern India - Challenges in Education

UNIT II LEARNING THEORIES

Learning Theories – Behaviorism – Cognitivism – Social Constuctivism – Humanism Learning Styles – Multiple Intelligences – Emotional Intelligence – Blooms Taxonomy

UNIT III TECHNOLOGICAL ADVANCEMENTS

Web tools – Social media in education – elearning – MOOCs – Mobile assisted learning – Learning Apps – Blended learning - Self-directed learning

UNIT IV EDUCATIONAL TECHNOLOGY

Technological implications on Education – Teaching, Learning & Testing with Technology - Advantages and drawbacks – Critical analysis on the use of technology

UNIT V ETHICAL IMPLICATIONS

Plagiarism – Online Copyright issues – Ethical and value implications of education and technology on individual and society.

TOTAL:45 PERIODS

TEACHING METHODS

Teaching modes include guest lectures, discussion groups, presentations, visual media, and a practicum style of learning.

EVALUATION

As this is course is not a content based course, it focuses more on the ethical use of technology in education and society, and so, evaluation can be based on assignments and discussions. So there is no need for an end semester examination. Internals marks can be taken for the total marks.

INTERNAL (100 % WEIGHTAGE)

(a) Written Test (40 marks)
(b) Assignment: Write a real time report of the technology use in any school / college (15 marks)
(c) Presentation: Students choose any one of the technological tools and present its relevance to education and society (15 marks)
(d) Group discussion: Students discuss in groups on case studies relating to various challenges in education and technology use in society (20 marks)
(e) Blog entry: Making weekly blog posts in Class Blog on the topics related to the course posted by the instructor and commenting on others' posts. (10 marks)

REFERENCES

1) Education and Social order by Bertrand Russel
2) Theories of learning by Bower and Hilgard
3) Technology and Society by Jan L Harrington

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HU5176 **PHILOSOPHY** **L T P C**
3 0 0 3

OBJECTIVES

- To create a new understanding by teaching philosophy through a comparison of Indian and Western traditions.
- To Fosters critical thinking and imagination by dealing with inter-related concepts in literature and science.
- To bridge the gap between the sciences and humanities through introspective analyses.
- To nurture an understanding of the self and elucidates ways to progress towards a higher understanding of one's self and others.

UNIT I KNOWLEDGE 9

Knowledge (Vidya) Versus Ignorance (Avidya)- Brihadaranyaka Upanishad. Unity and Multiplicity – Isha Upanishad. What is True Knowledge? Ways to True Knowledge. Introduction to Philosophy of Yoga, Socratic Debate, Plato's Views. Asking and Answering Questions to Stimulate Critical Thinking and to Draw Ideas. Argumentative Dialogues. Dialectical Methods to Arrive at Conclusions.

UNIT II ORIGIN 9

Origin of Universe And Creation – 'Nasidiya Sukta' in Relation With Big Bang Theory. Greek Concept of Chaos. The Concept of Space – Space as the Final Goal – Udgitha. Relationship Between Teacher And Student – The Knowledge Of Combinations, Body And Speech – Siksha Valli – Taittriya Upanishad.

UNIT III WORD 9

Aum- Speech and Breath as Pair – Chandogya Upanishad and Brihadaryanaka Upanishad. Significance of Chants, Structure of Language and Cosmic Correspondences. The Non-Dual Word – Bhartrihari's Vakyapadiyam. Sphota-Ultimate Reality Expressed Through Language. Intention. Thought 'Sabdanaor' and Speaking.

UNIT IV KNOWLEDGE AS POWER/OPPRESSION 9

Power- as Self-Realization in Gita. Krishna's Advice to Arjuna on How to Conquer Mind. Francis Bacon – Four Idols – What Prevents One From Gaining Knowledge? Michel Foucault-Knowledge as Oppression. Panopticon. Rtam (Truth) and Satyam (Eternal Truth).

UNIT V SELF KNOWLEDGE/BRAHMAN 9

Knowledge about Self, Transcendental Self. The Different Chakras and the Stages of Sublimation. Philosophy of Yoga and Siva for Union of Mind and Body. Concept of Yin/Yang. Aspects of the Feminine / Masculine.

TOTAL : 45 PERIODS

OUTCOMES:

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

1. Think sceptically, ask questions and to arrive at deductions.
2. Connect and relate different branches of thought.
3. Comprehends the relation between language, thought and action.
4. Arrive at a better understanding of self and others and forms a new outlook.

REFERENCES:

1. Swami Nikhilananda: The Upanishads, Swami Nikhilananda, Advaita Ashrama, Kolkata.
2. Swamy Tapasyananda: Srimad Bhagavad Gita, The Scripture of Mankind, Sri Ramakrishna Math, Chennai.
3. Subrahmanyam, Korada: Vakyapadiyam of Bhartrhari Brahmakanda, Sri Garib Dass series.
4. Swami Lokeswarananda: Chandogya Upanishad, Swami Lokeswarananda, Ramakrishna Mission Institute of Culture, Kolkata.

5. Brahma, Apuruseya: The Four Vedas: Translated in English.
6. Haich, Elizabeth: Sexual Energy and Yoga.
7. Bacon, Francis: Power as Knowledge
8. Vlastos, Gregory: Socrates Ironist and Moral Philosopher.
9. Plato: The Republic, Penguin.
10. Gutting, Garry: Foucault A Very Short Introduction, Oxford.

HU5177 APPLICATIONS OF PSYCHOLOGY IN EVERYDAY LIFE L T P C
3 0 0 3

UNIT I INTRODUCTION 7
Nature and fields.

UNIT II PSYCHOLOGY IN INDUSTRIES AND ORGANIZATIONS 9
Job analysis; fatigue and accidents; consumer behavior.

UNIT III PSYCHOLOGY AND MENTAL HEALTH 11
Abnormality, symptoms and causes psychological disorders

UNIT IV PSYCHOLOGY AND COUNSELING 7
Need of Counseling, Counselor and the Counselee, Counseling Process, Areas of Counseling.

UNIT V PSYCHOLOGY AND SOCIAL BEHAVIOUR 11
Group, group dynamics, teambuilding, Prejudice and stereotypes; Effective Communication, conflict and negotiation.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Schultz, D. & Schultz, S.E. (2009). Psychology and Work Today (10th ed.). New Jersey:Pearson/Prentice Hall
2. Butcher, J. N., Mineka, S., & Hooley, J. M. (2010). Abnormal psychology (14th ed.). New York: Pearson
3. Gladding, S. T. (2014). Counselling: A comprehensive profession. New Delhi: Pearson Education
4. Aronson, E., Wilson, T. D., & Akert, R. M. (2010). Social Psychology (7th Ed.). Upper Saddle River, NJ: Prentice Hall

HSMC– ELECTIVES – HUMANITIES II (EVEN SEMESTER)

HU5271 GENDER, CULTURE AND DEVELOPMENT L T P C
3 0 0 3

COURSE DESCRIPTION

This course offers an introduction to Gender Studies that asks critical questions about the meanings of sex and gender in Indian society. The primary goal of this course is to familiarize students with key issues, questions and debates in Gender Studies, both historical and contemporary drawing from Indian literature and media studies, to examine cultural assumptions about sex, gender, and sexuality. This course integrates analysis of current events through student presentations, aiming to increase awareness of contemporary and historical experiences of women, and of the multiple ways that sex and gender interact with class, caste and other social identities. This course also seeks to build an understanding of the concepts of gender, gender-based violence, sexuality, and rights and their impact on development through a number of discussions, exercises and reflective activities.

OBJECTIVES

- ✓ To familiarize students with the concepts of sex and gender through literary and media texts.
- ✓ To help students ask critical questions regarding gender roles in society.
- ✓ To provide students with the material to discuss gender issues such as gender based discrimination, violence and development.
- ✓ To help students think critically about gender based problems and solutions.

LEARNING OUTCOMES

- ➢ Students will be able to critically read literary and media texts and understand the underlying gender perspectives in them.
- ➢ Students will be able to analyse current social events in the light of gender perspectives.
- ➢ Students will be able to discuss, analyse and argue about issues related to gender and their impact on society, culture and development.

UNIT I: INTRODUCTION TO GENDER

- Definition of Gender
- Basic Gender Concepts and Terminology
- Exploring Attitudes towards Gender
- Social Construction of Gender

Texts:

1. Sukhu and Dukhu (Amar Chitra Katha)
2. The Cat who Became a Queen (Folk tale, J. Hinton Knowles, Folk-Tales of Kashmir. London: Kegan Paul, Trench, Trübner, and Company, 1893, pp. 8-10.)

UNIT II: GENDER ROLES AND RELATIONS

- Types of Gender Roles
- Gender Roles and Relationships Matrix
- Gender-based Division and Valuation of Labour

Texts:

1. Muniyakka (Short Story, Lakshmi Kannan, Nandanvan and Other Stories, Hyderabad: Orient Blackswan, 2011)
2. Video: Witness: Freeing Women From Cleaning Human Waste (2014, HRW, Manual Scavenging, India)

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UNIT III: GENDER DEVELOPMENT ISSUES

- Identifying Gender Issues
- Gender Sensitive Language
- Gender, Governance and Sustainable Development
- Gender and Human Rights
- Gender and Mainstreaming

TEXTS:

1. The Many Faces of Gender Inequality (Essay, Amartya Sen, Frontline, Volume 18 - Issue 22, Oct. 27 - Nov. 09, 2001)
2. Tell Us Marx (Poem, Mallika Sengupta, Translated by Sanjukta Dasgupta)

UNIT IV: GENDER-BASED VIOLENCE

- The concept of violence
- Types of Gender-based violence
- The relationship between gender, development and violence
- Gender-based violence from a human rights perspective

Texts:

1. Lights Out (Play, Manjula Padmanabhan)
2. Lights Out (Video of play enacted)

UNIT V: GENDER AND CULTURE

- Gender and Film
- Gender, Media and Advertisement

Texts:

1. Mahanagar (Movie: Satyajit Ray)
2. Beti Bachao Beti Padhao Advertisements

READINGS: Relevant additional texts for readings will be announced in the class. Classes will consist of a combination of activities: dialogue-based lectures, discussions, collaborative learning activities, group work and in-class assignments.

ASSESSMENT AND GRADING:

Discussion & Classroom Participation: 20%
Project/Assignment: 30%
End Term Exam: 50%

HU5272 **ETHICS AND HOLISTIC LIFE** **L T P C**
3 0 0 3

OBJECTIVES:

- To emphasize the meaning and nature of ethics, human values and holistic life for leading a good, successful and happy life through continuous examination of thoughts and conduct in day to day life.
- To understand the status and responsible role of individual in abatement of value crisis in contemporary world in order to develop a civilized and human society. Understanding the process of ethical decision making through critical assessment of incidents/cases of ethical dilemmas in personal, professional and social life.
- To view the place of Ethics and Human Values in the development of individual and society through identification and cross examination of life values and world view of his/her role models in society.

UNIT I HUMAN LIFE, ITS AIM AND SIGNIFICANCE

The concept of a successful life, happy life and a meaningful life, Ethical and decision making capability and its development: Meaning of Ethical dilemma, sharing real life experiences.

UNIT II CREATIVE AND LEADERSHIP ABILITY AND THEIR DEVELOPMENT

Intellectual, Emotional, Creative, Ethico - spiritual development, Aesthetic sense, Self-dependency, Activeness, Development of positive attitude.

UNIT III HARMONY IN PERSONAL AND SOCIAL LIFE:

Concept of personal and group Ethics; Balance between - rights and duties-welfare of self and welfare of all, creating a value based work culture in hostel, classroom and other places in the campus and society.

UNIT IV CHARACTER, RIGHTEOUSNESS AND VIRTUES FOR A MEANINGFUL LIFE

Egolessness, Humility, Righteousness, Purity, Truthfulness, Integrity, Self-restraint, Self-control, Sense of responsibility, Empathy, Love, Compassion, Maitri / Comradeship, Cooperation, Tolerance.

UNIT V DILEMMA BETWEEN MATERIALISTIC DEVELOPMENT AND HUMAN WELFARE

Science, Technology, Consumerism, Relation with Nature and Environment, New dimension of Global Harmony: Democracy, Equality, Social Justice

TOTAL:45 PERIODS

OUTCOMES:

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

1. Enable students to understand the concept of contemporary ethics at different levels: Individual, local and Global and enable them to cross examine the ethical and social consequences of the decisions of their life-view and world view.
2. Develop the ability of students to create a balance between their individual freedom and social responsibilities and enable them to identify the personal, professional and social values and integrate them in their personality after cross examination.
3. Enable students to cross examine their earlier decisions taken in life and understand the meaning of ethical dilemma to overcome the ethical dilemmas and engage in critical reflection.
4. Develop positive habits of thought and conduct and work cohesively with fellow beings who have variety of strengths, experiences, shortcomings and challenges, hence to enable them to handle diverse type of personalities.
5. Enable students to develop a method for making ethically sound decisions for themselves, within hostels, classrooms, university campus and society.

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HU5273 LAW AND ENGINEERING L T P C
3 0 0 3

UNIT I THE LEGAL SYSTEM: SOURCES OF LAW AND THE COURT STRUCTURE 9
Enacted law -Acts of Parliament are of primary legislation, Common Law or Case law- Principles taken from decisions of judges constitute binding legal rules. The Court System in India and Foreign Courtiers. (District Court, District Consumer Forum, Tribunals, High Courts, Supreme Court) Arbitration: As an alternative to resolving disputes in the normal courts, parties who are in dispute can agree that this will instead be referred to arbitration.

UNIT II LAWS 9
Basic principles of contract law, sale of goods law, laws relating to industrial pollution, accident, environmental protection, health and safety at work, patent law, constitutional law: the supreme law of the land, Information technology law and cyber crimes.

UNIT III BUSINESS ORGANISATIONS 9
Sole traders (Business has no separate identity from you, all business property belongs to you). Partnerships: Types of Partnerships - Limited Liability Partnership, General Partnership, Limited Partnerships. Companies: The nature of companies, Classification of companies, Formation of companies, Features of a public company, Carrying on business, Directors– Their Powers and Responsibilities/Liabilities.

UNIT IV LAW AND SOCIETY 9
Interdisciplinary nature of law, legal ideologies/philosophy/ schools of jurisprudence**.**

UNIT V CASE STUDIES 9
Important legal disputes and judicial litigations

TOTAL: 45 PERIODS

HU5274 FILM APPRECIATION L T P C
3 0 0 3

COURSE DESCRIPTION
This is an intensive course designed to promote comprehensive understanding and insights into the nature of cinema and other related forms and practices. Movies, though at times are used more as escapism, they are also a true art form and expressive tool used by writers, directors and actors. This course will explore the aesthetics of cinema, the concepts behind storytelling and various other elements of a film. It will also explore the impact of movies in our society and in our lives. It also encourages students to use films as a medium to analyse visual texts and read underlying messages.

OBJECTIVES:
- To help learners understand the various movie genres and its types.
- To understand various elements that contributes to film making.
- To make them realize the impact of film in society.
- To analyse the visual media and interpret the underlying messages.

UNIT I THE COMPONENTS OF FILMS 9
Story, Screenplay & Script – Actors – Director – Crew Members – Mis En Scene – Structure of A Film – Narrative Elements – Linear & Non-Linear – Types of Movie Genres: Mysteries, Romantic Comedies, Horror Etc.

UNIT II EVOLUTION OF FILM 9

History of Films – Early Cinema – Silent Movies – Talkies – Film Language, Form, Movement – Film Theories – Realist, Auteurists, Feminist, Psychonalyic, Idealogical Theories.

UNIT III FILMS ACROSS THE WORLD 9

European Films – Russian Films – Japanese Films – Korean Films – Hollywood Film – Studio Culture – All Time Great Movies.

UNIT IV INDIAN FILMS 9

The Early Era – History Of Indian Cinema – Movies for Social Change – Hindi Movies that Created Impact – Regional Movies – Documentaries – Cultural Identity.

UNIT V INTERPRETING FILMS 9

Film Criticism & Appreciation – Censorship in Movies – Cultural Representation in Movies – Television – New Media & Online Media – Films Beyond Entertainment.

TOTAL: 45 PERIODS

OUTCOMES

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

- Recognize types of films, their impact on society and their roles in our lives.
- Have an understanding of the concepts of storytelling, Mise en Scene, and other elements of film making.
- Interpret the underlying messages in the movies.

Teaching Methods

- Each unit consists of reading materials, learning activities videos, websites. Students are expected to watch movies sometimes in class and at times at home and discuss in class.

Evaluation

- As this is course is critical appreciation course on films, there is no written end semester examination. The course is more on learning how to critically analyse a movie and appreciate its finer elements. Therefore evaluation can be based on assignments and discussions. Internals marks can be taken for the total marks.

Internal (100 % weightage)

- Assignment 1: Write a movie review with critical analysis (20 marks).
- Assignment2 : Write a script for a scene taken from a short story / novella (20 marks).
- Presentation: Students choose any one topic related to films and present it to the audience. (25 marks)
- Group discussion : Students discuss in groups on the various aspects of movies and its impact on society. (25 marks)
- Blog entry: Making weekly blog posts in Class Blog on the topics related to the course posted by the instructor and commenting on others' posts. (10 marks)

REFERENCES

1. A Biographical Dictionary of Film by David Thomson, Secker & Warburg, 1975
2. Signs and Meaning in the Cinema by Peter Wollen, Secker & Warburg, 1969
3. The World Viewed by Stanley Cavell 1971
4. Film Style and Technology: History and Analysis by Barry Salt, Starword, 1983
5. The Encyclopedia of Indian Cinema Edited by Ashish Rajadhyaksha and Paul Willemen, BFI, 1994.

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HU5275 FUNDAMENTALS OF LANGUAGE AND LINGUISTICS L T P C
3 0 0 3

OBJECTIVES

- To broadly introduce students to the formal and theoretical aspects of linguistics.
- To enable learners to understand the various practical applications of language and recent findings in the field of applied linguistics.

CONTENTS : -

UNIT I LANGUAGE AND LINGUISTICS: AN OVERVIEW 9

Language and Linguistics-Linguistic Knowledge-Knowledge of Sound Systems & Words – Creativity of Language – Relationship of form and meaning. Grammar – descriptive, prescriptive, universal-Human Language – Animal Language – Sign Language- Computers and Language.

UNIT II MORPHOLOGY - WORDS OF LANGUAGE 9

Content and function words – morphemes -free & bound –prefixes – suffixes – roots and stems –inflectional and derivational morphology-compound words and their formation – malapropisms – slips of the tongue.

UNIT III SYNTAX- THE SENTENCE PATTERNS OF LANGUAGE AND SEMANTICS-THE MEANING OF LANGUAGE 9

Syntax : Rules of Syntax- Sentence Structure-Structural Ambiguity-Syntactic Categories. Semantics: Lexical Semantics – Anomaly-Metaphors- Idioms- Synonyms – Antonyms – Homonyms -Pragmatics– Speech Acts

UNIT IV PHONETICS – THE SOUNDS OF LANGUAGE 9

Speech sounds- Introduction to branches of Phonetics- The Phonetic Alphabet – IPA – Consonants - Vowels – Diphthongs- Tone and Intonation.

UNIT V APPLIED LINGUISTICS - THE PRACTICAL APPLICATIONS OF LANGUAGE 9

Language learning and teaching (ELT)- lexicography-translation studies-computational linguistics-neurolinguistics (speech pathology and language disorders)- forensic linguistics – sociolinguistics.

TOTAL : 45 PERIODS

Teaching Methods:
Lectures, discussion.

Evaluation Internal and External:
Internal: 2 written tests + assignments, seminars, project (50+15+15+20).
External: A 3 hour written exam (50 marks)

REFERENCES:

1. Victoria Fromkin, Robert Rodman, Nina Hyams.2019.An Introduction to Language.USA.CENGAGE.11th edition
2. Cook. G,2003. Applied linguistics.UK: Oxford University Press.

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HU5276 UNDERSTANDING SOCIETY AND CULTURE THROUGH LITERATURE L T P C
3 0 0 3

OBJECTIVES

- To internalize the importance of language by understanding its role in the transformation of man.
- To look at language, literature and culture as locus of identity and change.
- To extract meaning from existing literatures and cultures.
- To identify meanings in modern life by reconnecting with lost cultures.

UNIT I INTRODUCTION

Why study literature? Tracing the origin – pictures. Tokens as precursors of writing. Movement from three dimensions to two dimensions- Pictography. From visual to oral - Logography. Reading out literature to young children- Edmund J Farrell.

UNIT II READING CULTURE

Reading culture through language, signs and consumables- Roland Barthes. Culture through poems- Nissim Ezekiel's ' The night of the Scorpion' . 'Nothing's Changed'- Tatamkhulu Afrika- Apartheid. Ruskin Bond- 'Night train at Deoli'- How real life is different from movies.

UNIT III IDENTIFYING MEANING

Searching and locating meaning through literature. Looking for order in a chaotic world. The Myth of Sisyphus (Albert Camus) and Adi Shankar's 'Jagat Mithya'- the world as an illusion. The Indian version as 'meaninglesss meaning'.

UNIT IV POST MODERNISM

'If on a winter's night a traveler'- Italo Calvino. The book about the reader- the experience of reading as reading. Metafiction. Selfie Culture. Visual Culture as purpose of modern life.

UNIT V RETURNING TO PICTURES

Literature of the present- Emphasis on the visual world. Twitterature. SMS. Whatsapp language. Consumer culture. Change in fixed gender notions. Interactive sessions. Introspection.

READING LIST

1. Bond, Ruskin: 'Night train at Deoli'
2. Ezekiel, Nissim: ' The Night of the Scorpion'
3. Afrika,Tatamkhulu: 'Nothing's Changed'
4. Barthes, Roland: *Mythologies*
5. Shankaracharya: *Viveka Chudamani*
6. Camus, Albert- *The Myth of Sisyphus*
7. Calvino, Italo: *If on a winter's night a traveler*
8. Farrell, Edmund J: 'Listen, my children, and you shall read'

OUTCOMES

- Can identify the connections among language, literature and culture.
- Is able to relate between seemingly different aspects of life.
- Understands the fractions in modern life and can assimilate meanings.