Curriculum
for
Degree Level Programme
in
AERONAUTICAL ENGINEERING

for

PUNJAB STATE CIVIL AVIATION COUNCIL, PATIALA

Prepared by:

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FOREWORD

The wave of liberalization and globalization has created an environment for free flow of information and technology through fast and efficient means the world over. This has lead to shrinking of world, bringing people from different cultures and environment together, giving rise to a global village. A shift has been taking place in India from closed economy to knowledge based and open economy. In order to cope-up with the challenges of handling new technologies, materials and methods, we have to develop human resources having appropriate knowledge, professional skills and attitude. Technical education system is one of the significant components for human resource development. Technical Universities and Institutions play an important role in meeting the requirements of trained technical manpower for industries and field organizations. The initiatives being taken by the Punjab State Civil Aviation Council, Patiala to start new degree level programme as per the needs of the industry are laudable.

In order to meet the requirements of future technical manpower, constant efforts have to be made to identify new employment opportunities, carryout activity analysis and design need based curricula of degree level programme. This curriculum document has been designed by identifying job potential and expected learning outcomes from the degree holders, leading to identification of curriculum areas for the programme.

It is needless to emphasize that the real success of the degree level programme will depend upon its effective implementation. This will require harnessing and effective utilization of resources. In addition to acquisition of appropriate physical resources, the availability of competent and qualified faculty is an essential element for the effective implementation of the curriculum.

It is time for the managers of technical education system to reorganize the system to accept the challenges of both quantitative and qualitative expansion of technical education. The creation of EDUSAT, ICT and other facilities in the country must be exploited to its fullest extent to reap the benefits of interactive digital and electronic media for teaching-learning process.

It is hoped that institute will carry out job market research on a continuous basis to identify the new skill requirements and develop innovative methods of programme offering and thereby infuse dynamism in the system.

Director
National Institute of
Technical Teachers' Training and Research
Chandigarh

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PK Singla
Coordinator

1. SALIENT FEATURES OF DEGREE LEVEL PROGRAMME IN AERONAUTICAL ENGINEERING

1)	Name of the Programme	:	Degree Level Programme in Aeronautical Engineering
2)	Duration of the Programme	:	Four years (Eight Semesters)
3)	Entry Qualification	:	10+2 or as prescribed by AICTE
4)	Intake	:	40/60 (or as prescribed by AICTE))
5)	Pattern of the Programme	:	Semester Pattern
6)	Ratio between theory and Practice	:	60 : 40 (Approx.)

7) Industrial Training:
Four weeks of summer vacation training is included after 2nd semester, 6 weeks Vocational training is included after 4th Semester and 8 weeks vocational training is included after 6th semester in the curriculum.

8) Ecology and Environment:
As per Govt. of India directives, a subject on Environmental Science has been incorporated in the curriculum.

9) Entrepreneurship Development:
A full subject on Management and Entrepreneurship have been incorporated in the 6th semester of the curriculum.

10) Two elective courses of 4 credit each have been included in the 7th semester of the curriculum

11) Student Centred Activities:
A subject on Soft Skills is included in the 3rd Semester of the degree programme

12) Project Based Industrial Training:
A full 8th semester project based industrial training has been included in the curriculum to enable the student get familiarize with the practices and procedures being followed in the industries and provide an opportunity to work on some live projects in the industry. 100 marks and 8 credits are allotted to this industrial training.

2. EMPLOYMENT OPPORTUNITIES FOR DEGREE HOLDERS IN AERONAUTICAL ENGINEERING

CIVIL AVIATION SCENARIO

Civil aviation in India has progressed very fast in last one decade and in that airline industry has contributed a lot in the economic development of country. The next six years up-to 2020, will be a period of immense significance for air transport industry. The rapid rise in global trade, economic liberalization and upward mobility in large middle class of India population is expected to give a fillip to steady expansion of civil aviation in India.

To meet the challenges of the future, a lot of technical manpower both for licensing and non-licensing categories will be required for carrying out design, maintenance and servicing activities in aeronautic industries. It is known fact that modern high-tech belongs to state-of-art technology with more and more computer applications in cock-pit management. Radical advancements in the field of avionics, engine and aircraft materials will necessitate airline industry to redefine its training needs and methodologies to meet the challenges posed to the industry by introduction of satellite based technology in navigation and communication, ground positioning, data communication and fly by wire transmission of date. All this will require higher skill and more technical personnel to work on the sophisticated systems of aircraft. There will be need to train more people in the areas of aircraft, engine and avionics for both production and certification work.

Major employment opportunities for the students who have passed the degree in Aeronautical Engineering are as follows:

(i) Defense and Paramilitary Services: All the wings having Aviation - Air force, Army, Navy, BSF and Coast Guards etc.
(ii) Defense Organizations such as Defense Research and Development Organization (DRAO)
(iii) Hindustan Aeronautical Limited (HAL)
(iv) National Aerospace Laboratories (NAL)
(v) Aeronautical Development Agency (ADA)
(vi) Indian Space Research Organization (ISRO)
(vii) Airlines in Public and Private sectors
(viii) Aircraft maintenance and servicing organizations in private sectors
(ix) Manufacturing organizations in public and private sectors
(x) Maintenance, Repair and Overhauling (MRO) organizations
(xi) Civil Aviation Clubs
(xii) Director General Civil Aviation (DGCA)
(xiii) Director General of Aeronautical Quality Assurance (DGAQA)
(xiv) Educational Institutions etc.

3. LEARNING OUTCOMES OF DEGREE LEVEL PROGRAMME IN 'AERONAUTICAL ENGINEERING'

At the end of the programme, the students will be able to:

Sr. No.	Learning Outcomes
1.	Use basic concepts and principles of physics to understand various engineering subjects and apply the same in engineering/industrial problems.
2.	Apply the elementary concepts and principles of mathematical techniques like matrices, complex numbers, differential equations etc. in the solution of engineering problems.
3.	Communication effectively in listening, speaking, reading and writing in different situation.
4.	Apply basic concepts and principles of electrical engineering in different situations
5.	Value human relations and work ethically in professional working environment.
6.	Explain different environmental issues related to industries and reduce pollution while working in the field.
7.	Develop basic manual skills.
8.	Apply various concepts and principles of chemistry to understand engineering subjects and apply the same in engineering/industrial problems
9.	Trace different curves with computation of area, volume and surface of curves with multiple integrations. Students will also use the concepts of vectors and their important theorems in solving various problems.
10.	Apply basic principles of thermodynamics, fluid dynamics and other elements of mechanical engineering in various problems.
11.	Operate basic electronic devices used for testing, measurement and analysis
12.	Develop an algorithm, pseudo code and write program in C language to solve a given problem.
13.	Develop mastery over language of engineers i.e. engineering drawing; will acquire skills to draw the points, lines, planes, solids, sections of solids and develop surfaces with isometric and orthographic projection.

14.	Explain basic principles of Aeronautics.
15.	Apply concepts of various types of fluid flow for calculating aerodynamic characteristics of different bodies.
16.	Apply important oriented mathematical techniques like Laplace transform, Fourier transforms, their uses in solving ordinary and partial differential equations, analytic function of complex numbers, use of Cauchy's formula to solve complex integrations.
17.	Model and analyze basic loads on the structures
18.	Develop appropriate soft skills for better placement in the industries and live a good life in the society
19.	Apply various numerical methods in solving different variety of equations numerically.
20.	Design bodies and shapes with required aerodynamic characteristics in high speed flow.
21.	Analyse basis aircraft structural loads
22.	Explain and apply the working principles of air breathing engines.
23.	Apply qualitative and quantitative methods in the selection of materials as a fundamental step in the design phase of aircraft structures and components.
24.	Use various Aircraft Systems and Instrumentation.
25.	Calculate and analyze flight coefficients and parameters of an aircraft.
26.	Analyze basic working of avionics, navigation and communication equipment of aircraft.
27.	Analyze the aircraft structures
28.	Estimate performance parameters of different parts of air breathing engines (Internal combustion and jet).
29.	Develop various codes of finite element method to analyze structural loads on different aircraft components.
30.	Analyze various longitudinal and lateral dynamic modes coefficients and parameters.
31.	Apply computational fluid dynamics for the assessment and analysis of fluid flows and their effect on aircraft structures.
32.	Analyze aircraft vibrations and aircraft flutter phenomenon.
33.	Set-up an enterprise and manage a small unit.
34.	Explain general maintenance, ground handling of aircraft and safety support systems.
35.	Design autopilots for aircraft.
36.	Design an Aircraft.
37.	Explain aircraft rules and regulations applicable to civil aviation for continuing airworthiness.
38.	Explain basic functioning of helicopter operation, design and stability parameters.
39.	Work in aircraft manufacturing and maintenance industries.

4. DERIVING CURRICULUM AREAS FROM LEARNING OUTCOMES OF THE PROGRAMME

The following curriculum area subjects have been derived from learning outcomes:

S. No.	Learning Outcomes	Curriculum Areas/Subjects

1.	Use basic concepts and principles of physics to understand various engineering subjects and apply the same in engineering/industrial problems.	Applied Physics and Lab.
2.	Apply the elementary concepts and principles of mathematical techniques like matrices, complex numbers, differential equations etc. in the solution of engineering problems.	Applied Mathematics-I
3.	Communication effectively in listening, speaking, reading and writing in different situations.	Communicative English and Lab.
4.	Apply basic concepts and principles of electrical engineering in different situations	Basic of Electrical Engineering.
5.	Value human relations and work ethically in professional working environment.	Human Values and Professional Ethics
6.	Explain different environmental issues related to industries and reduce pollution while working in the field.	Environmental Science
7.	Develop basic manual skills.	Manufacturing Practice
8.	Apply various concepts and principles of chemistry to understand engineering subjects and apply the same in engineering/industrial problems	Applied Chemistry and Lab.
9.	Trace different curves with computation of area, volume and surface of curves with multiple integrations. Students will also use the concepts of vectors and their important theorems in solving various problems.	Applied Mathematics-II
10.	Apply basic principles of thermodynamics, fluid dynamics and other elements of mechanical engineering in various problems.	Elements of Mechanical Engineering.
11.	Operate basic electronic devices used for testing, measurement and analysis	Basic of Electronic Engineering. And Lab.
12.	Develop an algorithm, pseudo code and write program in C language to solve a given problem.	Basic of Computer Programming and Lab,.
13.	Develop mastery over language of engineers i.e. engineering drawing; will acquire skills to draw the points, lines, planes, solids, sections of solids and develop surfaces with isometric and orthographic projection.	Engineering Drawing
14.	Explain basic principles of Aeronautics.	Basic of Aeronautics
15.	Apply concepts of various types of fluid flow for calculating aerodynamic characteristics of different bodies.	Aerodynamics and Lab.
16.	Apply important oriented mathematical techniques like Laplace transform, Fourier transforms, their uses in solving ordinary and partial differential equations, analytic function	Applied Mathematics-III

	of complex numbers, use of Cauchy's formula to solve complex integrations.	
17.	Model and analyze basic loads on the structures	Strength of Materials
18.	Develop appropriate soft skills for better placement in the industries and live a good life in the society	Soft Skills
19.	Apply various numerical methods in solving different variety of equations numerically.	Numerical Methods
20.	Design bodies and shapes with required aerodynamic characteristics in high speed flow.	High speed Aerodynamics and Lab.
21.	Analyse basis aircraft structural loads	Aircraft Structures and Lab.
22.	Explain and apply the working principles of air breathing engines.	Aircraft Propulsion and Lab.
23.	Apply qualitative and quantitative methods in the selection of materials as a fundamental step in the design phase of aircraft structures and components.	Aircraft materials and processes
24.	Use various Aircraft Systems and Instrumentation.	Aircraft System and Instrumentation
25.	Calculate and analyze flight coefficients and parameters of an aircraft.	Airplane performance
26.	Analyze basic working of avionics, navigation and communication equipment of aircraft.	Avionics and Lab.
27.	Analyze the aircraft structures	Aircraft Structural Analysis and Lab.
28.	Estimate performance parameters of different parts of air breathing engines (Internal combustion and jet).	Jet Propulsion and Lab.
29.	Develop various codes of finite element method to analyze structural loads on different aircraft components.	Finite Element Methods
30.	Analyze various longitudinal and lateral dynamic modes coefficients and parameters.	Aircraft Stability and Control
31.	Apply computational fluid dynamics for the assessment and analysis of fluid flows and their effect on aircraft structures.	Computational Fluid Dynamics and Lab.
32.	Analyze aircraft vibrations and aircraft flutter phenomenon.	Vibration and Aero Elasticity and Lab.
33.	Set-up an enterprise and manage a small unit.	Management and Entrepreneurship
34.	Explain general maintenance, ground handling of aircraft and safety support systems.	Aircraft Maintenance
35.	Design autopilots for aircraft.	Automatic Flight Control
36.	Design an Aircraft.	Aircraft Design
37.	Explain aircraft rules and regulations applicable to civil aviation for continuing	Air worthiness and Certification

	airworthiness.	
38.	Explain basic functioning of helicopter operation, design and stability parameters.	Helicopter Engineering and Dynamics
39.	Work in aircraft manufacturing and maintenance industries.	Project Work and Project Based Industrial Training

5. ABSTRACT OF CURRICULUM AREAS

a) General Studies

1. Communicative English and Lab.
2. Human Values and Professional Ethics
3. Management and Entrepreneurship
4. Environmental Science
5. Soft Skills

b) Applied Sciences

1. Applied Mathematics
2. Applied Physics and Lab.
3. Applied Chemistry and Lab.
4. Numerical Methods

c) Basic Courses in Engineering/Technology

1. Engineering Drawing
2. Basics of Electrical Engineering and Lab.
3. Basics of Electronic Engineering and Lab.
4. Basics of Computer Programming and Lab.
5. Elements of Mechanical Engineering
6. Strength of Materials
7. Manufacturing Practice

d) Applied Courses in Engineering/Technology

1. Basics of Aeronautics
2. Aerodynamics
3. Aircraft Structures and Lab.
4. High speed aerodynamics and Lab.
5. Aircraft Propulsion and Lab.
6. Aircraft Materials and Propulsion
7. Aircraft Suability and control
8. Aircraft Systems and Instrumentation
9. Airplane Performance
10. Avionics and Lab.
11. Aircraft Structural Analysis and Lab.
12. Jet propulsion and Lab.
13. Finite Element Methods
14. Aircraft Stability and Control
15. Computational Fluid Dynamics
16. Vibration and Aero Elasticity and Lab.
17. Aircraft Maintenance
18. Automatic Flight Control
19. Aircraft Design
20. Air Worthiness and Certification
21. Helicopter Engineering and Dynamics

e) Specialized Courses in Engineering/Technology (Electives)

22. Elective-I : (Choose any one)
    - Boundary Layer Theory,
    - Aircraft Composite Material
    - Rockets and Missiles
    - Air Transportation and Operation
    - Rocket Propulsion

23. Elective-II : (Choose any one)
    - Aircraft Modelling and Simulation
    - Advanced Aerodynamics
    - Experimental Aerodynamics
    - Unmanned Aerial Systems

24. Project Work
25. Project Based Industrial Training

6. HORIZONTAL AND VERTICAL ORGANISATION OF THE SUBJECTS

Sr. No.	Subjects	Distribution in Hours per week in Various Semesters							
		I	II	III	IV	V	VI	VII	VIII
1.	Applied Physics	4	-	-	-	-	-	-	-
2.	Applied Mathematics-I , II & III	5	5	5	-	-	-	-	-
3.	Communicative English	3	-	-	-	-	-	-	-
4.	Basics of Electrical Engineering	2	-	-	-	-	-	-	-
5.	Human Values and Professional Ethics	2	-	-	-	-	-	-	-
6.	Environmental Science	2	-	-	-	-	-	-	-
7.	Applied Physics Lab.	2	-	-	-	-	-	-	-
8.	Communicative English Lab	2	-	-	-	-	-	-	-
9.	Basic of Electrical Engineering Lab	2	-	-	-	-	-	-	-
10.	Manufacturing Practice	7	-	-	-	-	-	-	-
11.	Applied Chemistry	-	4	-	-	-	-	-	-
12.	Elements of Mechanical Engineering	-	4	-	-	-	-	-	-
13.	Basics of Electronics Engineering	-	2	-	-	-	-	-	-
14.	Basics of Computer Programming	-	3	-	-	-	-	-	-
15.	Engineering Drawing	-	5	-	-	-	-	-	-
16.	Applied Chemistry Lab.	-	2	-	-	-	-	-	-
17.	Basics of Electronics Engineering Lab	-	2	-	-	-	-	-	-
18.	Basic of Computer Programming Lab	-	4	-	-	-	-	-	-
19.	Basics of Aeronautics	-	-	4	-	-	-	-	-
20.	Aerodynamics	-	-	4	-	-	-	-	-
21.	Strength of Materials	-	-	5	-	-	-	-	-
22.	Aerodynamics Lab.	-	-	4	-	-	-	-	-
23.	Soft Skills	-	-	4	-	-	-	-	-
24.	Numerical Methods	-	-	-	4	-	-	-	-
25.	High Speed Aerodynamics	-	-	-	4	-	-	-	-
26.	Aircraft Structures	-	-	-	4	-	-	-	-
27.	Aircraft Propulsion	-	-	-	4	-	-	-	-
28.	Aircraft Materials and Processes	-	-	-	4	-	-	-	-
29.	Aircraft Systems and Instrumentation	-	-	-	3	-	-	-	-
30.	High Speed Aerodynamics Lab.	-	-	-	4	-	-	-	-
31.	Aircraft Structures Lab.	-	-	-	2	-	-	-	-
32.	Aircraft Propulsion Lab.	-	-	-	2	-	-	-	-
33.	Airplane Performance	-	-	-	-	5	-	-	-
34.	Avionics	-	-	-	-	4	-	-	-
35.	Aircraft Structural Analysis	-	-	-	-	4	-	-	-
36.	Jet Propulsion	-	-	-	-	4	-	-	-
37.	Finite Element Methods	-	-	-	-	4	-	-	-
38.	Aircraft Structural Analysis Lab.	-	-	-	-	4	-	-	-
39.	Jet Propulsion Lab.	-	-	-	-	4	-	-	-
40.	Avionics Lab.	-	-	-	-	2	-	-	-
41.	Aircraft Stability and Control	-	-	-	-	-	5	-	-
42.	Computational Fluid Dynamics	-	-	-	-	-	4	-	-
43.	Vibration and Aero Elasticity	-	-	-	-	-	4	-	-

44.	Management and Entrepreneurship	-	-	-	-	-	2	-	-
45.	Aircraft Maintenance	-	-	-	-	-	3	-	-
46.	Automatic Flight Control	-	-	-	-	-	5	-	-
47.	Computational Fluid Dynamics Lab	-	-	-	-	-	4	-	-
48.	Vibration and Aero Elasticity Lab.	-	-	-	-	-	4	-	-
49.	Aircraft Design	-	-	-	-	-	-	4	-
50.	Air Worthiness and Certification	-	-	-	-	-	-	3	-
51.	Helicopter Engineering and Dynamics	-	-	-	-	-	-	4	-
52.	Elective - I	-	-	-	-	-	-	4	-
53.	Elective-II	-	-	-	-	-	-	4	-
54.	Project Work	-	-	-	-	-	-	12	-
55.	Project Based Industrial Training	-	-	-	-	-	-	-	30
	Total	**31**	**31**	**26**	**31**	**31**	**31**	**31**	**30**

7. STUDY AND EVALUATION SCHEME FOR DEGREE LEVEL PROGRAMME IN AERONAUTICAL ENGINEERING

FIRST SEMESTER

SR. NO.	SUBJECTS	STUDY SCHEME Hours/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of **Int. & Ext.**
						INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
		L	**T**	**P**		**Th**	**Pr**	**Tot**	**Th**	**Hrs**	**Pr**	**Hrs**	**Tot**	
1.1	Applied Physics	3	1	-	4	40	-	40	60	3	-	-	60	100
1.2	Applied Mathematics-I	4	1	-	5	40	-	40	60	3	-	-	60	100
1.3.	Communicative English	2	1	-	3	40	-	40	60	3	-	-	60	100
1.4	Basics of Electrical Engineering	2	-	-	2	40	-	40	60	3	-	-	60	100
1.5	Human Values and Professional Ethics	2	-	-	2	40	-	40	60	3	-	-	60	100
1.6	Environmental Science	2	-	-	2	40	-	40	60	3	-	-	60	100
1.7	Applied Physics Lab.	-	-	2	1	-	60	60	-	-	40		40	100
1.8	Communicative English Lab	-	-	2	1	-	60	60	-	-	40		40	100
1.9	Basic of Electrical Engineering Lab	-	-	2	1	-	60	60	-	-	40		40	100
1.10	Manufacturing Practice	1	-	6	4	-	60	60	-	-	40		40	100
	Total (6 Theory + 4 Labs.)	**16**	**3**	**12**	**25**	**240**	**240**	**480**	**360**	**-**	**160**	**-**	**520**	**1000**

SECOND SEMESTER

SR. NO.	SUBJECTS	STUDY SCHEME Hours/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of **Int. & Ext.**
						INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
		L	**T**	**P**		**Th**	**Pr**	**Tot**	**Th**	**Hrs**	**Pr**	**Hrs**	**Tot**	
2.1	Applied Chemistry	3	1	-	4	40	-	40	60	3	-	-	60	100
2.2	Applied Mathematics-II	4	1	-	5	40	-	40	60	3	-	-	60	100
2.3.	Elements of Mechanical Engineering	3	1	-	4	40	-	40	60	3	-	-	60	100
2.4	Basics of Electronics Engineering	2	-	-	2	40	-	40	60	3	-	-	60	100
2.5	Basics of Computer Programming	3	-	-	3	40	-	40	60	3	-	-	60	100
2.6	Engineering Drawing	1	-	4	3	40	-	40	60	3	-	-	60	100
2.7	Applied Chemistry Lab.	-	-	2	1	-	60	60	-	-	40		40	100
2.8	Basics of Electronics Engineering Lab	-	-	2	1	-	60	60	-	-	40		40	100
2.9	Basic of Computer Programming Lab	-	-	4	2	-	60	60	-	-	40		40	100
	Total (6 Theory + 4 Labs.)													
	Total	**16**	**3**	**12**	**25**	**240**	**180**	**420**	**360**	**-**	**120**	**-**	**480**	**900**

Note: There will be 4 weeks summer vacation training after 2nd semester. Marks & Credits for 4 weeks summer training will be included in 3rd semester.

THIRD SEMESTER

SR. NO.	SUBJECTS	STUDY SCHEME Hours/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of **Int. & Ext.**
						INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
		L	**T**	**P**		**Th**	**Pr**	**Tot**	**Th**	**Hrs**	**Pr**	**Hrs**	**Tot**	
3.1	Basics of Aeronautics	4	-	-	4	40	-	40	60	3	-	-	60	100
3.2	Aerodynamics	3	1	-	4	40	-	40	60	3	-	-	60	100
3.3.	Applied Mathematics - III	4	1	-	5	40	-	40	60	3	-	-	60	100
3.4	Strength of Materials	4	1	-	5	40	-	40	60	3	-	-	60	100
3.5	Aerodynamics Lab.	-	-	4	2	-	60	60	-	-	40	3	40	100
3.6	Soft Skills	-	-	4	2	-	60	60	-	-	40	3	40	100
	Training–I : 4 weeks Summer Vacation Training (Workshop & Training)	-	-	-	2	-	60	60	-	-	40	3	40	100
	Total (4 Theory & 2 Labs.)	**15**	**3**	**8**	**24**	**160**	**180**	**340**	**240**		**120**		**360**	**700**

FOURTH SEMESTER

SR. NO.	SUBJECTS	STUDY SCHEME Hours/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of **Int. & Ext.**
						INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
		L	**T**	**P**		**Th**	**Pr**	**Tot**	**Th**	**Hrs**	**Pr**	**Hrs**	**Tot**	
4.1	Numerical Methods	3	1	-	4	40	-	40	60	3	-	-	60	100
4.2	High Speed Aerodynamics	3	1	-	4	40	-	40	60	3	-	-	60	100
4.3.	Aircraft Structures	3	1	-	4	40	-	40	60	3	-	-	60	100
4.4	Aircraft Propulsion	3	1	-	4	40	-	40	60	3	-	-	60	100
4.5	Aircraft Materials and Processes	4	-	-	4	40	-	40	60	3	-	-	60	100
4.6	Aircraft Systems and Instrumentation	3	-	-	3	40	-	40	60	3	-	-	60	100
4.7	High Speed Aerodynamics Lab.	-	-	4	2	-	60	60	-	-	40	3	40	100
4.8	Aircraft Structures Lab.	-	-	2	1	-	60	60	-	-	40	3	40	100
4.9	Aircraft Propulsion Lab.	-	-	2	1	-	60	60	-	-	40	3	40	100
	Total (6 Theory & 3 Labs.)	**19**	**4**	**8**	**27**	**240**	**180**	**420**	**360**	**-**	**120**	**-**	**480**	**900**

Note: Vocational Training of 6 weeks (3 credits) to be completed after 4th semester. Marks and Credits will be included in the 5th Semester.

FIFTH SEMESTER

SR. NO.	SUBJECTS	STUDY SCHEME Periods/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of **Int. & Ext.**
						INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
		L	**T**	**P**		**Th**	**Pr**	**Tot**	**Th**	**Hrs**	**Pr**	**Hrs**	**Tot**	
5.1	Airplane Performance	4	1	-	5	40	-	40	60	3	-	-	60	100
5.2	Avionics	4	-	-	4	40	-	40	60	3	-	-	60	100
5.3.	Aircraft Structural Analysis	3	1	-	4	40	-	40	60	3	-	-	60	100
5.4	Jet Propulsion	3	1	-	4	40	-	40	60	3	-	-	60	100
5.5	Finite Element Methods	3	1	-	4	40	-	40	60	3	-	-	60	100
5.6	Aircraft Structural Analysis Lab.	-	-	4	2	-	60	60	-	-	40	3	40	100
5.7	Jet Propulsion–II Lab.	-	-	4	2	-	60	60	-	-	40	3	40	100
5.8	Avionics Lab.	-	-	2	1	-	60	60	-	-	40	3	40	100
	Training -II	-	-	-	3	-	60	60	-	-	40	3	40	100
	Total (5 Theory+ 3 Labs.)	**17**	**4**	**10**	**29**	**200**	**240**	**440**	**300**	**-**	**160**	**-**	**460**	**900**

SIXTH SEMESTER

SR. NO.	SUBJECTS	STUDY SCHEME Hours/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of **Int. & Ext.**
						INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
		L	**T**	**P**		**Th**	**Pr**	**Tot**	**Th**	**Hrs**	**Pr**	**Hrs**	**Tot**	
6.1	Aircraft Stability and Control	4	1	-	5	40	-	40	60	3	-	-	60	100
6.2	Computational Fluid Dynamics	4	-	-	4	40	-	40	60	3	-	-	60	100
6.3.	Vibration and Aero Elasticity	3	1	-	4	40	-	40	60	3	-	-	60	100
6.4	Management and Entrepreneurship	2	-	-	2	40	-	40	60	3	-	-	60	100
6.5	Aircraft Maintenance	3	-	-	3	40	-	40	60	3	-	-	60	100
6.6	Automatic Flight Control	4	1	-	5	40	-	40	60	3	-	-	60	100
6.7	Computational Fluid Dynamics Lab	-	-	4	2	-	60	60	-	-	40	3	40	100
6.8	Vibration and Aero Elasticity Lab.	-	-	4	2	-	60	60	-	-	40	3	40	100
	Total (6 Theory & 2 Labs.)	**20**	**3**	**8**	**27**	**240**	**120**	**360**	**360**	**-**	**80**	**-**	**440**	**800**

Note: Vocational Training of 8 weeks (3 credits) to be completed after 6th semester. Marks & Credits will be included in the 7th semester.

SEVENTH SEMESTER

SR. NO.	SUBJECTS	STUDY SCHEME Hours/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of **Int. & Ext.**
						INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
		L	**T**	**P**		**Th**	**Pr**	**Tot**	**Th**	**Hrs**	**Pr**	**Hrs**	**Tot**	
7.1	Aircraft Design	3	1	-	4	40	-	40	60	3	-	-	60	100
7.2	Air Worthiness and Certification	3	-	-	3	40	-	40	60	3	-	-	60	100
7.3.	Helicopter Engineering and Dynamics	3	1	-	4	40	-	40	60	3	-	-	60	100
7.4	* Elective - I	4	-	-	4	40	-	40	60	3	-	-	60	100
7.5	** Elective-II	4	-	-	4	40	-	40	60	3	-	-	60	100
7.6	Project Work	-	-	12	4	-	60	60	-	-	40	3	40	100
	Training -III	-	-	-	3	-	60	60	-	-	40	3	40	100
	Total	**17**	**2**	**12**	**26**	**200**	**120**	**320**	**300**	**-**	**80**	**-**	**380**	**700**

*** Elective-I** (All four credits courses) : (Choose any one)
7.4.1. Boundary Layer Theory
7.4.2. Aircraft Composite Material
7.4.3. Rockets and Missiles
7.4.4. Air Transportation and Operation
7.4.5. Rocket Propulsion

**** Elective II (**All Four Credit Courses**)** (Choose any one)
7.5.1. Aircraft Modelling and Simulation
7.5.2. Advanced Aerodynamics
7.5.3 Experimental Aerodynamics
7.5.4. Unmanned Aerial Systems

EIGHTH SEMESTER

SR. NO.	SUBJECTS	STUDY SCHEME Hours/Week			Credits	MARKS IN EVALUATION SCHEME								Total Marks of **Int. & Ext.**
						INTERNAL ASSESSMENT			EXTERNAL ASSESSMENT					
		L	**T**	**P**		**Th**	**Pr**	**Tot**	**Th**	**Hrs**	**Pr**	**Hrs**	**Tot**	
8.1.	Project Based Industrial Training	-	-	30	8	-	60	60	-	-	40	3	40	100

9. INDUSTRIAL TRAINING OF STUDENTS

It is needless to emphasize further the importance of Industrial Training of students during their 4 years of studies at Engineering Colleges. It is industrial training, which provides an opportunity to students to experience the environment and culture of industrial production units and commercial activities undertaken in field organizations. It prepares student for their future role as degree engineers in the world of work and enables them to integrate theory with practice. Engineering Colleges have been arranging industrial training of students of various durations to meet the above objectives.

This document includes guided and supervised summer vacation training of 4 weeks duration to be organized after 2nd semester, 6 weeks after 4th semester and 8 weeks after 6th semester. An internal assessment of 60 and external assessment of 40 marks have been provided in the Study and Evaluation scheme of 3rd Semester. An internal assessment of 60 and external assessment of 40 marks have been provided in the study and evaluation scheme of 5th Semester for vocational training of 6 weeks duration after 4th semester. Similarly, an 8 weeks vocational training is planned after 6th semester. Marks and Credits for this training is allotted in the Study and Evaluation scheme of 7th Semester. The concerned HODs along with other teachers will guide and help students in arranging appropriate training places relevant to their specific branch. It is suggested that a training schedule may be drawn for each student before starting of the training in consultation with the training providers. Students should also be briefed in advance about the organizational setup, product range, manufacturing process, important machines and materials used in the training organization.

Equally important with the guidance is supervision of students training in the industry/organization by the teachers. A minimum of one visit per week by the teacher is recommended. Students should be encouraged to write daily report in their diary to enable them to write final report and its presentation later on.

Evaluation of professional industrial training report through viva-voce/presentation aims at assessing students understanding of materials, industrial process, practices in industry/field organization and their ability to engage in activities related to problem solving in industrial setup as well as understanding of application of knowledge and skills learnt in real life situations. The formative and summative evaluation may comprise of weightage to performance in testing, general behaviour, quality of report and presentation during viva-voce examination. It is recommended that such evaluations may be carried out by a team comprising of concerned HOD, teachers and representative from industry.

Teachers and students are requested to see the footnote below the study and evaluation scheme of each Semester for further details.

FIRST SEMESTER

1.1 APPLIED PHYSICS

LTPC
3 1 0 4

COURSE OBJECTIVES

- The course aims at developing a basic understanding among the students about concepts and principles of physics so that they are able to use it in other engineering subjects and apply the same in industries.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Explain basic concepts and principles related to EM waves and quantum theory.
- Apply concepts and principles of crystallography, magnetic materials and superconductivity in different engineering problems.
- Explain concepts of lasers and its industrial applications of fibre optics.
- Describe special theory of relativity and industrial applications of nanophysics.

DETAILED CONTENTS

UNIT –I (12 Hrs.)

1. EM waves & dielectrics: Introduction and physical significance of Gradient, Divergence & Curl, Dielectric polarization (qualitative only), Types of polarization, Displacement Current Maxwell's Equations, Equation of EM waves in free space, velocity of EM waves, Poynting Theorem, Electromagnetic Spectrum (Basic ideas of different region).

2. Quantum theory: Need and origin of Quantum Concept, Wave-particle duality, Matter waves, Group & Phase velocities, Concept of Uncertainty Principle, wave function & its Significance, normalization of wave function, Schrodinger wave equation: time independent and dependent, Eigen functions & Eigen values, particle in a box in 1-D.

UNIT-II (12 hrs)

3. Elements of crystallography: Unit cell, Basis, Space lattice, Crystal Systems, Miller Indices of Planes & Directions in cubic system, Continuous & Characteristic X-Rays, X-Ray Diffraction & Bragg's law in Crystals, Bragg's spectrometer, X-ray radiography.

4. Magnetic Materials & Superconductivity

Basic ideas of Dia, Para, Ferro & Ferri, Ferrites, Magnetic Anisotropy, Magnetostriction its applications in production of Ultrasonic waves, Superconductivity, Superconductors as ideal diamagnetic materials, Signatures of Superconducting state, Meissner Effect, Type I & Type II superconductors, Introduction to BCS theory, Application of superconductivity.

UNIT-III (12 Hrs)

5. Lasers: Spontaneous & Stimulated emissions, Population Inversion, Pumping Mechanisms, Einstein's Coefficients, Components of a laser System, Three and four level laser systems; Ruby, He-Ne, CO2 and semiconductor Lasers, Introduction to Holography.

6. **Fibre Optics :** Introduction, Acceptance Angle, Numerical Aperture, Normalized frequency, Modes of propagation, material dispersion & pulse broadening in optical fibres, fibre connectors, splices and couplers, applications of optical fibres.

UNIT-IV (12 Hrs)

7. Special theory of relativity: Concept of Ether, Michelson Morley Experiment, Einstein's postulates, Lorentz transformation equations; length, time and simultaneity in relativity, addition of velocity, variation of mass with velocity (concept only), Mass-Energy and Energy-momentum relations.

8. Nanophysics: Nanoscale, surface to volume ratio, electron confinement, nanoparticles (1D, 2D, 3D), Nanomaterials, Unusual properties of nanomaterials, synthesis of nanomaterials- ball milling and sol-gel techniques, Carbon nanotubes (synthesis and properties), applications of nanomaterials.

INSTRUCTIONAL STRATEGY

Teachers should give practical examples from life and their industrial application to explain concepts and principle.

RECOMMENDED BOOKS:

1. Serway and Jewett, 'Physics of Scientists and Engineers', (Vol.1 & Vol. 2), 6th Edn, Cengage Learning.
2. A. K. Malik, H.K. Singh, 'Engineering Physics', Tata McGraw Hill, 2010.
3. V. Raghvan, 'Material Sciences and Engg.', 5th Edition., Prentice Hall of India, 2004.
4. A. Beiser, S. Mahajan, S. R. Choudhary, 'Concepts of Modern Physics', 6th Edition., Tata McGraw Hill, 2003.
5. D.J. Griffiths, 'Introduction to Electrodynamics', 4th Edition., Prentice Hall, 2013.
6. C.K. Kao, 'Optical Fibre System, Technology, Design & Applications', McGraw Hill, 1982
7. K. Thygrajan; A.K. Ghatak, 'Laser Theory & Applications', Mc Millan India Ltd. 2007

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	12	25
2	12	25
3	12	25
4	12	25
Total	48	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

1.2 APPLIED MATHEMATICS-1

LTPC
4 1 0 5

COURSE OBJECTIVES

- The subject will create ability to understand the scope of elementary mathematics and its applications in solving various Engineering and scientific problems.
- The subject will also create ability to explain and use theoretical and computational aspects of various mathematical techniques.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Apply concepts of matrices and its applications in solving mathematical problems.
- Apply the concepts and principles of complex numbers, its different formats and relationship with trigonometric functions.
- Use sequence and series, their different convergence tests in their mathematical based computational problems.
- Solve differential equations of first and higher order with different methods.
- Use the concept of differential equations in solving simple engineering/scientific problems.

DETAILED CONTENTS

UNIT –I (14 Hrs.)

1. Linear algebra: Elementary transformations, Rank of a matrix, Row reduced echelon form, Reduction to normal form, Linear independence and dependence of vectors, Gauss-Jordan method to find inverse of a matrix, Solution of simultaneously linear algebraic equations, Linear transformations, Orthogonal transformations, Eigen values and eigen vectors, Cayley-Hamilton theorem, Reduction to diagonal form, Orthogonal, Unitary, Hermitian matrices.

UNIT-II (14 Hrs.)

2. Complex numbers and elementary functions of complex variable: De-Moivre's theorem and its applications, Real and imaginary parts of exponential, Logarithmic, circular, Inverse circular, Hyperbolic, Inverse hyperbolic functions of complex variables. Summation of trigonometric series (C+iS method).

UNIT-III (14 Hrs.)

3. Sequence and series: Introduction to sequence and series, Convergence and divergence of series, Tests of convergence (without proofs), Comparison test, Integral test, Ratio test, Raabe's test, Logarithmic test, Cauchy's root test and Gauss test. Alternating series- Absolute and conditional convergence, Leibnitz test. Power series-Weirstrass M-test.

UNIT-IV(22 Hrs)

4. Differential equations and its applications: Leibnitz's linear and Bernoulli's equation, Exact differential equations, Equations reducible to exact form by integrating factors, Equations of the first order and higher degree, Clairaut's equation.

Solution of linear ordinary differential equations of second and higher order; Methods of finding complementary functions and particular integral, Special methods for finding particular integrals- Method of variation of parameters. Cauchy's homogeneous and Legendre's linear equation. Simultaneous linear equations with constant coefficients.

Applications to electric R-L-C circuits, Deflection of beams, Simple harmonic motion, Simple pendulum.

INSTRUCTIONAL STRATEGY

Teachers should lay maximum emphasis in making the concept and principles clear to the students. A number of exercises should be given to the students, so that they get the mastery over the concepts and principles. Teachers should also explain the application of mathematical concepts and principles in the engineering problems.

RECOMMENDED BOOKS

1. E. Kreyszig, 'Advanced Engineering Mathematics', 9th Edition., John Wiley, **2006.**
2. Michael D. Greenberg, 'Advanced Engineering Mathematics', 2nd Edition, Pearson Education, **1998**.
3. Peter V.O. Nil, 'Advanced Engineering Mathematics', 7th Edition. Wordsworth Publishing Company, **2012.**
4. R.K. Jain and S.R.K. Iyengar, 'Advanced Engineering Mathematics', 4th Edition., Narosa, 2014
5. B.S. Grewal, 'Higher Engineering Mathematics', 40th Edition., Khanna Publishers, New Delhi, **2007**.
6. pipes, L.A. and Harvill, L.R., Applied Mathematics for Engineers and physicists, 3rd Edition, Mc Graw Hill, **1970**.
7. H.C. Taneja, 'Engineering Mathematics, Volume-I & Volume-II', 2nd Edition., I.K. Publishers, **2010.**
8. Babu Ram, 'Advanced Engineering Mathematics', Pearson Education, **2009**.
9 J.S. Bindra, 'Applied Mathematics', Volume II, 9th Edition., Kataria Publications, **2012**

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	14	22
2	14	22
3	14	22
4	22	34
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

1.3 COMMUNICATIVE ENGLISH

LTPC
2 1 0 3

COURSE OBJECTIVES

- To expose the students to effective communication strategies and different modes of communication.
- To enable the students to analyze his/her communication behaviour and that of others.
- To enable a student to apply effective communication skills professionally and socially.

LEARNING OUTCOMES

The students after undertaking this course will be able to:

- Use different strategies of effective communication and select the most appropriate mode of communication for a given situation.
- Read and write effectively.
- Listen and Speak effectively and assertively.
- Correspond effectively through different modes of written communication.
- Present himself/herself professionally through effective resumes and interviews.
- Communicate effectively.
- Write various types of letters/correspondence.
- Talk effectively on telephone.
- Use correct grammar in communication.
- Read and write correctly in English language.

DETAILED CONTENTS

UNIT-I (6 Hrs)

1. Communication: Meaning, its types, Significance, Process, Channels, Barriers to Communication, Making Communication Effective, Role in Society.

2. Business Correspondence: Elements of Business Writing, Business Letters: Components and Kinds, Memorandum, Purchase Order, Quotation and Tenders, Job Application Letters, Resume Writing etc.

UNIT-II (10 Hrs)

3. Discussion Meeting and Telephonic Skills: Group Discussion, Conducting a Meeting, Telephone Etiquettes, Oral Presentation: Role of Body Language and Audio Visual Aids.

4. Grammar: Transformation of Sentences, Words used as Different Parts of Speech One Word Substitution, Abbreviations, Technical Terms etc.

UNIT-III (8 Hrs)

5. Reading Skills: Process of reading, Reading Purposes, Models, Strategies, Methodologies, Reading Activities.

6. Writing Skills: Elements of Effective Writing, Writing Style, Technical Writing: Report Writing.

UNIT-IV (8 Hrs)

7. Listening Skills: The process of Listening, Barriers to Listening, Effective Listening Skills and Feedback Skills.

8. Speaking Skills: Speech Mechanism, Organs of Speech, Production and Classification of Speech Sound, Phonetic Transcription, Skills of Effective Speaking, Components of Effective Talk.

INSTRUCTIONAL STRATEGY

Use of pre-recorded CDs/DVDs should be made to help the students in developing listening skills. Student centred activities such as group discussions, role play should be used to ensure active participation of students in the classroom

RECOMMENDED BOOKS

1. M. V, Rodriques, 'Effective Business Communication', Concept Publishing Company New Delhi, **1992, reprint 2000.**
2. Adhikari Sethi, 'Business Communication', McGraw Hill.
3. Indrajit Bhattacharya, 'An Approach to Communication Skills', Dhanpat Rai Co., (Pvt.) Ltd. New Delhi.
4. Chrissie Wright, 'Handbook of Practical Communication Skills', Jaico Publishing House, Mumbai.
5. L. Gartside, 'Modern Business Correspondence', Pitman Publishing London.
6. Rizvi M Ashraf, 'Effective Technical Communication', McGraw Hill.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	6	18
2	10	34
3	8	24
4	8	24
Total	32	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

1.4 BASICS OF ELECTRICAL ENGINEERING

LTPC
2 0 0 2

COURSE OBJECTIVES

- The subject aims at imparting the basic understanding among the student about DC circuits, AC fundamental and three phase balanced systems
- The subject also deals with magnetic circuits, working principle of transformer and working of different rotating electrical machines

LEARNING OUTCOMES

The students after undertaking this course will be able to:

- State and illustrate Ohm's Law and Kirchoff's Law
- Executive star delta conversion
- Calculate peak, rms, average, rectangular and polar values of alternating quantities, effective resistance and reactance values of series and parallel circuits
- Explain the effect of resonance in series and parallel circuits.
- Explain the relation between line values and phase values.
- Explain the concept of electromagnetic induction and working principle of single phase transformers
- Explain the working principle of dc series and shunt machines and three-phase squirrel cage and slip ring induction motors.

DETAILED CONTENTS

UNIT-1 (6 Hrs)

1. Review of direct current (dc) circuits: Review of circuit elements and connected terminology, Kirchoff's Laws- Statement and Illustrations, Star-Delta Conversion, Ohm's Law- Statement, Illustration and Limitation, Effect of Temperature on Resistance.

UNIT-II (10 Hrs)

2. Alternating current (AC) fundamentals: Generation of alternating electro-motive force (EMF), Peak, Root Mean Square and average value of alternating current, Phasor representation of alternating quantities, Alternating Quantities in Rectangular and polar forms. Introduction of Resistive, Inductive & Capacitive circuits and their series and parallel combinations, Concept of resonance in series and parallel circuits.
I

3. Three phase balanced systems: Concept of 3-phase EMF Generation, Numbering of phases, phase sequence, Types of connections: star and delta connections, relationship between line voltages/currents and phase voltages/currents, Phasor diagrams.

UNIT-III (10 Hrs)

4. Magnetic circuits and transformer: Comparison between magnetic and electric circuits, Electromagnetic Induction and its law, Self-Inductance, Mutual Inductance, Coupling Coefficient between two magnetically coupled circuits. Single Phase Transformer: Construction, Working principle, Losses & Efficiency.

UNIT-IV (6 Hrs.)

5. Rotating Electrical Machines

Construction and working principle of D.C. machines (series and shunt), three phase Induction motor (squirrel cage and slip ring) and their applications**.**

INSTRUCTIONAL STRATEGY

The teachers should lay maximum emphasis in making the concept and principles clear to the students. Techers should demonstrate various application of concepts and principles of electrical engineering in the industrial problems.

RECOMMENDED BOOKS

1. Vincent Deltoro, 'Electrical Engineering fundamentals', 2nd Edition, Prentice Hall, New Delhi, **2007.**
2. Mittle and Mittle, 'Basic Electrical Engineering', 3rd Edition., Tata McGraw Hill, New Delhi, **2006.**
3. H. Cotton, 'Advanced Electrical Technology', Reem Publications Ltd., **1983.**
4. I.J. Nagrath and D.P. Kothari, 'Electrical Machines', Tata McGraw, Delhi, **2006**.
5. Ashfaq Husain, 'Fundamentals of Electrical Engineering' Danpat Rai Publications, **2002.**

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	6	18
2	10	32
3	10	32
4	6	18
Total	32	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

1.5 HUMAN VALUES AND PROFESSIONAL ETHICS

LT PC
2 0 0 2

COURSE OBJECTIVES

- This course is an effort to provide our students significant input about values and ethics.
- The course encourages students to discover what they consider valuable. Accordingly, they should be able to discriminate between different values.
- It will enable the students to discriminate between what is valuable and what is superficial in real situations in their life.

LEARNING OUTCOMES

At the end of the subject the students will be able to:

- Discriminate between what is valuable and what is superficial in the life.
- Develop the critical ability to distinguish between essence and form in life.
- Develop sensitivity and awareness; leading to commitment and courage to act on their own belief.
- Act with discrimination in a given situation.
- Take ethical decision.
- Work harmonious in different groups/teams.

DETAILED CONTENTS

UNIT –I (6 Hrs)

1. **Course introduction - need, basic guidelines, content and process for value education:** Understanding the need, basic guidelines, content and process for Value Education. Self-Exploration-what is it? - its content and process; "Natural Acceptance" and Experiential Validation- as the mechanism for self-exploration, Continuous Happiness and Prosperity- A look at basic Human Aspirations Right understanding, Relationship and Physical Facilities- the basic requirements for fulfillment of aspirations of every human being with their correct priority, Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario Method to fulfill the above human aspirations: understanding and living in harmony at various levels.

UNIT-II (10 Hrs)

2. **Understanding harmony in the human being - harmony in myself:** Understanding human being as a co-existence of the sentient "I" and the material "Body" Understanding the needs of Self ("I") and "Body" - Sukh and Suvidha

   Understanding the Body as an instrument of "I" (I being the doer, seer and enjoyer) Understanding the characteristics and activities of "I" and harmony in "I"

   Understanding the harmony of I with the Body: Sanyam and Swasthya; correct appraisal of Physical needs, meaning of Prosperity in detail, Programs to ensure Sanyam and Swasthya.

3. **Understanding harmony in the family and society- harmony in human-human relationship:** Understanding harmony in the Family- the basic unit of human interaction; Understanding values in human-human relationship; meaning of Nyaya and program for its fulfillment to ensure Ubhay-tripti; Trust (Vishwas) and Respect (Samman) as the foundational values of relationship; Understanding the meaning of Vishwas; Difference between intention and competence Understanding the meaning of Samman, Difference between respect and differentiation; the other salient values in relationship.

UNIT-III (8 Hrs)

4. **Understanding the harmony in the society (society being an extension of family):** Samadhan, Samridhi, Abhay, Sah-astitva as comprehensive Human Goals Visualizing a universal harmonious order in society- Undivided Society (Akhand Samaj), Universal Order (Sarvabhaum Vyawastha)- from family to world family!

5. **Understanding harmony in the nature and existence - whole existence as co-existence:** Understanding the harmony in the Nature; Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature; Understanding Existence as Co-existence (Sah-astitva) of mutually interacting units in all-pervasive space; Holistic perception of harmony at all levels of existence.

UNIT-IV (8 Hrs)

6. **Implications of the above holistic understanding of harmony on professional ethics:** Natural acceptance of human values Definitiveness of Ethical Human Conduct; Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order; Competence in professional ethics:

- Ability to utilize the professional competence for augmenting universal human order,
- Ability to identify the scope and characteristics of people-friendly and eco-friendly production systems,
- Ability to identify and develop appropriate technologies and management patterns for above production systems
- Case studies of typical holistic technologies, management models and production systems; Strategy for transition from the present state to Universal Human Order:
- At the level of individual: as socially and ecologically responsible engineers, technologists and managers

At the level of society: as mutually enriching institutions and organizations

INSTRUCTIONAL STRATEGY

Teachers should use case study method to impact instruction. Also, audio-visual motivational media may be used.

RECOMMENDED BOOKS

1. R. R. Gaur, R. Sangal, G. P. Bagaria, ‘A Foundation Course in Value Education’, **2009.**

2. Ivan Illich, 'Energy & Equity', The Trinity Press, Worcester, and Harper Collins, USA, 1974

3. E.F. Schumacher, 'Small is Beautiful: A Study of Economics as if People mattered', Blond & Briggs, Britain, **1973.**

4. A. Nagraj, 'Jeevan Vidya ek Parichay', Divya Path Sansthan, Amarkantak, **1998.**

5. Sussan George, 'How the Other Half Die's, Penguin Press. Reprinted **1986, 1991.**

6. P.L. Dhar, R.R. Gaur, 'Science and Humanism', Commonwealth Publishers, **1990**.

7. A.N. Tripathy, 'Human Values', New Age International Publishers, **2003.**

8. Subhas Palekar, 'How to practice Natural Farming', Pracheen (Vaidik) Krishi Tantra Shodh, Amravati, **2000.**

9. Donella H. Meadows, Dennis L. Meadows, Jorgen Randers, William W. Behrens III,

10. 'Limits to Growth - Club of Rome's report', Universe Books, **1972.**

11. E. G. Seebauer & Robert L. Berry, 'Fundamentals of Ethics for Scientists & Engineers', Oxford University Press, **2000.**

12. M. Govindrajran, S. Natrajan & V.S. Senthil Kumar, 'Engineering Ethics (including Human Values)', Eastern Economy Edition, Prentice Hall of India Ltd.

13. B P Banerjee, 'Foundations of Ethics and Management', Excel Books, **2005.**

14. B. L. Bajpai, **2004,** 'Indian Ethos and Modern Management', New Royal Book Co., Lucknow, Reprinted **2008.**

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	6	20
2	10	32
3	8	24
4	8	24
Total	32	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

1.6 ENVIRONMENTAL SCIENCE

L T PC
2 0 0 2

COURSE OBJECTIVES

- The course will enable the students understand various global environment and ecological issues.
- It will help students to use technologies that reduce pollution.

LEARNING OUTCOMES

At the end of the subject, the students will be able to:

- Identify global environmental problems arising due to various engineering/industrial/ and technological activities and the science behind these problems.
- Explain importance of ecosystem and biodiversity for maintaining ecological balance.
- Identify the major pollutants and abatement devices for environmental management and sustainable development.
- Estimate the current world population scenario and thus calculating the economic growth, energy requirement and demand.
- Explain the conceptual process related with the various climatologically associated problems and their plausible solutions.

DETAILED CONTENTS

UNIT-1 (4 Hrs)

1. **The Multidisciplinary Nature of Environmental Studies:** Definition, scope and importance. Need for public awareness.

   Natural Resources

   Renewable and Non-renewable Resources:

   Natural resources and associated problems.

   Forest resources: Use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their effects on forests and tribal people.

   Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.

Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources, case studies.

Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification.

Role of an individual in conservation of natural resources.

Equitable use of resources for sustainable lifestyles.

UNIT-II (10 Hrs.)

2. Ecosystems

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 following ecosystem:

Forest ecosystem.

Grassland ecosystem.

Desert ecosystem.

Aquatic ecosystems (ponds, streams, lakes, rivers, ocean estuaries).

Biodiversity and Its Conservation

Introduction – Definition: genetic, species and ecosystem diversity.

Biogeographical classification of India.

Value of biodiversity: consumptive use, productive use, social, ethical aesthetic and option values.

Biodiversity at global, national and local levels.

India as a mega-diversity nation.

Hot-spots of biodiversity.

Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts.

Endangered and endemic species of India.

Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT-III (10 Hrs)

3. Environmental Pollution

Definition

Causes, effects and control measures of:

Air pollution
Water pollution
Soil pollution
Marine pollution
Noise pollution
Thermal pollution
Nuclear pollution

Solid Waste Management: Causes, effects and control measures of urban and industrial wastes.

Role of an individual in prevention of pollution.

Pollution Case Studies.

Disaster management: floods, earthquake, cyclone and landslides

Social Issues and the Environment

From unsustainable to sustainable development

Urban problems and related to energy

Water conservation, rain water harvesting, Watershed Management

Resettlement and rehabilitation of people; its problems and concerns. Case studies.

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

Environmental Protection Act

Air (Prevention and Control of Pollution) Act

Water (Prevention and control of Pollution) Act

Wildlife Protection Act

Forest Conservation Act

Issues involved in enforcement of environmental legislation

Public awareness

UNIT-IV (8 Hrs)

4. Human Population and the Environment

Population growth, variation among nations

Population explosion – Family Welfare Programmes

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

Field Work

Visit to a local area to document environmental assets river/

forest/grassland/hill/mountain

Visit to a local polluted site – Urban / Rural / Industrial / Agricultural
Study of common plants, insects, birds

Study of simple ecosystems-pond, river, hill slopes, etc (Field work equal to 5 lecture hours)

INSTRUCTIONAL STRATEGY

Motivational expert lecturers from various organizations may be arranged. Student may be taken to field visits to study good examples.

RECOMMENDED BOOKS

1. J.G. Henry and G.W. Heinke, 'Environmental Sc. & Engineering', Pearson Education, **2004.**
2. G.B. Masters, 'Introduction to Environmental Engg. & Science', Pearson Education, **2004.**
3. Erach Bharucha, 'Textbook for Environmental Studies', UGC, New Delhi.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	4	12
2	10	32
3	10	32
4	8	24
Total	32	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

1.7 APPLIED PHYSICS LAB. `

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COURSE OBJECTIVES

- The course will enable the students to appreciate and understand various concepts of physics.

LIST OF PRACTICALS

At least 10 experiments should be performed in one semester

To study the magnetic field of a circular coil carrying current.

To find out polarizability of a dielectric substance.

To study the laser beam characteristics like; wave length using diffraction grating element.

Study of diffraction using Laser beam and thus to determine the grating element.

To study the angular divergence of laser beam.

To study laser interference using double slit or Michelson's Interferometer.

To determine numerical aperture of an optical fibres

To determine attenuation and propagation losses in optical fibres.

To find out the frequency of AC mains using electric-vibrator.

To find the refractive index of a material (solid or liquid) using spectrometer.

To study the B-H curve using CRO.

To determine the grain size of a material using optical microscope.

To find the velocity of ultrasound in liquid.

RECOMMENDED BOOKS

1. C.L. Arora, 'Practical Physics', S. Chand & Co., **1997.**
2. R.S. Sirohi, 'Practical Physics', Wiley Eastern.

MEANS OF ASSESSMENT

Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva-voce.

1.8 COMMUNICATIVE ENGLISH LAB

L T P C

0 0 2 1

COURSE OBJECTIVES

- The Communicative English Language Lab focuses on the production and practice of sounds of language and familiarizes the students with the use of English language in everyday situations and contexts.
- To expose the students to a variety of self-instructional, learner-friendly modes of language learning.
- To help the students cultivate the habit of reading passages from the computer monitor, thus providing them with the required facility to face computer-based competitive exams.
- To enable them to learn pronunciation through stress on word accent, intonation, and rhythm.
- To train them to use communication skills effectively for interviews, group discussions, public speaking etc.

DETAILED CONTENTS

The following course content is prescribed for the Communicative English Laboratory sessions:

Introduction to the Sounds of English- Vowels, Diphthongs & Consonants.

Introduction to Stress and Intonation.

Situational Dialogues / Role Play.

Oral Presentations- Prepared and Extempore.

'Just A Minute' Sessions (JAM).

Describing Objects / Situations / People.

Information Transfer

G.D. and Debate

The teacher may use following different classroom techniques to give practice and monitor the progress of the students:

Role Play

Question-Answer

Discussion

Presentation of Papers

Seminars etc.

Minimum Requirement

The Communicative English Language Lab shall have two parts:

- The Computer aided Language Lab for 30 students with 30 systems, one master console, LAN facility and English language software for self- study by learners.
- The Communication Skills Lab with movable chairs and audio-visual aids with a P.A System & a LCD projector/ T. V.

System Requirement (Hardware Component)

Computer network with LAN with minimum 30 multimedia systems

Suggested Software

- Cambridge Advanced Learners' English Dictionary with CD.
- The Rosetta stone English Library
- Clarity Pronunciation Power – Part I
- Mastering English in Vocabulary, Grammar, Spellings, Composition
- Dorling Kindersley series of Grammar, Punctuation, Composition etc.
- Language in Use, Foundation Books Pvt. Ltd with CD.
- Oxford Advanced Learner's Compass, 7th Edition
- Learning to Speak English - 4 CDs
- Microsoft Encarta with CD
- Murphy's English Grammar, Cambridge with CD.
- English in Mind, Herbert Puchta and Jeff Stranks with Meredith Levy, Cambridge

INSTRUCTIONAL STRATEGY

The students after undertaking this course will be able to:

- Understand and appreciate the need of communication skills in personal and professional life.
- Use different medias/channels of communication and select the most appropriate for a given situation.
- Speak and present himself/herself professionally and socially effectively through effective talks, resumes, interviews etc.

RECOMMENDED BOOKS

Books Suggested for English Language Lab Library (to be located within the lab in addition to the CDs of the text book which are loaded on the systems):

1. Spoken English (CIEFL) in 3 volumes with 6 cassettes, OUP.
2. English Pronouncing Dictionary, Daniel Jones Current Edition with CD.
3. R. K. Bansal and J. B. Harrison, 'Spoken English', Orient Longman, **2006**.
4. Dr. A. Ramakrishna Rao, Dr. G. Natanam & Prof. S.A. Sankaranarayanan, 'English Language Communication: A Reader cum Lab Manual'. Anuradha Publications, Chennai.
5. Krishna Mohan & N.P. Singh, 'Speaking English Effectively', Macmillan.
6. J. Sethi, Kamlesh Sadanand & D.V. Jindal, 'A Practical Course in English Pronunciation, (with two Audio cassettes)', Prentice-Hall of India Pvt. Ltd., New Delhi.
7. T. Balasubramanian, 'A Text Book of English Phonetics for Indian Students', Macmillan.
8. 'English Skills for Technical Students**,** WBSCTE' with British Council, OL

MEANS OF ASSESSMENT

Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva-voce.

1.9 BASICS OF ELECTRICAL ENGIEERING LAB.

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LIST OF PRACTICALS

NOTE: Students are required to perform eight experiments, they must perform at least one experiment each from Group I to III and all experiments from Group-IV.

Group-I

To verify Ohm's law and its limitations.

To verify Kirchoff's Laws (KVL and KCL)

To measure the resistance and inductance of a coil by ammeter-voltmeter method.

To find voltage-current relationship in a R-L series circuit and to determine the power factor of the circuit.

Group-II

To verify the voltage and current relations in star and delta connected systems.

To measure power and power factor in a single- phase AC circuit.

To Study the various types of switches like Relays, SPST, DPST, MCB and Stair case switch.

Group-III

To study the principle of fluorescent lamp.

To verify the rating of compact fluorescent lamp (CFL).

To Study the home power supply system.

Group-IV

To perform open- and short circuit tests on a single phase transformer and calculate its efficiency

To start and reverse the direction of rotation of a

DC motor

Induction motor

RECOMMENDED BOOKS

1. S.K. Bhattacharya, 'Experiments in Basic Electrical Engineering', New Age International, New Delhi, **2007.**

MEANS OF ASSESSMENT

Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva-voce.

1.10 MANUFACTURING PRACTICE

L T P C

1 0 6 4

Introduction of various manufacturing practices, tools and equipment used, Hand on experience by making different jobs in respective shops like:

Machine Shop

Sheet Metal Shop

Fitting Shop

Welding Shop

Carpentry and Pattern Making Shop

Forging Shop

Foundry Shop

Electrical and Electronics Shop

Safety Awareness in workshop: it is very important to know & understand to keep the safety in workshop during working. The concerned shop in-charge must ensure the safe practice sessions. The student must be aware of and follow safety norms and rules during practice in Workshop.

SECOND SEMESTER

2.1 APPLIED CHEMISTRY

LTPC
3 1 0 4

COURSE OBJECTIVES

- The subject will enable students to choose particular raw materials in preference to many conventional materials which can be converted into finished products by utilizing minimum energy, maximum efficiency and eco-friendly or easily recyclable. In the pursuit of exploration and production of such materials without affecting economical growth is not only tough, but challenging task.
- This course addresses various aspects of spectroscopic chemical analysis, their relative merits, the operating principles, and develop problem solving skills generally useful in chemical analysis relevant to research and industry.
- The students will learn about the exploration, extraction and production of oil and gas to meet energy needs, as well as refining of crude oil for a wide spectrum of useful products such as chemicals, petrochemicals, Plastics, pesticides etc.
- The course will develop an understanding about available water sources, methods of water treatment in order to improve process efficiency so as to provide clean water to the growing population of the world and industries.
- The course will develop an understanding among the students the nature of material corrosion and its preventive measures so as to reduce demand on diminishing natural resources.
- The subject also enforces green chemistry strategies and tools to develop and apply novel, sustainable chemicals, processes, and products, after thorough exploration, characterization of material structure, scientific investigation of their physical, chemical properties and applications of materials.

LEARNING OUTCOMES

After studying this subject, the student will be able to:

- Explain advanced chemical principles; how light interacts with matter and how it can be used to quantitatively understand chemical samples; spectroscopy the way other common tools of measurement like the watch or the ruler are understood; basic concepts of instrumentation, data acquisition and data processing.
- Isolate the key design features of a product which relate directly to the material(s) used in its development.
- Indicate how the properties of polymeric materials can be exploited by a product designer.
- Describe the role of rubber-toughening in improving the mechanical properties of polymers.
- Identify the repeat units of particular polymers and specify the isomeric structures which can exist for those repeat units which determines their properties.
- Estimate the number- and weight-average molecular masses of polymer samples given the degree of polymerization and mass fraction of chains present.

- Explain different refining processes and choose the suitable refining technology for maximizing the gasoline yield by enhancement of process efficiency.
- Explain safety and pollution control in the refining industries.
- Explain specification of water required for specific use; need for treatment of surface waters and some ground-waters for drinking and industrial purposes; function of each treatment process in treating drinking-water and make an assessment for water treatment plants.
- Explain the key features of coordination compounds, including the variety of structures, oxidation numbers, and electronic configurations, coordination numbers- ligands, chelates bonding, stability of complexes
- Use Crystal Field Theory to understand the magnetic properties (and in simple terms the colour) of coordination compounds and describe the shapes and structures of coordination complexes with coordination numbers ranging from 4 to 12.4.
- Estimate stability of metal complexes by the use of formation constants and to calculate thermodynamic parameters from them and recognize the types of isomers in coordination compounds.
- Name coordination compounds, draw the structure based on their name and use the applications of coordination compounds.
- Leverage green chemistry strategies and tools to develop and apply novel, sustainable chemicals, processes, and products.
- Distinguish erosion, chemical and electrochemical corrosion and causes of material corrosion and applying correct and efficient methods of corrosion prevention.

DETAILED CONTENTS

UNIT – I (14 Hrs)

1. Molecular Spectroscopy: UV/Visible Spectroscopy: Selection rule, Principle and instrumentation, Electronic Transitions, Chromophores & Auxochromes, Factors affecting λ_{max} intensity of spectral lines, Types of absorption bands, Frank Condon Principle, Applications.

IR Spectroscopy: Principle and instrumentation; Force Constant, Anharmonic Oscillator Model, Finger Print region, Fundamental modes of vibrations, Factors affecting vibrational frequency, Applications.

2. NMR Spectroscopy: Principle & instrumentation; Chemical shift; Factors affecting Chemical Shift; Spin-Spin Splitting; Coupling Constant, High resolution NMR spectrum, NMR spectrum of EtOH, Relaxation process, Applications.

UNIT – II (10 Hrs.)

3. Polymers: Introduction; Functionality; Classifications of Polymers, Types of polymerization; Specific features of polymers; Structures - regularity and irregularity; Tacticity of polymers; Average molecular weights and size; Effect of molecular weight on the properties of polymers; Glass Transition Temperature, Crystallinity of polymers, Introduction to polymer reinforced composite.

4. Petrochemicals: Introduction; First, second & third generation petrochemicals; Primary Raw Materials for Petrochemicals. Natural gas and its treatment processes; Properties of natural gas; Crude oil: Composition of and classification of crude oil; Physical separation processes; Conversion processes.

UNIT – III (12 Hrs)

5. Water and its Treatment

Specifications of water, Hardness of water, Treatment and problems of Boiler feed water, Different methods of the water softening, Domestic water treatment of water, Desalination of water.

6. Coordination and Organometallic Chemistry

Coordination number and structures of coordination complexes, Nomenclature of Coordination Compounds, Theory of bonding- crystal field and molecule orbital theory for Tetrahedral and octahedral complexes, JT distortion.

UNIT - IV (12 Hrs)

7. Green Chemistry and its Applications

Introductory overview - Definition and concepts of Green chemistry; Twelve Principles of Green chemistry, Use of alternative feedstock (bio-fuels); Use of innocuous reagents in natural processes; Alternative solvents; Design of the safer chemicals; Designing alternative reaction methodology. Microwave and ultrasonic radiation in Green synthesis - Minimizing energy consumption.

8. Corrosion and its Prevention

Introduction; Wet and Dry corrosion; Different types of surface films; Mechanisms of wet corrosion; Galvanic corrosion; Galvanic Series; Concentration cell corrosion and differential aeration corrosion; Soil and microbial corrosion; Factors affecting corrosion; Various methods of corrosion control.

INSTRUCTIONAL STRATEGY

Faculty may take help of various models and charts, online expert lectures by eminent professor of national and international institutions while imparting instructions to make the concept clear. More emphasis should be laid on discussing and explaining practical applications of various process and reactions. In addition, students should be encouraged or motivated to study those processes in more details, by arranging educational tour to esteemed laboratories/industries such as NPL, IISc, CSIO, CECRI, IITs, where they can observe practical application.

RECOMMENDED BOOKS

1. William Kemp, 'Organic Spectroscopy', Palgrave Foundations, **1991.**
2. D. A. Skoog, F. J. Holler and A. N. Timothy, 'Principle of Instrumental Analysis', 5th Edition., Saunders College Publishing, Philadelphia, **1998.**

3. G. W. Castellan, 'Physical Chemistry', 3rd Edn, 1995, Narosa, reprint **2004**.
4. C. P. Poole, Jr., F. J. Owens, 'Introduction to Nanotechnology', Wiley Interscience, **2003**.
5. L.E. Foster, 'Nanotechnology', Science Innovation & Opportunity, Pearson Education, 2007
6. M. Lancaster, 'Green Chemistry- An Introductory Text', 1st Edn,, Royal Society of Chemistry, Cambridge, UK, **2010**.
7. Sami Matar, Lewis F. Hatch, 'Chemistry of Petrochemical Processes', 2nd Edn, Gulf Publishing Company, Houston, Texas, **2000.**
8. Jones, Denny, 'Principles and Prevention of Corrosion', 2nd Edn, Upper Saddle River, New Jersey: Prentice Hall, **1996**.
9. Nicholas J. Turro, 'Modern Molecular Photochemistry', University Science Books, Sausalito, California, **2010**.
10. Mohamed Belgacem, Alessandro Gandini, 'Monomers, Polymers and Composites from Renewable Resources', ELSEVIER, **2008**.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	14	28
2	10	22
3	12	24
4	12	26
Total	48	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

2.2 APPLIED MATHEMTICS -II

LTPC
4 1 0 5

COURSE OBJECTIVES

- The subject will introduce the theoretical and practical aspects of classical mathematical techniques to handle different engineering applications.
- The subject will also create ability in the students to correlate computational aspects of mathematical techniques with engineering problems.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Trace standard Cartesian, Parametric and Polar curves and compute their curvatures. LO2: Compute the area under the curves, volume and surface of revolutions of curves.
- Apply classical concepts and computational techniques related to partial differential equations, limit and continuity, chain rule, error and approximations, maxima and minima.
- Apply concepts of double integration and triple integration, change of order of integration and their applications.
- Apply concepts and principles of vector and scalar quantities, divergence and curl of vectors with useful theorems like – Gauss' theorem, Green's theorem and Stoke's theorem.

DETAILED CONTENTS

UNIT-I (16 Hrs)

1. **Differential & Integral Calculus and its Applications:** Curve tracing- Tracing of standard cartesian, Parametric and polar curves, Curvature of cartesian, Parametric and polar curves. Rectification of standard curves, Areas bounded by standard curves, Volumes and surfaces of revolution of curves, Applications of integral calculus to find center of gravity and moment of inertia.

UNIT-II (16 Hrs)

2. **Partial Differentiation and its Applications:** Functions of several variables, Limit and continuity, Change of variable, Chain rule, Partial differentiation, Homogeneous functions and Euler's theorem, Composite functions, Total derivative, Derivative of an implicit function; Change of variable, Jacobians. Tangent and normal to surface, Taylor's and Maclaurin's series for functions of two variables, Errors and approximations, Maxima and minima of function of several variables, Lagrange's method of undetermined multipliers.

UNIT-III (16 Hrs)

3. **Multiple Integrals and its Applications:** Double and triple integrals and their evaluation, Change of order of integration, Change of variables, Applications of double and triple integral to find area and volumes.

UNIT-IV (16 Hrs)

4. **Vector Calculus and its Applications:** Scalar and vector fields, Differentiation of vectors, Velocity and acceleration, Vector differential operators: Del, Gradient, Divergence and curl and their physical interpretations, Formulae involving del applied to point function and their products, Line, surface and volume integrals, Solenoidal and irrotational vectors, Gauss divergence theorem, Green's theorem in plane, Stoke's theorem (without proofs) and their applications.

INSTRUCTIONAL STRATEGY

The teachers should lay maximum emphasis in making the concept and principles clear to the students. A number of exercises should be given to the students, so that they get the mastery over the concepts and principles. Techers should also explain the application of mathematical concepts and principles in the engineering problems.

RECOMMENDED BOOKS

1. G. B. Thomes, R.L. Finney, 'Calculus and Analytic Geometry', 9th Edition., Pearsons Education, **1995.**
2. E. Kreyszig, 'Advanced Engineering Mathematics', 9th Edition., John Wiley, **2006.**
3. Peter V.O. Nil, 'Advanced Engineering Mathematics', Wordsworth Publishing Company.
4. Jain, R.K. and S.R.K. Iyengar, 'Advanced Engineering Mathematics', 4th Edition., Narosa.
5. B.S. Grewal, 'Higher Engineering Mathematics', 40th Edition., Khanna Publishers, New Delhi, **2007**.
6. H.C. Taneja, 'Engineering Mathematics', Volume-I & Volume-II, 2nd Edition., I.K. Publisher,**2010**.
7. Babu Ram, 'Advanced Engineering Mathematics', Peaeson Education, **2009**.
8. J.S. Bindra, 'Applied Mathematics', Volume-I, 9th Edition., Kataria Publications, **2009**.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	16	25
2	16	25
3	16	25
4	16	25
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

2.3 ELEMENTS OF MECHANICAL ENGINEERING

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3 1 0 4

COURSE OBJECTIVES

- This subject gives a very primitive information about vide applications in day to day life of the basics principles and fundamentals in mechanical engineering.
- The student will learn three basic thermodynamic laws and its engineering applications such as functioning of IC engine components, basic function of power transmission, clutch, brake, differential, axle, tyres etc.
- The student will lean about types of fluids and their properties, fluid mechanics and its applications in engineering problems.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Distinguish different types of materials & select appropriate materials for different applications
- Apply basic principles of fluid and hydraulic machines in different engineering problems
- Apply laws of thermodynamics in various processes
- Explain construction and principle of working of internal combustion engines - both Petrol and Diesel
- Measure frictional forces, centroid, moment of inertia and apply these concepts and principles in different problems

DETAILED CONTENTS

UNIT-I (18 Hrs)

1. Basic Concepts of Thermodynamics and various laws: Thermodynamic System, Boundary and Surroundings, Thermodynamic System types, basic definitions, reversible and irreversible process, Temperature, pressure, heat, work, internal energy, enthalpy and specific heat, Zeroth law of Thermodynamics, first law of Thermodynamics, its corollaries and applications on various cyclic processes (constant volume, constant pressure, constant temperature, adiabatic and polytropic, Free Expansion Process), Steady State energy flow process and its engineering applications

Second Law of Thermodynamics, its corollaries and applications. Heat Engine, Heat Pump and Refrigerator, Claussius Inequality, concept and philosophy of entropy, entropy changes during various Processes, third law of thermodynamics

2. Basics of Automobiles: IC engines and its classification, petrol and diesel engines, two and four stroke engines, basic components of IC engines, BHP, IHP, FHP, Mechanical efficiency, gears and its types, power transmission in automobiles, basic function of clutch, brake, differential, axle, tyres.

UNIT-II (6 Hrs.)

3. Fluids and Fluid Mechanics: Fluids, types of fluids, properties of Fluids, Pascal law, Archimedes law, buoyancy and buoyant force, Continuity equation and Bernoulies equation

UNIT-III (12 Hrs.)

4. Laws of forces: Two dimensional force system, basic concepts, rigid body, free body diagram, resolution of forces into components, triangle law of forces, parallelogram law of forces, polygon law of forces, Lami's equation. Varigon's theorem, Application,

5. Friction: Introduction: Laws of Coulomb's friction, equilibrium of bodies involving dry friction, Applications.

UNIT-IV (12 Hrs.)

6. Centroid, Centre of Gravity and Moment of Inertia: Difference between centre of gravity and centroid. determination of position of centroid of plane geometric figures of I, T, Circular and Triangular Sections. Determination of position of Centre of Gravity (CG) of simple solid figures. Parallel axis theorem, Perpendicular axes Theorem, Radius of gyration, determination of area Moment of Inertia of I, T, Circular and Triangular Sections.

INSTRUCTIONAL STRATEGY

Teachers should try to give practical examples to explain concepts and principles. PowerPoint and Video films may also be used in the classroom. Wherever possible, teachers should demonstrate real materials and arrange industrial visits.

RECOMMENDED BOOKS

1. A. Yunus Cengel and Mishal A. Boles, 'Thermodynamics & Engineering Approach', 4th Edition., Tata Mc Graw Hill, **2011.**
2. G.S. Sawhney, 'Fundamentals of Mechanical Engg.: Thermodynamics, Mechanics, Theory of Machines, Strength of Materials and Fluid Dynamics' 3rd Edition., PHI, **2013.**
3. P.N. Chandramouli, 'Engineering Mechanics', PHI, **2013.**
4. K.U. Siddiqui, 'A Text Book of Automobile Engineering', 1st Edition., New Age, **2011.**
5. K.L. Kumar, 'Engineering Fluid Mechanics', S. Chand, **2015.**
6. R.K. Rajput, 'A text Book of Fluid Mechanics', S. Chand, **2013.**

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	18	38
2	06	12
3	12	24
4	12	26
Total	48	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

2. 4 BASICS OF ELECTRONICS ENGINEERING

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2 0 0 2

COURSE OBJECTIVES

- The subject aims at exposing the students to basic concepts of electronics like diodes, transistors, digital electronics and transducers.
- The subject will also enable to students to use simple applications of electronics in various industries.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Operate different types of diodes along with its applications.
- Analyze the performance of different configurations.
- Optimize Boolean algebra using existing theorems in K-maps simplification techniques.
- Analyze the working principle and performance for version Transducers for measurement systems.

DETAILED CONTENTS

UNIT-I (4 Hrs.)

1. **Diodes:** PN Junction diode, LED, Photodiode, Zener diode, Avalanche & Zener phenomenon.

Diode Applications: Rectification: Half Wave & Full Wave, Bridge vs Centre Tapped Rectifiers; Switching: ideal vs Practical; Regulation, Power supply design

UNIT-II (12 Hrs.)

2. **Transistors:** Bipolar Junction Transistors: NPN, PNP types; Terminology: Biasing, Q-Point; JFET.

Transistor Applications: Common Emitter, Common Base, Common Collector configurations; Transistor as Amplifier and Switch.

UNIT-III (8 Hrs)

3. **Digital Electronics Fundamentals:** Analog vs Digital Signals, Digital Signal Representations with Binary and Timing diagrams, Multi-input Basic and Composite Gates working with symbolic representation, Universal Gates, ICs, Performance Characteristics terminology, Boolean Expression simplification with K-maps upto 4-variables.

UNIT-IV (8 Hrs)

4. **Transducers:** Measurements, Measurement system with blocks, Transducers & their nomenclature; Static Performance Characteristics- Qualitative & Quantitative description; Representation of Working Principal on fully labelled graphs and Applications of LVDT, RTD, Thermistors, Strain Gauges.

INSTRUCTIONAL STRATEGY

As far as possible, the teachers should demonstrate practical aspects of various electronic devices and their practical applications in the industry.

RECOMMENDED BOOKS

1. Robert Boylestad and Louis Nashelsky, 'Electronic Devices and Circuits', Prentice Hall of India 10th Edition,, **2009.**
2. R.P. Jain, 'Modern Digital Electronics', Tata McGraw Hill, **2003.**
3. Bhargava, Kulshreshtha, Gupta, 'Basic Electronics and Linear Circuits' TTTI Chandigarh, TMH, **1984.**
4. M.S. Sukhija and T.K. Nagsarkar, 'Basic of Electrical and Electronics Engineering' Oxford University Press, **2012**,

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	4	12
2	12	40
3	8	24
4	8	24
Total	32	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

2.5 BASICS OF COMPUTER ENGINEERING

L T P C
3 0 0 3

COURSE OBJECTIVES

- The course will help in developing comprehensive knowledge about the fundamental principles, concepts and constructs of modern computer programming.
- The course will also develop competencies for the design, coding and debugging of programs in 'C' language.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Apply basic concepts of problem solving, algorithm design, development of programs and programming languages
- Design and implement C programs
- Incorporate use of sequential, selection and repetition control structures into C programs.
- Design and implement C programs using arrays and pointers
- Implement programs with functions and passing of parameters to solve more complex problems by using structured design
- Utilize programming constructs which uses input and output devices for acquiring displaying data including sequential files

DETAILED CONTENTS

UNIT-I (12 Hrs.)

1. **Introduction to Problem Solving and Programming Languages :** Problem Solving Aspects, Program Development Steps, Introduction to Programming Languages, Types and Categories of Programming Languages, Program Development Environments

2. **Logic development and Algorithms:** Types of Problem: Data Centric and Process Centric, Problem Solving Strategies, Problem Analysis, formal definition of problem, Top- Down design and Bottom –Up design, Algorithms, Flow charts, Flow chart symbols, Pseudo codes, illustrative examples

UNIT-II (12 Hrs.)

3. **Introduction to C Programming Language:** Introduction to C Language, Evolution and Characteristics of C Language, Compilation Model, Character Set, Keywords, Identifiers, Data Types, Variables, Constants, Operators, Expressions, Type conversion and Type Casting, Overview of Pre-processors, Structure of a C Program, Input and Output Statements

4. **Control Statements:** Basic Programming Constructs, Sequence, Selection Statements 'if' Statement, Conditional /Ternary /?: Operator, Switch Statement, Iteration Statements, 'for' statement, 'while' statement, 'do - while' statement, break, continue Statement

UNIT-III (12 Hrs)

5. Arrays and Strings: Need for an Array, Memory Organization of an Array, Declaration and Initialization, Basic Operation on Arrays, Multi-dimensional Array, Strings

6. Pointers: Introduction, Declaration and Initialization, Pointer Arithmetic, Pointers and Arrays, Dynamic Memory Allocation

UNIT-IV (12 Hrs.)

7. Functions and Storage Classes: Need for Functions, Function Prototype, Function Definition, Function Call Passing Arguments, Functions and Arrays, Functions and Pointers, Command Line Arguments, Recursive Functions, String Functions, Automatic Storage Class, Register Storage Class, Static Storage Class, External Storage Class

8. Structures: Declaration and Initialization, Structures and Arrays, Structures and Pointers, Structures and Functions, Introduction to Unions, Enumeration, Typedef Statement

9. Files: Introduction, File Operations, Character I/O, String I/O, Numeric I/O, Formatted I/O, Block I/O

INSTRUCTIONAL STRATEGY

1. Classroom teaching using slides.
2. Problem solving laboratory style exercises to reinforce the topics taught.

RECOMMENDED BOOKS

1. Yashwant P. Kanetkar, 'Let us C', BPB Publications.

2. Yashwant P. Kanetkar, 'Pointers in C', BPB Publications.

3. Jitender Chhabra, 'Programming with C', Schaum's Series.

4. Reema Thareja, 'Computer Fundamentals & Programming in C', Oxford.

5. Peter Nortan, 'Computing Fundamentals', Tata McRaw Hill.

6. Cognizant, 'Problem Solving and C Programming',

7. R.S. Salaria, 'Problem Solving and Programming in C'.

8. Allen B. Tucker, 'Computer Science Handbook', CRC Press B.E. Computer Science and Engineering 2014-2015.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	12	25
2	12	25
3	12	25
4	12	25
Total	48	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

2.6 ENGINEERING DRAWING

L T P C
1 0 4 3

COURSE OBJECTIVES

- Students will be learning basic engineering drawing, projection of points, lines and planes w.r.t. reference planes HP and VP planes in this subject.
- The students will also learn to draw projection of solids**, s**ectioning of solids and development of surfaces of different geometrical primitives.
- The subject also aims at imparting skills in drawing isometric projections and orthographic projections of different solids such as cube, prism, pyramid, cone and cylinder etc.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Use appropriate drawing instruments, and also demonstrate an ability to recognize the different types of scale used in engineering.
- Recognize different types of curves and their engineering applications.
- Interpret the principles of visualization in first and third angle orthographic projection and explain basic concepts related to constructions.
- Draw different view of planes and solids in first angle orthographic projection.
- Draw different view of solid by cut the different section of plane, draw and develop the surfaces of solids.
- Explain basic principles of isometric and orthographic projections and draw/sketch the different projections.

Note: Theoretical instructions may be imparted along with practicals.

DETAILED CONTENTS

UNIT-I (20 Hrs.)

1. **Introduction:** Introduction to drawing equipment and use of instruments. Symbols and conventions in drawing Practice. Types of lines and their use, BIS codes for lines, Technical lettering as per BIS codes, Introduction to Dimensioning, Concepts of scale in drawing, Types of scales.

2. **Projection of Points and Lines:** Projection of points in quadrants, projection of lines parallel to both H P and V P, Parallel to one and inclined to other, inclined to both. True length and angle orientation of straight line: rotation method and trapezoidal method and trace of line.

UNIT-II (20 Hrs.)

3. **Projection of Planes:** Difference between plane and lamina. Projection of lamina Parallel to one and perpendicular to other, Perpendicular to one and inclined to other, Inclined to both reference planes and trace of planes.

4. **Projection of Solids:** Definition of solids, types of solids. Projection of solids in first or third quadrant, with axis parallel to one and perpendicular to other, axis parallel to one inclined to other, axis inclined to both the principle plane, Visible and invisible details in the projection.

UNIT-III (20 Hrs)

5. Section of Solids: Definition of Sectioning and its purpose. Procedure of Sectioning, Types of sectional planes. Illustration through examples.

6. Development of Surface: Purpose of development, Parallel line, radial line and triangulation method. Development of prism, cylinder, cone and pyramid surface for both right angled.

UNIT-IV (20 Hrs)

7. Isometric Projection: Basic Principle of Isometric projection, Difference between isometric projection and isometric drawing. Isometric projection of solids such as cube, prism, pyramid and cylinder

8. Orthographic Projection: Review of principle of Orthographic Projection, Sketch/drawing of blocks, and of simple machine parts.

INSTRUCTIONAL STRATEGY

Teachers should try to give practical examples to explain concepts and principles of drawing Power Point may also be used in the classroom. Wherever possible, teachers should demonstrate real materials and arrange industrial drawings/manuals.

RECOMMENDED BOOKS

1. P.S. Gill, 'Engineering Drawing', 4th Edition., S.K. Kataria.
2. N.S. Parthasarthy Vela Murli, 'Engineering Drawing', 3rd Edition., Oxford University Press.
3. Basant Aggarwal and C.M. Aggarwal, 'Engineering Drawing', 3rd Edition., Mc Graw Hill Education (India) Pvt., Ltd.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	20	25
2	20	25
3	20	25
4	20	25
Total	80	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

2.7 APPLIED CHEMISTRY LAB.

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COURSE OBJECTIVES

- The subject is aimed at developing a basic understanding of various concepts and principles in chemistry.

DETAILED CONTENTS

1. Analysis of Effluents

Determination of Residual Chlorine.
Determination of water by EDTA method.
Determination of COD in a given water sample.
Determination of H2O by dissolved oxygen analyser.
Determination of turbidity byNephelometer

2. Analysis of Fuels and Lubricants

Determination of Iodine value of oil.

Determination of Flash & Fire point by Abele's Apparatus

Determination of the viscosity of oil.

Determination of Acid Value of and Aniline point of oil

Determination of refractive index for oils.

3. Synthesis & analysis of metal complexes

Preparation of Ni-DMG complex.

Preparation of Tetramminecopper(II)sulphatemonohydrate [Cu(NH3)4]SO4.H2O]

Determination of copper & nickel in the given solution by iodometric method.

Determination of amount of Cu in the copper ore.

Estimation of ferrous & ferric ions in the given solution

4. Instrumental Analysis

Determination of the surface tension by stalagmometer

Determination λ-max by spectrophotometer and determination of unknown conc. of binary mixture of two liquids.

Determination of the strength of a solution pH metrically.

Determination of the concentration of a solution conductometrically.

Distinction between acid, ester, ketone using IR spectrophotometer.

5. Synthesis & Green Chemistry experiments

Preparation of aspirin.

Preparation of a polymer phenol/urea formaldehyde resin

Preparation of Nylon 66 polymer

Preparation of ethyl-2-cyano-3-(4-methoxyphenyl)-propeonate (Microwave assisted reaction)

Base catalysed aldol condensation by Green Methodology Acetylation of primary amines using eco-friendly method.

Note: Each student is required to perform two experiments from each of the 5 titles (presented bold) depending on his/her Branch and Aptitude.

RECOMMENDED BOOKS

1. Vogel A-I, 'Quantitative Inorganic Analysis', 4th Edition., Longman Sc & Tech, **1980.**
2. Vogel A-I, Quantitative Organic Analysis, Oxford ELBS
3. dst.gov.in/green-chem.pdf (monograph of green chemistry laboratory experiments)
4. S. S. Dara, 'A Textbook on Experiments and Calculations in Engineering Chemistry', 9th Edition., S. Chand Publications, **2003**.
5. Sunita Rattan, 'Experiments in Applied Chemistry' 3rd Edition., S. K. Kataria & Sons Publications, **2015**.

MEANS OF ASSESSMENT

Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva-voce.

2.8 BASICS OF ELECTRONICS ENGINEERING LAB.

L T P C
0 0 2 1

LIST OF PRACTICALS

NOTE: Students shall perform at least 10 experiments out of the following to qualify and need to submit written record of each experiment in a Practical File with sketch and specifications of all components/Devices used in that Experiment

1. To measure amplitude and frequency of various signals (Sine, Triangular & Square) with CRO.
2. To plot and analyze fully labeled V-I characteristics of P-N junction diode and compare results with the data sheets.
3. To obtain and plot input-output waveforms of half wave Rectifier.
4. To obtain and plot input-output waveforms of Full Wave Rectifier (Centre-tap and Bridge).
5. To obtain and plot input-output characteristics of Zener diode and compare results with the data sheets.
6. To plot V-I characteristics of BJT in CB configuration and calculate static transistor parameters and compare results with the data sheets.
7. To plot V-I characteristics of BJT in CE configuration and calculate static transistor parameters and compare results with the data sheets.
8. To plot and evaluate V-I characteristic of FET and evaluate static parameters and compare results with the data sheets.
9. To verify truth tables of various logic gates and realize various gates using universal gates.
10. To obtain and analyze I/O graphical plot for LVDT and compare results with the data sheets.
11. To obtain and analyze I/O graphical plot for RTD or Thermistor and compare results with the data sheets.
12. Collect and comprehend the technical specifications of any two commercial electronic systems (LED TV, LCD TV, Microwave oven, Washing machine etc.).

RECOMMENDED BOOKS

1. Paul B. Zbar, Albert Paul Malvino, Michael A. Miller, ‘Basic Electronics’, 7th Edition., Glenco, **1994.**

2. R.P. Jain, ‘Modern Digital Electronics’, Tata Mc Graw Hill**.**

3. L.K. Maheshwari, M.M.S. Anand, ‘Laboratory Manual for Introductory Electronics Experiments’, New Age International, **1997.**

MEANS OF ASSESSMENT

Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva-voce.

2.9 BASICS OF COMPUTER PROGRAMMING LAB.

L TPC
0 0 4 2

1. Getting used to with the Computer System: To explore the part of the computer system such as system unit, input devices, output devices connected to the computer, the outside view of the system unit that includes the panels on front and ports at the rear, the inside view of the system unit that includes the motherboard, processor, expansion slots, various add-on cards, storage devices, power supply, fans, the booting process that includes switching on the system, execution of POST routine, then bootstrap loader, and loading of the operating system, and getting it ready for use, the graphical user interface (desktop) of operating system o to explain the various elements of the desktop such as taskbar, icons, short cuts, notification area, the desktop that includes selecting the wall paper, selecting the screen saver with or without password protection, selecting the screen resolution and color quality.

2. Working with Files & Folders: Practical knowledge to navigate with the drives, create new folders, move folders from one drive to another drive, move files from one folder to another folder, search files and folders, share files and folders, view and/or change the attributes of the files and folders.

3. Setting the Environment: Practical knowledge to work with date and time to create new user accounts, install new hardware and configuring existing hardware, install new software or remove existing installed software, configure network connections, manage security profile, practical view to work on the command prompt, open an application, folder, document or internet resource from the Run command, initialize storage media (formatting) To understand the menace of viruses, understand the working of virus guards and antivirus software.

4. Exploring the Internet: Hand on to understand the working of the internet that include the use of protocols, domains, IP addresses, URLs, web browsers, web servers, mail-servers, etc. create email-account, sending mails, receiving mails, sending files as attachments, etc., login to a remote computer, search information using search engines.

5. Documentation Tool: Practical Knowledge to familiarize with parts of documents, create and save a document, set page settings, create headers and footers, edit a document and resave it, use copy, cut and paste features, use various formatting features such as bold face, italicize, underline, subscript, superscript, line spacing, etc., use spelling and grammar checking feature, preview print a document, create a table with specified rows and columns, enter data in a table, select a table, a row, a column or a cell, inset new row and/or a column, delete a row and/or a column, split and merge a row, column or a cell, understand the mail-merge feature.

Practical Knowledge to familiarize with parts of spreadsheets, create and save a workbook with single and/or multiple worksheets, edit and format text as well numbers, apply operations on range of cells using built-in formulae, preview and print a worksheet, insert new row and/or column in a worksheet, delete a row and/or column in a worksheet, create a variety of charts, import and export data to or from worksheet.

Hand on to familiarize with parts of Presentations, create and save a new presentation, apply design templates to a presentation, insert, edit and delete a slide, use different views of slides, use slide show from beginning or from the current slide, preview and print a presentation, check spellings in a presentation, add clip art and pictures in a slide, add chart,

diagram and table in a slide, set animation for a selected slide and/or for entire presentation, create slide master and title master, create a custom show.

Introduction to Various C Compilers: Turbo C, GCC, Borland etc. Practical implementation of Programs using C

Practical exercises to use various data types.

Practical exercises using Conditional statements: if statements, if else statements, and nested statements

Practical exercises using for loop, while loop, do while loop, Nested looping.

Practical exercises using switch statements

Practical exercises using arrays

Practical exercises using strings and is functions

Practical exercises using structures, unions, enumerations

Practical exercises using functions

Practical exercises using pointers

Practical exercises to read and write the file content.

MEANS OF ASSESSMENT

Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva-voce.

THIRD SEMESTER

3.1 BASICS OF AERONAUTICS

LTPC
4 0 0 4

COURSE OBJECTIVES

- To enable the student to understand prominent design features of Flight vehicle structures
- To enable the student to understand basic principles of flight along with historical developments.
- To enable the student to find basic flight performance and stability parameters of aircrafts.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Distinguish different components of aircrafts based on design features.
- Estimate aerodynamic performance of various Aerodynamic Shapes.
- Estimate basic flight parameters of aircrafts.
- Estimate power of propulsive devices of aircrafts.
- Distinguish different components of aircrafts navigation and communication systems.

DETAILED CONTENTS

UNIT –I (16 Hrs.)

1. **Basics of flight vehicles:** Classification of Flight Vehicles along with prominent design features, Importance of Strength/Weight Ratio, Loads on different parts of the Vehicle, detailed description of the Fuselage, Wing & Tail Surfaces, Wing Surfaces, Wing Fuselage Joining Methods, different types of Under Carriages, of Manned & Unmanned Space Vehicles Airplanes, Hovercraft, Helicopter & other V/STOL Machines along with examples. Historical Note: Very Early Flight vehicle Development, Sir George Caley, Otto Lilienthal, Percy Pilcher, Wilber and Orville Wright, The Aeronautical Triangle-Langley, the Wright and Glenn Curtiss.

UNIT-II (14 Hrs.)

2. **Airfoils, wings and other aerodynamic shapes:** Airfoil Nomenclature, Lift, Drag, and Moment, Airfoil Data, Infinite versus Finite wings, Pressure Coefficient, Lift coefficient from pressure coefficient, Compressibility Correction, Drag-Divergence Mach No., Wave Drag, Finite Wings, Calculation of Induced Drag, Change in the Lift Slope, Swept Wings, High Lift Flaps, Aerodynamics of cylinder and spheres, alternate explanation of Lift, Historical Note: Airfoils and Wings, The Wright Brothers, British and United States Airfoils(1910 to1920), 1920 to 1930, NACA series Digital Airfoils, Later Airfoils, Modern Airfoil , Finite Wings.

UNIT III (16 Hrs.)

3. **Basics of flight mechanics:** Equations of Motion, Thrust required for level Flight, Thrust available and Maximum velocity, Power required for level Flight, Power available and Maximum Velocity, Rate of Climb, Gliding Flight, Absolute and service Ceilings, Historical Note: Drag Reduction- Early Prediction of Airplane Performance.

   Definition of Stability and Control, Moments on the airplane, Criteria for Longitudinal Static Stability, Wing Contribution, tail Contribution, Static Stability equations, Neutral Point, Static Margin, Historical Note: Drag Reduction- Early Prediction of Airplane Performance, Wright Brothers versus the European philosophy on Stability and Control, The Development of Flight controls, Airplane Design-Evolution and Revolution.

UNIT-IV (18 Hrs.)

4. **Basics of aircraft propulsion:** Propeller, Reciprocating Engine, Jet Propulsion-The thrust Equations, Turbojet, Turbofan, Ramjet and Rocket Engine, Historical Note: Early Development of the Internal Combustion Engine for Aviation, Inventors of the Early Jet Engines, Early History of the Rocket Engine, Solid & liquid Propellant.

5. **Navigation & communication:** Different Navigation Methods, Dead Reckoning, Astronavigation, Ratio Aids, Positive Fixing, Related modern instruments. Instruments landing system, HF& VHF System, Simple Description of Communication Systems using Earth Station & Satellites.

INSTRUCTIONAL STRATEGY

Session Plan / course-material uploading, Visit to Aircraft Hanger, Class-room teaching associated with assignments, presentations, Videos, quiz, in-class tests, viva-voce and evaluation.

RECOMMENDED BOOKS

1 "Introduction to Flight", J. D. Anderson, 8th Edition, 2015

2 "Flight without Formulae", A. C. Kermode, Pitman Publishing; 4th revised edition, 1970

3 "Aerodynamics", L. J. Clancy, Wiley & Sons, 1975

VIDEOS

1. "Aerodynamics: Airfoil Camber, Flaps, Slots-Slats & Drag", Youtube Video

2 "How Airplanes Fly 1968 FAA Basic Aerodynamics ," Youtube Video

3 "Jet Engines, How it works?" ," Youtube Video

4 "Basic Aerodynamics"-CG and Stability," Youtube Video

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	16	20
2	14	24
3	16	26
4	18	30
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

3.2 AERODYNAMICS

LTPC
3 1 0 4

COURSE OBJECTIVES

- Differentiate between various types of fluid flow.
- Understand physical significance of Bernoulli's equation, momentum equation and Naiver-Stokes equations.
- Apply concepts of viscous flow to calculate laminar and turbulent boundary layer.

LEARNING OUTCOME

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

- Classify flow in different categories on the basis of various parameters.
- Develop understanding of various significant non-dimensional numbers used in fluid dynamics.
- Evaluate aerodynamic properties of different planer bodies in inviscid flow theoretically.
- Develop governing equations of flow properties using different conservation principles.
- Find lift force over Joukowsky airfoils by Kutta-Joukowsky theorem.

DETAILED CONTENTS

UNIT – I (10 Hrs.)

1. **Introduction:** Dimensional analysis, units of measurements, similarity parameters, Buckingham-pi theorem, classifications of flow- Continuum and free molecular flows, inviscid and viscous flows, incompressible and compressible flows. Newtonian and Non-Newtonian flows. Streamlines, Pathlines, Streaklines, Pitot static tube, measurement of air-speed, pressure coefficient. Aerodynamic force and moments. Reynolds number.

UNIT – II (18 Hrs.)

2. **Kinematics and Dynamics of Fluid Flow:** Lagrangian and Eulerian methods, Description of properties in a moving fluid, Gradient of a scalar field , Divergence and Curl of a vector field, Line, Surface and Volume integrals and their relationship ,Finite control volume and molecular approach, Divergence of velocity.

   Equation of conservation of mass for control volume, special form of equation of conservation of mass, differential form of equation of conservation of mass, Euler's and Naiver-Stoke equations. Derivation of Bernoulli's equation for inviscid and viscous flow fields. Momentum equation in integral form. Application of momentum equation.

UNIT – III (10 Hrs.)

3. **Inviscid-Incompressible Flow:** Incompressible flow in a duct, Condition on velocity for incompressible flow. Laplace's equations. Vorticity and circulation, Potential function, stream function. Basic elementary flows: Uniform flows, source flow, Doublet flow and Vortex flow. Superimposition of elementary flows. Non-lifting and lifting flow over a circular cylinder, comparison with real flow over circular cylinder. Kutta-Joukowski theorem, generation of lift.

UNIT – IV (10 Hrs.)

4. **Viscous flow:** Boundary layer concept, boundary layer properties, derivation of Prandtl's boundary layer equations, Blasius solution, Karman's Integral equation. Turbulent boundary layer over a plate, skin friction drag, boundary layer control.

INSTRUCTIONAL STRATEGY

Videos and images may be referred to explain basic concepts in a better way.

RECOMMENDED BOOKS

1. "Fundamentals of Aerodynamics", John D.Anderson(Jr.), McGraw Hill
2. "Fluid Mechanics", Frank M.White 2nd Edition., McGraw Hill
3. "Aerodynamics for Engineering Students", E.L.Houghton and P.W.Carpenter, 4th Edition., CBS Publishers , India

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	10	20
2	18	40
3	10	20
4	10	20
Total	48	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

3.3 APPLIED MATHEMATICS-III

L T P C
4 1 0 5

COURSE OBJECTIVES

- The subject will introduce the knowledge about various application oriented mathematical methods with their applications in solving engineering applications.
- The subject will also create ability to explain and use the theoretical and computational aspects of mathematical techniques.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Use concepts of Fourier series, Dirichlet's conditions and other formats of fourier series.
- Apply Fourier transform, Fourier sine and cosine transform, their properties in various problems.
- Apply Laplace transform, its various properties and its applications in solving ordinary differential equations.
- Formulate PDEs, classifications of PDEs, solution techniques and its applications in solving one and two dimensional PDEs.
- Use analytic function, its properties and related mathematical examples.
- Use Cauchy's Integral formula, derivatives of analytic function and its uses in computing complex integrations with residue formula.

DETAILED CONTENTS

UNIT-I (20 Hrs.)

1. **Fourier Series**: Periodic function, Fourier Seies, Dirichlet's conditions, Fourier series for even and odd functions, Change of interval, Half range Fourier series, Other forms of Fourier series.

2. **Fourier Transforms**: Dirichlet's conditions, Fourier integral formula (without proof), Fourier transform, Inverse Theorem for Fourier transform, Fourier sine and cosine transforms and their inversion formulae. Properties of Fourier transform, Convolution theorem of Fourier transforms, Parseval's identity.

UNIT-II (14 Hrs.)

3. **Laplace Transforms:** Laplace transforms of various standard functions (Exponential, Algebraic, Sine, Cosine), Properties of Laplace transforms, inverse Laplace transforms, transform of derivatives and integrals, Laplace transform of unit step function, impulse function.

4. **Application of Laplace Transforms**: Solution of ordinary linear differential equations with constant coefficients, and simultaneous differential equations.

UNIT-III (16 Hrs.)

5. **Partial Differential Equations:** Formation of partial differential equations, Linear partial differential equations, homogeneous partial differential equations with constant coefficients. Classification of partial differential equation.

6. **Applications of PDEs:** Wave equation and Heat conduction equation in one dimension. Two dimensional Laplace equation in Cartesian Coordinates, solution by the method of separation of variables.

UNIT-IV (14 Hrs.)

7. **Functions of Complex Variable:** Limits, continuity and derivative of the function of complex variable, Analytic function, Cauchy-Riemann equations, conjugate functions, harmonic functions; Conformal Mapping: Definition, standard transformations, translation, rotation, inversion, bilinear. Complex Integration: Line integrals in the complex plane, Cauchy's theorem, Cauchy's integral formula and derivatives of analytic function. Taylor's and Laurent's expansions (without proofs), singular points, poles, residue, Integration of function of complex variables

INSTRUCTIONAL STRATEGY

The teachers should lay maximum emphasis in making the concept and principles clear to the students. A number of exercises should be given to the students, so that they get the mastery over the concepts and principles. Techers should also explain the application of mathematical concepts and principles in the engineering problems.

RECOMMENDED BOOKS

1. E. Kreyszing, 'Advanced Engineering Mathematics', 8th Edn., John Wiley, New Delhi.
2. B.S. Grewal, 'Higher Engineering Mathematics', Khanna Publishers, New Delhi.
3. Ian N. Sneedon, 'Elements of Partial Differential Equations', McGraw- Hill, Singapore, 1957.
4. Peter. V. O'Nil, 'Advanced Engineering Mathematics', Wadsworth Publishing Company.
5. H.C. Taneja, 'Engineering Mathematics', Volume-I & II, I.K. Publisher.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	20	30
2	14	20
3	16	25
4	14	25
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

3.4 STRENGTH OF MATERIALS

LTPC
4 1 0 5

COURSE OBJECTIVES

- This course will make the students understand the concept of stress and strain in different types of structure/ machine under different loading conditions.

- The course also covers the simple and compound stresses due to forces, stresses and deflection in beams due to bending, torsion in circular section, strain energy, different theories of failure, stress in thin cylinder thick cylinder and spheres due to external and internal pressure.

LEARNING OUTCOME

At the end of the subject, the student will be able to:

- Model and analyze the behaviour of structural and machine components subjected to various loading and support conditions based on principles of equilibrium and material constitutional relationships.
- Understand and apply the concept of stress and strain to analyze and design structural members and machine parts under axial load, shear load, bending moment and torsional moment.
- Solve practical problems through evaluating the relationship between stress and strain.
- Analyse composite beams and shafts
- Determine the deflections and deformations of loaded flexural members.
- Analyze a structural member and machine part when loaded beyond elastic limit (inelastic and plastic cases).

DETAILED CONTENTS

UNIT –I (16 Hrs.)

1. Simple stresses and strains : Concept of stress and strain; St. Vernants principle, stress and strain diagram, Hooke's law, Young's modulus, Poisson ratio, stress at a point, stress and strains in bars subjected to axial loading. Modulus of elasticity, stress produced in compound bars subject to axial loading. Temperature stress and strain calculations due to applications of axial loads and variation of temperature in single and compound bars. Compound stress and strains, the two dimensional. system; stress at a point on a plane, principal stresses and principal planes; Mohr's circle of stress; ellipse of stress and their applications. Generalized Hook's Law, principal stresses related to principal strains

UNIT –II (20 Hrs.)

2. Bending moment and shear force diagrams: S.F and B.M definitions. BM and SF diagrams for cantilevers, simply supported beams with or without overhangs and calculation of maximum BM and SF and the point of contra-flexure under the following loads:

a. Concentrated loads

b. Uniformity distributed loads over the whole span or part of span

c. Combination of concentrated loads (two or three) and uniformly distributed loads

d. Uniformity varying loads

e. Application of moments

f. Relation between rate of loading, shear force and bending moment

3. Theory of bending stresses in beams due to bending: assumptions in the simple bending theory, derivation of formula: its application to beams of rectangular, circular and channel, I & T-sections,: Combined direct and bending stresses in aforementioned sections, composite / flitched beams.

UNIT –III (12 Hrs.)

4. Torsion: Derivation of torsion equation and its assumptions. Applications of the equation to the hollow and solid circular shafts, torsional rigidity, combined torsion and bending of circular shafts principal stress and maximum shear stresses under combined loading of bending and torsion, analysis of close-coiled-helical springs.

5. Thin cylinders and spheres : Derivation of formulae and calculation of hoop stress, Longitudinal stress in a cylinder, effects of joints, change in diameter, length and internal volume; principal stresses in sphere and change in diameter and internal volume

UNIT –IV (16 Hrs.)

6. Columns and struts : Columns and failure of columns : Euler's formulas; Rankine- Gordon's formula, Johnson's empirical formula for axially loaded columns and their applications.

7. Slope and deflection: Relationship between moment, slope and deflection, Moment area method; method of integration; Macaulay's method: Use of all these methods to calculate slope and deflection for the following :

a) Cantilevers

b) Simply supported beams with or without overhang

c) Under concentrated loads, uniformly distributed loads or combination of concentrated and uniformly distributed loads

INSTRUCTIONAL STRATEGY

The course pedagogy will include lectures, numerical practice, seminars and presentations. It also includes discussion on real life problems related to design of mechanical components which includes all types of stresses. The teachers should demonstrate the following experiments to the students in the Strength of Materials Lab:-

Tensile Test (MS), Compression Test (CI), Brinell Hardness No., Izod Impact, Rockwell Hardness Tester, Spring Stiffness (Spring Compression Testing Machine), Torsion Testing Machine.

RECOMMENDED BOOKS

1. Introduction to Solid Mechanics by D.H Shames, Prentice Hall Inc. 2010
2. Elements of strength of Materials by Timoshenko and Young 2010
3. Strength of Materials by DS Bedi; Khanna book Publishing Company, 2014
4. Strength of materials by R.S Lehri and A.S. Lehri, S.K Kataria and Sons. 2014
5. Strength of Materials by Ferdinand P Singer and Andrew Pytel,Harper and Row H. Kogakusha Publishers, New York
6. Mechanics of Materials by SI Version, end edition by Ferdinand P. Beer and E Russel Johnston (Jr); McGraw Hill, India
7. Mechanics of Materials-SI Version 2nd Edition by EP Popov, Prentice Hall India

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	16	25
2	20	30
3	12	20
4	16	25
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

3.5 AERODYNAMICS LAB

L T P C
0 0 4 2

COURSE OBJECTIVES

- Select appropriate experimental techniques to study the aerodynamic characteristics of any body.
- Interpret experimental result.

DETAILED CONTENTS

1. Visualization and plotting streamlines of flow field around Symmetric Airfoil and cambered airfoil at subsonic speed in smoke tunnel. Repeat the experiment for three different angles of attack.
    a. Negative angle of attack (say -5^o)
    b. Zero lift angle of attack
    c. Positive angle of attack of small value, say 5^o
    d. Stall angle of attack (i.e. > 15^o)
2. Identification and plotting different flow structure (wing tip vortices, downwash region, up-wash region, trailing edge wake) around finite wing using smoke at subsonic speed in wind tunnel.
3. Visualization of flow using smoke at subsonic speed around delta wing in wind tunnel.
4. Obtain vortex shedding frequency vs speed plot for Von-Karman vortex around circular non-rotating cylinder in smoke tunnel at subsonic speed.
5. Calculating rotational speed of cylinder for fixed incoming freestream velocity at which
    a. Two stagnation points are obtained
    b. One stagnation point is obtained
    c. No stagnation point is obtained on the surface of cylinder

    Use smoke tunnel for this experiment. Repeat this experiment for at least three different velocity.
6. Calculating angle of attack at which flow separates over the surface of aircraft using tufts in wind tunnel. Identify the regions over the aircraft surface where flow remains separated at relatively low angles of attack.
7. Visualization and plotting of flow separation process and wing tip vortices around 3D wing at different angle of attack using tufts in wind tunnel.
8. Plotting the flow field, using oil pattern, around airfoil at different angle of attack in wind tunnel.

RECOMMENDED BOOKS

1. “Low speed wind tunnel testing”, Jewel B. Barlow, John Wiley & sons
2. “Experimental Aerodynamics”, Henry Christensen, Pavian, Pitman Publishing
3. “Wind Tunnels: Aerodynamics, Models & Experiments (Engineering Tools, Techniques and Tables)”, Justin D. Pereira.

MEANS OF ASSESSMENT

Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva-voce.

3.6 SOFT SKILLS

L T P C
0 0 4 2

COURSE OBJECTIVES

- This course will prepare students for employability in job market
- Develop all-round personality of the students

LEARNING OUTCOMES

After undergoing this course, the students will be able to:

- Demonstrate effective communication skills
- Write technical report
- Apply techniques of enhancing memory
- Develop a good personality
- Work in teams
- Resolve conflict
- Enhance leadership qualities
- Follow moral and ethics
- Write resume, participate in GD and appear in a personal interview without
- Make an effective presentation
- Manage the time effectively
- Manage the stress
- Face problems with confidence

DETAILED CONTENTS

1. Soft Skills – Concept, Importance, types and tips for developing soft skills
2. Communication Skills – Verbal (listening, speaking, reading and writing) and Non-verbal (body language)
3. Aspects of Report Writing – concept, significance, types and format
4. Techniques for enhancing memory and concentration
5. Personality Development – Various aspects and tips for developing a good personality
6. Developing interpersonal relations
7. Conflict Management – Tips on how to manage conflicts in the personal and professional lives
8. Motivation and leadership
9. Ethics and values – Significance and developing ethics and values
10. Health, hygiene and safety
11. Disaster Management
12. Resume Writing – Types, format and tips for writing a good resume
13. Group Discussions - GD Vs Debate, Tips for participation in a GD
14. Appearing for a personal interview
15. Presentation Techniques – with or without power-points
16. Time management – Significance and tips for managing time effectively

17. Stress Management
18. Problem solving – How to approach and solve a problem

In addition, the following activities need to be carried out by students:

- Sports
- NCC
- NSS
- Camps – Environmental Awareness, Entrepreneurship, Energy Conservation, First-aid, Blood donation, Tree plantation
- Cultural Events

INSTRUCTIONAL STRATEGIES:

The teachers should encourage the students to develop soft skills through experiential learning by participation in various activities. Expert lectures may be arranged from time to time on various topics.

FOURTH SEMESTER

4.1 NUMERICAL METHODS

L T P C
3 1 0 4

COURSE OBJECTIVE

- Differentiate between different numerical methods applicable to different type of equations
- Apply numerical techniques in solving mathematical equations

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Evaluate total error in calculations rising due to different factors
- Develop understanding of different numerical methods if solving equations.
- Apply interpolation techniques for finding results for missing data points
- Differentiate and integral using different numerical techniques
- Solve linear system of equations using numerical methods
- Apply numerical methods for solving differential equations

DETAILED CONTENTS

UNIT – I (12 Hrs.)

1. **Error calculation:** Errors in numerical calculations, Absolute, relative and percentage errors, Round off and truncation errors, Error propagation, Loss of significant digits, Errors in series approximation, Speed of convergence.
2. **Solution of equations:** Bisection method, fixed point iteration and its convergence, Acceleration of convergence using Aitken's method; Regula-Falsi, Newton-Raphson, Generalized Newton's, Chebyshev's and Halley's methods.

UNIT – II (10 Hrs.)

3. **Interpolation:** Lagrange Interpolation, Newton's divided difference interpolation, Finite differences, Newton's, Bessel's, Stirling's and Guass' difference formulae.

UNIT – III (12 Hrs.)

4. **Numerical differentiation & integration:** Differentiation using differences, Integration using Newton-cote's formulas with errors, Gaussian Quadrature

UNIT – IV (14 Hrs.)

5. **Solution of linear system of equations:** Direct methods - Gauss elimination, partial pivoting, complete pivoting, Gauss-Jordan and factorization methods, Iterative methods- Gauss Siedal and Jacobi's methods.

6. **Numerical methods for differential equations:** Solution of first order differential equations using Taylor's series, Euler's, Picard's and Runge-Kutta method upto 4th order, Predictor-Corrector methods (Adam's and Milne's method),

INSTRUCTIONAL STRATEGY

Assignments should be designed to give students exposure to computationally solving different numerical methods.

RECOMMENDED BOOKS

1. "Advanced Engineering Mathematics", E. Kreyszig, John Wiley
2. "Numerical Methods for Mathematics, Science and Engineering", Mathews, Prentice Hall
3. "An Introduction to Numerical Analysis", Atkinson, John Wiley

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	12	25
2	10	20
3	12	25
4	14	30
Total	48	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

4.2 HIGH SPEED AERODYNAMICS

L T P C
3 1 0 4

COURSE OBJECTIVE

- Differentiate between compressible and incompressible aerodynamics.
- Differentiate between finite wing and infinite wing aerodynamics.
- Know various experimental techniques for measurement of aerodynamic forces & moments.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Analyze aerodynamic characteristics of finite and infinite wings.
- Analyze lift generation over delta wing and tapered wing.
- Generate different airfoil shapes by using Kutta-Joukowsky transformation.
- Compare various experimental methods for measurement of aerodynamic characteristics.

DETAILED CONTENTS

UNIT – I (10 Hrs.)

1. **Conformal Transformation:** Complex potential function, principles of conformal transformation, Kutta-Joukowsky transformation of a circle into flat plate, airfoils & ellipses, lift, velocity and pressure distribution on Joukowsky airfoil section.

UNIT – II (12 Hrs.)

2. **Incompressible Flow:** Classical thin airfoil theory, symmetrical airfoil, cambered airfoil, flapped airfoil, Description of flow about multi-element airfoils. , Biot-Savart's law and Helmholtz's theorem

   Vortex system, Downwash & induced drag, Prandtl's classical lifting line theory, fundamental equations. Elliptic and general lift distribution over finite un-swept wings, effect of aspect ratio, Lifting Surface theory, Formation Flying, Ground effect. Drag reduction by variable twist, variable camber wings, Laminar flow control, and winglets. Boundary layer theory, viscous flow dynamics, boundary layer control

UNIT – III (14 Hrs.)

3. **Normal and Oblique Shock Waves:** Point source in a compressible flow, Mach waves and shock waves. Normal Shock waves: equation of motion for a normal shock, normal shock relations for a perfect gas.
   Introduction to oblique shock relations, M-θ-β relations, shock polar, supersonic flow over wedge and cone, weak oblique shock. Supersonic expansion by turning, Prandtl-Meyer flow, Numerical problems

UNIT – IV (12 Hrs.)

4. **Measurement Techniques in Aerodynamics:** Subsonic , Transonic, supersonic wind tunnels, shock tube, wind tunnel balances, wind tunnel corrections, measurement of forces and moments, measurement of profile drag by pitot traverse of wake, shadowgraph system, Schlieren system, interferometer, Hot wire Anemometer

INSTRUCTIONAL STRATEGY

Video and other visual aids may be resorted to, in order to generate interest of the students.

RECOMMENDED BOOKS

1. "A First course in Turbulence" by Tennekes and Lumley. MIT Press
2. "Fluid Mechanics", Frank M.White 2nd Edition,McGraw Hill
3. "Fluid Mechanics" by Kundu & Cohen
4. "Aerodynamics", L.J.Clancy, 5th Ed. Himalayan Books
5. "Aerodynamics for Engineering Students", E.L.Houghton and P.W.Carpenter, 4th Edition., CBS Publishers , India

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	10	20
2	12	25
3	14	30
4	12	25
Total	48	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

4.3 AIRCRAFT STRUCTURES

L T P C
3 1 0 4

COURSE OBJECTIVES

- To enable the student to explain basic principles of elasticity.
- The student should be able to calculate loads acting on the aircraft.
- The student should also be able to do stress analysis of statically determinate and indeterminate structures by matrix method and Finite Element methods.
- To enable the student to find buckling loads of columns and plates

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Perform stress analysis of beams, columns and trusses by applying various methods.
- Calculate deflection of structures by various methods..
- Perform stress analysis of statically determinate and indeterminate structures.
- Estimate loads acting on an aircraft.
- Estimate buckling loads of columns and plates.

DETAILED CONTENTS

UNIT –I (8 Hrs.)

1. **Basics of elasticity:** Equations of equilibrium, plane stress, stresses on inclined planes, principal stresses ,compatibility equations ,plane strain ,principal strains, stress-strain relationship**,** numerical problems, temperature effects, experimental measurement of surface strains,2- D problems, stress functions, St. Venant's principle, bending of end loaded cantilever.

UNIT-II (16 Hrs.)

2. **Statically determinate and indeterminate structures:** Statically determinate and indetermi Truss analysis by method of joints, Truss analysis with single and double redundancy, othe with single redundancy, shear center, principle of superposition, Maxwell reciprocal theorem problems.

3. **Matrix methods:** Introduction to flexible and stiffness methods, choice of method ,stiffness matrix for elastic springs, analysis of pin jointed framework, stiffness matrix for uniform beams. Finite Element Method for continuum structures

UNIT-III (16 Hrs.)

4. **Elastic buckling of columns and plates:** Buckling load of Euler columns with different end conditions, beam columns, effect of initial imperfections, pure bending of thin plates, plates subjected to bending and twisting, plates subjected to distributed transverse loads, numerical problems.

5. **Loads on aircraft:** Pure translation, inertia forces on rotating bodies, load factors for translational acceleration, load factors for angular acceleration, numerical problems.

UNIT IV (8 Hrs.)

6. **Analysis of aircraft components:** Loads on structural components, functions of structural components, fabrication of structural components, connections, V-n diagram, Gust loads, crack propagation, stress concentration factor, crack tip plasticity, crack propagation rates

INSTRUCTIONAL STRATEGY

Aircraft Structures being fundamental course, teachers are expected to lay emphasis explain the basic concepts, principles and their applications to aircraft structures. For this purpose teachers are expected to give simple problems and provide tutorial exercises. The teachers are expected to show the actual parts of aircraft wing and fuselage.

RECOMMENDED BOOKS:

1 "Aircraft Structures for Engineering Students", T.H.G.Megson ,4th Edition,Elsevier Ltd., 20
2 "Aircraft structures", D.J.Peery and J.J.Azhar, 2nd Edition., McGraw Hill, 1996
3 "Structural stability of Columns and Plates", N G R Iyengar, John Wiley & sons, 1988
4 Ocw.mit.edu/courses/aeronautics-and-astronautics

SUGGESTED DISTRIBUTION OF MARKS

UNIT NO.	TIME ALLOTTEED (HRS.)	MARKS ALLOTTED (%)
1.	8	16
2.	16	34
3.	16	34
4.	8	16
Total	48	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

4.4 AIRCRAFT PROPULSION

LTPC
3 1 0 4

COURSE OBJECTIVES

- The basic knowledge and governing laws of various modes of heat transfer, aero- and thermodynamic aspects of propulsive devices, such as, propellers, piston type and turbine type aero engines, their performance parameters and the essential knowledge of fuel combustion, standard ratings of aviation fuels and propellants used in rocket engines.

- With this basic knowledge, the student can move on to studying the advance propulsion systems.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Define governing laws of various IC Engines, cycles and modes of heat transfer; thermodynamic aspects of aerospace propulsion systems and their performance parameters
- Describe fuel combustion and flame-stability.
- Examine and analyze compressors and turbines.
- Estimate performance of various types of engines

DETAILED CONTENT

UNIT I: (16 Hrs.)

1. **Heat Transfer and Propellers:** Heat transfer process, Heat conduction, thermal conductivity, general equations of heat conduction with source, conduction problems in 1D and 2D with and without source; Convective heat transfer fundamentals, Introduction to radiative heat transfer, Coupled heat transfer problems.

   Ideal momentum theory and blade element theory and their relative merits, numerical problems on the performance of propellers using propeller charts, selection of propellers, fixed, variable and constant speed propellers, prop-fan, material for propellers, shrouded propellers helicopter rotor in hovering performance.

UNIT II: (12 Hrs.)

2. **Aircraft Piston Engines**: Brief historical sketch of S.I. and C.I. engines, 4-stroke and 2-stroke engines, thermodynamics of engine analysis, combustion process, air standard cycles, various type of arrangements or multi-cylinder aircraft engines, their merits and operational efficiencies, intake and exhaust manifolds, cooling and lubrication systems, valve timing and arrangements, I.H.P., B.H.P and F.H.P, engine performance, effect of altitude, power required and power available, supercharging, preliminary design of aircraft piston engine.

UNIT III: (10 Hrs.)

3. **Fuels and Combustion:** Liquid fuels, hydrocarbons, gasoline, starting mixtures and temperatures, vapor lock, other liquid fuels and blends, combustion knock and knock rating, carburetion and fuel injection, ignition of the charge, ignition system, and gas turbine fuels, solid and liquid propellants

UNIT IV: (10 Hrs.)

4. **Aircraft Gas Turbine Engines:** Air-standard Brayton cycle, actual gas turbine engine cycle, compressor and turbine efficiencies, compressor work and turbine work, centrifugal and axial type of compressor, their comparative action, relative merits in operations, combustion chambers: various arrangements, simplex and duplex burners.

INSTRUCTIONAL STRATEGY

Session plan/course-material uploading, class-room teaching associated with assignments, quiz, viva-voce and evaluation.

RECOMMENDED BOOKS

1. Holman J.P., "Heat Transfer", 2nd Edition, McGraw Hill.
2. Gebhart B., "Heat Transfer", 2nd Edition, McGraw Hill.
3. Dommasch, Sherby and Connolly, "Airplane Aerodynamics", Pitman.
4. Litchy L.C., "I C. Engines", McGraw Hill.
5. Mattingly J.D., "Elements of Gas Turbine Propulsion", McGraw Hill 1st Ed.1997.
6. Cohen Rogers and Sarvanmattoo, "Gas Turbine Theory", John Wiley.
7. P. G. Hill and C. R. Peterson, "Mechanics and Thermodynamics of Propulsion", Addison Wesley, 1970.
8. J.L Kereebrock, "Aircraft Propulsion System Technology and Design", MIT Press, 1991.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	16	35
2	12	25
3	10	20
4	10	20

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

4.5 AIRCRAFT MATERIALS AND PROCESSES

LTPC
4 0 0 4

COURSE OBJECTIVES

- This course builds up a strong knowledge base of aerospace students in respect of various important materials used in the manufacture of aircraft including certain salient manufacturing processes that are specific to the aircraft manufacturing.

- The course also covers the design principles of jigs and fixtures, Electron Beam welding, etc, which are used for manufacturing various components and assemblies of aircraft so as to ensure symmetry of the geometric shapes and to obtain accuracy / repeatability in dimensions.

LEARNING OUTCOME

After undergoing the subject, the student will be able to:

- Describe and identify materials for development of aircraft and its components.
- Apply engineering processes associated with aircraft manufacture.
- Analyze Properties of Aircraft Light Alloys, Aircraft Steels & Composites.
- Review standardization of Aircraft materials, Crystalline / material micro-structures.
- Evaluate modern aircraft component fabrication Techniques.
- Apply qualitative and quantitative methods in the selection of materials as a fundamental step in the design phase of aircraft structures and components.
- Explain recent scientific and technological developments in the field of aircraft materials, and assess their potential to enhance the performance of aircraft in near future (e.g. smart-materials, functionally graded materials, new alloys and fabrication processes)

DETAILED CONTENTS

UNIT – I (20 Hrs)

1. Introduction: Properties of Flight Vehicle Materials, Importance of strength/weight ratio of materials for Aerospace vehicles structures, Importance of temperature variations, factors affecting choice of material for different parts of Airplane. Weldability, standard welding practices e.g. gas welding, resistance welding.

2. Light Metal Alloys: Aluminum alloys, heat treatment, High strength and high corrosion resistant alloys. Magnesium alloys and their properties, Application of Aluminum & Magnesium alloys to Aerospace vehicles. Titanium and its alloys. Welding of light alloys, Riveting.

UNIT – II (20 Hrs)

3. Aircraft Steels: Classical of alloys steels, Effect of alloying elements, Carbon Steel V/s Alloys. Effects of alloying elements & micro structures. Heat treatment, Application to Aerospace Vehicle of these alloys. Fatigue & Creep in aeronautical components

4. High Strength and Heat Resistant Alloys: Classification of heat resistant materials, Iron, Nickel and Cobalt base alloys, Refractory materials, Ceramics, , properties of Inconel Monel & K-Monel, Nimonic and Super Alloys; Application to Aerospace Vehicles.

UNIT – III (12 Hrs)

5. Composite and advanced Materials: Introduction, Fibers, glass fibers, carbon fibers, Aramid fibers, Baron Fibers, Engineering ceramics. Matrix Materials – Their functions, various types, curing of resins. Modern Fighter aircraft, Transport aircraft & Helicopters materials for various components & Parts. Stealth material and the applications.

UNIT – IV (12 Hrs)

6. Metal Joining Processes: General methods of construction of aircraft and aero engine parts. Profiling, Hydro forming, forming bending rolls, Spar milling, Spark erosion and Powdered metal parts, integral machining, Contour etching, High energy rate forming, Manufacturing of honeycomb structures, Electron Beam Welding, Hydro-forming.

INSTRUCTIONAL STRATEGY

Session Plan/course-material uploading, Class-room teaching associated with assignments**,** presentations**,** quiz, viva-voce, in-class tests and evaluation.

RECOMMENDED BOOKS

1. Aircraft Material and Processes: G F Titterton, Himalayan Books, New Delhi. 5th Edition
2. Advanced Composite materials: Lalit Gupta, Himalayan Books, New Delhi, 2005
3. Workshop technology: WAJ Chapman, Replika Press Pvt. Ltd.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	20	32
2	20	32
3	12	18
4	12	18
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

4.6 AIRCRAFT SYSTEMS AND INSTRUMENTATION

L T P C
3 0 0 3

COURSE OBJECTIVES

- To enable the student to describe control systems of aircraft.
- The student should be able to describe working principle of Flight instruments
- The student should be able to apply the knowledge of digital system to covert and acquire data from various subsystems.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Illustrate various types of aircraft control systems mechanisms.
- Design Hydraulic and Pneumatic Systems for aircraft subsystems.
- Use Gyroscope and Accelerometer for effective navigation and guidance of aircraft.
- Explain the role of cockpit instruments and system of aircraft.
- Use digital system to confined and acquire data from various subsystems.

UNIT –I (12 Hrs)

1. **Flight control systems:** Conventional Systems, Power assisted and Fully Powered Flight Controls, Power Actuated Systems, Engine Control Systems, Push Pull Rod System, Flexible Push Full Rod System, Components, Modern Control Systems, Digital Fly by Wire Systems, Auto Pilot System, Active Control Technology.

2. **Communication and navigation system:** Introduction to Communication and navigation system of aircraft, Instrument Landing Systems, VOR, CCV Case Studies.

UNIT –II (10 Hrs.)

3. **Aircraft systems:** Hydraulic Systems: Study of Typical Workable System components, Hydraulic System Controllers, Modes of Operation, Pneumatic Systems: Advantages, Working Principles, Typical Air Pressure System, Brake System, Typical Pneumatic Power SystemComponents, Landing Gear Systems: Classification, Shock Absorbers, Retraction Mechanism.

UNIT –III (12 Hrs.)

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4. **Engine systems:** Fuel Systems for Piston and Jet Engines, Components of Multi Engines, Lubricating Systems for Piston and Jet Engines, Engine Starting and Ignition Systems, Typical examples for Piston and Jet Engines.

5. **Auxiliary system:** Basic Air Cycle Systems, Vapor Cycle Systems, Boot-Strap Air Cycle System, Pressurization system, Oxygen Systems, Fire Protection Systems, Deicing and Anti Icing Systems.

UNIT –IV (14 Hrs)

6. **Gyroscopic instruments:** Gyroscope and its properties, gyro system, Vertical gyroscope-Horizon, Direction gyro-direction indicator, Rate gyro-rate of turn and slip indicator, acceleration and turning errors.

7. **Measurements and instrumentation:** Pressure measurement, temperature measurement, fuel quantity measurement, engine power and control instruments-measurement of RPM, manifold pressure, torque, exhaust gas temperature, EPR, fuel flow, engine vibration, monitoring. Data acquisition and Handling systems: Introduction-signal conditioners-Instrumentation amplifiers-filters. Data conversion -multiplexers-A/D-D/A conversion. Telemetry-Airborne and ground system-PC based telemetry system. Introduction to telemetry flight data testing. Application of telemetry in UAVs and Satellites.

INSTRUCTIONAL STRATEGY

Session Plan/course-material uploading, Aircraft Hanger Visit, Class-room teaching associated with assignments, presentations, Videos of animation of aircraft systems and Flight Instruments working, quiz, in-class tests, viva-voce and evaluation.

RECOMMENDED BOOKS

1 Electrical and Electronics measurements and instruments. Author, A.K. Shawney, 2010
2 Aircraft flight instrumentation by Pallett, 1988
3 Advanced Aircraft Systems by David A. Lombardo, 1993
4 Airframe and Powerplant MECHANICS (Airframe Book), FAA, 1976

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	12	16
2	10	16
3	12	28
4	14	40
Total	48	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

4.7 HIGH SPEED AERODYNAMICS LAB

L T P C
0 0 4 2

COURSE OBJECTIVE

- Select appropriate experimental techniques to study the aerodynamic characteristics of any body.
- Interpret experimental result.

DETAILED CONTENTS

1. Calculate drag polar of symmetric airfoil using strain gauge based load cell in wind tunnel.
2. Calculate drag polar of cambered airfoil using strain gauge based load cell in wind tunnel.
3. Calculate coefficient of lift of symmetric airfoil with flap at different flap deflection angle using strain gauge based load cell in wind tunnel.
4. Calculate of Drag coefficient of cylinder at different Reynolds number.
5. Measurement of boundary layer thickness over flat plate using hot wire anemometry.
6. Determining and map coefficient of pressure around symmetric and cambered airfoil using software.
7. Determining and map coefficient of pressure around 3D wing using software.
8. Measuring pressure distribution around cylinder using software.
9. Determine pressure distribution over a swept back wing using software.
10. Determine pressure distribution over swept forward wing using software.
11. Calculate oblique shock angle around a sharp cone of fixed cone angle at different Mach numbers using Schlieren/shadowgraph technique.
12. Calculate oblique shock angle around sharp cones of different cone angles at a fixed Mach numbers using Schlieren/shadowgraph technique.

RECOMMENDED BOOKS

1. “Low speed wind tunnel testing”, Jewel B. Barlow, John Wiley & sons
2. “Experimental Aerodynamics”, Henry Christensen, Pavian,Pitman Publishing
3. “Wind Tunnels: Aerodynamics, Models & Experiments (Engineering Tools, Techniques and Tables)”, Justin D. Pereira.

MEANS OF ASSESSMENT

Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva-voce.

4.8 AIRCRAFT STRUCTURES LAB

L T P C
0 0 2 1

COURSE OBJECTIVE

- The aircraft structures Lab with enable the student to conduct experiments, so that they are able to understand the theoretical concepts and principles in a better way.

DETAILED CONTENTS

1 Prove Maxwell Reciprocal theorem for a simply supported beam

2 Prove Maxwell Reciprocal theorem for a cantilever beam

3 To determine/calculate shear centre of a channel section

4 Determine/calculate shear centre of a Z section

5 To Determine/calculate shear centre of a rectangular section

6 Find direct strain in a simply supported beam by strain gauges

7 Determine/calculate direct strain in a cantilever by strain gauges

8 Stress analysis of a truss by using software

9 Stress analysis of initially bent column by using software

10 Stress analysis of a pinned column by using software

11 Stress analysis of a column with both ends fixed by using software

MEANS OF ASSESSMENT

Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva-voce.

4.9 AIRCRAFT PROPULSION LAB

L T P C
0 0 2 1

COURSE OBJECTIVE

- At the end of this course, the student should be able to perform experiments to measure different aircraft engine parameters.

DETAILED CONTENTS

1. Study the functioning of aircraft piston engines having various arrangements of cylinders.
2. Study of Jet Engine.
3. Experiments on Continuous Combustion test rig.
4. Conduct Morse test on given multi cylinder engine.
5. Conduct dynamometer test and retardation test
6. Performance test on reciprocating air compressor.

MEANS OF ASSESSMENT

Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva-voce.

FIFTH SEMESTER

5.1 AIRPLANE PERFORMANCE

LTPC
4 1 0 5

COURSE OBJECTIVES

- The course enables students to learn various concepts related to atmosphere, aerodynamic characteristics, performance parameters and energy methods.
- The course enables students to analyze and estimate performance parameters of different types of aircraft for steady and accelerated flights.

LEARNING OUTCOME

After undergoing the subject, the student will be able to:

- Analyze atmosphere and estimate atmospheric properties.
- Analyze drag for 2D and 3D cases for subsonic and supersonic aircrafts.
- Analyze aerodynamic characteristics of different types of aircrafts.
- Estimate performance parameters for steady flight.
- Estimate performance parameters for accelerated flight.
- Analyze maneuvers and Energy methods.

DETAILED CONTENTS

UNIT – I (8 Hrs.)

1. Atmosphere: Standard atmosphere, Relation between geo-potential and geometric altitudes, Pressure, temperature and density altitudes. Relations for isothermal and gradient atmospheric regions, Stability of atmosphere, Measurement of air-speed: Indicated airspeed, Calibrated airspeed, Equivalent airspeed and True airspeed, Airspeed indicator.

UNIT – II (20 Hrs.)

2. Drag: Drag, Causes of drag, Types of drag, Factors affecting drag. Drag polar, Compressibility drag, Design for minimum drag, Estimation of drag of complete airplane for subsonic and supersonic cases, Terminal velocity.

3. Aerodynamic characteristics: Force and Moment coefficients from dimensional analysis and their variation with angle of attack, Lift, Drag and moment coefficients, Relations between lift and drag, Aerodynamic center, Center of pressure, Pressure distribution over 2-D airfoil, Estimation of aerodynamic characteristics from measured pressure distribution, Variation of aerodynamic coefficients with Reynold's Number and Mach number, Effect of span, aspect ratio, plan form, sweep, taper and twist on aerodynamic characteristics of a lifting surface, Delta wing aerodynamics.

UNIT – III (20 Hrs.)

4. High lift devices: Maximum lift coefficient of airfoils, Leading and trailing edge devices, Deep stall, Propulsive lift, V/STOL configurations.

5. Aircraft performance in steady flight: Straight and Level flight, Variation of drag with flight speed, Minimum drag conditions, Variation of power with flight speed, Minimum power conditions, Gliding flight, Shallow and steep angles of glide, Sinking speed, Minimum sinking speed, Time of descent, Climbing flight at shallow angles, Correction for steep angles, Time to flight, Maximum rate of climb.

UNIT – IV (16 Hrs.)

6. Aircraft performance in accelerated flight: Take-off and landing, Calculation of take-off ground run and take off distances, Minimum ground run, Assisted take-off, Calculation of landing ground run and landing distances, Range and endurance, Numerical problems.

7. Maneuvers and energy method: Maneuvering performance, Introductory comments on spins and stalls, Analysis of Spin, Various types of stalling behavior of wings, Turning flight, Maneuvers in 3-D space, Karman's method of JATO, Energy method of performance calculations

INSTRUCTIONAL STRATEGY

The course consists of conceptual and numerical contents for which a combination of LCD projector and black/white boards can be used as teaching aids.

RECOMMENDED BOOKS

1. Aircraft Performance and Design: J. D. Anderson Jr., TATA McGraw-Hill, 2010.
2. Aerodynamics for Engineering Students: E.L. Houghton and N.B. Carruthers, Butterworth Heinemann, 1982.
3. Introduction to Flight: J. D. Anderson Jr., TATA McGraw-Hill, 8th Edition, 2015.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	8	15
2	20	30
3	20	30
4	16	25
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

5.2 AVIONICS

LTPC
4 0 0 4

COURSE OBJECTIVES

- To enable the student to describe different types avionics systems of aircraft.
- The student should be able to apply Avionics verification and validation techniques.
- The student should be able to understand working of Communication and Navigation of aircraft.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

.

- Identify avionics System/subsystem requirements
- Compare the Military and Civil Avionics requirements
- Describe working principles of communication systems
- Describe working principles of navigation systems

DETAILED CONTENTS

UNIT –I (20 Hrs.)

1. **Role of avionics:** Role for Avionics in Civil and Military Aircraft systems, Avionics sub-systems and design, defining avionics System/subsystem requirements-importance of ilities, Avionics system architectures

2. **Avionics system data buses, design and integration:** MIL-STD-1553B, ARINC-429, ARINC-629, CSDB, AFDX and its Elements, Avionics system design, Development and Integration-Use of simulation tools, stand alone and integrated Verification and Validation

UNIT –II (14 Hrs.)

3. **Avionics system essentials**: displays, i/o devices and power: Trends in display technology, Alphanumeric displays, character displays etc., Civil and Military aircraft cockpits, MFDs, MFK, HUD, HDD, HMD, DVI, HOTAS, Synthetic and enhanced vision, situation awareness, Panoramic/big picture display, virtual cockpit-Civil and Military Electrical Power requirement standards, comparing the Military and Civil Requirements and Tips for Power System Design

UNIT –III (14 Hrs.)

4. **Communication systems:** Fundamentals of radio wave propagation, antennas, transmission lines, communication, receiver and transmitter; Working principles of following systems: Very High Frequency (VHF) communication, High Frequency (HF) communication, Audio, Emergency Locator Transmitters, Cockpit Voice Recorder, ARINC communication and reporting

UNIT –IV (16 Hrs.)

5. **Navigation systems:** Fundamentals of Very High Frequency omnidirectional range (VOR); Automatic Direction Finding (ADF); Instrument Landing System (ILS); Microwave Landing System (MLS); Distance Measuring Equipment (DME);Radio altimeter, Very Low Frequency and hyperbolic navigation(VLF/Omega); Doppler navigation; Area navigation, RNAV systems; Flight Management Systems; Global Positioning System (GPS), Global Navigation Satellite Systems (GNSS); Inertial Navigation System; Air Traffic Control transponder, secondary surveillance radar; Traffic Alert and Collision Avoidance System(TCAS),Weather avoidance radar;

INSTRUCTIONAL STRATEGY

The teachers should do proper lesson planning, include ppt and demonstracts actual avionics components in the class. Expert lectures may be arranged.

RECOMMENDED BOOKS

1. "Digital Avionics Handbook," Third Edition 3rd Edition, CRC Press, 2012
2. "Introduction to Avionics Systems", R P G Collinson, 3rd ed. Edition. Springer, 2011
3. "Micro Electronics Aircraft System," E.H.J.Pallett

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	20	30
2	14	20
3	14	20
4	16	30
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

5.3. AIRCRAFT STRUCTURAL ANALYSIS

LTPC
3 1 0 4

COURSE OBJECTIVES

- To enable the student to describe and calculate inelastic buckling characteristics of columns and plates.
- The student should be able to evaluate stresses in various aircraft components like wing, fuselage and wing ribs.
- The student should be able to apply concept of structural idealization for stress analysis of open and closed section beams.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Carry out stress analysis of aircraft wing, fuselage and wing ribs .
- Apply concept of structural idealization for stress analysis of open and closed section beams.
- Structural analysis of aircraft wing, fuselage and wing ribs.
- Compute loads acting on an aircraft
- Compute aircraft fatigue life

UNIT –I (8 Hrs.)

1. **Inelastic buckling:** Flexural - torsional buckling of thin walled columns, buckling of thin plates, inelastic buckling of plates ,experimental determination of critical load, local instability, instability of stiffened panels, full tension and semi tension field beams

UNIT –II (14 Hrs.)

2. **Airframe loads:** Aircraft inertia loads, symmetric maneuver loads, steady pull out, correctly banked turn, numerical problems, fatigue, safe life and fail-safe structures, designing against fatigue, fatigue strength of components, prediction of aircraft fatigue life.
3. **Bending and shear of open and closed tubes:** Symmetrical bending, direct stress due to bending, deflection due to bending, approximation for thin walled section, shear centre, shear of open section beams, shear of closed section beams.

UNIT –III (16 Hrs.)

4. **Structural Idealization:** Analysis of combined open and closed sections in shear and torsion, effect of idealization on bending, shear and torsion analysis of open and closed section beams, deflection of open and closed section beams.
5. **Stress analysis of wing and fuselage:** Tapered wing spar, open and closed sections, beams with variable stringer areas, bending, shear and torsion analysis of fuselage.

UNIT –IV (10 Hrs.)

6. **Stress analysis of aircraft components:** Analysis of wing in bending, shear and torsion, stress analysis of tapered wings, cut – outs in wings, stiffened webs, fuselage frame, wing ribs.

INSTRUCTIONAL STRATEGY

Aircraft Structures II being an advanced course, teachers are expected to lay emphasis on the stress analysis of aircraft components by explaining the detailed procedure of solution. The teachers are expected to give the students home assignments ,project problems and quizzes to test the students skills.

RECOMMENDED BOOKS

1 "Aircraft Structures for Engineering Students": T.H.G.Megson ,4th Edition., Elsevier Ltd., 2012
2 "Structural stability of Columns and Plates",N G R Iyengar, John Wiley and sons, 1988
3 "Aircraft structures", D.J.Peery and J.J.Azhar, 2nd Edition., McGraw Hill
4 ocw.mit.edu/courses/aeronautics-and-astronautics, 1996

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT NO.	TIME ALLOTTEED (HRS.)	MARKS ALLOTTED (%)
1	8	16
2	14	32
3	16	34
4	10	18
Total	48	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

5.4. JET PROPULSION

LTPC
3 1 0 4

COURSE OBJECTIVES

- Make the students understand the flow dynamics of supersonic and compressible flows through compressor, combustion chamber, nozzles and turbine passages and flows involving heat transfer and frictional effects.
- The differences in the performance analysis of a turbine engine in ideal and real conditions are also discussed so that the students can appreciate the need to study both of these situations.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Describe compressible flows through compressor, combustion chamber, nozzles, and turbine passages.
- Analyze various types of engine cycles.
- Estimate the performance of centrifugal compressor and combustion chamber.
- Estimate the performance of axial flow compressor and turbine.

DETAILED CONTENT

UNIT I: (12 Hrs.)

1. **Steady 1-Dimensional Gas Dynamics;** Basics, simple flows: nozzle flow, nozzle design, nozzle operating characteristics for isentropic flow, nozzle flow and shock waves. Nozzle characteristics for some operational engines. Rayleigh flow and Fanno flow. Effect of frictional duct length in subsonic flow and supersonic flow, numerical problems in 1D flow. Principles of Supersonic Combustion and Thrust Vectoring.

2. **Inlets and Nozzles:** Subsonic inlets: pressure recovery, inlet sizing drag flow distortion. Supersonic inlets: Total and sonic state points, A/A* normal shock based internal compression inlets, design sizing and performance. Exhaust nozzle, C-D nozzle, engine back pressure control, exit area ratio, and exhaust nozzle system performance in details.

UNIT II: (12 Hrs.)

3. **Parametric Cycle Analysis of Ideal Engines and Real Engines:** Ideal Engines: Steps of engine parametric cycle analysis, basic assumptions. Applications to

    a) Ideal Ramjet
    b) Ideal Turbojet with and without afterburner
    c) Ideal Turbofan engine, optimum BPR and afterburning
    d) Ideal turboprop engine
    e) Ideal Turbo shaft engine.

Real Engines: Cycle analysis of turbojet, turbojet with after burner, turbofan and turboprop

UNIT III: (8 Hrs.)

4. **Combustion Chambers and centrifugal compressor**: Combustion systems, burners, ignition, flame stability. After burners: System design, flame stability, pressure losses etc. Centrifugal compressor – principle of operation, work done and pressure rise, diffuser, compressibility effects, compressor characteristics, computerized design procedures.

UNIT IV: (16 Hrs.)

5. **Axial Flow Compressor**: Euler's Turbo-machinery equations. Axial flow compressor analysis, cascade action, flow field. Euler's equation, velocity diagrams, flow annulus area stage parameters. Degree of reaction, cascade airfoil nomenclature and loss coefficient, diffusion factor, stage loading and flow coefficient, stage pressure ratio, Blade Mach Number, repeating stage, repeating row, mean line design. Flow path dimensions, number of blades per stage. Radial variation, design process, performance.

6. **Axial Flow Turbine:** Turbine: Introduction to turbine analysis, mean radius stage calculations, stage parameters, stage loading and flow coefficients degree of reaction, stage temperature ratio and pressure ratio, blade spacing, radial variation, velocity ratio. Axial flow turbine, stage flow path, Dimensional stage analysis. Multistage design; steps of design: single stage and two stages. Turbine performance. Blade cooling.

INSTRUCTIONAL STRATEGY

Session Plan/course-material uploading, Class-room teaching associated with assignments**,** Propulsion Lab experiments and Report preparation, quiz, viva-voce and evaluation.

RECOMMENDED BOOKS

1. J.D. Mattingly, "Elements of Gas Turbine Propulsion", McGraw Hill 1st Ed. 1997.
2. Cohen, Rogers and Sarvanmottoo, "Gas Turbine Theory", John Wiley.
3. P.G. Hill and C.R. Peterson, "Mechanics and Thermodynamics of Propulsion", Addison- Wesley, 1970.
4. Gorden C. Oates, "Aircraft Propulsion Systems, Technology and Design", AIAA Pub.
5. J.L. Kereebrock, "Aircraft Engines and Gas Turbine", MIT Press 1991.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	12	24
2	12	24
3	08	20
4	16	32
Total	48	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

5.5 FINITE ELEMENT METHODS

LTPC
3 1 0 4

COURSE OBJECTIVES

- The course will introduce the numerical analysis techniques to solve the various problems related to structural loading like bending, deflection and buckling etc.
- It will teach the students how to model the loading problems in structures like trusses and beam which can't be easily solved by analytical approaches.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Apply finite element method to analyze airplane structures under various load conditions.
- Analyze formation of stress and strain matrix in 2D and 3D cases.
- Analyze various shape functions in higher order elements in 2D and 3D cases.
- Develop various codes of FEM to analyze structural loads on different aircraft components.

DETAILED CONTENT

UNIT- I (16 Hrs.)

1. **Introduction to Finite Element Method and One-Dimensional Elements:** Engineering Analysis, History, Advantages, Classification, Basic steps, Convergence criteria, Role of finite element analysis in computer-aided design., Mathematical Preliminaries, Differential equations formulations, Variational formulations, weighted residual methods.

   Analysis of Bars and Trusses, Basic Equations and Potential Energy Functional, 1-D Bar Element, Admissible displacement function, Strain matrix, Stress recovery, Element equations, Stiffness matrix, Consistent nodal force vector: Body force, Initial strain, Assembly Procedure, Boundary and Constraint Conditions, Single point constraint, Multipoint constraint, 2-D Bar Element, Shape functions for Higher Order Elements.

UNIT- II (10 Hrs.)

2. **Dimensional Elements:** Analysis of Plane Elasticity Problems: Three-Noded Triangular Element (TRIA 3), Four-Noded Quadrilateral Element (QUAD 4), Shape functions for Higher Order Elements (TRIA 6, QUAD 8), Analysis of Bodies of Revolution under axi-symmetric loading: Axisymmetric Triangular and Quadrilateral Ring Elements. Shape functions for Higher Order Elements.

UNIT III (10 Hrs.)

3. **Dimensional Elements:** Applications to Solid Mechanics Problems: Basic Equations Potential Energy Functional, Four-Noded Tetrahedral Element (TET 4), Eight-No Hexahedral Element (HEXA 8), Tetrahedral elements, Hexahedral elements: Serendi family, Hexahedral elements: Lagrange family. Shape functions for Higher Or Elements.

Unit IV (12 Hrs.)

4. **Application to Finite Element Method:** Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, axisymmetric triangular element, quadrilatateral element, beam element. Lumped mass matrix, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams.

INSTRUCTIONAL STRATEGY

Session Plan / course-material uploading, Class-room teaching associated with assignments**,** presentations**,** quiz, viva-voce and evaluation.

RECOMMENDED BOOKS:

1. Chandrupatla T. R., Finite Elements in engineering, 2nd Edition, PHI, 2007.
2. Lakshminarayana H. V., Finite Elements Analysis – Procedures in Engineering, Universities Press, 2004
3. Rao S. S., Finite Elements Method in Engineering, 4th Edition, Elsevier, 2006.
4. P.Seshu, Textbook of Finite Element Analysis -PHI, 2004.
5. J.N.Reddy, Finite Element Method, McGraw -Hill International Edition.
6. Bathe K. J. Finite Elements Procedures, PHI.
7. Finite Element Analysis C.S. Krishnamoorthy, TMH

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	16	32
2	10	20
3	10	22
4	12	26
Total	48	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

5.6 AIRCRAFT STRUCTURAL ANALYSIS LAB

L T P C

0 0 4 2

COURSE OBJECTIVES

- The course will enable the students perform experiments on various analysis of structures, so that they understand the theoretical concepts, better and execute the analysis efficiently.

DETAILED CONTENTS

1 Stress analysis of landing gear using software

2 Stress analysis of statically determinate truss using software

3 Stress analysis of rectangular wing using software

4 Stress analysis of fuselage using software

5 Stress analysis of rudder using software

6 Stress analysis of wing ribs using software

7 Stress analysis of tapered wing using software

8 Stress analysis of swept back wing using software

9 Stress analysis of wing spars using software

10 Stress analysis of statically indeterminate truss using software

RECOMMENDED BOOKS

1 "Aircraft Structures for Engineering Students": T.H.G.Megson ,4th Ed. Elsevier Ltd., 2012

2 "Structural stability of Columns and Plates", N G R Iyengar, John Wiley and sons, 1988

3 "Aircraft structures", D.J.Peery and J.J.Azhar, 2nd Ed., McGraw Hill, 1996

4 ocw.mit.edu/courses/aeronautics-and-astronautics

MEANS OF ASSESSMENT

Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva-voce.

5.7 JET PROPULSION LAB

LTPC
0 0 4 2

COURSE OBJECTIVE

At the end of this course, the student should be able to perform experiments to measure different aircraft engine parameters.

DETAILED CONTENTS

1. Finding efficiency of gas turbine engine
2. Determining theoretical and actual heat transfer coefficient using forced convention apparatus
3. Calculating propulsion efficiency of a propeller
4. Measuring thrust generated by a propeller at different speed and extrapolating the results
5. Determining calorific value of different solid fuels
6. Determining calorific value of different gaseous fuels using Boy's gas calorimeter
7. Determining velocity profile of free jet of various size
8. Calculating pressure distribution inside convergent nozzle

MEANS OF ASSESSMENT

Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva-voce.

5.8 AVIONICS LAB

LTPC
0 0 2 1

COURSE OBJECTIVE

At the end of this course, the student should be able to analyze avionics system for aircraft.

DETAILED CONTENTS

1. VHF/HF Communications LRU replacement and Communication Check
2. Use of various test equipment for avionics system maintenance
3. VHF Navigation LRU replacement and system tests
4. Inspection/testing of ELT
5. CVR switching and recording
6. Antenna replacement and system testing
7. Radio Standing Wave ratio Measurement Tests
8. Function Testing of ATC/TCAS system components
9. Operation test of Weather Radar system
10. Intercommunication/Passenger Address Component function testing
11. ILS/VOR Systems function testing using appropriate test equipment e.g. Nav 401/402
12. Radio Altimeter system test utilizing appropriate (555) test set
13. DME/VOR Functional Testing utilizing appropriate test set
14. ADF component functions and tests
15. Functional check of inertial navigation system
16. Operational testing of Flight Director systems and auto pilot systems
17. Locate Auto throttle systems components and bite test.
18. Perform BITE on centreal maintenance system.

MEANS OF ASSESSMENT

Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva-voce.

SIXTH SEMESTER

6.1 AIRCRAFT STABILITY AND CONTROL

L T P C
4 1 0 5

COURSE OBJECTIVE

- The course enables students to understand and apply various concepts related to aircraft stability and control.
- The course enables students to analyze and estimate various aspects related to longitudinal and lateral static and dynamic stability.

LEARNING OUTCOME

After undergoing the subject, the student will be able to:

- Explain various concepts related to aircraft stability and control.
- Analyze and estimate static longitudinal stability (stick-fixed and stick-free).
- Analyze and estimate maneuvering longitudinal stability (stick-fixed and stick-free).
- Analyze and estimate static lateral and directional stability (stick-fixed and stick-free).
- Analyze and estimate dynamic longitudinal stability.
- Analyze and estimate dynamic lateral and directional stability.
- Analyze various longitudinal and lateral dynamic modes, coefficients and parameters.

UNIT –I (16 Hrs.)

1. Stick fixed static longitudinal stability: Introduction to stability, Criterion for static stability of an aircraft, Contribution of different parts to stick fixed static longitudinal stability of aircraft, Effect of power, Neutral point (stick fixed), Centre of gravity limits. Static margin, In flight measurement of stick fixed neutral point.

UNIT-II (16 Hrs.)

2. Stick free static longitudinal stability: Contribution of different parts to stick free static longitudinal stability of aircraft, Control surface hinge moments, Floating and restoring tendencies, Different types of tabs used on airplanes, Effect of free elevator on airplane stability, Elevator control power, Stick force gradients, Neutral point (stick free), Controls free center of gravity limit. In flight measurement of stick free neutral point.

3. Maneuvering flight: Effect of acceleration on airplane stability, Elevator angle per g, Stick force per g, Maneuver points and in flight measurement of maneuver points (stick fixed and stick free), Maneuver margins.

UNIT-III (16 Hrs.)

4. Directional stability and controls: Asymmetric flight, Weather cock stability, Contribution of different parts of Aircraft, Adverse yaw, Frise Aileron, Spoiler Controls. Rudder Fixed and Rudder free static directional stability, Rudder control power, Rudder lock.

5. Lateral stability and control: Dihedral Effect. Contribution of different parts of aircraft, Aileron control power, Cross coupling of lateral and directional effects.

UNIT- IV (16 Hrs.)

6. Dynamic stability: Introduction to dynamics, Spring-mass system. Equations of motion, Stability and control derivatives, Longitudinal dynamic stability, Lateral and Directional dynamic stability, Analysis of different stability modes.

INSTRUCTIONAL STRATEGY

The course consists of conceptual and numerical contents for which a combination of LCD projector and black/white boards can be used as teaching aids.

RECOMMENDED BOOKS

1. Flight Stability and Automatic Control, R. C. Nelson, McGraw-Hill Book, 2007.
2. The Airplane Performance Stability and Control, C.D. Perkins and R.E. Hage, 1949.
3. Dynamics of Flight: Bernard Etkin, John Wiley and Sons, 1996.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	16	25
2	16	25
3	16	25
4	16	25
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

6.2 COMPUTATIONAL FLUID DYNAMICS

L T P C
4 0 0 4

COURSE OBJECTIVE

- The course will introduce the discretization techniques to solve the essential flow equations like N-S equation and RANS which are in complex partial differential forms.
- The course will enable students to acquire techniques to model the entire flow domain into regular and irregular grid system and adopting the suitable boundary condition to solve them.
- The course will also teach the common errors and solution instabilities in numerical analysis of any flow problem.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Explain partial differential, Navier strokes and Euler equations of the flow over the body.
- Describe disretization techniques, equation transformation and grid generation.
- Apply different CFD techniques to assess pressure, pressure coefficient, forces and moments over different aerodynamic shapes**.**

DETAILED CONTENTS

UNIT –I (14 Hrs.)

1. **Governing Equations and Boundary Conditions:** General introduction about the scope of the subject, Models of flow, Concept of substantial derivative and divergence of velocity, Different Types of Flows, Integral form of conservation equations, Differential form of conservation equations, Navier-Stokes and Euler Equations, Classification of partial differential equations using Cramer's Rule, General behaviour of different classes of PDEs and their impact on physical computational fluid dynamics.

UNIT –II (24 Hrs.)

2. **Discretization Transformation and Grid Generation:** Basic discretization techniques, Introduction to Finite Differences, Difference Equations, Explicit and Implicit approaches, concept of stability. General transformation of equations, Metrics and Jacobians, Form of governing equations suited for CFD, Stretched grids, Boundary-fitted coordinate systems-Elliptic grid generation, Adaptive grids, Some modern developments in grid generation.

UNIT –III (14 Hrs.)

3. **Simple CFD Technique :** Lax-Wendroff technique, Maccormack's technique, Relaxation technique, Pressure correction technique, Philosophy of pressure correction method. Numerical procedure for SIMPLE algorithm, Boundary conditions for pressure-correction method. Brief discussion of some computer graphic techniques used in CFD.

UNIT –IV(12 Hrs.)

4. **Finite Volume Method:** The finite volume method for one-dimensional steady state diffusion problems and for two-dimensional steady state diffusion problems, The finite volume method for one-dimensional convection and diffusion, The central differencing scheme, The upwind differencing scheme. The pressure-velocity coupling.

INSTRUCTIONAL STRATEGY

Session Plan / course-material uploading, Class-room teaching associated with assignments**,** presentations**,** quiz, viva-voce and evaluation.

RECOMMENDED BOOKS

1. John D. Anderson, Computational Fluid Dynamics: The Basics with Applications, Mc Graw Hill, 1995.
2. H.K. Versteeg and W. Malalasekera, An Introduction to Computational Fluid Dynamics – The Finite Volume Method, Pearson Education. 2007.
3. D.C. Wilcox, Turbulence Modelling for CFD, 1993.
4. S.V. Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill,1981.
5. Patrick Knupp and Stanly Steinberg, Fundamentals of Grid Generation, CRC Press, 1994.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	14	22
2	24	40
3	14	20
4	12	18
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

6.3 VIBRATION AND AERO ELASTICITY

L T P C
3 1 0 4

COURSE OBJECTIVES

- Explain fundamentals of vibration such as natural frequencies and modes, resonance, and effect of mass, stiffness and damping on vibration characteristics.
- Analyze dynamic aero elastic instability due to interactions among aerodynamics, structure and inertia effect such as flutter.
- Analyze and explain fundamentals of modeling and analysis techniques, including the energy approach.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Explain the concepts of vibration such as natural frequencies and modes, resonance and effect of mass, stiffness and damping on vibration characteristics.
- Analyze dynamic aero elastic instability due to interactions among aerodynamics, structure and inertia effect such as flutter.
- Apply the fundamental of vibration and aero elasticity on different engineering and airplane components.
- Analyze the effect of flutter and buffeting on airplane structure.
- Analyze effect of divergence on aircraft wing.

DETAILED CONTENTS

UNIT –I (10 Hrs.)

1. **Undamped free and transient vibrations:** Definitions and terminology, simple harmonic motion, combinations of two simple harmonic motions, solution of second order differential equations, complex numbers, classical solution, energy solution, summary of procedures for determining natural frequency, transient, response, equivalent systems.

UNIT-II (16 Hrs.)

2. **Damped free and transient vibrations-single degree of freedom:** Introduction, iscous damping, critical damping, over damping, under damping, equivalent dampers, Coulomb damping.

3. **Steady state forced vibrations –single degree of freedom:** Introduction, sources of excitation, impressed harmonic force, impressed force due to unbalance excitation, transverse critical speed of a single disk, motion excitation, transmissibility and isolation, summary of simple harmonic excitation, commercial isolator materials.

UNIT-III (14 Hrs.)

4. **Aero elasticity:** Introduction, definition and historical background, static and dynamic aero elastic phenomenon, integration of aerodynamic, elastic and inertia forces, influence of aero elastic phenomenon on aircraft design, comparison of critical speeds.

5. **Divergence of lifting surfaces:** Phenomenon of divergence, divergence of 2-D wing section, divergence of an idealized cantilever wing, solution based on semi-rigid assumptions, solution to generalized coordinates method of successive approximation , use of numerical methods.

UNIT IV (8 Hrs.)

6. **Steady state aero elastic problems:** Loss and reversal of aileron control, 2-D and general case, lift distribution on a rigid and elastic wing, effect of reversal of aileron control on static longitudinal stability of airplane, flutter and buffeting.

INSTRUCTIONAL STRATEGY

This is a fundamental course in vibration and aero elasticity. The teachers are expected to lay stress on basics of damped and undamped vibrations. The teachers are expected to show the application of aero elasticity to the aircraft structural problems.

RECOMMENDED BOOKS

1. Mechanical vibrations: Austin H. Church, John Wiley and sons, 1963
2. Vibration problems in engineering: S. Timoshenko Van Nostrand Co.,.John Wiley Publishers, 1974
3. Mechanical Vibrations: V.P.Singh, Dhanpat Rai and Co. Pvt. Ltd., Delhi., 2012
4. An introduction to the Theory of Aeroelasticity: Y.C.Fung, Dover Publications., 1969
5. Aeroelasticity: R.L.Bisplinghoff Holt Ashley R.L.Halfman, Addison Wesley Publishing Co. Reading, Mass., 1965,

SUGGESTED DISTRIBUTION OF MARKS

UNIT NO.	TIME ALLOTTEED (HRS.)	MARKS ALLOTTED (%)
1	10	18
2	16	34
3	14	32
4	08	16
Total	48	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

6.4 MANAGEMENT AND ENTREPRENEURSHIP

L T P C
2 0 0 2

COURSE OBJECTIVES

- The course aims at imparting entrepreneurship and management concepts to students so that a significant percentage of them can be directed towards setting up and managing their own small enterprises.
- This subject focuses on imparting the necessary competencies and skills of enterprise set up and its management.

LEARNING OUTCOME

After undergoing the subject, the student will be able to:

- Explain the principles of management including its functions in an organisation.
- Have insight into different types of organizations and their structures.
- Inculcate leadership qualities to motivate self and others.
- Manage human resources at the shop-floor
- Maintain and be a part of healthy work culture in an organisation.
- Use marketing skills for the benefit of organization .
- Maintain books of accounts and take financial decisions.
- Undertake store management.
- Use modern concepts like TQM, TPM and CRM.

DETAILED CONTENTS

UNIT –I (8 Hrs.)

SECTION – A ENTREPRENEURSHIP

1. Introduction
   - Concept /Meaning and its need
   - Qualities and functions of entrepreneur and barriers in entrepreneurship
   - Sole proprietorship and partnership forms of business organisations
   - Schemes of assistance by entrepreneurial support agencies at National, State, District level: NSIC, NRDC, DC:MSME, SIDBI, NABARD, Commercial Banks, SFC's TCO, KVIB, DIC, Technology Business Incubator (TBI) and Science and Technology Entrepreneur Parks (STEP).

2. Market Survey and Opportunity Identification
   - Scanning of business environment
   - Salient features of National and State industrial policies and resultant business opportunities

- Types and conduct of market survey
- Assessment of demand and supply in potential areas of growth
- Identifying business opportunity
- Considerations in product selection

UNIT –II (8 Hrs.)

3. Project report Preparation

- Preliminary project report
- Detailed project report including technical, economic and market feasibility
- Common errors in project report preparations
- Exercises on preparation of project report

UNIT –III (8 Hrs.)

SECTION –B MANAGEMENT

4. Introduction to Management

- Definitions and importance of management
- Functions of management: Importance and Process of planning, organising, staffing, directing and controlling
- Principles of management (Henri Fayol, F.W. Taylor)
- Concept and structure of an organization
- Types of industrial organizations

a) Line organization
b) Line and staff organization
c) Functional organization

5. Leadership and Motivation

a) Leadership

- Definition and Need
- Qualities and functions of a leader
- Manager Vs leader
- Types of leadership

b) Motivation

- Definitions and characteristics
- Factors affecting motivation
- Theories of motivation (Maslow, Herzberg, McGregor)

UNIT –IV (8 Hrs.)

6. Management Scope in Different Areas
   a) Human Resource Management

      - Introduction and objective
      - Introduction to Man power planning, recruitment and selection
      - Introduction to performance appraisal methods

   b) Material and Store Management

      - Introduction functions, and objectives
      - ABC Analysis and EOQ

   c) Marketing and sales

      - Introduction, importance, and its functions
      - Physical distribution
      - Introduction to promotion mix
      - Sales promotion

   d) Financial Management

      - Introductions, importance and its functions
      - Elementary knowledge of income tax, sales tax, excise duty, custom duty and VAT

7. Miscellaneous Topics

   a) Customer Relation Management (CRM)

      - Definition and need
      - Types of CRM

   b) Total Quality Management (TQM)

      - Statistical process control
      - Total employees Involvement
      - Just in time (JIT)

   c) Intellectual Property Right (IPR)

      - Introductions, definition and its importance
      - Infringement related to patents, copy right, trade mark

Note: In addition, different activities like conduct of entrepreneurship awareness camp extension lecturers by outside experts, interactions sessions with entrepreneurs and industrial visits may also be organized.

INSTRUCTIONAL STRATEGY

Some of the topics may be taught using question/answer, assignment or seminar method. The teacher will discuss stories and case studies with students, which in turn will develop appropriate managerial and entrepreneurial qualities in the students. In addition, expert lecturers may also be arranged from outside experts and students may be taken to nearby industrial organizations on visit. Approach extracted reading and handouts may be provided.

RECOMMENDED BOOKS

1. A Handbook of Entrepreneurship, Edited by BS Rathore and Dr JS Saini; Aapga Publications, Panchkula (Haryana)
2. Entrepreneurship Development published by Tata McGraw Hill Publishing Company Ltd., New Delhi
3. Entrepreneurship Development in India by CB Gupta and P Srinivasan; Sultan Chand and Sons, New Delhi
4. Entrepreneurship Development - Small Business Enterprises by Poornima M Charantimath; Pearson Education, New Delhi
5. Entrepreneurship : New Venture Creation by David H Holt; Prentice Hall of India Pvt. Ltd., New Delhi
6. Handbook of Small Scale Industry by PM Bhandari
7. Principles and Practice of Management by L M Prasad; Sultan Chand & Sons, New Delhi.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	8	24
2	8	26
3	8	26
4	8	24
Total	32	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

6.5 AIRCRAFT MAINTENANCE

L T P C
3 0 0 3

COURSE OBJECTIVES

- To familiarize the students with maintenance and inspections required on aircraft.
- Use of Non Destructive Testing for finding flaws on the aircraft and components.
- To familiarize with Snag rectification and Emphasis should also be given on the Ground handling safety and support system.

LEARNING OUTCOME:-

At the end of the course students will gain knowledge of :

- Use of various types of tools, fits, clearances, and safety precautions used in aviation.
- Explain different types of non-destructive testing techniques.
- Analyze different types of Corrosion and maintenance procedures.
- Define transmission methods, pipes and union, flexible hoses used in aviation
- Explain various types of springs used on aircraft.

DETAILED CONTENTS

UNIT –I (8 Hrs.)

1 **Safety precautions-aircraft and workshop:** Aspects of safe working practices including precautions to take when working with electricity, gases especially oxygen, oils and chemicals; Instructions on the remedial action to be taken in the event of a fire or another accident with one or more of these hazards including knowledge on extinguishing agents.

2 **Workshop Practices :** Care of tools, control of tools, use of workshop materials; Dimensions, allowances and tolerances, standards of workmanship; Calibration of tools and equipment, calibration standards.

3 **Tools :** Common hand tool types; Common power tool types; Operation and use of precision measuring tools; Lubrication equipment and methods. Operation, function and use of electrical general test equipment.

4 **Air Transport Association (ATA) Standards and Wiring Diagrams:** Specification 100 of the Air Transport Association (ATA) of America; Aeronautical and other applicable standards including ISO, AN, MS, NAS and MIL; Wiring diagrams and schematic diagrams.

5 Fits and Clearances: Drill sizes for bolt holes, classes of fits; Common system of fits and clearances; Schedule of fits and clearances for aircraft and engines; Limits for bow, twist and wear; Standard methods for checking shafts, bearings and other parts.

UNIT-II (18 Hrs.)

6 Corrosion:
(a) Chemical fundamentals; Formation by, galvanic action process, microbiological, stress;
(b) Types of corrosion and their identification; Causes of corrosion; Material types, susceptibility to corrosion.
(c) Corrosion removal, assessment, re-protection and corrosion control programs.

7 Welding, Brazing, Soldering and Bonding :
(a) Soldering methods; inspection of soldered joints.
(b) Welding and brazing methods; Inspection of welded and brazed joints; Bonding methods and inspection of bonded joints.

8 Disassembly, Inspection, Repair and Assembly Techniques:
(a) Types of defects and visual inspection techniques.
(b) General repair methods, Structural Repair Manual; Ageing and fatigue.
(c) Non-destructive inspection techniques including, penetrant, radiographic, eddy current, ultrasonic and borescope methods.
(d) Disassembly and re-assembly techniques.
(e) Trouble shooting techniques

9 Maintenance Procedures: Maintenance planning; Modification procedures; Stores procedures; Certification/release procedures; Interface with aircraft operation; Maintenance Inspection/Quality Control/Quality Assurance; Additional maintenance procedures; Control of life limited components

UNIT-III (10 Hrs.)

10 Bearings: Introduction and function of bearings, loads, material, construction; Types of bearings and their application. Testing, cleaning and inspection of bearings; Lubrication requirements of bearings; Defects in bearings and their causes.

11 Transmissions: Gear types and their application; Gear ratios, reduction and multiplication gear systems, driven and driving gears, idler gears, mesh patterns; Belts and pulleys, chains and sprockets. Inspection of gears, backlash; Inspection of belts and pulleys, chains and sprockets; Inspection of screw jacks, lever devices, push-pull rod systems.

12 Control Cables : Types of cables; End fittings, turnbuckles and compensation devices; Pulleys and cable system components; Bowden cables; Aircraft flexible control systems.
Swaging of end fittings; Inspection and testing of control cables; Bowden cables; aircraft flexible control systems.

13 Pipes and Unions :
(a) Identification of, and types of rigid and flexible pipes and their connectors used in aircraft;
(b) Standard unions for aircraft hydraulic, fuel, oil, pneumatic and air system pipes.

14 Pipes and Hoses: Bending and belling/flaring aircraft pipes; Inspection and testing of aircraft pipes and hoses; Installation and clamping of pipes.

15 Springs: Types of springs, materials, characteristics and applications. Inspection and testing of springs.

UNIT-IV (12 Hrs)

General maintenance, ground handling safety and support system:

16 Part-I

Rigging of flight control surfaces and duplicate inspection; Rigging checks-Angular alignment checks and symmetry checks, Knowledge and use of Tensiometers, Protractors etc.

17 Part-II

Maintenance of hydraulic accumulators, reservoirs and filters, Maintenance of landing gear (L/G), Shock strut charging and bleeding, Maintenance of L/G brakes i.e., Dragging, Grabbing, Fading, Brakes and excessive brake pedal travel. Maintenance on wheels, tyres and tubes i.e., dismantling, inspection, assembling, inflating, inspection and installation Storage of Rotables.

18 Part-III

General knowledge of ground handling of Aircraft, Aircraft Safety; Mooring, Jacking, Levelling, Hoisting of aircraft, Towing, Mooring of an a/c during adverse conditions. Aircraft cleaning and maintaining.
Ground signalling/marshalling of aircraft in day and night time.

19 Part-IV
Maintenance and handling of ground equipment's used in maintenance of aircraft. Compressors, Portable hydraulic test stands, Electrical power supply equipment, charging trolley. Air-conditioning and Heating unit, Ground support air start unit. Pressure oil unit, Fire extinguishers, jacks, Hoisting cranes/gantry, Ladders, Platforms, Trestles, and Chocks.

20 Part-V

Knowledge of safety and fire precautions to be observed during maintenance including refueling, defueling and engine start.

21 Part-VI

Brief knowledge of airport and its procedures. Control tower, Dispersal areas, Aprons, Tarmac, Taxy track, Runway and its ends. Approach and clear zone layout. Brief knowledge of the signals given by the control tower. Knowledge of Airfield lighting system, Aircraft Rescue and Fire Fighting.

INSTRUCTIONAL STRATEGY:

For better understanding of the subject, visit to CAR-M subpart F or CAR-145 approved maintenance organization is recommended. Students should be taken to Aircraft Maintenance workshops to demonstration various aircraft maintenance operation.

RECOMMENDED BOOKS

1. Airframe and Powerplant Mechanics (AC 65-15A)-Airframe Hand Book FAA.
2. Civil Aircraft Inspection Procedure (CAP 459) Part II Aircraft.
3. Aircraft Maintenance and Repair By Kroes, Watkin and Delph.
4. Acceptable Methods, Techniques and practices (FAA)-EA-AC 43.13-1 Aand2A.
5. FAA-H-8083-30 - Aircraft Maintenance Technician Handbook - General, US Department of Transportation, Federal Aviation Administration.

SUGGESTED DISTRIBUTION OF MARKS

UNIT NO.	TIME ALLOTTEED (HRS.)	MARKS ALLOTTED (%)
1	8	16
2	18	38
3	10	20
4	12	26
Total	48	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

6.6 AUTOMATIC FLIGHT CONTROL

L T P C
4 1 0 5

COURSE OBJECTIVES

- To enable the student to understand fundamentals of control theory.
- The student shall be able to apply concept of control theory to design autopilot.
- The student shell be able to evaluate feedback control system

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Identify type of control system and develop Block Diagrams of Feedback control system
- Analyze Steady State response of Feedback Control System
- Conduct stability analysis of feedback control systems.
- Develop conceptual design of autopilot for aircraft

DETAILED CONTENTS

UNIT –I (10 Hrs.)

1. **Introduction:** Open Loop and Closed Loop (Feed Back) control systems. Types of Feedback Control Systems. Laplace's Transform. Application of open and closed loop control systems, digital, sophisticated and non-linear control system

UNIT –II (12 Hrs.)

2. **Feed back control system:** Transfer Function of Linear Systems. Impulse response of Linear Systems, Block Diagrams of Feed Back Control Systems, Straight variables, Icon values, Multivariable Systems. Transformation of physical system to block diagram and its analysis, Block Diagram Algebra.

UNIT –III (22 Hrs.)

3. **Analysis of feedback control systems:** Typical Test Input Signals, Time Domain Performance Characteristics of Feedback Control Systems. Effects of Derivative and Integral Control. Steady State response of Feedback Control System-Steady State Error, Frequency Response.

4. **System stability:** Routh-Hurwitz Criterion, the Root Locus Method. Applications of this criterion to improve the system stability, sensitivity

UNIT –IV (20 Hrs.)

5. **Auto-pilots:** Longitudinal Auto Pilots: Brief description through Block Diagrams and Root Locus of Displacement Auto Pilot, Pitch Orientation Control System. Acceleration Control System.

6. **Advance topics:** Introduction to control tool box of MATLAB, Fly-By-Wire control system, Instrument Landing System

INSTRUCTIONAL STRATEGY

The teachers should invite experts to deliver lectures. Audio-video aid may be used. Field visits may be arranged.

RECOMMENDED BOOKS

1. "Modern Control Engineering" Katsuhiko Ogata, 5th Edition, 2009

2. "Flight Stability and Automatic Control" 2nd Edition, McGraw-Hill Education, 1997

3 "Dynamics of Flight: Stability and Control", Bernard Etkin, Wiley Publication. 1995

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	10	16
2	12	16
3	22	34
4	20	34
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

6.7 COMPUTATIONAL FLUID DYNAMICS LAB

L T P C
0 0 4 2

COURSE OBJECTIVES

- The course will enable the student to develop modeling techniques.

DETAILED CONTENTS

- Modeling a 2-D object with structured mesh using GAMBIT software.
- Modeling a 2-D object with unstructured mesh using GAMBIT software.
- Modeling a 3-D object with structured mesh using GAMBIT software.
- Solving a simple 2-D flow problem using Fluent software.
- Solving a simple axisymmetric flow problem using FLUENT software.

MEANS OF ASSESSMENT

Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva-voce.

6.8 VIBRATION AND AERO ELASTICITY LAB

L T P C
0 0 4 2

COURSE OBJECTIVES

- The course will enable the students to conduct experiments and study various aspects and vibration for aircraft design.

DETAILED CONTENTS

- Determine natural frequency of longitudinal vibration of a spring under tensile load
- Determine natural frequency of longitudinal vibration of springs. Two in parallel and one spring in series under tensile load.
- Determine natural frequency of transverse vibrations of a cantilever subjected to transverse vibration.
- Determine the natural frequency of axial vibrations of a bar suspended by two cords
- Determine the natural frequency of torsional vibrations of a bar suspended by two cords
- Determine the natural frequency of torsional vibrations of a ring suspended by three cords and to determine mass moment of inertia of a bar of rectangular sections.
- Determine the logarithmic decrement of torsional vibrations of a shaft subjected to air damping
- Determine experimentally the whirling speed of shaft for a given system.
- Determine the damping coefficient of kerosene oil as damping medium for a spring with axial vibrations.

MEANS OF ASSESSMENT

Actual laboratory and practical work, model/prototype making, assembly and disassembly exercises and viva-voce.

SEVENTH SEMESTER

7.1 AIRCRAFT DESIGN

L T P C
3 1 0 4

COURSE OBJECTIVES

- The course enables students to understand and apply various concepts related to aircraft design.
- The course enables students to conceptually design various types of aircrafts.

LEARNING OUTCOME

After undergoing the subject, the student will be able to:

- Analyze various concepts related to aircraft design.
- Estimate weight & geometrical parameters of different types of aircrafts.
- Analyze aerodynamic and stability characteristics during design of different types of aircrafts.
- Analyze and estimate performance parameters during aircraft design.
- Analyze and estimate structural aspects and apply in aircraft design.

DETAILED CONTENTS

UNIT – I (14 hrs)

1. **Introduction:** Aircraft design, Requirements and specifications, Airworthiness requirements, Importance of weight, Aerodynamic and structural design considerations, Classifications of airplane, Concept of configuration, Features of special purpose airplanes, unmanned aerial vehicles and their features, Control configured vehicles.

2. **Weight estimation and wing design:** Estimation of airplane weight based on airplane type / mission and material used, Trends in wing loading and thrust loading, Iterative approach, Estimation of Horizontal and vertical tail volume ratios.

UNIT – II (12 hrs)

3. **Symmetrical maneuvering loads:** Classical methods of estimating symmetrical maneuvering loads on a wing in flight, Basic flight loading conditions, Load factor, V-n diagram, Gust loads, Estimation of gust loads, Gust envelope, Use of panel methods to estimate air load distribution on a wing.

4. **Wing design:** Factors influencing selection of airfoil and plan form, Span wise air loads variation, Super critical wing, Stalling, take-off and landing considerations, BM and SF diagrams, Design principles of all metal, stressed skin wing (Civil & Military airplane), Estimation of wing drag.

UNIT – III (14 hrs)

5. **Structural integration:** Structural layout of straight, tapered and swept (forward and aft) wings, Cockpit and passenger cabin layout, Layout of flight and engine controls, Wing-fuselage joining methods, All metal airplane considerations, Use of composite materials, Preparation of 3-views, CG location.

6. **Undercarriage and inlets:** Requirement of undercarriage, Different arrangements, Mechanism for retraction into fuselage and wing, Absorption of landing loads, Calculations of loads, Number of engines, Types and location for inlets, Variable geometry inlets, Revised CG location.

UNIT – IV (08 hrs)

7. **Complete design problem:** Preparation of conceptual design of an airplane from given specifications, Use and analysis of existing designs for this purpose, Design of airframe for the specifications, Prediction of performance, stability and control, Relaxed stability, Selection of engines from all considerations with all details, Freezing the design, Preparation of preliminary drawings including 3 views and lay out.

INSTRUCTIONAL STRATEGY

The course consists of conceptual and numerical contents for which a combination of LCD projector & black/white boards can be used as teaching aids. Students may be encouraged to design a working model of drone aircraft.

RECOMMENDED BOOKS

1. Aircraft Design: A Conceptual Approach: D. P. Raymer, AIAA Publication, 5th Ed., 2012.
2. The Design of the Airplane: D. Stinton, Bsp Professional Books, 1985.
3. Aircraft Performance and Design: J. D. Anderson Jr., TATA McGRAW-HILL, 2010.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	14	30
2	12	24
3	14	28
4	08	18
Total	48	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

7.2 AIRWORTHINESS AND CERTIFICATION

L	T	P	C
3	-	-	3

COURSE OBJECTIVES

- To impart knowledge of Aircraft act and aircraft rules applicable to civil aviation Industry.
- To familiarize with Categories of Aircraft Maintenance Engineer licenses.
- To familiarize with Aviation certificates and documents, human errors and human factors involved in Aviation Industry.

LEARNING OUTCOME

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

- Explain aircraft act and aircraft rules applicable to civil aviation Industry.
- Define categories of licenses, type certification, supplemental type certification and type training.
- Enlist aviation certificates and documents.
- Analyze human errors and human factors involved in Aviation Industry.
- Prepare maintenance Programme and use continuing airworthiness procedures and safety management system.

DETAILED CONTENTS

Unit -I (12 Hrs.)

1 Regulatory Framework: Introduction to ICAO, Convention, Standards and Recommended Practices; Role of International Civil Aviation Organization; Introduction to Chicago Convention, 1944 The Aircraft Act, 1934; The Aircraft Rules, 1937 – Part I, II, III, IV, VI, VII, IX, XIIA, XIIB, XIIC, XIII, XIV. Role of the DGCA, Aeronautical Information Circulars (Applicable to Aircraft Maintenance and Release), CAR – Sections-2

2 CAR-M: Detailed understanding of CAR M provisions related to Continuing Airworthiness.

3 Approved Maintenance Organizations (CAR-145) : Detailed understanding of CAR-145.

Unit II (12 Hrs.)

4 Certifying Staff (Maintenance) and Categories of AME licenses **(CAR-66).**

5 Supplemental Type Certification; Type Approval; CAR-21 Sub-Part F, G, H, I, M, P & Q.

6 Introduction to Approved Maintenance Training Organization (CAR-147).

7 Aircraft Operations: Commercial Air Transport/Commercial Operations; Air Operators Certificates; Operators Responsibilities, in particular regarding continuing airworthiness and maintenance; Documents to be carried on board; Aircraft Placarding (Markings).

Unit III (16 Hrs.)

8 Aircraft Certification:

(a) General - Certification rules: FAA & EASA 23/25/27/29; Type Certification.
Aircraft Modifications and repairs approval and certification; permit to fly requirements

(b) Documents - Certificate of Airworthiness; Certificate of Registration; Noise Certificate; Weight Schedule; Radio Station License and Approval.

9 Human Factors

(a) Human Error

Error models and theories; Types of error in maintenance tasks; Implications of errors (i.e. accidents); Avoiding and managing errors.

(b) Hazards in the Workplace

Recognizing and avoiding hazards; Dealing with emergencies.

(c) Human Factors in Aircraft Maintenance and Inspection

Human Factors — Aircraft Maintenance and Inspection; Contemporary Maintenance Problems; the SHEL Model; the Reason Model; Human Error

(d) Human Error in Aircraft Maintenance and Inspection (an organizational perspective)

(e) Human Error in the Maintenance Environment

Human Factors Issues Affecting Aircraft Maintenance and Dirty Dozen; Information Exchange and Communication; Training; Aircraft Maintenance Technician Facilities and Work Environment.

(f)Teams and Organizational Issues in Aircraft Maintenance

Team Work; Job Design; Reward Systems; Selection and Staffing; Training

Unit IV (8 Hrs.)

10 Applicable National and International Requirements

Aircraft Maintenance and certification (ICAO, FAR, EASA Regulations).

(a) Maintenance Programme, Maintenance checks and inspections; Master Minimum Equipment Lists, Minimum Equipment List; Dispatch Deviation Lists; Airworthiness Directives; Service Bulletins, manufacturer's service information; Modifications and repairs; Maintenance documentation: maintenance manuals, structural repair manual, illustrated parts catalogue, etc.;
(b) ETOPS /EDTO, maintenance and dispatch requirements; RVSM, maintenance and dispatch requirements; RNP, MNPS Operations, All Weather Operations; Category 2/3 operations and minimum equipment, maintenance, training and certification requirements.

11 Safety Management Systems: State Safety Programme; Basic Safety Concepts; Hazards & Safety Risks; SMS Operation; SMS Safety performance; Safety Assurance.

12 Fuel Tank Safety: Special Federal Aviation Regulations (SFARs) from 14 CFR SFAR 88 of the FAA and of JAA TGL 47; Concept of CDCCL, Airworthiness Limitations Items (ALI).

INSTRUCTIONAL STRATEGY

The CAR Section 2, CAR-M, CAR-145, CAR-21, CAR-147 and CAR-66 are available on the DGCA website www.dgca.nic.in. Teachers are expected to teach latest revisions of above mentioned CARs. For better understanding of the subject, visit to CAR-M subpart F or CAR-145 approved maintenance organization is recommended.

RECOMMENDED BOOKS

- CAR Section 2, CAR-M, CAR-145, CAR-21, CAR-147.
- The Aircraft Act, 1934
- The Aircraft Rules, 1937 VOL 3
- CAP 715 - An Introduction to Aircraft Maintenance Engineering Human Factors for JAR 66, Civil Aviation Authority, UK.
- CAP 718 - Human Factors in Aircraft Maintenance and Inspection, Civil Aviation Authority, UK.
- FAA-H-8083-30 - Aircraft Maintenance Technician Handbook - General, US Department of Transportation, Federal Aviation Administration ICAO Doc 9806.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	12	26
2	12	26
3	16	32
4	8	16
Total	48	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

7.3 HELICOPTER ENGINEERING AND DYNAMICS

LTPC
3 1 0 4

COURSE OBJECTIVES

- The concepts related to Helicopter engineering and dynamics.
- Estimate the performance and stability aspects of helicopters.
- Analyze the vibrations of blade and helicopters under various dynamic conditions.

LEARNING OUTCOME

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

- Explain various concepts and phenomena involved in helicopter engineering and dynamics.
- Estimate power requirement for various flight conditions such as hovering, climbing, forward flights etc.
- Estimate various other performance and stability parameters.
- Analyze vibration levels in blades and helicopters under various conditions.

DETAILED CONTENTS

UNIT – I (14 hrs)

1. **Helicopter history, basic control:** Historical development of helicopter and overview, Classification based on main rotor configuration and tail rotor configuration. Comparative analysis, Major components of conventional helicopter, Composite structure.

   Rigid, semi-rigid and articulated rotors, Feathering, flapping and lead-lag motion, Rigid, Semi-rigid and articulated helicopter control system, Collective and cyclic pitch control, Yaw control, Throttle control, Anti-torque control, Solidity, Tip-speed ratio, In-flow ratio, Figure of merit.

UNIT – II (14 hrs)

2. **Aerodynamics of main rotor and helicopter vertical flight:** Coning of rotor, Dissymmetry of lift, Precession, Coriolis effect, Compressibility effects, Retreating blade stall, Reverse flow region, Flapping, feathering and lead-lag motion, Autorotation, Schrenk's diagram, Various types of autorotative landings.

3. **Performance during hovering and vertical:** The actuator-disc theory, Working states of rotor, Optimum rotor, Efficiency of rotor, Ground effect on lifting rotor, The effect of finite number of blades, Induced velocity and induced power, Total power.

UNIT – III (10 hrs)

4. **Helicopter forward flight:** Blade forces and motion in forward flight, Force, torque and flapping coefficient, Induced velocity and induced power in forward flight – Mangler and Squire method, Flight and wind tunnel test, The vortex wake, Aerofoil characteristics in forward flight, Helicopter trim analysis, Performance in forward flight.

UNIT – IV (10 hrs)

5. Helicopter vibration stability and control:

a) DYNAMIC STABILITY AND CONTROL

Longitudinal and lateral stability, Equations of motion, Stability characteristics, Auto stabilization, Control response.

b) HELICOPTER VIBRATIONS

Sources of vibration, Active and passive methods for vibration control, Fuselage response, Measurement of vibration in flight.

INSTRUCTIONAL STRATEGY

Teachers should invite experts to deliver lectures. Field visits may be arranged.

RECOMMENDED BOOKS

1. Helicopter Dynamics , ARS Braimwell, G. Done and D. Babuford, Butterworth Hermann publication
2. Helicopter Engineering, Jacob Shajuro, Hill Publication
3. Helicopter Engineering, Lalit Gupta, Himalaya Publication

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	14	30
2	14	30
3	10	20
4	10	20
Total	48	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

7.4.1 BOUNDARY LAYER THEORY

L T P C
4 - - 4

COURSE OBJECTIVES

- This course will provide knowledge of basic concepts of momentum and thermal boundary layers, formulation of equations and solutions given by different investigators in case of flat surface and axi-symmetric bodies.
- The study involves the analysis and understanding of empirical results for laminar boundary layer, transition and turbulent boundary layer.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Describe and formulate momentum and thermal boundary layers equations in respect of flat surface and axi-symmetric bodies.
- Analyze empirical results obtained for laminar, transition and turbulent boundary layers.

UNIT – I (16 hrs)

1. **Review of Basic Concepts and Formulation of Equation:** Descriptors/Topics: Boundary layer thickness, Momentum thickness, Energy thickness, Shape Factor, separation equations of Motion and energy equation for compressible viscous fluid-derivation and discussion, boundary layer equation and their general properties.

UNIT – II (16 hrs)

2. **Exact and Approximate Methods and Axially Symmetrical Body:** Descriptors/Topics: Flat plate at zero incidence, Flows with pressure gradient, von Karman and Polhausen Methods. Rotation near ground, Circular jet, Boundary layer on a body of revolution, flow in the entrance section of pipe.

UNIT – III (16 hrs)

3. **Thermal Boundary Layer, Transition and Boundary Layer Control:** Descriptors/Topics: Heat transfer from heated surface. Incompressible and compressible laminar flow over a flat plate, Plate thermometer problem. Pipe flow and flow over a flat plate, Critical Reynolds number, Turbulent spots, Principles of theory of stability of Laminar flows, Sommer-field equation, factors affecting transition, Laminar airfoils.

   Methods of control, Fundamental equations and exact solution for a flat plate with uniform suction, Compressible Boundary Layers with suction, Approximate solution for a flat plate with uniform suction, compressible boundary layers with suction approximate solutions, theoretical and experimental results.

UNIT – IV (16 hrs)

4. Turbulent Boundary Layer and pipe flows: Descriptors/Topics: Fundamentals of Turbulent flow, Mean motion and fluctuations, Reynolds, stresses, wind tunnel Turbulence, Prandtls mixing Length theory, Von Karman's similarity Hypothesis, Velocity distribution laws. Experimental results through smooth pipes, Relation between laws of friction and velocity distribution, Universal Resistance law for smooth pipe at large Reynolds number, Rough pipe and equivalent roughness.

INSTRUCTIONAL STRATEGY

Pedagogy for Course Delivery: Session Plan/ course-material uploading, Classroom teaching associated with assignments, presentations, quiz, viva-voce and evaluation.

RECOMMENDED BOOKS

1. John D. Anderson (Jr.), 'Fundamentals of Aerodynamics', 2nd Edition., McGraw Hill.
2. Gupta and Gupta, 'Fluid Mechanics and its Applications', Wiley Eastern, **1960**
3. H. Schlichting, 'Boundary Layer Theory', 6th Edition., McGraw Hill, **1986.**
4. Frank M. White, 'Fluid Mechanics', 2nd Edition, McGraw Hill, **1986.**

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	16	25
2	16	25
3	16	25
4	16	25
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

7.4.2. AIRCRAFT COMPOSITE MATERIALS

L	T	P	C
4	-	-	4

COURSE OBJECTIVES

- This course will provide an understanding of the strength and stress behavior of the composite materials as explained by certain recent theories on the subject.
- The students are to be equipped with the knowledge of the composite material performance under fatigue, impact and other adverse conditions that an aircraft is subjected to.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Explain stress strain relation of composite material.
- Describe performance of composite components under fatigue, impact and other flight conditions.
- Differentiate and examine various types of aircraft composite materials
- Evaluate strength of composite materials.
- Explain composite materials, their applications to structure design, technology and calculate strength.
- Develop new solutions.

DETAILED CONTENTS

UNIT – I (10 hrs)

1. Introduction to Aerospace Composites. Classification and characteristics of Composite materials. Elementary study of mechanical behavior of composite materials. Advantages of composite materials when applied to Aerospace fabrications.

UNIT – II (16 hrs)

2. **Macro-mechanical Behavior of a Lamina.** Analysis of a lamina: Constitutive equations for the lamina of an arbitrary – Orientation, Transformation relations. Strength concepts, Experimental determination of strength and stiffness. Biaxial strength theories for an orthotropic Lamina: Maximum stress theory, maximum strain theory, Tsai - Hill theory. Tsaiwn tensor theory applications as applied to aerospace structures.

UNIT – III (12 hrs)

3. **Micro-mechanical Behavior of a Lamina.** Determination of elastic constants of an orthotropic Lamina by mechanics of materials approach for a aircraft Wing Body. Determination of tensile and compressive strength of a lamina in the fiber direction of mechanics of materials approach.

UNIT – IV (26 hrs)

4. **Analysis of Laminated Components.** Classical Lamination Theory: Lamina Stress-Strain behavior, strain and stress behavior in a Laminate. Resultant Laminated forces and moments. Laminate Stiffnesses: Symmetric, Anti-symmetric and non-symmetric Laminate stiffness, Laminate strength: Laminate strength analysis procedure. Laminate, strength criteria, thermal and mechanical strength analysis, strength of cross-ply and Angle-ply laminates.

5. **Special Topics relating to Aircraft Composite Materials.** Inter-laminar stresses and their implications. Performance of composites under fatigue. Impact and adverse environment. Introduction to advance composite materials.

INSTRUCTIONAL STRATEGY

Session Plan / course-material uploading, Class-room teaching associated with assignments**,** presentations**,** quiz, in-class tests, viva-voce and evaluation.

RECOMMENDED BOOKS

1. R.M. Jones, "Mechanics of Composite Materials".
2. Sabodh K. Garg, "Analysis of Structural Composite Materials".
3. Robert Nicholle, "Composite Construction Materials Handbook".
4. Bhagwan D. Agarwal and Lawrence, "Analysis and performance of Fiber Composites", Broutman, John Wiley.
5. Ronald and F. Gibson, "Principles of composite Materials Mechanics", McGraw Hill Int. Ltd.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	10	16
2	16	26
3	12	18
4	26	40
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

7.4.3 ROCKETS & MISSILES

L T P C
4 0 0 4

COURSE OBJECTIVES

Main objectives of this course are:

- Basic knowledge of rockets / missiles
- Guidance & navigation
- Performance, stability & control of rockets and missiles including maneuvering flights
- Launch operations & Re-entry

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Describe different types of rockets and missiles.
- Differentiate between rockets and missiles.
- Calculate various stability aspects of various control configuration of space vehicles.
- Analyze problems related to launch and recovery of space vehicles.
- Predict various types of trajectories of space vehicles.

DETAILED CONTENTS

UNIT – I (16 hrs)

1. **Introduction:** Introduction to rockets and missiles, Difference between Rocket and missile, Type of Rockets and missiles, satellites, satellite launch vehicles.

2. Aerodynamic Characteristics of Airframe Components: Bodies of revolution, Different fore-body shapes, Summary of characteristics of bodies of revolution, Base pressure, Aerodynamic control, Jet control, various subsystems of missile & rockets

UNIT – II (16 hrs)

3. Performance and Propulsion of Missiles and Rockets Introduction of drag, various types of drags, Boost glide trajectory, Graphical solution, Boost sustainer trajectory, staging & stage separation, long range cruise trajectory, long range ballistic trajectory, Powered and un-powered flight, Brief description of Fin Stabilized, spin stabilized Rockets and their force systems, ramjet, scramjet, rocket (liquid/solid fuel based) engines, Thrust misalignment.

4. Guidance, Control & Navigation of Missiles and Rockets Introduction to guidance and navigation, various types of guidance schemes & their application. Types of Control and actuation systems, navigation systems for high accuracy & its suitability

UNIT –III (24 Hrs.)

5. Stability and Control Longitudinal: Two degrees of freedom Analysis, Complete Missile Aerodynamics with forward and rear control, Static stability margin.

Directional: Introduction, cruciform configuration, Body wing and Tail contribution on directional control.

Lateral: Induced roll, internal control and design consideration for cruciform and Monowing, Damping in roll.

6. Maneuvering Flight: Introduction to maneuvering of missiles and rockets, Flat turn for cruciform and mono-wing, Pull-ups, Relationship of maneuverability and static stability margin.

UNIT IV (8 hours)

7. Dynamic Stability: Equation of motion, longitudinal dynamic degree of freedom, classical solution, lateral dynamics.

8. Advanced topics: Launching problems, Re-entry and recovery of space vehicles, Modern Concepts, Manned Missions, Current topics.

INSTRUCTIONAL STRATEGY

Session Plan / course-material uploading, Class-room teaching associated with assignments, presentations**,** quiz, viva-voce and evaluation.

RECOMMENDED BOOKS

1. S.S Chin, “Missile Configuration Design” McGraw Hill
2. Davis Follin and Blitzer, “Exterior Ballistics of Rockets”, Van Nostrand.
3. Seifert and Brown, “Ballistic Missiles and Space Vehicle Systems”, John Wiley
4. Seifert (Edited by), “Space Technology”, John Wiley.
5. SR Mohan, “Fundamentals od Guided Missile” , DRDO
6. SK Ray, “Missile Control Systems”, DRDO
7. EL Fleeman, “Tactical Missile Design”, AIAA Education Series
8. A Greensite, “Analysis and Design of Spacecraft Control Systems”, Spartan Books
9. P Garnel, “Guided Weapon Control Theory”
10. EL Fleeman, “Missile Design and System Engineering”, AIAA Education Series

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT NO.	TIME ALLOTTEED (HRS.)	MARKS ALLOTTED (%)
1	16	25
2	16	25
3	24	38
4	08	12
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

7.4.4. AIR TRANSPORTATION AND OPERATIONS

L T P C
4 0 0 4

COURSE OBJECTIVES

- Understand air traffic control, airlines, airports & its maintenance issues.
- Understand the procedures for various segments of aircraft operations and various issues involved during the airline operations.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Develop a process for designing airports and airline operations.
- Compare different communication aids used in air transportation operations.
- Infer working of air traffic control and management
- Evaluate the operational procedures and standards in air transportation industry.

DETAILED CONTENTS

UNIT – I (16 hrs)

1. Air Transportation Industry: Introduction to airline industry and economics, determination of operating costs, Airline route selection and scheduling, Methods of describing peaking, planning of flight operations, special topics in airline operations, Emergence of Low Cost Carrier (LCC).

Aircraft characteristics affecting airport design, Functions of airport, Components of an airport, Airport layouts and configurations, Geometric design of the airfield, Wind Rose Diagram, Geometric design of the airfield, Design alternatives, Airport operations manual.

UNIT – II (16 hrs)

2. Airspace Classification and Communication: Airspace classification, controlled versus uncontrolled airspace, Instrument Flying Rules (IFR) & Visual Flying Rules (VFR) in controlled & uncontrolled airspace, Airspace classes, Radio communication, Air Traffic Control (ATC) communication procedures, clearance, aircraft identification, destination airport, departure instructions, route of flight, altitude assignment, required reports, holding instructions.

UNIT – III (16 hrs)

3. Air Traffic Control (Part I): Modeling & Simulation of ATC systems, Factors affecting Capacity & Delay, Estimation of airway Capacity & Delay, Human Factors and Controller Workload, Performance Based Navigation, Free Flight, Conflict Detection and resolution, Environmental effects of Aviation, Modeling air transport systems.

UNIT – IV (16 hrs)

4. Air Traffic Control (Part II) and Procedures: Principles of Air Navigation and Air Traffic Control, Overview of CNS & ATM, Separation standards, Radar and Non-radar separation, wake turbulence longitudinal separation minima, Precision approaches for landing, Radar systems for ATC. Control towers, Delegation of responsibility,

INSTRUCTIONAL STRATEGY

Supplement the theory with field visit to air traffic control tower and airport and observe taxi way markings, runway markings, different lighting systems at runway and other such observations.

RECOMMENDED BOOKS

1. Fundamentals of Air Traffic Control, 4th Edition, Michael S. Nolan, Thomson Brooks/Cole, USA.
2. Planning and Design of Airports, 4th Edition, Robert Horonjeff & Francis X. McKelvey, McGraw Hill Professional Publishing.
3. Airline Route Planning, John H. H. Grover, BSP Professional Books, Blackwell Scientific Publications, Oxford, UK.
4. Air Transportation: A Management Perspective, 6th Edition, John G. Wensveen, Ashgate Publishing Ltd., UK.
5. Airport Planning and Management, sixth edition, Seth B. Young & Alexander T. Wells, McGraw Hill Education.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hours)	Marks Allotted (%)
1	16	25
2	16	25
3	16	25
4	16	25
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

7.4.5. ROCKET PROPULSION

L T P C
4 0 0 4

COURSE OBJECTIVE

- This course is aimed to provide knowledge of construction and working of solid, liquid and hybrid engines used in rockets and missiles.
- The student should be able to evaluate propulsive performance of the aerospace vehicle during the course.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Classify and explain working of various engines used in the rockets.
- Estimate flight performance of the rocket.
- Explain various types of missile trajectories and motion through the atmosphere.

DETAILED CONTENTS

UNIT – I (12 hrs)

1. Propulsion Systems: Jet Propulsion and Rocket Propulsion – Definition, Principle, Classification, Description and Application; Electrical, Nuclear and other Advanced Propulsion Systems.

2. Nozzle Theory: Ideal Rocket; Isentropic Flow through Nozzles; Exhaust Velocity; Choking; Nozzle Types; Nozzle Shape; Nozzle Area Expansion Ratio; Under expansion and Overexpansion; Nozzle Configurations; Real Nozzles; Performance Correction Factors; Multiphase Flow.

UNIT – II (16 hrs)

3. Thrust and Thrust Chambers: Thrust Equation; Specific Impulse, Thrust Coefficient, Characteristic Velocity and other Performance Parameters; Thrust Chambers; Methods of Cooling of Thrust Chambers; Steady State and Transient Heat Transfer; Heat Transfer Distribution; Steady State Heat Transfer to Liquids in Cooling Jackets; Uncooled Thrust Chambers; Thermal insulation; Radiation; Exhaust Plumes.

UNIT – III (16 hrs)

4. **Solid Propellant Rocket Motors** Application and Classification of Solid Propellant Rocket Motors; Propellants and Characteristics; Composite, Double Base and Composite Modified Double Base Propellants; Metallized Propellants; Ingredients and Processing; Propellant Burning Rate; Erosive Burning; Propellant Grains and Grain Configurations; Propellant Grains Stress and Strain.

UNIT-IV (20 Hrs.)

5. Liquid Propellant Rocket Engines: Propellant and their Properties; Monopropellants and Bipropellants; Storable, Cryogenic and Gelled Propellants; Fuels and Oxidizers; Metals; Propellant Tanks; Liquid Propellant Feed Systems; Injectors; Thrust Chamber Shapes and Characteristic Length; Hybrid Propellant Rocket Motors; Gaseous Propellant Rocket Motors and Reaction Control Systems.

6. Rocket Testing: Types of Tests; Test Facilities and Safeguards; Safety and Environmental Concerns; Facilities and Safeguards; Monitoring and Control of Toxic Materials and Exhaust Gases; Instrumentation and Data Management; Reliability and Quality Control; Flight Testing.

INSTRUCTIONALS STRATEGY

Session Plan / course-material uploading, Class-room teaching associated with assignments, presentations**,** quiz, viva-voce and evaluation.

RECOMMENDED BOOKS

1. Rocket Propulsion Elements – Sutton, George P. and Biblarz, Oscar, 7th Edition, John Willey and Sons
2. Rocket Propulsion – Barrere, M., Elsevier Publication
3. Rocket and Spacecraft Propulsion: Principle, Practice and New Developments -Turner, Martin J. L., Springer Verlag

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	12	20
2	16	25
3	16	25
4	20	30
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

7.5.1. AIRCRAFT MODELLING AND SIMULATION

L T P C
4 0 0 4

COURSE OBJECTIVES

- To enable the student to describe process of Mathematical modeling for solving engineering problems.
- The student should be able to build mathematical models of aircraft dynamics.
- The student should be able to carry out simulation of aircraft dynamics in professional software.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Do mathematical modeling for solving engineering problems
- Develop aircraft mathematical models using standard techniques
- Execute computational simulation of aircraft dynamic models using professional softwa

DETAILED CONTENTS

UNIT – I (14 hrs)

1. **Mathematical Modelling :**Mathematical concepts in Modelling, Why modelling, Goals of modelling studies, Process of Mathematical modeling, Real world problem, falling rock modeling, Computational problem, Basics of curve fittings, Engineering simulations and process of solving engineering problems, Analytical and numerical problem solutions with example.

UNIT –II (20 Hrs.)

2. **Aircraft Modeling :**Aircraft modeling, Aircraft state-space vectors, body-fixed coordinate systems, rotation matrix for wind and stability axes, Aircraft Equation of motion, kinetic equations for translation, kinematic equations for attitude, rigid-body kinetics, sensors and measurement systems, Introduction to Perturbation, Perturbation theory, nominal and perturbation values, Linearization of rigid body kinetics, Linear state-space model based on using wind and stability axes.

UNIT –III (16 Hrs.)

3. **Dynamic Models :** Decoupling: longitudinal and lateral modes: Longitudinal and lateral equations, Aerodynamic Forces and Moments, longitudinal and lateral forces and moments, standard aircraft maneuvers, bank to turn, altitude control dynamic models, longitudinal and lateral stability analysis, Satellite modelling, Attitude model

UNIT –IV (14 Hrs.)

4. **Simulation models :** Software Simulation of Aircraft dynamics models, 767 longitudinal and lateral model, F-16 Longitudinal and Lateral Mode, F2B Bristol Lateral model

INSTRUCTIONAL STRATEGY

Session Plan / course-material uploading, use of Aerospace Tool Box in MATLAB, Class-room teaching associated with assignments, presentations, Videos , quiz, in-class tests, viva-voce and evaluation.

RECOMMENDED BOOKS:

1. "Computational Modelling and Simulation of Aircraft and the Environment": Dominic J. Diston, John Wiley & Sons, Ltd., 2009
2. "Flight Stability and Automatic Control", R. C. Nelson, McGraw-Hill Book, 1989

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	14	24
2	20	26
3	16	30
4	14	20
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

7.5.2 ADVANCED AERODYNAMICS

LTPC
4 0 0 4

COURSE OBJECTIVES

- Analyze supersonic flows by applying different techniques.
- Calculate boundary layer thickness by applying different methods.
- Analyze complete supersonic and hypersonic configurations.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Analyze flow properties in compressible medium.
- Design supersonic nozzle by method of characteristics
- Evaluate aerodynamic characteristics of supersonic airfoils theoretically.
- Analyze and design supersonic and hypersonic aircraft configurations

DETAILED CONTENTS

UNIT – I (16 hours)

1. Elements of compressible flow: Compressible flow properties: Total Enthalpy, Total Temperature, Temperature and Pressure ratios as a function of Mach No., Mass Flow Parameter (MFP). Isentropic Area ratio (A/A*), Velocity-Area variations, Rayleigh Pitot tube formula, Flow in constant area duct with friction and heat transfer.

UNIT – II (16 hours)

2. Non-Linear Supersonic Flows: Numerical techniques, method of characteristics, supersonic nozzle design, finite difference method, time dependent technique for supersonic blunt bodies, numerical problems. Compressibility effects of aerodynamic characteristics of lift generating surfaces

UNIT – III (16 hours)

3. **Supersonic Analysis for configurations:** Governing equations and boundary conditions, consequences of linearity, conical flow method for rectangular, swept, delta and arrow wings, singularity distribution method, design nsideration for supersonic aircraft, aerodynamic interaction, supersonic analysis for complete configurations.

UNIT – IV (16 hours)

4. Supersonic Lift Theory and Hypersonic flow: Shock –Expansion theory, flow field in supersonic flows, numerical problems, thin airfoil theory, analytical determination of lift and drag coefficients on flat plate, bi-convex, and diamond shaped sections in supersonic flows, numerical problems, supersonic leading and trailing edges. Qualitative aspects, Newtonian theory, lift and drag of wings at hypersonic speeds, hypersonic shock wave relations, Mach no. independence, hypersonic and CFD, high L/D hypersonic configurations, Aerodynamic heating, ground test data and flight test data.

INSTRUCTIONAL STRATEGY

Visual aids like videos and presentations must be used in order to explain theoretical concepts in a better way, where applicable.

RECOMMENDED BOOKS

1. "Modern Compressible Flow with Historical Perspective", Anderson, J. D., 3rd edition., McGraw-Hill
2. "Aerodynamics", L.J.Clancy, 5th Ed. Himalayan Books
3. "Aerodynamics for Engineers", John J Bertin, 4th Ed, Pearson Publishers
4. "Gas Dynamics", Vol I , Zucrow, M J and J D Hoffman, John Wiley & sons
5. "Gas Dynamics (Fifth Edition)", Dr. E. Rathakrishnan, PHI Learning, Delhi, India, 2013.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	16	25
2	16	25
3	16	25
4	16	25
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

7.5.3 EXPERIMENTAL AERODYNAMICS

L T P C
4 0 0 4

COURSE OBJECTIVES

- Gain insight on the problem associated with design, setup and execution of experimental methods pertinent to aerodynamics/fluid mechanics and the most important and up-to-date measurement techniques.
- Develop a practical knowledge and capability to perform measurements in dedicated facilities aimed at studying fundamental problems in aerodynamics/fluid mechanics.

LEARNING OUTCOME

At the end of the subject, the student will be able to:

- Differentiate between different types tunnels
- Select an appropriate technique to perform an experiment to study aerodynamic characteristics of a body
- Acquire and interpret data using different data acquisition techniques.
- Integrate experimental equipment with data acquisition system using graphical programming.

DETAILED CONTENTS

UNIT – I (16 hours)

1. Introduction: Types of wind tunnels – Open and closed wind tunnels; wind tunnels with open and closed test sections; variable density wind tunnels; smoke tunnels; vertical wind tunnels; sub-sonic, super-sonic, trans-sonic wind tunnel; water tunnels. Wind tunnel calibration, Measurements techniques in wind tunnels: forces and moments, pressure, velocity, temperature, aero-acoustic measurements.

UNIT – II (16 hours)

2. Qualitative and Quantitative Measurements: Low speed flow visualization techniques, Schlieren, shadowgraph, interferometry, introduction to laser diagnostic techniques.

Measurement of temperature using thermocouples, resistance thermometers, temperature sensitive paints and liquid crystals, Steady and unsteady pressure measurements and various types of pressure probes and transducers, errors in pressure measurements, thermocouples, thermography, velocity measurement using hot wire anemometry , Laser Doppler Velocimetry and Particle Image Velocimetry

UNIT – III (16 hours)

3. Data Acquisition and Processing: Data acquisition and digital signal processing techniques, wind tunnel data acquisition, measurement of steady and unsteady pressure, velocity, temperature, turbulence intensity, calibration of force, pressure and acoustic sensors. Calibration of single and two wire probes.

Data validation techniques: verifying experimental data with theoretical and computational results.

UNIT – IV (16 hours)

4. Virtual Instrumentation: Introduction to VI (virtual instrumentation) and its typical applications, functional systems, graphical programming, data flow techniques, advantages of VI techniques. VI programming techniques; VIs and sub-VIs, loops and charts, arrays, clusters and graphs, case and sequence structures, formula nodes, string and file I/O, DAQ methods, code interface nodes.

INSTRUCTIONAL STRATEGY

In case of data acquisition and analysis, hands on experience in instruments and computational facilities should supplement classroom teaching.

RECOMMENDED BOOKS

- "Low speed wind tunnel testing", Jewel B. Barlow, John Wiley & sons
- "Experimental Aerodynamics", Henry Christensen, Pavian,Pitman Publishing
- "Wind Tunnels: Aerodynamics, Models & Experiments (Engineering Tools, Techniques and Tables)", Justin D. Pereira.
- "Virtual instrumentation using LabVIEW", Jerome Jovitha, PHI Learning Private Ltd.

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	16	25
2	16	25
3	16	25
4	16	25
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

7.5.4. UNMANNED AERIAL SYSTEMS

LTPC
4 0 0 4

COURSE OBJECTIVES

- To enable the student to describe different types of UAVs and its components.
- The student should be able to apply concept of flight mechanics to UAVs
- The student should be able to describe different types of Sensors and Actuators required for operation of UAVs

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Compute loads acting on various types of UAVs
- Apply concept of performance and stability analysis of UAVs
- Derive equation of motion of UAV
- Identify application of sensors and actuators in UAV

DETAILED CONTENTS

UNIT –I (16 Hrs.)

1. **Introduction and overview of uav:** Classification of Flight Vehicles along with prominent features of Design; Remote controlled and Autonomous Fixed wing and rotary wing UAVs and UCAVs along with examples. UAV payloads Types: Nondispensable Payloads- Electro-optic Payload Systems, Radar Imaging Payloads - Other Nondispensable Payloads, Dispensable Payloads.

UNIT –II (14 Hrs.)

2. **Flight mechanics of uav:** Lift & Drag of Aerofoils, Stalling, Finite Span Wing, Induced Drag, Wing Planform Variations, use of Control Surfaces, Elementary Ideas about Stability & Control of UAVs

UNIT –III (16 Hrs.)

3. **Dynamic modeling of uav**

   Aerodynamic models, equation of motion, dynamics modelling. Path and trajectory planning: continuous path and interpolated motion, elementary idea of guidance and navigation.

UNIT –IV (18 Hrs.)

4. **Uav sensors and vision**

   Sensors for UAV, position and motion sensors, proximity sensors, force and torque sensors, vision controlled UAV system.

5. **Control of actuators:** Open and close loop control, joint actuators, control schemes. Principles of UAV application, remote sensing and surveillance.

INSTRUCTIONAL STRATEGY

Session Plan/course-material uploading, Visit to Aircraft Hanger, Class-room teaching associated with assignments, presentations, Videos, quiz, in-class tests, viva-voce and evaluation.

RECOMMENDED BOOKS

1. "Designing Unmanned Aircraft Systems": Ja Gundlach 4th Edition, Elsevier Ltd,2012
2. "Unmanned Aircraft Systems :UAV design, development and deployment" Reg Ausing, Wiley, 2010

SUGGESTED DISTRIBUTION OF MARKS FOR EXTERNAL EVALUATION

UNIT No.	Time Allotted (Hrs)	Marks Allotted (%)
1	16	22
2	14	22
3	16	26
4	18	30
Total	64	100

MEANS OF ASSESSMENT

Assignments and quiz/class tests, mid-term and end-term written tests, model/prototype making.

7.6 PROJECT WORK

L T P C
0 0 12 4

Project work aims at developing skills in the students whereby they apply the totality of knowledge and skills gained through the course in the solution of particular problem or undertaking a project. The students have various aptitudes and strengths. Project work, therefore, should match the strengths of students. For this purpose, students should be asked to identify the type of project work, they would like to execute. It is also essential that the faculty of the respective department may have a brainstorming session to identify suitable project assignments. The project assignment can be individual assignment or a group assignment. The students should identify the project at least two to three months in advance. The project work identified in collaboration with industry may be preferred.

Each teacher is expected to guide the project work of 5-6 students.

- Projects related to increasing productivity and better services
- Projects related to quality assurance
- Projects related to estimation and economics of production and services
- Projects connected with repair and maintenance of plant and equipment and aircraft
- Projects related to identification of raw material thereby reducing the wastage
- Projects related to analysis and design of aircraft components and aircraft.
- Any other related problems of interest of host industry

A suggestive criteria for assessing student performance by the external (personnel from industry) and internal (teacher) examiner is given in table below:

Sr. No.	Performance criteria	Max. marks	Rating Scale				
			Excellent	Very good	Good	Satis-factory	Poor
1.	Selection of project assignment	10	10	8	6	4	2
2.	Planning and execution of considerations	10	10	8	6	4	2
3.	Quality of performance	20	20	16	12	8	4
4.	Providing solution of the problems or production of final product	20	20	16	12	8	4
5.	Sense of responsibility	10	10	8	6	4	2
6.	Self expression/ communication skills	5	5	4	3	2	1
7.	Interpersonal skills/human relations	5	5	4	3	2	1
8.	Report writing skills	10	10	8	6	4	2
9.	Viva voce	10	10	8	6	4	2
Total marks		**100**	**100**	**80**	**60**	**40**	**20**

The overall grading of the practical training shall be made as per following table

	Range of maximum marks	**Overall grade**
i)	More than 80	*Excellent*
ii)	65-80	Very good
iii)	50-64	Good
iv)	41-49	Fair
v)	Less than 40	Poor

In order to qualify for the degree, students must get "Overall Good grade" failing which the students may be given one more chance of undergoing 8 -10 weeks of project work in the same industry and re-evaluated before being disqualified and declared "not eligible to receive degree ". It is also important to note that the students must get more than six "goods" or above "good" grade in different performance criteria items in order to get "Overall Good" grade.

Important Notes

1. This criteria must be followed by the internal and external examiner and they should see the daily, weekly and monthly reports while awarding marks as per the above criteria.

2. The criteria for evaluation of the students have been worked out for 100 maximum marks. The internal and external examiners will evaluate students separately and give marks as per the study and evaluation scheme of examination.

3. The external examiner, preferably, a person from industry/organization, who has been associated with the project-oriented professional training of the students, should evaluate the students performance as per the above criteria.

4. It is also proposed that two students or two projects which are rated best be given merit certificate at the time of annual day of the institute. It would be better if specific nearby industries are approached for instituting such awards.

The teachers are free to evolve another criteria of assessment, depending upon the type of project work.

It is proposed that the institute may organize an annual exhibition of the project work done by the students and invite leading Industrial organizations in such an exhibition.

EIGHTH SEMESTER

8.1 PROJECT BASED INDUSTRIAL TRAINING

L	T	P	C
-	-	30	8

COURSE OBJECTIVES

Industry Based Project Work aims at developing innovative skills in the students, whereby they apply the knowledge and skills gained through the course by undertaking a project. The individual students have different aptitudes and strengths. Project work, therefore, should match the individual strengths of students. The prime emphasis of the project work is to understand and apply the basic knowledge of the principles and practices in real life situations, so as to participate and manage a large projects in future.

LEARNING OUTCOMES

After undergoing the subject, student will be able to:

- Implement the theoretical and practical knowledge and skills gained through various subjects/courses into an application suitable for a real practical working environment, preferably in an industrial environment.
- Explain the working of industrial environment and its work ethics.
- Explain what entrepreneurship is and how to become an entrepreneur.
- Identify and contrast gap between the technological knowledge acquired through curriculum and the actual industrial need and to compensate it by acquiring additional knowledge as required.
- Carry out cooperative learning through synchronous guided discussions within the class in key areas, asynchronous document sharing and discussions, as well as prepare collaborative edition of the final project report.
- Achieve real life experience in aeronautical industries/organization.
- Apply the knowledge about safety and disaster management in practical situations.

Heads of Department/Training and Placement Officer may be given the complete autonomy/freedom to select relevant organization to send the students for the project based industrial training for full 8^{th} semester. While selecting the training station, care should be taken to select such organizations that are willing to accept the trainees and where there is sufficient scope for the trainee to undertake varied kind of experiences relevant to their profession and aptitude. **All efforts may be made to get internship/stipend/scholarship for the students from the organization.** This training may be considered as an internship, so that the training organizations engage the student(s) in some project and the training is effective. If some students are not able to find training placement in the industry, it is recommended that the department TPO/HOD's/Teachers may take up some consultancy project from industry or select any project in the institute itself and execute the same through students under their own supervision. The institute may sign MOUs with the industries or other government/semi-government/private organizations for the collaborative projects.

The purpose of this project based professional training is to expose the students to the world of work and provide professional experience in real life situation. The students will have to maintain a daily/weekly diary and submit detailed reports of their activities to their guide and supervisor (a faculty member from the institute) at regular intervals. These reports will be certified by a responsible officer of the organization where the student is undergoing

professional training and doing his/her project. **Each student is required to undergo one Practical Based Project according to his/her area of interest and the final comprehensive project report is to be submitted at the end of project based professional training period.** The concerned teachers from the institute will guide and supervise the students on work stations at regular intervals. **A systematic plan of action is required to be prepared, well in advance, by the students and institutes in consultation with the organizations where professional training and project has to be carried out.** Performa shall be developed by the institute teachers, in consultation with personnel from industry/organization, to monitor the progress of the students. The Performa should be filled by the students on daily, weekly and monthly basis. It should be duly countersigned by the personnel from industry and concerned teacher attached to the particular student. Each teacher is supposed to guide and supervise about 5 – 10 students. **The project based industrial training shall consist of minimum 6 hours per day, 30 hours per week of training and the total training shall be of minimum 480 hours.**

GUIDELINES FOR PROJECT FORMULATION

The project work constitutes a major component in most of the professional programmes and it is to be carried out with due care and should be executed with seriousness by the students. Following guidelines shall be helpful in the project formulation:

Type of Project

As majority of the students are expected to work on a real life project in some industry/research and development laboratories/educational institutions/software companies, so it is suggested that the project is to be identified which should have some direct relevance in day-to-day activities of the students in his/her institution. However, it is not mandatory for a student to work on a real life project in the industry only. The student can formulate a project problem with the help of guide and supervisor.

Project Proposal (Project Synopsis)

The project proposal should be prepared by the students in consultation with the guide and supervisor during fifth semester itself. The project proposal should clearly state the project objectives and the environment in which the proposed project is to be undertaken. The project work should compulsorily include the software development.

The project proposal should contain complete details in the following format:

1. Title of the Project.
2. Introduction and Objectives of the Project.
3. Project Category
4. Analysis
5. Are you doing this project for any Industry/Client? Mention Yes/No. If Yes,
6. Mention the Name and Address of the Industry or Client.
7. Future scope and further enhancement of the project. Also mention limitation of the project.

Project Proposal Submission and Approval

After finalizing the topic and the selection of the guide and supervisor, students should be submitting the Project Proposal (synopsis) to the HOD for final approval. Incomplete project proposals in any respect will be immediately rejected.

GUIDELINES FOR INTERNAL ASSESSMENT

The internal assessment should be calculated based on the review of the progress of the work done by the student periodically as follows.

Sr. No.	Detail of assessment	Period of assessment	Max. Marks
1	Project Proposal (Project Synopsis)	Within 15 days from the start of 6th semester	15%
2	First Review	6th week	25%
3	Second Review	14th week	35%
4	Attendance, discipline and responsibility	Entire semester	25%
5	**Total Marks**		**100**

GUIDELINES FOR EXTERNAL EVALUATION

Details of Mark allocation

Max Marks	**100**
Actual Project work	60
Project Report	30
Viva-voce/Seminar	10

A criteria for assessing student performance by the examiner is given in table below:

Sr No	Performance criteria	Max** Marks	Rating Scale				
			Excellent	Very good	Good	Fair	Poor
1.	Punctuality and regularity	10	10	8	6	4	2
2.	Initiative in learning/ working at site	10	10	8	6	4	2
3.	Level/proficiency of practical skills acquired	20	20	16	12	8	4
4.	Ability to solve live practical problems	20	20	16	12	8	4
5.	Sense of responsibility	10	10	8	6	4	2
6.	Self expression/communication skills	5	5	4	3	2	1
7.	Interpersonal skills/human relations	5	5	4	3	2	1
8.	Report writing skills	10	10	8	6	4	2
9	Viva voce	10	10	8	6	4	2
Total marks		100	100	80	60	40	20

The overall grading of the practical training shall be made as per following table:

Range of maximum marks		Over grade
i)	More than 80	Excellent
ii)	79 <> 65	Very good
iii)	64 <> 50	Good
iv)	49 <> 40	Fair
v)	Less than 40	Poor

In order to qualify for the degree, students must get "**Overall Good grade" failing which the students may be given just one more chance of undergoing one semester of project based professional training in the same industry, before being disqualified from the degree and declared "not eligible to receive degree level programme in Aeronautical Engineering".** It is also important to note that the students must get more than six "good" or above "good" grade in different performance criteria items in order to get "Overall Good" grade.

Important Notes:

1. This criteria must be followed by the internal and external examiner and they should see the daily/weekly reports while awarding awards as per the above criteria.
2. The criteria for evaluation of the students have been worked out for 100 maximum marks. The internal and external examiners will evaluate students separately and give marks as per the study and evaluation scheme of examination.
3. The external examiner, preferably, should be the person from industry/organization, who has been associated with the project- professional training of the students, so that he can properly evaluate the students on the above criteria.

GENERAL INSTRUCTIONS FOR 6 MONTHS PROJECT BASED INDUSTRIAL TRAINING

1. **Training Guide**: Training Guide will be assigned to each student from the respective departments of the college. The students are required to keep in contact with him/her and they can discuss their problems, which they face in the industry, with the Training Guide. Training Guide may visit the industry in which the student is undergoing industrial training.

2. **Confirmation Letter**: Before joining the training in the industry, the Confirmation Letter from the industry should reach to the Training & Placement Officer/Guide and Supervisor/Coordinator/HOD. Each student should ensure that Training & Placement Officer/ Guide and Supervisor/Coordinator/HOD have received the Confirmation Letter. If there is some delay from the company in sending the Confirmation letter, then the student should send an application that he/she has joined the training at _____ industry from _____ date and the Confirmation Letter shall reach the institute by _____ date (not later than one month of joining the company.

3. **Synopsis**: The students are required to send the synopsis within a 15DAYS after joining the training to HOD/Training & Placement Officer/Guide and Supervisor/Coordinator.

4. **Daily Diary**: The students will have to prepare a daily diary (duly signed by a responsible officer of the organization), which will be checked during seminar & viva in the college.

5. **Mid-Term Review**: After 6th week and 14th week of the date of joining the training, mid-term reviews (detailed report of projects done by that time) are to be submitted to the HOD/Training & Placement Officer/Guide and Supervisor/Coordinator.

6. **Final Report of Project Based Industrial Training:** All the students are required to prepare the Final Report of Project Based Industrial Training and the same is to be submitted in the college within 15 days of completion of the training project.

7. **Seminar/Viva**: After the completion of Project Based Industrial Training, the student will have to give a presentation/seminar followed by viva voce in the college, on the basis of which the marks will be awarded to the student. Internal and External evaluation will be conducted in the college. The concerned person from the industry shall be consulted, while awarding marks to the students. Wherever possible, the concerned person from industry may be invited in the final presentation and viva voce.

8. **Duration :** The project based industrial training shall consist of minimum 6 hours per day, 30 hours per week of training and the total training shall be of minimum 480 hours of training.

GUIDELINES FOR PROJECT SEMESTER

(A) Duration:

8th Semester (Full Semester)

(B) Nature of Training

i) Guiding Principle behind Project based industrial training/internship would be improvement in knowledge/skills and employability of the students and emphasis would be on core companies and practical/field work on any project.

ii) Students would be allowed Project based industrial training/internship in research institutes if they indicate academics/research as their career choice.

iii) Students who undergo overseas internship would be monitored through emails/telecalls or even remote supervisors.

iv) For non-core companies, each department would frame a policy by constituting a department level committee chaired by the HOD. There would be no blanket ban on training/internship in non-core organizations and for each student choosing to go to such an organization, the department level committee would review the case on merit after receiving the views/justification from the student.

v) In exceptional cases, students can appeal for reconsideration to a college level committee duly constituted by the Director of the institute.

(C) Arrangement of Slots

(i) Database of the companies shall be maintained by the TPO.

(ii) TPO shall send the first letter to the companies to initiate dialogue.

(D) Distribution of Slots

i) Companies visiting the campus can select the students as per their selection process.

ii) All the slots offered by companies to Punjab State Civil Aviation Council, Patiala as an institution will be allotted to students on the basis of merit.

iii) Allotment letters to the students are to be issued by department.

iv) Once the names of allotted students have been communicated to the industry, no change will be permissible.

(E) Monitoring

i) Students to ensure that their Joining reports are received by the department within 15 days of joining.

ii) Consolidated summary sheet of joining report from each department is to be submitted to the TPO within 21 days of joining.

iii) For effective monitoring of students who are taking training outside the India, Adjunct Faculty/Experts/PEC Alumni with an experience of minimum 5 years from that country may be requested to supervise such students during their training. The concerned department would identify and request such Adjunct Faculty/Experts/ Punjab State Civil Aviation Council, Patiala for this purpose and explain them the detailed parameters of the internship semester requirement necessary for evaluation.

iv) All visit / monitoring reports are to be submitted to the respective departments by the faculty/Adjunct Faculty/Experts/ Punjab State Civil Aviation Council, Patiala.

v) Faculty-Industry Interaction: In addition to making 2 to 3 visits to the industry, the faculty coordinator will contact the industry coordinator fortnightly via e-mail/phone, to keep a close watch on the students progress.

vi) Consolidated Summary Sheet of each visit/monitoring shall be submitted by each department to TPO.

vii) Database regarding project semester will be maintained centrally at TPO office.

(F) Preparation of Report:

i) Every student shall prepare a project semester report as per the specified guideline **(Annexure – I).** A standard cover page has to be used **(As per Annexure-II).**

The report shall contain a declaration **(As per Annexure – III)**.

(G) Feedback Form:

i) The Faculty Coordinator, Adjunct Faculty / Experts / PEC alumni shall collect the feedback from the industry **(As per Annexure – IV)** and student **(As per Annexure – V)**.

(H) Guidelines for Evaluation:

i) The distribution of credits for finalizing the grades for project semester

S.No.	Subject	Credits	Remarks
1.	Credits by Industry	3	Proforma to be filled jointly by Industry coordinator and faculty coordinator **(As per Annexure – VI)**
2.	Credits by Faculty Coordinator, Adjunct Faculty / Experts / Punjab State Civil Aviation Council, Patiala	2	Interaction/presentation of student during project semester **(As per Annexure – VII)**
3.	Evaluation by Department • Report • Presentation • Viva Voce	 1 1 1	The final Presentations/ evaluations will be made before faculty panel. **(As per Annexure – VIII)**
4.	Total Credits	8	To be displayed on notice board **(As per Annexure – IX)**

(I) Evaluation Process:

1. Faculty coordinator and the industry coordinator will directly award a letter grade out of A, B, C, D & F based on their assessment of the work done by a student.
2. The industry coordinator has to be communicated the meaning of these letter grades.
3. For the remaining 3 components i.e. report, presentation and viva voce a committee comprising of 3 to 4 members shall be notified by the Head of the department. The faculty coordinator of the training shall be an additional member of the committee for the evaluation of the above 3 components. Each member of the committee, including the faculty coordinator will award marks separately for the 3 components out of the maximum marks specified for these. Average of these marks shall be taken as the final marks of the student and these shall be then converted into grades.

ANNEXURE – I

CONTENTS OF THE REPORT

1. Cover page – on hard paper
2. Inner page – same as cover page but on the soft paper
3. Declaration
4. Acknowledgement (if any)
5. Contents
   - Summary
   - Introduction
   - Work
   - Industry
   - Review
   - Details of the work including work programme & results
   - Conclusions and Future Scope of Work
   - References (if any)

6. Impediments/difficulties faced during project semester on project work; Suggestions related to work/project semester.

Please note the case of letters in the cover page. The 3rd. line is 16 pt bold and other lines are 12 pt. The page is centered. Department and Institute names are bold.

The matter contained in the report should be typed in MS word (1.5 spacing) Times New Roman, 12 pt or equivalent with other software.

Figures and tables may be inserted in the text as they appear or may be appended in order.

List of references shall be appended at the end.

Subject matter should be typed on both sides.

A total of THREE copies may be prepared – one for the student, second for the industry coordinator and third for the institute.

ANNEXURE – II

PROJECT REPORT

(Project Semester January-June 20)

(TITLE OF THE PROJECT)

Submitted by

(Name of student)

Student I D……..

Under the Guidance of

(Name of faculty coordinator with designation)

(Name of Industry coordinator with designation)

Department of …… Engineering
Punjab State Civil Aviation Council, Patiala

_____ to_____, _____
(Start Month) (End Month) (Year)

ANNEXURE – III

Punjab State Civil Aviation Council, Patiala

DECLARATION

I hereby declare that the project work entitled ("Title of the project") is an authentic record of my own work carried out at (Place of work) as requirements of six months project semester for the award of degree of B.E. (Aeronautical Engineering), Punjab State Civil Aviation Council, Patiala, under the guidance of (Name of Industry coordinator) and (Name of Faculty coordinator), during _____to _____, 20).

(Signature of student)
Name of Student:
Student I D:

Date: _____

Certified that the above statement made by the student is correct to the best of our knowledge and belief.

(Name & Designation)
Faculty Coordinator

(Name & Designation)
Industry Coordinator

ANNEXURE-IV

Punjab State Civil Aviation Council, Patiala

Department of _____ Engineering

PROJECT SEMESTER Session 20 -

FEEDBACK FROM INDUSTRY ON PROJECT SEMESTER

1.	Were the students serious about their work?	A	B	C	D	
2.	Were they allotted specific projects?			Yes / No		
3.	Has the work done by the students been of value to the Company?			Yes / No		
4.	Did the students have adequate background knowledge?	A	B	C	D	
5.	Did the students have adequate maturity and adjustability?	A	B	C	D	
6.	Do you think that the Institute can interact with the industry / organization in some other way also? Please specify.			Yes / No		
7.	How do you rate the student overall?	A	B	C	D	
8.	Will you consider the student to be absorbed in your organization (if chance given)?			Yes / No		
9.	Would you like to take PSCAC, Patiala students again in next year?			Yes/No		

A Excellent
B Very Good
C Satisfactory
D Marginal

Signature _____

Name: _____
of Faculty coordinator/Adjunct Faculty/ Expert/ PEC alumni

ANNEXURE-V

Department of Aeronautical Engineering
PROJECT SEMESTER Session 20 -

STUDENTS FEED BACK FORM

1. Name and Place of the Industry:
2. Student's name
3. Student I D Branch
4. Are you satisfied with the manner the department did your:

(i)	Placement in various industrial units	Satisfied	Unsatisfied
(ii)	Registration & Orientation	Satisfied	Unsatisfied
(iii)	Evaluation	Satisfied	Unsatisfied

If not satisfied, please give your suggestions overleaf.

5. Was the technical assistance/guidance received from the Institute satisfactory? If not, identify the areas where assistance was lacking?

_____

_____

6. Were you given a single project or number of similar projects?

Single	No. of Projects	

7. **Specify below areas of the project carried out by you** Analysis & Design/Fabrication/ R&D/Supervision/……

i. What additional subjects did you study in order to successfully complete the projects in the Industry?

PROJECT	SUBJECT

9. **Problems faced in the Industry with regard to:**

		YES	No
i)	Project identification		
ii)	Problem analysis		
iii)	Implementation of the Project		
iv)	Acceptance in Industry		
v)	Recognition of the work done by you		

10. Has the Project Semester proved to be an exercise that has enhanced your

		YES	No
A.	**Personal Attributed at work**:		
i)	Communications Skills		
ii)	Confidence level		
iii)	Creativity		
iv)	Planning skills		
v)	Adaptability		
vi)	Being methodical		
vii)	Organizational skills		
B.	**Technical Aspects**		
	Knowledge		
	Skill at work		

11. Were you provided the following

i)	Stipend		
ii)	Accommodation		
iii)	Conveyance		

12. Any additional information/suggestion for further improvement of the project:

_____

A-Excellent B-Good C-Fair

ANNEXURE – VI

Punjab State Civil Aviation Council, Patiala

EVALUATION OF PROJECT SEMESTER PERFORMANCE IN INDUSTRY

(To be filled jointly by Faculty Coordinator and Industrial/Site Coordinator during Third Monitoring)

NAME OF THE ORGANISATION _____

(Please indicate grade out of 'A', 'B', 'C', 'D' & 'F'. For grading system & evaluation parameters, please see below.)

S.No.	Student ID	Name of Student	Name of Project	Grades

(Name & Designation)
Faculty Coordinator

(Name & Designation)
Industry Coordinator

Grading System

The performance of the student is to be reported in terms of broadband grades. The following letter grades are to be used: -

Letter Grade	Performance
A	Excellent
B	Very Good
C	Satisfactory
D	Marginal
F	Failing

Evaluation Parameters:

Following parameters may be kept in mind while evaluation evaluating the student:

i	JOB KNOWLEDGE (refers to knowledge clarity of fundamentals, and latest development	**ix**	ADAPTABILITY TO NEW ENVIRONMENT (refers to ability to acclimatize himself/herself to new work environment/culture.
ii	CREATIVITY (refers to the ability to generate new and practical ideas for improvement of systems and operations related to the job)	**X**	PROBLEM FORMULATION (refers to initiative shown in converging to project formulation)
iii	PLANNING SKILLS (refer to the ability to conceptualize all aspect of the project and to systematically plan the series of activities to achieve the goals)	**xi**	TECHNIQUES/TOOLS used at various stages
iv	ORGANISING SKILLS (refers to the ability to mobilize co-ordinate, integrate various activities/resources to achieve fast completion)	**xii**	EXECUTION OF THE PROJECT)(S) (refers to (a) Setting Time frames (b) Efforts put into complete the project. Maintenance of work diary.
v	APPLICATION SKILLS (refer to the ability to apply knowledge to real life situations)	**xiii**	PROJECT REPORT & DEFENCE
vi	JOB INVOLVEMENT (refers to the concern and diligence shown in execution of the project)	**xiv**	PRESENTATION (Refers to style and effectiveness)
vii	INTERPERSONAL RELATIONSHIP (refers to ability to work harmoniously with superiors and subordinates)	**xv**	Written Expression
viii	REGULARITY & PUNCTUALITY (refers to (i) Sanctioned authorized leave, absence without permission (ii) late coming & leaving work place early)	**xvi**	Oral Expression

ANNEXURE-VII

Department of _____ Engineering

PROJECT SEMESTER Session 20 -

EVALUATION PERFORMA FOR FACULTY COORDINATOR/ ADJUNCT FACULTY/ EXPERTS/ PSCAC, PATIALA

NAME OF COORDINATOR(S):_____

Credits Assigned: 06

S.No.	Student ID	Name of Student	Name of Project	Grades

(Description of Grades given below)

Signature:_____

Name:_____

Grading System

The performance of the student is to be reported in terms of broadband grades. The following letter grades are to be used: -

Letter Grade	**Performance**
A	Excellent
B	Very Good
C	Satisfactory
D	Marginal
F	Failing

ANNEXURE- VIII

Department of _____ Engineering

PROJECT SEMESTER Session 20 -

INSTITUTE EVALUATION PERFORMA

S. No.	SID	Name of Student	**Evaluation (Grades)**		
			Report (1 Credit)	Presentation (1 Credit)	Viva Voce (1 Credit)

(Department Coordinator) **(Head of the Department)**

ANNEXURE – IX

Department of _____ Engineering

PROJECT SEMESTER Session 20 -

OVER-ALL EVALUATION PERFORMA

S. No	SID	Name of Student	**Evaluation (Grades)**				
			Industry Coordinator (3 Credits)	Faculty Coordinator (2 Credits)	Institute		
					Report (1 Credit)	Presentation (1 Credit)	Viva Voce (1 Credit)

(Department Coordinator) **(Head of the Department)**

ANNEXURE - X

Department of _____ Engineering

PROJECT SEMESTER Session 20 -

OVER-ALL EVALUATION PERFORMA

FORMAT FOR TENTATIVE DATES OF VISITS FOR PROJECT SEMESTER MONITORING

S.No	Name of Faculty member	Name of the student	Student I D	Name of industry	Tentative date/week of 1st visit	Tentative date/week of 2nd visit	Tentative date/week of 3rd visit

(Department Coordinator) **(Head of the Department)**

10. RESOURCE REQUIREMENTS

10.1 Equipment Requirement:

1.	Wind Tunnel
2.	Smoke tunnel
3.	Venturi meter
4.	Orifice meter
5.	Pilot Static Tube
6.	Hele Shaw apparatus
7.	Positioning system
8.	Manometer
9.	Aray Piezo –electric Pressure
10.	Lod cell based Force balance
11.	3D Printer
12.	Workstations
13.	CADD Software
14.	CFD Software
15.	Simulation Software
16.	Supersonic Open Jet wind tunnel
17.	Schlieren System
18.	Fog generator
19.	Column buckling apparatus
20.	Thin Walled cylindrical pressure vessel Apparatus
21.	Unsymmetrical Bending and Shear Centre measurement Apparatus
22.	Strain Gauge Trainer Apparatus
23.	Shear force in a beam apparatus
24.	Defection of Beams and Cantilevers Apparatus
25.	Continuous and Indeterminate Beam Apparatus
26.	Laser Doppler vibrometer
27.	Micro Raman Spectrometer
28.	Multi cylinder CRDI diesel engine
29.	Two stage reciprocating air compressor
30.	Centrifugal blower
31.	Axial ow fan
32.	Gas turbine test rig
33.	Multiplexer (4 to 1 Line)
34.	De-Mltiplexer (1 to 4 Line)
35.	Encoder (8 to 3)
36.	Decoder (3 to 8)
37.	Weighted Resistor Discrete D/A Converter-4 BIT
38.	R-2R Ladder Discrete D/A Converter-4 BIT
39.	Stair Case Ramp ADC-4 BIT
40.	Successive Approximation ADV-8BIT
41.	Satellite Link Emulator STC24
42.	GUNN Power supply and VSWR

NOTE :

In addition to above, laboratories in respect of all the subjects mentioned in the curriculum, will be required for effective implementation of the course.

Provision for overhead projector, TV with VCR facility slide cum strip projector, TV with VCR facility slide cum strip projector, 16 mm film projector, photocopier, PC-XT facilities, duplicating machines, drafting machines etc has also to be made.

10.2 Space Requirement:

Norms and standards laid down by All India Council for Technical Education (AICTE) may be followed to work out space requirement in respect of class rooms, tutorial rooms, drawing halls, laboratories, space required for faculty, student amenities and residential area for staff and students.

10.3 Furniture Requirement

Norms and standards laid down by AICTE be followed for working out furniture requirement for this course.

10.4 Human Resources:

Weekly work schedule, annual work schedule, student teacher ratio for various group and class size, staffing pattern, work load norms, qualifications, experience and job description of teaching staff workshop staff and other administrative and supporting staff be worked out as per norms and standards laid down by the AICTE.

11. EVALUATION STRATEGY

11.1 INTRODUCTION

Evaluation plays an important role in the teaching-learning process. The major objective of any teaching-learning endeavor is to ensure the quality of the product which can be assessed through learner's evaluation.

The purpose of student evaluation is to determine the extent to which the general and the specific objectives of curriculum have been achieved. Student evaluation is also important from the point of view of ascertaining the quality of instructional processes and to get feedback for curriculum improvement. It helps the teachers in determining the level of appropriateness of teaching experiences provided to learners to meet their individual and professional needs. Evaluation also helps in diagnosing learning difficulties of the students.

Evaluation is of two types: Formative and Summative (Internal and External Evaluation)

Formative Evaluation

It is an on-going evaluation process. Its purpose is to provide continuous and comprehensive feedback to students and teachers concerning teaching-learning process. It provides corrective steps to be taken to account for curricular as well as co-curricular aspects.

Summative Evaluation

It is carried out at the end of a unit of instruction like topic, subject, semester or year. The main purpose of summative evaluation is to measure achievement for assigning course grades, certification of students and ascertaining accountability of instructional process. The student evaluation has to be done in a comprehensive and systematic manner since any mistake or lacuna is likely to affect the future of students.

In the present educational scenario in India, where summative evaluation plays an important role in educational process, there is a need to improve the standard of summative evaluation with a view to bring validity and reliability in the end-term examination system for achieving objectivity and efficiency in evaluation.

11.2 STUDENTS' EVALUATION AREAS

The student evaluation is carried out for the following areas:

- Theory
- Practical Work (Laboratory, Workshop, Field Exercises)
- Project Work
- Professional Industrial Training

11.2.1 Theory

Evaluation in theory aims at assessing students' understanding of concepts, principles and procedures related to a course/subject, and their ability to apply learnt principles and solve problems. The formative evaluation for theory subjects may be caused through sessional/class-tests, home-assignments, tutorial-work, seminars, and group discussions etc. For end-term evaluation of theory, the question paper may comprise of three sections.

Section-I

It should contain objective type items e.g. multiple choice, matching and completion type. Total weightage to Section-1 should be of the order of 20 percent of the total marks and no choice should be given in this section. The objective type items should be used to evaluate students' performance in knowledge, comprehension and at the most application domains only.

Section-II

It should contain short answer/completion items. The weightage to this section should be of the order of 40 percent of the total marks. Again, no choice should be given in section-II

Section-III

It may contain two to three essay type questions. Total weightage to this section should be of the order of 40 percent of the total marks. Some built-in, internal choice of about 50 percent of the questions set, can be given in this section

Table II : Suggested Weightage to be given to different ability levels

Abilities	Weightage to be assigned
Knowledge	10-30 percent
Comprehension	40-60 percent
Application	20-30 percent
Higher than application i.e. Analysis, Synthesis and Evaluation	Upto 10 percent

11.2.2 Practical Work

Evaluation of students performance in practical work (Laboratory experiments, Workshop practicals/field exercises) aims at assessing students ability to apply or practice learnt concepts, principles and procedures, manipulative skills, ability to observe and record, ability to interpret and draw conclusions and work related attitudes. Formative and summative evaluation may comprise of weightages to performance on task, quality of product, general behaviour and it should be followed by viva-voce.

11.2.3 Project Work

The purpose of evaluation of project work is to assess students ability to apply, in an integrated manner, learnt knowledge and skills in solving real life problems, manipulative skills, ability to observe, record, creativity and communication skills. The formative and summative evaluation may comprise of weightage to nature of project, quality of product, quality of report and quality of presentation followed by viva-voce.

11.2.4 Professional Industrial Training

Evaluation of professional industrial training report and viva-voce/ presentation aims at assessing students' understanding of materials, industrial processes, practices in the industry/field and their ability to engage in activities related to problem-solving in industrial setting as well as understanding of application of learnt knowledge and skills in real life situation. The formative and summative evaluation may comprise of weightages to performance in testing, general behaviour, quality of report and presentation during viva-voce.

11.3 ASPECTS OF QUESTION PAPER SETTING

Validity and reliability are the most important considerations in the selection and construction of evaluation procedures. First and foremost are the evaluation tools to measure the specific outcomes for which they are intended to measure. Next in importance is reliability, and following that is a host of practical features that can be classified under the heading of usability.

For weightage of marks assigned to formative (internal) and summative (external) evaluation and duration of evaluation has been given in the study and evaluation scheme of the curriculum document. Teachers/Paper-setters/Examiners may use Manual for Students' Evaluation developed by National Institute of Technical Teachers' Training & Research, Sector-26, Chandigarh to bring objectivity in the evaluation system.

12. RECOMMENDATIONS FOR EFFECTIVE CURRICULUM IMPLEMENTATION

Teachers are educational managers at class room level and their success in achieving course level objectives lies in using course plan and their judicious execution which is very important for the success of programme by achieving its objectives.

Teachers are required to plan various instructional experiences viz. theory lecture, expert lectures, lab/workshop practicals, guided library exercises, field visits, study tours, camps etc. In addition, they have to carry out progressive assessment of theory, assignments, library, practicals and field experiences. Teachers are also required to do all these activities within a stipulated period of 16 weeks which is made available to them. With the amount of time to their credit, it is essential for them to use it judiciously by planning all above activities properly and ensure execution of the plan effectively.

Following is the gist of suggestions for subject teachers to carry out T-L process effectively:

1. Teachers are required to prepare a course plan, taking into account departmental academic plan, number of weeks available, course to be taught, different learning experiences required to be developed etc.

2. Teachers are required to prepare lesson plan for every theory class. This plan may comprise of content to be covered, learning material (transparencies, Video Films, Models etc.) for execution of a lesson plan. They may follow steps for preparing lesson plan e.g. drawing attention, state instructional objectives, help in recalling pre-requisite knowledge, deliver planned subject content, check desired learning outcome and reinforce learning etc.

3. Teachers are required to plan for expert lectures from field/industry. Necessary steps are to plan in advance, identify field experts, make correspondence to invite them, take necessary budgetary approval etc.

4. Teachers are required to plan for guided library exercises by identification of course specific experience requirement, setting time, assessment, etc. The tutorial, assignment and seminar can be thought of as terminal outcome of library experiences.

5. Concept and content based field visits may be planned and executed for such content of course which otherwise is abstract in nature and no other requisite resources are readily available in institute to impart them effectively.

6. There is a dire need for planning practical experiences in right perspective. These slots in a course are the avenues to use problem based learning/activity learning/ experiential learning approach effectively. The development of lab instruction sheets for the course is a good beginning to provide lab experiences effectively.

7. Planning of progressive assessment encompasses periodical assessment in a semester, preparation of proper quality question paper, assessment of answer sheets immediately and giving constructive explicit feed back to every student. It has to be planned properly; otherwise the very purpose of the same is lost.

8. The co-curricular activities like camp, social gathering, study tour, hobby club , NCC, NSS, Library studies, Civil Defence and Disaster Management etc. may be used to develop generic skills like task management, problem solving, managing self, collaborating with others etc.

9. Wherever possible, it is essential to use activity based learning rather than relying on delivery based conventional teaching all the time.

10. While imparting instructions, emphasis may be laid on the development of cognitive, psychomotor, reactive and interactive skills in the students.

11. Teachers may take working drawings from the industry/field and provide practices in reading these drawings.

12. Teachers may take initiative in establishing liaison with industries and field organizations for imparting field experiences to their students.

13. Students be made aware about issues related to ecology and environment, safety, concern for wastage of energy and other resources etc.

14. Students may be given relevant and well thought out minor and major project assignments, which are purposeful and develop practical skills. This will help students in developing creativity and confidence for their gainful employment (wage and self).

15. A Project bank may be developed by the concerned department of the institute in consultation with related Industry, Research Institutes and other relevant field organizations in the state.

11. LIST OF PARTICIPANTS

a) Workshop on "Orientation of PSCAC faculty and staff on NSQF and Curriculum Design for Degree Level Programme in "Aeronautical Engineering" at Punjab Aircraft Maintenance Engineering College, Patiala on 14.10.2016.

S. No.	Name, Designation and Official address
From Field/Industries/Institutions of Higher Learning	
1.	Ms. Gurdeep Kaur, Computer Instructor, PAMEC, Patiala, Punjab
2.	Sh. Kundan Jee, Dy. Chief Instructor, PAMEC, Patiala
3.	Sh. Piara Singh Randhawa, Workshop Instructor, PAMEC, Patiala
4.	Sh. Victor Sagayaraj, Airframe Instructor, PAMEC, Patiala
5.	Sh. Kulbhushan, PA to CEO, PSCAC, Patiala
6.	Sh. Rajesh Sharma, Dy. C.I., PAMEC, Patiala
7.	Sh. Mandeep Singh, M.M., Patiala Aviation Club, Patiala
8.	Sh. Tarun Saini, CAM, Patiala Aviation Club, Patiala
9.	Ms. Jaswinder Kaur, Quality Manager, Patiala Aviation Club, Patiala
10.	Sh. Balvinder Singh Pattar, W/shop Demonstrator, PSCAC, Patiala
11.	Sh. Paramjit Singh Bedi, Workshop Demonstrator, PSCAC, Patiala
12.	Sh. Bawa, Workshop Demonstrator, PSCAC, Patiala
13.	Sh Mir Hussain, Instructor, PSCAC, Patiala
14.	Ms. Pallavi, Instructor, PSCAC, Patiala
15.	Sh. Pushpinder Arrora, Librarian, PSCAC, Patiala
16.	Sh. Rajeev Bagga, ADO, PSCAC,, Patiala
17.	Sh. KD Singh, Chief Engineer, Civil Aviation, Punjab
18.	Sh. Tushar Singh, Assistant Prof. Punjab Engineering College, Chandigarh
19.	Sh. HB Singh, Principal, PAMEC, Patiala
20.	Sh. Ugersan Davaji, Gurukul Vidyapeeth Institute of Engineering & Tech. Banur, Patiala

21.	Sh. APS Virk, IAS, Chief Executive Officer, PSCAC, Patiala
22.	Sh. Harpreet Singh, PSCAC, Patiala
23.	Sh. Harsh, PSCAC, Patiala
From NITTTR, Chandigarh	
24.	Dr. AB Gupta, Prof. & Head, Curriculum Development Centre
25.	Sh. P.K. Singla, Associate Professor, Curriculum Development Centre **Coordinator**

b) Workshop for Design of Curriculum for degree level programme in Aeronautical Engineering' from 29-30 December, 2016 at NITTTR, Chandigarh.

S. No.	**Name, Designation and Official address**
From Field/Industries/Institutions of Higher Learning	
1.	Dr. Om Parkash, Associate Professor & Head, Dept. of Aerospace Engineering University of Petroleum and Energy Studies, Dehradun
2.	Sh. KD Singh, Chief Engineer, Civil Aviation, Govt. of Punjab, Sector-22, Chandigarh
3.	Sh. HB Singh, Principal, PAMEC, Patiala
4.	Sh. Jimmy Kansal, Jt. Director and Head, HR, SASE, DRDO, Chandigarh.
5.	Dr. Rakesh Kumar, Head, Aerospace Engineering, PEC University of Technology, Chandigarh
6.	Sh. Tushar Siag, Assistant Prof. Punjab Engineering College, Chandigarh
7.	Dr. Sanjay Singh, Head of Dept. Aerospace Engineering Amity University, NOIDA, U.P.
8.	Prof. Praveen Khanna, Professor, Amity University, NOIDA, U.P.
9.	Sh. Kishori Lal, Associate Professor, Aerospace Engineering Department, Punjab Engineering College, Chandigarh
From NITTTR, Chandigarh	
10	Dr. AB Gupta, Prof. &Head, Curriculum Development Centre.
11	Sh. P.K. Singla, Associate Professor, Curriculum Development. Centre **Coordinator**

c) Workshop for Design of Curriculum for degree level programme in Aeronautical Engineering' for PSCAC, Patiala from 24-25 January, 2017 at NITTTR, Chandigarh.

S. No.	**Name, Designation and Official address**
From Field/Industries/Institutions of Higher Learning	
1.	Dr. Om Parkash, Associate Professor & Head, Department of Aerospace Engineering University of Petroleum and Energy Studies, Dehradun
2.	Sh. KD Singh, Chief Engineer, Civil Aviation, Govt. of Punjab, Sector-22, Chandigarh
3.	Sh. Jimmy Kansal, Jt. Director and Head, HR, SASE, DRDO, Chandigarh.
4.	Dr. Rakesh Kumar, Head, Aerospace Engineering, PEC University of Technology, Chandigarh
5.	Sh. Tushar Siag, Assistant Prof. Punjab Engineering College, Chandigarh
6.	Sh. Kishori Lal, Associate Professor, Aerospace Engineering Department, Punjab Engineering College, Chandigarh
7.	Sh. Rajesh Sharma, Dy. Chief Instructor, PAMEC, Patiala
8.	Sh. Amit Singh Tanwar , Gurukul Vidyapeeth Institute of Engineering & Tech. Banur, Patiala
9.	Sh. Subhash Chander, Scientist F, JD(PDS), TBRL, Chandigarh
10.	Dr. Amarjit Singh, SASE, DRDO, Chandigarh
From NITTTR, Chandigarh	
11.	Dr. AB Gupta, Prof. &Head, Curriculum Development Centre
12.	Sh. P.K. Singla, Associate Professor, Curriculum Development. Centre **Coordinator**

d) Workshop for Design of Curriculum for degree level programme in Aeronautical Engineering' from 28.2.2017 to 1.3.2017 at NITTTR, Chandigarh.

S. No.	Name, Designation and Official address
From Field/Industries/Institutions of Higher Learning	
1.	Sh. KD Singh, Chief Engineer, Civil Aviation, Govt. of Punjab, Sector-22, Chandigarh
2.	Dr. Rakesh Kumar, Head, Aerospace Engineering, PEC University of Technology, Chandigarh
3.	Sh. Tushar Siag, Assistant Prof. Punjab Engineering College, Chandigarh
4.	Sh. Rajesh Sharma, Dy. Chief Instructor, PAMEC, Patiala
5.	Sh. Amit Singh Tanwar,, Gurukul Vidyapeeth Institute of Engineering & Tech. Banur, Patiala
6.	Sh. Subhash Chander, Scientist F, JD(PDS), TBRL, Chandigarh
From NITTTR, Chandigarh	
7.	Dr. AB Gupta, Prof. &Head, Curriculum Development Centre
8.	Sh. P.K. Singla, Associate Professor, Curriculum Development Centre **Coordinator**

e) Workshop for Design of Curriculum for degree level programme in Aeronautical Engineering' from 4-5 May, 2017 at NITTTR, Chandigarh.

S. No.	Name, Designation and Official address
From Field/Industries/Institutions of Higher Learning	
1.	Sh. KD Singh, Chief Engineer, Civil Aviation, Govt. of Punjab, Sector-22, Chandigarh
2.	Dr. Rakesh Kumar, Head, Aerospace Engineering, PEC University of Technology, Chandigarh
3.	Sh. Tushar Siag, Assistant Prof. Punjab Engineering College, Chandigarh
4.	Sh. Rajesh Sharma, Dy. Chief Instructor, PAMEC, Patiala
5.	Sh. Vikram Singh, Lecturer, Gurukul Vidyapeeth Institute of Engineering & Tech. Banur, Patiala
6.	Sh.A.K. Goel, Director, CDC, MRS Punjab Technical University,, Bathinda, Punjab
7.	Prof. Praveen Khanna, Professor, Amity University, NOIDA, U.P.
From NITTTR, Chandigarh	
8.	Shri P.K. Singla, Associate Professor, Curriculum Development Centre **Coordinator**