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SHIVAJI UNIVERSITY, KOLHAPUR

A syllabus of

(B.E. Aeronautical Engineering)

Structure (Semester III to VIII)

and

Syllabus of

Semester (III and IV)

To be introduced from Academic Year 2014-15

i.e. from June 2014 Onwards

(Subject to the modifications will be made from time to time)

SHIVAJI UNIVERSITY, KOLHAPUR,

Structure of S.E. (AERONAUTICAL ENGINEERING) **Semester III**

WITH EFFECT FROM THE ACADEMIC YEAR JUNE/JULY 2014-2015

Sr. No.	Course Title	Teaching Scheme				Examination Scheme				
		L	T	P	Total Hrs.	TP	TW	OE	POE	Total Marks
1	Engineering Mathematics – III	3	1	--	4	100	25	--	--	125
2	Applied Thermodynamics	3	--	2	5	100	25	--	25	150
3	Fluid Mechanics	3	--	2	5	100	25	--	25	150
4	Elements of Aeronautics	3	--	2	5	100	25	--	--	125
5	Mechanics of Solids	4	--	2	5	100	25	--	--	125
6	Professional Skill Development	1	--	--	1	--	25	--	--	25
7	Aircraft Component Drawing	--	--	2	2	--	50	25	--	75
8	Computer Programming in C++	--	--	2	2	--	25	--	--	25
Total		17	1	12	30	500	225	25	50	800

L: Lecture, T: Tutorial, P: Practical, TP: Theory Paper, TW: Term Work, OE: Oral Exam. , POE: Practical and Oral Exam.

SHIVAJI UNIVERSITY, KOLHAPUR,

Structure of S.E. (AERONAUTICAL ENGINEERING) **Semester IV**

WITH EFFECT FROM THE ACADEMIC YEAR JUNE/JULY 2014-2015

Sr. No.	Course Title	Teaching Scheme				Examination Scheme				
		L	T	P	Total Hrs.	TP	TW	OE	POE	Total Marks
1	Aerodynamics-I	3	1	--	4	100	25	--	--	125
2	Aircraft Production Technology	4	1	--	5	100	25	--	--	125
3	Material Science and Engineering	3	--	2	5	100	25	25	--	150
4	Applied Numerical Methods	3	--	2	5	100	25	--	--	125
5	Electrical, Electronics and Communications Engineering	3	--	2	5	100	25	--	--	125
6	Instrumentation Lab	--	--	2	2	--	25	25	--	50
7	Computer Aided Drafting Lab	--	--	2	2	--	50	--	--	50
8	Aircraft Production Technology Lab	--	--	2	2	--	25	--	25	50
Total		16	02	12	30	500	225	50	25	800

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SHIVAJI UNIVERSITY, KOLHAPUR,

Structure of T.E. (AERONAUTICAL ENGINEERING) **Semester V**

WITH EFFECT FROM THE ACADEMIC YEAR JUNE/JULY 2015-2016

Sr. No.	Course Title	Teaching Scheme				Examination Scheme				
		L	T	P	Total Hrs.	TP	TW	OE	POE	Total Marks
1	Aircraft Structures	4	--	2	6	100	25	--	--	125
2	Aerodynamics – II	3	1	--	4	100	25	--	--	125
3	Aerospace Propulsion- I	3	1	--	4	100	25	--	--	125
4	Flight Mechanics- I	3	--	2	5	100	25	--	--	125
5	Air Transportation Systems	3	--	2	5	100	25	--	25	150
6	Aircraft Structures Lab	--	--	2	2	--	25	25	--	50
7	Aerodynamics Lab	--	--	2	2	--	25	--	25	50
8	Mini Project-I	--	--	1	1	--	50	--	--	50
Total		16	02	11	29	500	225	25	50	800

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SHIVAJI UNIVERSITY, KOLHAPUR,

Structure of T.E. (AERONAUTICAL ENGINEERING) **Semester VI**

WITH EFFECT FROM THE ACADEMIC YEAR JUNE/JULY 2015-2016

Sr. No.	Course Title	Teaching Scheme				Examination Scheme				
		L	T	P	Total Hrs.	TP	TW	OE	POE	Total Marks
1	Machines and Mechanisms	3	--	2	5	100	25	--	--	125
2	Design of Aircraft Structures	3	--	2	5	100	25	--	--	125
3	Aerospace Propulsion- II	3	1	--	4	100	25	--	--	125
4	Industrial Management and Operation Research	3	--	2	5	100	25	--	--	125
5	Flight Mechanics- II	3	--	2	5	100	25	25	--	150
6	Aerodynamics and Propulsion Lab	--	--	2	2	--	25	--	25	50
7	Seminar	--	--	2	2	--	50	--	--	50
8	Mini Project-II	--	--	1	1	--	25	--	25	50
Total		15	01	13	29	500	225	25	50	800

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SHIVAJI UNIVERSITY, KOLHAPUR,

Structure of B.E. (AERONAUTICAL ENGINEERING) **Semester VII**

WITH EFFECT FROM THE ACADEMIC YEAR JUNE/JULY 2016-2017

Sr. No.	Course Title	Teaching Scheme				Examination Scheme				
		L	T	P	Total Hrs.	TP	TW	OE	POE	Total Marks
1	Mechanical Vibration and Structural Dynamics	4	--	2	6	100	25	25	--	150
2	Computational Aerodynamics	3	--	2	5	100	25	25	--	150
3	Control Theory- Application to Flight Control Systems.	3	--	2	5	100	25	25	--	150
4	Elective-I.	3	--	2	5	100	25	--	--	125
5	Elective-II	3	--	2	5	100	25	--	--	125
6	Industrial Training@	--	--	--	--	--	50	--	--	50
7	Project Phase– I	--	--	2	2	--	50	--	--	50
Total		16	00	12	28	500	225	75	00	800

Sr. No.	Elective – I
1	Helicopter Theory
2	Aircraft Design
3	Airframe Maintenance and Repair
4	Flight Scheduling and Operations
5	Aircraft Materials

Sr. No.	Elective – II
1	Industrial Aerodynamics
2	Heat Transfer
3	Total Quality Management
4	Computer Aided Design and Analysis
5	Aircraft Maintenance Engineering

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@ Industrial training of minimum two (2) weeks should be done after T.E. (II) in summer vacation and it's assessment will be done in B.E. (I) based on report submitted.
Work load of the assessment can be assigned to the project seminar guide.

SHIVAJI UNIVERSITY, KOLHAPUR,

Structure of B.E. (AERONAUTICAL ENGINEERING) **Semester VIII**

WITH EFFECT FROM THE ACADEMIC YEAR JUNE/JULY 2016-2017

Sr. No.	Course Title	Teaching Scheme				Examination Scheme				
		L	T	P	Total Hrs.	TP	TW	OE	POE	Total Marks
1	Finite Element Method	3	--	2	5	100	25	--	--	125
2	Avionics and Instrument Systems	3	--	2	5	100	25	25	--	150
3	Airport Planning and Operations	3	--	2	5	100	25	25	--	150
4	Elective – III	3	--	2	5	100	25	--	--	125
5	Elective – IV	3	--	2	5	100	25	--	--	125
6	Project Phase– II	--	--	4	4	--	75	50	--	125
Total		15	00	14	29	500	200	100	00	800

Sr. No.	Elective – III
1	Hypersonic Aerodynamics
2	Air traffic Control and Planning
3	Cryogenics
4	Composite material and structures
5	Rocket and Missile Design

Sr. No.	Elective – IV
1	Satellite communication and Navigation
2	Probability and Statistics
3	Engineering Design Optimization
4	Reliability Engineering
5	Management Information System

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SHIVAJI UNIVERSITY, KOLHAPUR
T.E. (Aeronautical Engineering) Semester V

1. Aircraft Structures

Teaching scheme:
Lectures : 4 Hrs / week
Practical : 2 Hrs/week

Examination scheme:
Theory Paper : 100 Marks
Term Work : 25 Marks

Course Objectives:
The course aims to:
1 Review unsymmetrical bending
2 Enable the aircraft structure with its classification
3 Enable knowledge on Stiffened structure
4 Enrich the knowledge on Stability of structures
5 Give knowledge on shells

Course Outcomes:
Upon successful completion of this course, the student will be able to:
1. Understand the stresses in unsymmetrical sections with experiments
2. Have a fundamental knowledge of monocoque and semi monocoque structure, torsion and thin walled structure with experiments
3. Understand the analysis of stiffened tubular structure, analysis of multi cell, rings and frames revlent to aircraft structure
4. Know the buckling and failures of thin walled structures
5. Have an understanding of idealization of stiffened panels.
6. Know shear centre and shear flow of multi cell.

Unit 1 **Unsymmetrical Bending** [07]

Stresses in beams of unsymmetrical sections, Box beams.

Unit 2 **Aircraft Structure Monocoque and Semimonocoque** [09]

Analysis of tubular, monocoque and semi-monocoque structures, Torsion and flexure of thin walled boxes – Shear centre – Flexural axis and axis of twist.

Unit 3 **Analysis of Stiffened Structures** [10]

Idealization and analysis of stiffened tubular structures, Study of open tubes, Analysis of multi cell tubes. Analysis of rings and frames, Applications to aircraft structures.

Unit 4 **Stability Problems** [10]

Stability problems of thin walled structures – Flexural, torsional and local failures – Influence of eccentricity and in elasticity – Buckling of plates and sheet stringer combinations - crippling loads – Tension field theory.

Unit 5 **Shells** [07]

Idealization of stiffened shells, Shear center, Shear flow in thin walled multicell box beams, Effect of taper

Unit 6 Theories of Failure [09]

Maximum Stress theory, Maximum Strain Theory, Maximum Shear Stress, Theory, Distortion Theory, Maximum Strain energy theory, Application to aircraft Structural problems.

Term Work:

List of Experiments:

1. Use of Double Dial Gauge to find the deformations of the given Material.
2. Finding the flexibility coefficients of the given cantilever beam and verification of Maxwell's reciprocal theorem and Principle of superposition.
3. Experiment on unsymmetrical bending of cantilever beam.
4. Experiment on combined bending of hollow circular shaft.
5. Experiment on find the shear center of the given C-section.
6. Experiment on buckling of columns and plotting of Southwell's plot.

Text Books:

1 "Analysis of Aircraft Structures – An Introduction", Donaldson, B.K., Tata McGraw-Hill, (1993).

2 "Analysis and Design of Flight Vehicle Structures", E.F. Bruhn, Tristate Offset Co., (1980).

3 "Aircraft Structures for Engineering Students" Megson, T.M.G, Edward Arnold, (1989).

Reference Books:

1 "Aircraft Structures", Peery D.J. and Azar J.J., Tata McGraw-Hill, New York, 2nd Edition (1993).

2 "Theory of Plates and Shells", Stephen P. Timoshenko and S. woinowsky Krieger, McGraw-Hill, 2nd Edition, Singapore (1990).

SHIVAJI UNIVERSITY, KOLHAPUR
T.E. (Aeronautical Engineering) Semester V
2. Aerodynamics-II

Teaching scheme:
Lectures : 3 Hrs / week
Tutorial : 1 Hr / week

Examination scheme:
Theory Paper : 100 Marks
Term Work : 25 Marks

Course Objectives:
The course aims to:

1 Enable the knowledge of shock waves and their properties
2 Familiarize with various flow relations and flow conditions
3 Study the various flow relations and Method of characteristics
4 Enable the knowledge of flow over wings and Airplane
5 Study the types of wind tunnels and their importance
6 Introduce the students to Aircraft designing and Analysis

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1 Understand the different forms of energy equation, shock waves and their properties.
2 Require knowledge of area-velocity relation, mass flow rate, Stagnation conditions and various flow conditions (choked flow, over expanded, under expanded etc.)
3 Have a fundamental knowledge on supersonic flow, various equations related to the flow.
4 Understand the flow over wings and airplane
5 Understand the use of wind tunnels and their applications
6 Understand the performance parameters like range, endurance, Takeoff, landing and propellers and its types

Unit 1 One-Dimensional Flows **[08]**

Governing equations, Speed of sound and Mach number, Forms of energy equation, Normal shock waves, Basic equations, Hugoniot equation, Calculation of normal shock wave properties, Measurement of air speed, Incompressible subsonic and supersonic flows. One-dimensional flow with heat addition, Friction- thermal and friction choking.

Unit 2 QUASI-ONE DIMENSIONAL COMPRESSIBLE FLOWS **[04]**

Adiabatic flow in straight, variable area channels- Nozzles, Diffusers, Governing equations, Area-velocity relation, Mass flow rate, Effect of stagnation conditions, Back pressure, Choked flow- isentropic flow, ideally expanded, over expanded, under-expanded flows- Appearance of normal shock- Flow losses, Wave reflection from free boundary.

Unit 3 Linearised Supersonic Flows **[08]**

Linearised supersonic flow- Governing equations, Boundary conditions. Pressure coefficient, application to supersonic airfoils, Lift, Drag, Pitching moment, Symmetric and asymmetric double wedge and biconvex airfoils, General airfoil section, Second order theory, Shock expansion technique. Supersonic airfoils, flow, Airloads over wings of finite span- Supersonic leading edge and subsonic leading edge, Delta wings, Method of characteristics- Application to supersonic nozzle design

Unit 4 Supersonic Flow Over Wings and Airplane Configurations **[06]**

Three dimensional supersonic flow- Governing equation and boundary conditions, Consequences of linearity, Solution methods- Conical flow method – rectangular, Swept, Delta and arrow wings, Singularity distribution method.

Unit 5 Wind Tunnels **[07]**

Classification of wind tunnels, Subsonic and supersonic wind tunnels, Tunnel layouts and their design features, Subsonic and Supersonic tunnels, Helium and gun tunnels, Shock tubes, Various methods of flow visualizations.

Unit 6 Design and Analysis Of Aircraft **[07]**

Design considerations for supersonic aircraft, Aerodynamic interaction, Aerodynamic analysis of complete aircraft configurations in supersonic stream, Effect of Mach number on zero lift drag of two and three dimensional shapes.

Term Work:

Minimum ten assignments from the following topics:

1. Governing equations,
2. Hugoniot equation,
3. Shock wave
4. Variable area nozzles
5. Area-velocity relation,
6. Ideally expanded, over expanded, under-expanded flows
7. Application of supersonic airfoils,
8. Shock expansion technique
9. Supersonic and subsonic flow over delta wings,

Text Books:

1. "Aerodynamics for Engineers", Bertin J.J., Indian reprint, Pearson Education, ISBN: 81-297-0486-2, 4th Edition,(2004).
2. "Modern Compressible Flow with Historical Perspective", Anderson J.D., Tata McGraw-Hill, ISBN: 0-07-112161-7, 3rd Edition, (2003).
3. "Applied Aerodynamics: A Digital Textbook", KrooI, Desktop Aeronautics Inc.

Reference Books:

1. "Elements of Gas Dynamics", Liepmann, H.W., and Roshko, A., John Wiley,(1957).
2. "Aerodynamics, Aeronautics and Flight Mechanics", McCormick B.W, John Wiley, ISBN: 0-471-57506-2, 2nd Edition, (1995).
3. "The Dynamics and Thermodynamics of Compressible Fluid Flow", Shapiro A.H., Vols. I and II, John Wiley, (1953).
4. "Fluid Mechanics", Landau, L.D., and Lifshitz, E.M., Course of Theoretical Physics", Vol. 6, Maxwell Macmillan International Edition, Pergamon, ISBN: 0-02-946234-7, 2nd Edition ,(1989).

SHIVAJI UNIVERSITY, KOLHAPUR
T.E. (Aeronautical Engineering) Semester V
3. Aerospace Propulsion-I

Teaching scheme:
Lectures : 3 Hrs. / week
Tutorial : 1 Hr. / week

Examination scheme:
Theory Paper : 100 Marks
Term Work : 25 Marks

Course Objectives:
The course aims to :

1. Introduce aircraft propulsion through initial history and various propulsions systems.
2. Introduce theory differentiating aircraft propulsion systems through various means.
3. Impart awareness on thermodynamics of jet engines and various important components

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1. Distinctly understand the classification of power plants and differences of various propulsion systems including jet engine and rocket engine.
2. Have a fundamental knowledge turbojet, turbo prop and turbo fan engines
3. Understand concept of thermodynamic analysis on components of jet engine. Ram Jet and Pulse Jet application

Unit 1 Flight Propulsion- Aircraft Gas Turbine Engines- Generation of Thrust- Engine Performance Parameters **[08]**

History of flight propulsion, Role of reciprocating engines. Operating envelope of flight vehicles. Engine operational limits.
Air breathing engines- types, Aircraft Gas turbine engines- types, Operating principles, Distinguishing features, Schematic diagrams, Relative merits, applications. Engine components- Function, Schematic diagram, Layout, Engine station numbering, Thrust generation- Momentum equations, Gross net, Uninstalled, installed thrust, Propulsive efficiency. Engine performance parameters- Specific thrust, Specific fuel consumption, Total efficiency- Performance trends. Effect of flight conditions, Jet exit speed, Exit pressure. Role of propulsion in aircraft performance. Criteria for engine selection, Airframe-Engine matching.

Unit 2 Fundamentals of Gas Turbine Engines **[06]**

Illustration of working of gas turbine engine - The thrust equation - Factors affecting thrust – Effect of pressure, Velocity and temperature changes of air entering compressors – Method of thrust augmentation – Characteristics of turboprop, turbojet – Performance characteristics.

Unit 3 Subsonic and Supersonic Inlets **[06]**

Subsonic Inlets

Internal flow and Stall in Subsonic inlets - Boundary layer separation – Major features of external flow near a subsonic inlet – Relation between minimum area ratio and eternal deceleration ratio - Diffuser performance.

Supersonic Inlets

Supersonic inlets - Starting problem in supersonic inlets - Shock swallowing by area variation- External deceleration – Modes of inlet operation.

Unit 4 Combustion Chambers, Performance and Performance Sensitivity Combustion Chambers: Performance **[06]**

Classification of combustion chambers – Important factors affecting combustion chamber design – Combustion process – Combustion chamber performance.

Performance Sensitivity

Effect of operating variables on performance - Flame tube cooling - Flame stabilization – Use of flame holders – Numerical problems.

Unit 5 Nozzles **[06]**

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

Unit 6 Centrifugal and Axial Flow Compressors **[08]**

Centrifugal Flow Compressors

Principle of operation of centrifugal compressors - Work done and pressure rise - Velocity diagrams - Diffuser vane design considerations – Concept of Prewhirl – Rotating stall.

Axial Flow Compressors

Elementary theory of axial flow compressor – Velocity triangles – Degree of reaction - Three dimensional flow – Air angle distribution for free vortex and constant reaction designs - Compressor blade design - Centrifugal and Axial compressor performance characteristics.

Term Work:

Minimum ten assignments on the following topics

1. Thrust Augmentation
2. Gas Turbine Research Establishment (GTRE)
3. History of Flight Propulsion
4. Air Breathing Engines
5. Factors Affecting Thrust
6. Factors Affecting Combustion Chamber Design
7. Flame Stabilization and Flame Holders
8. Modes of Inlet Operations
9. Degree of Reaction
10. Compressor Blade Design
11. Nozzle Chocking
12. Aeronca Variants
13. General Electric J31 , CF700, TF39

Text Books:

1 "Gas Turbines and Jet and Rocket Propulsion", Mathur M L and Sharma R P,Standard Publisher, Delhi, (2000).

2 "H.I.H. Gas Turbine Theory", Cohen, H. Rogers, G.F.C. and Saravanamuttoo, Longman, ELBSEd, 4th Edition, (1989).

3 "The Jet Engine", Rolls Royce plc, ISBN 0-902121-2-5, 5th Edition ,(1986).

Reference Books:

1 "Aero Thermodyanamics of Aircraft Engine Components", Oates G C, AIAA Education Services, NewYork, (1986).

2 "Jet Engine", Rolls- Royce, 3rd Edition ,(1983).

3 "Gas Turbines", by Ganesan V, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2nd Edition, (1999).

4 "Mechanics and Thermodynamics of Propulsion", Philipa Hill and Carl Peterson, Addison Wesley Longman Inc. ,(1999).

5 "The Aircraft Gas Turbine Engine and Operation", Pratt and Whitney, United Technologies Publication, 3rd Edition, (1988).

SHIVAJI UNIVERSITY, KOLHAPUR
T.E. (Aeronautical Engineering) Part- I Semester V
4. Flight Mechanics-I

Teaching scheme:
Lectures : 3 Hrs. / week
Practical : 2 Hrs./week

Examination scheme:
Theory Paper : 100 Marks
Term Work : 25 Marks

Course Objectives:
The course aims to:
1 Understand drag forces acting on an airplane, and variations due to velocity and altitude
2 Understand elements of airplane performance
3 Understand static longitudinal stability of an aircraft
4 Understand lateral and directional stability
5 Understand dynamic stability of an aircraft

Course Outcomes:
Upon successful completion of this course, the student will be able to:
1. Know about the forces and moments that are acting on an aircraft, different types of Drag
2. Understand about aircraft performance in level flight, minimum drag and power required, climbing, gliding and turning flight, vn diagram and load factor
3. Know about degrees of stability, stick fixed and stick free stability, stability criteria, effect of fuselage and CG location, stick forces, aerodynamic balancing.
4. Understand about lateral control, rolling and yawing moments, static directional Stability, rudder and aileron control requirements and rudder lock
5. Understand dynamic longitudinal stability, stability derivatives, modes and Stability criterion, lateral and directional dynamic stability

Unit 1 Aerodynamic Characteristics and Importance of Stability, Stability Derivatives **[08]**

Airfoils, wings and bodies: Geometry, Nomenclature. Aerodynamic characteristics. Effect of geometry, Reynolds Number, Mach Number. Measures of aerodynamic performance. Performance augmentation methods.

Degree of freedom of a system - Static and dynamic stability - Need for stability in airplanes - Purpose of controls -Inherently and marginally stable airplanes.

Stability Derivatives

Aerodynamic stability and control derivatives. Relation to geometry, Flight configuration. Effects of power, Compressibility and flexibility.

Unit 2 Equations of Motion **[05]**

Equations of motion of a rigid body. Inertial forces and moments. Equations of motion of flight vehicles. Aerodynamic forces and moments. Decoupling of longitudinal and lateral-directional equations. Linearization of equations.

Unit 3 Static Longitudinal Stability and Control **[07]**

Static Longitudinal Stability – Control Fixed

Stick Fixed: Basic equilibrium equation - Stability criterion – Contribution of wing and tail and elevator to pitching moments - Effect of fuselage and nacelles - Effects of center of gravity location - Power effects - Stabilizer setting and center of gravity location – Elevator power– Elevator to trim . Trim gradients. Control fixed static stability – Control fixed neutral point. Stability margins.

Static Longitudinal Stability – Control Free
Effects of releasing the elevator. Hinge moment coefficients – Control forces to trim. Control free neutral point – Trim tabs. Aerodynamic balancing of control surfaces. Means of augmentation of control.

Unit 4 Maneuver Stability **[07]**
Contribution of pitch damping to pitching moment of flight vehicle - Effect on trim and stability. Control deflections and control forces for trim in symmetric maneuvers and coordinated turns. Control deflection and force gradients. Control fixed and control free maneuver stability. Maneuver points. Maneuver margins.

Unit 5 Static Lateral And Directional Stability and Control **[07]**
Dihedral effect - Coupling between rolling and yawing moment - Adverse yaw - Aileron power - Aileron reversal, Weather cocking effects – Rudder power. Lateral and directional stability- Definition, Control surface deflections in steady sideslips, Rolls and turns one engine in operative conditions - Rudder lock.

Unit 6 Dynamic Stability and Response to Control. **[06]**
Solutions to the stability quartic of the linearised equations of motion. The principal modes. Phugoid, Short period dutch Roll and Spiral modes - Further approximations. Restricted degrees of motion. Solutions. Response to controls, Auto rotation and spin.

Term Work:
Minimum ten assignments based on following topics should be submitted.

1. Stability derivatives
2. Performance augmentation methods
3. Equations of motion of a rigid body
4. Decoupling of longitudinal and lateral-directional equations
5. Effects of releasing the elevator
6. Control fixed static stability
7. Trim tabs
8. Effect on trim and stability
9. Contribution of pitch damping to pitching moment of flight vehicle
10. Effects of center of gravity location
11. Lateral and directional stability
12. Rudder lock
13. Auto rotation and spin.
14. Phugoid, Short Period dutch Roll and Spiral modes

Text Books:

1. "Aerodynamics for Engineering Students", Houghton, E.L. and Carruthers N.B., Edward Arnold Publishers Ltd., London ,(1989).
2. "Aerodynamics, Aeronautics and Flight Mechanics", Mc.Cormic, B.W., John Wiley, 2nd Edition, (1995)

Reference Books:

1. "Airplane Performance, Stability and Control",Perkins C.D., and Hage R.E., Wiley Toppan ,(1974).
2. "Flight Stability and Automatic Control", Nelson R.C., McGraw Hill limited ,(1989).

SHIVAJI UNIVERSITY, KOLHAPUR
T.E. (Aeronautical Engineering) Semester V
5. Air Transportation Systems

Teaching scheme:
Lectures : 3 Hrs/week
Practical : 2 Hrs / week

Examination scheme:
Theory Paper : 100 Marks
Term Work : 25 Marks
Practical and Oral Exam: 25 Marks

Course Objectives:
The course aims to:

1 Introduce the history of Aviation and Aerospace industry, evolution, development, growth, challenges.

2 Familiarize with different physical issues affecting demand including surface, core, and continents.

3 Introduce Regulatory environments at different levels- National and International.

4 Operational environment of aircraft and Airspace with control and monitoring systems in space

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1. Understand the need for Aviation and Aerospace industry- its current perspective.
2. Important physical factors affecting demand and need to understand.
3. Have knowledge of regulatory environments their importance at different levels and their role in maintaining safety at national and international level.
4. Understand different systems in space currently and expected future systems including communication, navigation, surveillance.
5. Understand importance of Airspace its categories and how is it regulated

Unit 1 **Aviation Industry** **[08]**

Introduction, History of aviation- Evolution, Development, Growth, Challenges. Aerospace industry, Air Transportation Industry- Economic impact- Types and causes. Airline Industry- Structure and economic characteristics. Airlines as oligopolists - Other unique economic characteristics. Significance of airline passenger load factors.

Unit 2 **Natural Environment** **[06]**

The earth as a habitat, The Earth: physical issues affecting demand- Surface, Core, continents. Shape of demand. Demand forecasting- Based on historical data, Comparative analysis, Theoretical demand models. Reliability of forecasts, Atmosphere of earth- Gaseous properties, distance and speed, Weather- Weather effects on navigation.

Unit 3 **Regulatory Environment** **[06]**

The breadth of regulation- ICAO, IATA, National authorities (DGCA, FAA). Service properties- Service volumes, International air service agreements, Deregulation, and privatization. Safety regulations- Risk assessment- Human factors and safety, security regulations, Environmental regulations.

Unit 4 Operational Environment **[08]**

Introduction. Evolution- Communication, Navigation and surveillance systems (CNSS). Radio communications- VHF, HF, ACARS, SSR, ADS. Navigation- NDB, VOR, DME, Area-navigation systems (R-Nav), ILS, MLS, GPS, INS, laser-INS. Surveillance- SSR, ADS . Airborne elements- AFCS, PMS, Electronic control and monitoring / engine instrumentation and central automated systems, EFIS, FMS, GPWS, TCAS- Future trends.

Unit 5 Aircraft **[06]**

Costs- Project cash-flow, Aircraft price. Compatibility with the operational infrastructure. Direct and indirect operating costs. Balancing efficiency and effectiveness- Payload-range, Fuel efficiency, Technical contribution to performance, operating speed and altitude, Aircraft field length performance. Typical operating costs. Effectiveness- wake-vortices, Cabin dimensions, Flight deck.

Unit 6 Airspace **[06]**

Categories of airspace- Separation minima, Airspace sectors- Capacity, demand and delay. Evolution of air traffic control system- Procedural ATC system, Procedural ATC with radar assistance, First generation 'automated' ATC system, Current generation radar and computer-based ATC systems. Aerodrome air traffic control equipment and operation - ICAO future air-navigation systems (FANS). Air-navigation service providers as businesses.

Term Work:

List of Experiments

1. Write about Oligopolists with practical scenario in Indian Aviation Sector.
2. Demand forecasting – an overview in Indian aviation, how is it different from other countries?
3. DGCA is policy maker for civil aviation in India – write at least 4-5 areas in this context.
4. Describe at least four equipment which are must to have for Air navigation.
5. Describe at least four equipment which are must to have for Air communication.
6. Describe at least three equipment which are must to have for central monitoring systems.
7. How Economy of Airlines is managed and what are different costs involved
8. Need for categories of airspace, types and what is concept of sectors in aviation.
9. Difference between first generation 'automated' ATC system, current generation radar and computer-based ATC systems
10. ICAO'sFuture Air-Navigation Systems (FANS), features and benefits.

Text Book:

1. "The Air Transport System", Hirst, M., Woodhead Publishing Ltd, Cambridge, England ,(2008).

Reference Books:

1. " Air Transportation" ,Wensven J.G., A Management Perspective, ASHGATE Publishing limited, (2007).
2. "Air Transportation", Wilson and Bryon, Prentice Hall (1949).
3. "Global Airline Industry", Belobaba, P., Odoni, A. and Barnhart, C., John Wiley & Sons Ltd. ,1st Edition, (2009).
4. "Fundamentals of Air Traffic Control", Nolan, M.S., Thomson Learning, 4th Edition, (2004).
5. "Airport Planning and Management", Wells A. and Young S. Tata McGraw-Hill ,5th Edition (1986).

SHIVAJI UNIVERSITY, KOLHAPUR
T.E. (Aeronautical Engineering) Semester V
6. Aircraft Structures Lab

Teaching scheme:
Practical: 2 Hrs / week

Examination scheme:
Term Work : 25 Marks
Oral Exam : 25 Marks

Course Objectives:

The course aims to:

1. Understand and appreciate various principles of aircraft structures
2. Understand various theorems involved in the theory of vibrations and experimental stress analysis.

Course Outcome:

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

1. Enrich their knowledge in the design of various aircraft structural components

List of Experiments: (Minimum Ten)

1. Study of construction and use of Universal Testing Machine, mechanical and optical extensometers- application to determine stress-strain curves and tensile and compressive strength of various engineering materials.
2. Bending tests- deflection of slender and short beams for various loading and end conditions- determination of influence coefficients- verification of Maxwell's and Castigliano's theorems.
3. Compression tests on long and short columns- determination of buckling loads– Southwell plot.
4. Determination of the strength and deformation of riveted and bolted joints.
5. Methods of inspection and non-destructive testing (NDT) of aircraft structural components.
6. Strain gauge techniques- measurement of strain in beams, thin and thick walled cylinders subjected to internal pressure, shaft subjected to combined loading.
7. Shear Centers of open section beam.
8. Shear Centers of closed section beam.
9. Post buckling behavior of shear panels- measurements on semi-tension field webs of beams.
10. Determination of elastic constants of composite materials- flexural test on composites.
11. Study and calibration of photo and magnetic speed pickups for the measurement of speed.
12. Free vibration of cantilever beam
13. Forced vibration of beam
14. Study and use of seismic pickups for the measurement of amplitude and frequency of vibration of structural components.
15. Determination of critical fracture toughness of aerospace materials.

Reference books:

1. "Aircraft Structures for Engineering Students", Megson, T.H.G., Elsevier, , ISBN 0-750-667397, 4th Edition ,(2007).
2. "Analysis and Design of Flight Vehicles Structures", Bruhn. E.H,Tri-state Off-set Company, USA, (1965).

SHIVAJI UNIVERSITY, KOLHAPUR
T.E. (Aeronautical Engineering) Semester V

7. Aerodynamics Lab

Teaching Scheme	**Examination Scheme**
Practical: 2 Hrs / week	Term Work : 25 Marks
	Practical and Oral Exam:25 Marks

Course Objectives:

The course aims to:

1. Enable the knowledge of wind tunnel and its application
2. Familiarize the students with the operation of wind tunnel
3. Enable to acquire data from different models from the wind tunnel
4. Perform various operations to study the flow physics over various aerodynamic models

Course Outcomes:

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

1. Have knowledge of subsonic wind tunnel and its applications
2. Will be able to operate the wind tunnel for doing various experiments
3. Collect data by performing various experiments on the wind tunnel
4. Have knowledge of various flow physics based on various aerodynamic model

List of Experiments:

Any ten experiment from the following

1. Study of subsonic wind tunnel
2. Calibration of a subsonic wind tunnel.
3. Tuft flow visualization on a circular cylinder
4. Study of flow over cambered airfoil using tuft flow visualization.
5. Smoke flow visualization studies on a circular cylinder.
6. Study of flow over an airfoil and comparing it with flow over circular cylinder using smoke flow visualization.
7. Surface pressure distributions on a two-dimensional circular cylinder.
8. Pressure measurement over the surface of a asymmetrical airfoil.
9. Measurement of surface pressure distribution over a cambered airfoil.
10. Boundary layer velocity profile measurement on the tunnel wall.
11. Total drag calculation of a circular cylinder using pitot-static probe wake survey.
12. Calculation of total drag of a cambered airfoil at incidence using pitot-static probe wake survey.

SHIVAJI UNIVERSITY, KOLHAPUR
T.E. (Aeronautical Engineering) Semester V
8. Mini Project-I

Teaching scheme: Practical: 1Hr. / week

Examination scheme: Term Work : 50 Marks

Course Objectives:
The course aims to:

1) Give the student a complete idea of interacting with industry
2) Understand the requirements of Industry and meeting them.

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1. Approach an Industry of their interest.
2. Write the Industry about how he could go there to work on their core areas of competence and interest, mutually.
3. Work in Industry according to their standards and meeting the requirements at the end in a given time line.

Topics:

Relevant topics in Industry which are current and in-demand and expected to be in current scenario not out-dated and up to date in trend (in all sense by material used, technology, by cause and reason for doing project)

Guidelines:
Students should carry out this Mini-Project in **'INDUSTRY'** under a guide or a supervisor there.

[Or]

Students could carry out this Mini-Project under the guidance of any faculty ONLY as a remote guide partially as a co-supervisor at the Department of Aeronautical Engineering provided the student already got the needed values or readings and want to formally complete analysis.

In either of the above cases work at **INDUSTRY**, coordination is **MUST**.

Duration: Should not be less than 2 weeks and **not exceeding 3 weeks**.

SHIVAJI UNIVERSITY, KOLHAPUR
T.E. (Aeronautical Engineering) Semester VI
1. Machines and Mechanisms

Teaching scheme:
Lectures : 3 Hrs. / week
Practical : 2 Hrs. / week

Examination scheme:
Theory Paper : 100 Marks
Term Work : 25 Marks

Course Objectives:
The course aims to:
1 Represent kinematic behavior of different machine elements and mechanisms.
2 Explain types of cam with followers and select according to their applications.
3 Compare types of governing mechanisms.
4 Study force analysis of flywheel.
5 Study static and dynamic Balancing of rotating masses.

Course Outcomes:
Upon successful completion of this course, the student will be able to:
1 Understand different types of mechanisms and their applications.
2 Analyze kinematic theories of mechanism.
3 Design cam with follower for different applications.
4 Select different governing mechanisms according to application.
5 Do static and dynamic Balancing of rotating masses.

Unit 1 Mechanisms **[10]**

Introduction ,Links, Pairs, Chain, Mechanism ,Machine structure, Degrees of freedom, Four bar chains, Terminology and definition, Planer, Spherical and Spatial Mechanisms , Grashoff's law, Kutzback criterion, Grubler's criterion for plane mechanism. Harding's notation, Inversion of mechanisms, Four bar, Single slider crank and double slider crank mechanisms, Simple problems , Instantaneous centre , Kennedy's theorem, Velocity and Acceleration of four bar and single slider crank mechanisms by relative velocity method.

Unit 2 Friction **[04]**

Friction in screw and nut, Pivot and collar, Thrust bearing, Plate and disc clutches, Belt (flat and V) and rope drives, Ratio of tensions, Effect of centrifugal and initial tension, Condition for maximum power transmission, Open and crossed belt drive.

Unit 3 Cams **[06]**

Concepts of cam mechanism, Comparison of cam mechanism with linkages, Types of cams and followers, Follower motion, Uniform, Parabolic, SHM and cycloidal. Cam terminology, Cam profiles construction for roller, Flat faced and knife edge follower types, Pressure angle, Derivatives of follower motion, High speed cams , Circular arc and tangent cams, Standard cam motion, Pressure angle and undercutting, Cam dynamics and jump-off phenomenon.

Unit 4 Gear Trains and Control Mechanisms **[07]**

Gear profile and geometry, Nomenclature of spur gear, Gear trains: simple, compound, reverted and epicyclic, Velocity ratio and torque calculation in gear trains, Automobile differential, Gyroscopes: Gyroscopic forces and couple , Forces on bearing due to gyroscopic action, Gyroscopic effect in ship, Motor Cycle, Car and Aircraft.

Unit 5 Static and Dynamic Force Analysis **[07]**

Free body diagram, Inertia force and inertia torque calculations, D'Alembert's principle, The principle of super position, Dynamic analysis in reciprocating engines, Gas forces, Equivalent masses, Bearing loads, Crank shaft torque, Turning moment diagrams: Fly wheels, Application of flywheel , Punching presses.

Unit 6 Balancing **[06]**

Static and dynamic balancing: Balancing machines and field balancing by vector diagram, Balancing of rotating masses, Balancing of single cylinder engine, Balancing of multi cylinder engine, Balancing in reciprocating mechanism, Partial balancing in locomotive engines, Hammer blow, Swaying couple, Tractive force , Balancing machines.

Term Work:

A term work shall consist of report on the following.

1. One A3 size sheet on velocity and acceleration problems by relative velocity and acceleration method.
2. One A3 size sheet on problem on Instantaneous center method and Klein's construction.
3. Minimum four numerical on friction
4. One A3 size sheet of problems on cam profile. (Minimum four problems).
5. Experiment on Gyroscope.
6. Generation of involute profile using rack cutter method.
7. Problems on epicyclic gear train using tabular method.
8. Balancing of rotary masses (Static and Dynamic)
9. Industrial visit based on above syllabus.

Text Books:

1 "Theory of Machines", Ratan, S.S., Tata McGraw Hill Publishing company Ltd., 2nd Edition ,(2005).

2 "Theory of Machines", Thomas Bevan, CBS Publishers and Distributors, 3rd Edition, (1984).

Reference Books:

1 "Theory of Machines and Mechanisms", Shigley J. E. and Uicker J. J., Tata McGraw Hill, (1995).

2 "Theory of Mechanisms and Machines", Ghosh, A. and Mallick A. K., Affiliated East West Pvt Ltd., New Delhi, (1988).

3 "Mechanism and Machine Theory", Rao, J. S. and Dukkipati R.V, Wiley Eastern Ltd., New Delhi ,(1995).

4 "Kinematics and Dynamic of Planer Machinery", Burton Paul, Prentice Hall of India, (1979).

5 "Theory of Machines", Sandorand Erdman.

SHIVAJI UNIVERSITY, KOLHAPUR
T.E. (Aeronautical Engineering) Semester VI
2. Design of Aircraft Structures

Teaching scheme:
Lectures : 3 hrs / week
Practical : 2 hrs / week

Examination scheme:
Theory Paper : 100 Marks
Term Work : 25 Marks

Course Objectives:
The course aims to:
1. Introduce fundamentals of aircraft design and forces acting on the structures.
2. Introduce the materials and manufacturing process used in aircraft structures.
3. Develop understanding of concepts of analysis of aircraft structures.
4. Develop understanding of concepts of aircraft structure repair and maintenance.

Course Outcomes:
Upon successful completion of this course, the student will be able to:
1. Understand the Basics of Aircraft Systems and Aircraft Structures.
2. Know Industry Practices on Design of Aircraft Structures and systems.
3. Understand the applicability of Design aspects in Aircraft Design.
4. Relate the theoretical knowledge with the design of Aircraft Structures and systems.

Unit 1 **Fundamentals of Aircraft Design and Structural Analysis** **[07]**

Introduction, Phases of Aircraft Design, Aircraft conceptual design process, Conceptual stage, preliminary design, Detailed design, Design methodologies review of Hooke's Law, Principal stresses, Equilibrium and Compatibility, Determinate structures, St Venant's principle, Conservation of energy, Stress transformation, Stress strain relations.

Unit 2 **Aircraft Structures and Loads** **[07]**

Types of structural members of fuselage and wing section ribs, Spars, Frames, Stringers, Longeron, Splices, Sectional properties of structural members and their loads, Types of structural joints, Type of Loads on structural joints, Aerodynamic loads, Inertial loads, Loads due to engine, Actuator loads, Maneuver Loads, VN diagrams, Gust loads, Ground loads, Ground conditions, Miscellaneous loads.

Unit 3 **Aircraft Materials and Manufacturing processes** **[06]**

Material selection criteria, Aluminum alloys, Titanium alloys, Steel alloys, Magnesium alloys, Copper alloys, Nimonic alloys, Non-metallic materials, Composite materials, Use of advanced materials Smart materials, Manufacturing of A/C structural members, Overview of types of manufacturing processes for composites, Sheet metal fabrication, Machining, Welding, Superplastic forming and diffusion bonding.

Unit 4 **Structural Analysis of Aircraft Structures - I** **[08]**

Theory of Plates - Analysis of plates for bending, Stresses due to bending, Plate deflection under different end conditions, Strain energy due to bending of circular, rectangular plates, Plate buckling, Compression buckling, Shear buckling, Buckling due to in plane bending moments, Analysis of stiffened panels in buckling, Rectangular plate buckling, Analysis of stiffened panels in post buckling, Post buckling under shear

Theory of Shells-Analysis of shell panels for buckling, Compression loading, Shear loading / Shell shear factor, Circumferential buckling Stress.

Unit 5 **Structural Analysis of Aircraft Structures – II** **[08]**

Theory of Beams- Assumptions in theory of bending, Moment of resistance, Section modulus, Neutral axis, Stress distribution diagram for cantilever and simply supported beam, Equation of bending, Symmetric beams in pure bending, Deflection of beams, Unsymmetrical beams in Bending, Plastic bending of beams, Shear stresses due to bending in thin walled beams, Bending of open section beams, Bending of closed section beams, Shear stresses due to torsion in thin walled Beams

Theory of Torsion- Assumptions in theory of pure torsion, Torsion equation for solid and hollow circular shaft, Shafts of non-circular sections, Torsion in closed section beams, Torsion in open section Beams, Multi cell sections

Unit 6 **Aircraft Structural Repair** **[04]**

Types of structural damage, Nonconformance, Rework, Repair, Allowable damage Limit, Repairable damage limit, Overview of ADL Analysis, Types of repair, Repair considerations and best practices

Term Work:

Term Work consist of Submission of assignments and Industrial Visit Reports.

A) Minimum Six Assignments based on the Syllabus.

Out of six, two assignments should contain the following:

- Hands-on calculation on exercises related to fundamentals of Structural Analysis
- Hands-on calculation on exercises involving, plate theory, beam theory and shell theory, Panel buckling, Shear flow Exercises in Aircraft Structures.

B) Industrial Visits

With an intent to get some exposure on Aerospace and related industries, arrange

- Industry Visits to some of the Industries in Aerospace like HAL (Hindustan Aeronautics Limited), NAL (National Aerospace Limited), ISRO (Indian Space Research Organization)

(**Or)**

- Visits to Aerospace Museums

(**Or)**

- Building miniature models of Aircraft /Gliders etc as a Hands on exercises conducted as competitions

Text Books:

1 "Aircraft Design-A Conceptual Approach", Daniel P.Raymer, AIAA Education Series,6th Edition

2 "Airframe Structural Design",Michael Niu, Conmilit Press, 2nd Edition ,(1988).

3 "Airframe Stress Analysis and Sizing", Michael Niu, Conmilit Press,3rd Edition ,(1999).

Reference Books:

1 "The Elements of Aircraft Preliminary Design", Roger D. Schaufele, Aries Publications, (2000).

2 "Aircraft Structural Maintenance", Dale Hurst, Avotek publishers, 2nd Edition ,(2006).

3 "Aircraft Maintenance and Repair", Frank Delp, Michael J. Kroes & William A. Watkins, Glencoe and McGraw-Hill, 6th Edition, (1993).

SHIVAJI UNIVERSITY, KOLHAPUR
T.E. (Aeronautical Engineering) Semester VI
3. Aerospace Propulsion-II

Teaching scheme:	**Examination scheme:**
Lectures :3Hrs / week	Theory Paper : 100 Marks
Tutorial : 1Hr / week	Term Work : 25 Marks

Course Objectives:
The course aims to:
1. Study about the turbines and its performance for various conditions.
2. Study the basics of ramjet and scramjet with their performance characteristics
3. Study the types of rockets and their working principles
4. Study about chemical rockets and propellants used in chemical rockets.
5. Study the advances in rocket propulsion and space propulsion.

Course Outcomes:
Upon successful completion of this course, the student will be able to:
1. Understand the working of turbine, blade profiles, performance, cooling methods in turbine blades and its limitations.
2. Understand the operating principle of ramjet, combustion and its performance basics of scramjet engine and integral ram engine.
3. Understand the rocket operating principles. Rocket nozzle classifications and performance of rockets.
4. Understand in detail about solid and liquid propellant rockets and the various types of propellants used with their grain structure and their burning rates.
5. Understand about electric, ion and nuclear rockets. The basics of solar sails and its operating principle.

Unit 1 **Aircraft Gas Turbines** **[08]**

Impulse and reaction blading of gas turbines, Velocity triangles and power output, Elementary theory, Vortex theory, Choice of blade profile, pitch and chord, Estimation of stage performance, Limiting factors in gas turbine design- Overall turbine performance, Methods of blade cooling, Matching of turbine and compressor, Numerical problems.

Unit 2 **Ramjet Propulsion** **[06]**

Operating principle, Sub critical, critical and Supercritical operation, Combustion in Ramjet Engine, Ramjet performance, Sample ramjet design calculations, Introduction to Scramjet- Preliminary concepts in supersonic combustion, Integral ram- rocket, Numerical problems.

Unit 3 **Fundamentals of Rocket Propulsion** **[06]**

Operating principle, Specific impulse of a rocket, Rocket nozzle Classification, Rocket performance considerations, Numerical Problems.

Unit 4 **Chemical Rockets** **[07]**

Solid propellant rockets , Selection criteria of solid propellants , Important hardware components of solid rockets , Propellant grain design considerations , Liquid propellant rockets, Selection of liquid propellants , Thrust control in liquid rockets , Cooling in liquid rockets ,Limitations of hybrid rockets , Relative advantages of liquid rockets over solid rockets, Numerical Problems.

Unit 5 **Ballistic Missile Trajectories** **[08]**

The general ballistic missile problem- Geometry of the trajectory, Free flight range equations, Flight path angle equation, Maximum range trajectory, Time of free flight. Effect of launching errors on range- Effect of lateral displacement of the burnout point, Cross range error due to incorrect launch azimuth, Effect of down range displacement of the burnout point, Errors in burn-out flight-path angle, Down range errors caused by incorrect burnout height and in correct speed at burnout. The effect of earth rotation- Compensating for the initial velocity of missile due to earth rotation, Compensating for movement of the target due to earth rotation.

Unit 6 **Advanced Propulsion Techniques** **[05]**

Electric rocket propulsion , Ion propulsion techniques, Nuclear rocket, Types, Solar sail- Preliminary concepts in nozzle less propulsion

Term Work:

Eight Assignments should be submitted as per following Guidelines

.

1. Make a chart with different Aircraft Gas- Turbines you know with their internal structure & their functions (preferably with colours, where ever the engine is cold will look blue hotter section should look red and shade it according to the hotter the more bright Edition)

2. Explain why we need different kinds of Aircraft Gas Turbine Engines for different applications with reason specific to each existing Gas-Turbine Engine. [Tabular column & specific explanations are expected]
3. Explain the applications of a Ramjet engine with neat sketches for at least six different applications.
4. Why do we need Rockets and why different kind of Rockets explain with specific details emphasizing on Solid, Liquid & hybrid propulsion systems in detail.
5. Write most popular Rocket propulsion system ever with all the detailed diagram of its propulsion system explaining why is it popular & what is it good for.
6. Compare distinctly a Solid propulsion rocket Engine & a Liquid propulsion Rocket engine for same purpose.
7. Take a specific Missile of Indian / U.S./ Russian origin and derive for a specific range or test conducted under Free flight range equation (Ballistic Missile Trajectory); Effects of launching errors on range (Ballistic Missile Trajectory); Flight path angle equation (Ballistic Missile Trajectory)
8. Write in detail about all specifications of most prospective (at least 3 including Electron rocket) Electric rocket propulsions in R & D and testing phase.

Text Books:

1 "Rocket Propulsion Elements", Sutton, G.P., John Wiley and Sons Inc., New York, 8th Edition, (2012).

2 "Rocket Propulsion and Spaceflight Dynamics", Cornelisse, J.W. PitmanPublishing,(1979).

3 "Mechanics and Thermodynamics of Propulsion", Hill, P.G. and Peterson, C.R. Addison, Wesley Longman INC, 2nd Edition, (1999).

Reference Books:

1 "H.I.H Gas Turbine Theory", Cohen, H., Rogers, G.F.C. and Saravanamuttoo, Longman Co., ELBS, 5th Edition, (1989).

2 "Aero thermodynamics of Gas Turbine and Rocket Propulsion", Gorden, C.V., AIAA Education Series, New York, (1989).

3 "Gas Turbines and Jet and Rocket Propulsion", Mathur, M. and Sharma, R.P., Standard Publishers, New Delhi (1988).

SHIVAJI UNIVERSITY, KOLHAPUR
T.E. (Aeronautical Engineering) Semester VI
4. Industrial Management and Operation Research

Teaching scheme:	**Examination scheme:**
Lectures : 3 Hrs / week	Theory Paper: 100 Marks
Practical : 2 Hrs / week	Term Work : 25 Marks

Course Objectives:
The course aims to:
1. Introduce evolution of Management, and how Planning, Organizing, Staffing and Control could be done.
2. Managing Personnel, industrial legislation and relations, Introduce industrial psychology, manpower planning, training and development, and other initiatives.
3. Introduce Operations Research with different tools and approach
4. Introduce tools in Project Management like different network models.
5. Introduce different types of business forms, organizations.
6. Introduce various kinds of financing, marketing options available, with risks involved in business and methodology to counter them.

Course Outcomes:
Upon successful completion of this course, the student will be able to:
1. Understand evolution of Management, and how Planning, Organizing, Staffing and Control could be done by different techniques.
2. Understand theoretically how to manage personnel, industrial legislation and relations, understanding how industrial psychology, manpower planning, training and development, and other initiatives work in Industry.
3. Understand Operations Research with different tools and approach with their application in different areas.
4. Understand different tools in Project management like network models to deal with different problems and finding more ideal solutions.
5. Understand different types of Business forms, organizations existing with their functions.
6. Understand various kinds of Financing, Marketing options available, with Risks involved in business and methodology to counter them in various ways for different scenarios.

Unit 1 Functions of Management **[08]**

Introduction: Evolution of Management Theory, Scientific management, Contributions of Taylor, Fayol, Mayo to scientific management.

Planning: The Process of Planning, Objectives, Policy and Procedures, Forecasting, Levels of Management Administration and Management, Principles and functions of Management: Leadership and decision making.

Organizing: Meaning, Importance and Principles, Span of Management, Centralization and Decentralization, Patterns of Organization, Line and Staff Relationships.

Staffing: Nature and Scope of staffing, Manpower planning, Selection and training, Performance Appraisal.

Controlling: Concept or Managerial Control, Control aids, Core responsibilities of managers

Unit 2 Human Resources Management **[06]**

Personnel management, industrial legislation and relations, Industrial psychology, Manpower planning, Training and development, Health, Safety, welfare, Remuneration and incentive schemes.

Unit 3 Operations Research **[06]**

Introduction to Operations Research, Definition, Linear programming, Graphical method, Simplex method, Dual problem, Dual simplex method, Concept of unit worth of resource, Sensitivity analysis, Transportation problems, Assignment problems.

Unit 4 Project Management **[04]**

Network models: CPM and PERT, Queuing theory. Game theory, Markov chain, Monte Carlo Simulation.

Unit 5 Business Forms and Organization **[10]**

Introduction: Nature and scope of business system, Objectives of business and social responsibilities of Business

Organizing a Business: Forms of ownership organization – Sole proprietor, partnership, Joint stock company, Co-operative society, State undertakings. Formation of Joint Stock Companies: Registration, issue of prospectus, Commencement Certificate, Private and Public Ltd. Companies, Choice of suitable form of business organization.

Public Sector: Central Government, Public Corporation, Local Government, Organization neither Public nor Private Sector, Clubs and Society, Cooperative Societies, Worker's Cooperatives, Building Societies.

Organization: Meaning, Types of organization, Line, Functional, Line Staff organization and line staff committee organization, Span of control.

Unit 6 Finance, Marketing and Risks **[06]**

Elements of Insurance: Meaning and causes of business risks, Insurance of business risks.

Marketing Functions: The marketing concept, Product planning, Choice of channels of distribution, Advertising and Salesmanship.

Financial Functions: Objectives and scope, Estimation of financial requirements Long Term, Medium Term, Short Term, Sources of Finance.

Term Work:

Minimum Ten Assignments from the following list should be submitted

1. Assignment on specific any Six different functions of management
2. Assignment on Human resource management how is it different from domestic to International markets.
3. Problems on linear programming and graphical method.
4. Problems on Simplex and Dual Simplex method
5. Assignment on transportation problems
6. Problems on CPM and PERT
7. Problems on Queuing theory
8. Assignment on game theory and Markov chain.
9. Assignment on Monte Carlo simulation
10. Different forms of ownership organization

11. Concept of organization and its types
12. Meaning, causes and Insurance of business risks
13. Different aspects of marketing function
14. Case study: Study of an organization nearby, its form of ownership, its type and different management functions (Planning, organizing, staffing and controlling etc.)

Text Books:

1. "Operations Research - An Introduction" H.A.Taha, Prentice Hall of India./Pearson Education, 9th Edition.
2. "Production Systems: Planning, Analysis and Control" ,J.L.Riggs, Wiley, 3rd Edition, (1987).
3. "Principles of Operations Research", Wagner H M, Prentice Hall of India Private Limited, New Delhi, 2nd Edition, (2003).

Reference Books:

1. "Graph Theory for Operations Research and Management: Applications in Industrial Engineering", Reza Zanjirani Farahani (Kingston University London, UK) and Elnaz Miandoabchi(Institute for Trade Studies and Research, Iran), (2012)
2. "Operations Research",Vijayakumar, Scitech Publication.

SHIVAJI UNIVERSITY, KOLHAPUR
T.E. (Aeronautical Engineering) Semester VI
5. Flight Mechanics-II

Teaching scheme:
Lectures : 3 Hrs./ Week
Practical : 2 Hrs./ Week

Examination scheme:
Theory Paper: 100 Marks
Term Work : 25 Marks
Oral Exam : 25 Marks

Course Objectives:
The course aims to:

1 Understand basic laws involving orbits, gravitation, concept of celestial sphere, equinoxes, co-ordinate systems, time systems.
2 Introduce two-body orbital mechanics, restricted three body problem and basics associated with them.
3 Introduction to different kind of orbits, Importance of Perturbations, different kinds of perturbations and their effect on Satellites.
4 Introduce basic orbital maneuvers their need, how and when they are used and their application.
5 Introduce trajectories, types including ballistic, lunar and interplanetary trajectories in detail

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1 Perfect the basics of coordinate systems in space, time systems, basics of astronomy and their calculations.
2 Understand conceptualise 2-Body and R3-Body mechanics and solve the problems associated with them.
3 Understand need of maneuver and types of maneuver and their applications.
4 Understand basics of orbits and their associated laws, applications of orbits. Significance of orbital perturbations in different calculations.
5 Understand trajectories their types including ballistic, lunar and interplanetary trajectories in detail with mission planning perspective and even design or does a case study on any mission design in given parameters.

Unit 1 Basic Concepts **[07]**

Solar system, comets and meteors, Kepler's laws and Newton's law of gravitation, Concept of celestial sphere, Vernal equinox, Ecliptic. Coordinate Systems, ECI system, Geographic coordinate system, Azimuth elevation coordinate system, Ecliptic system, Time systems-sidereal time, Mean solar time, Julian date, Universal time, Ephemeris time. Effect of orbital altitude on satellite lifetimes.

Unit 2 **Two-Body Orbital Mechanics** **[07]**

N-body problem, Two-body problem-simplifying assumptions. Equations of relative motion. Constants of the motion-conservation of angular momentum, Trajectory equation, Elliptical orbit-Geometry of the ellipse, Period of an elliptical orbit, Circular orbit, Parabolic orbit, Hyperbolic orbit. Geometry of the hyperbola, hyperbolic Excess speed orbital elements. Basic Problems associated with two-body problem.

Restricted Three Body Problem

Introduction, equations of motion, Lagrangian points, stability of the Lagrangian Points, Jacobi's integral, accessible regions. Basic Problems associated with Restricted Three Body Problem.

Unit 3 **Basic Orbital Maneuvres** **[06]**

Low altitude earth orbits, Effect of orbital altitude on satellite life times, Direct ascent to orbit, Perturbation so flow earth orbits due to the oblate shape of the Earth. High altitude earth orbits, The synchronous satellite, Launching a high altitude satellite. In-plane orbit changes, Adjustment of perigee and apogee height, Hohmann transfer, general coplanar transfer between circular orbits, Out of plane orbit changes, simple plane change.

Unit 4 **Orbit Perturbations** **[06]**

General overview of orbit perturbations, Earth Gravity Harmonics, Luni, Solar Gravitational attractions, Solar Radiation Pressure Effects, Atmospheric drag effects, Tidal friction effects and Mutual Gravitational attraction. Earth's Oblations (J_2) effects, Critical Inclination. Sun-synchronous orbits, J_3 effects and Frozen orbits, Earth's Tri-axiality effects and East-West Station keeping.

Unit 5 **Lunar Trajectories** **[07]**

The Earth, Moon system-Orbital elements of the moon, Simple Earth-Moon trajectories, Some simplifying assumptions, Time of flight versus injection speed, Minimum energy Trajectory, Miss distance at the Moon caused by injection errors. The patched conic approximation-Geocentric departure orbit, Condition satthe patch point, Seleno-Centric arrival orbit. Non-coplanar lunar trajectories, Some typical

Constraint sonlunar trajectories, Determining the geocentric sweep angle. Select ingan acceptable launch date.

Unit 6 **Interplanetary Trajectories** **[07]**

Patched-Conic approximation-Heliocentric transfer orbit, Phase angle at departure, Escape from the earth's sphere influence, Arrival at the target planet, Effective collision cross, Section. Locating the planets, Launch opportunity, Synodic period, Trajectory type and class, Ephemeris calculations, Non-coplanar inter planetary trajectories, Gravity-Assist maneuver. Fast interplanetary trajectories.

Term Work:
Six Assignments should be submitted as per following Guidelines

1. i. Write the JD of your Birthday according to your X^{th} standard certificate.
   ii. Write the JD of 12:00 am 1947, August 15^{th}; [Indian Independence]
   iii. Choose a standard recent launch time precisely with a mission & designation to derive its JD.

2. i. What do you understand by concept of celestial sphere, divisions how is it related to a common man on everyday basis.
   ii. Write applications with respect to common man;
   iii. Write applications with respect to Orbital mechanics specifically.

3. i. In studying effect of orbital altitude on satellite lifetimes what we are achieving?
   ii. Take a satellite or spacecraft which has been recently de-orbited or forced to re-entry into earth's atmosphere and write all the specific details with respect to its life-time, reasoning if the satellite has achieved its complete life time or not? If yes Why? If no Why?

4. Write a detailed description of Falcon-1 and Falcon-9 launch vehicles of Space X and write specifically what separates them from rest of the World's launchers.

5. Write a detailed understanding of India's Chandrayaan-I mission with highlights of mission & accomplishments with all possible details with respect to current course.

6. Write a detailed understanding of India's Mars Mission, Mangalyaan (or) Mars Orbiter Mission as on date recorded, with highlights of mission & accomplishments with all possible details with respect to current course.

Text Books:

1. "FundamentalsofAstrodynamics", Bate R.R., Mueller D.D.andWhite, J.E.,Dover Publications Inc.,New York ,(1971).
2. "Orbital Mechanics", Chobotov,V.A., ed, AIAA Education Series, 3^{rd} Edition, (2002).

Reference Books:

1. "Space flight Dynamics", Wiesel,W.E. , Tata McGraw-Hill, New York, 2^{nd} Edition, (1995).
2. "Introduction to Space Flight", Hale,F.J., Prentice Hall of India, (1994).
3. "Understanding Space: An Introduction to Astronautics", Sellers J.J., Tata McGraw-Hill, , 2^{nd} Edition, (2004).
4. "Rocket Propulsion and Space Flight Dynamics", Cornelisse J.W., Pitman Publishing, (1979).
5. "Fundamentals of Astrodynamics and Applications", Vallado D.A ,Microcosm Inc., 2^{nd} Edition. Illustrated Reprint Edition, (2001).
6. "Spacecraft Mission Design", Brown C.D, AIAA Education Series, 2^{nd}Edition (1998).

SHIVAJI UNIVERSITY, KOLHAPUR
T.E. (Aeronautical Engineering) Semester VI
6. Aerodynamics and Propulsion Lab

Teaching scheme:
Practical: 2 Hrs / week

Examination scheme:
Term Work : 25 Marks
Practical and Oral Exam:25 Marks

Course Objectives:
The course aims to:

1. Know about different types of aircraft engines and their parts
2. Get the knowledge of types of convective heat transfer
3. Understand the propellants parameters
4. Understand the nozzle flow and flow through fuel injector

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1. Demonstrate the different types of aircraft engine
2. Illustrate the types of heat transfer
3. Measures the performance parameters of a solid propellants
4. Demonstrate the different flow patterns of fuel injector and nozzle.

List of Experiments:

1. To study aircraft piston engine, and the assembly of sub systems
2. To understand aircraft piston engine's components, functions, operating principles
3. To study aircraft jet engine, and the assembly of sub systems
4. To understand aircraft jet engine's components, functions, operating principles
5. To study about forced convective heat transfer
6. To study about free convective heat transfer
7. To study performance of a propeller
8. To study the functioning of aircraft gas turbine engines.
9. Experiment on solid propellant test rig.
10. Experiment on continuous combustion test rig.
11. Study Fuel-injection characteristics
12. Study the nozzle flow.

SHIVAJI UNIVERSITY, KOLHAPUR
T.E. (Aeronautical Engineering) Semester VI
7. Seminar

Teaching scheme:
Practical: 2 Hrs. / week

Examination scheme:
Term Work :50 Marks

Topic
Any Advanced topic of Aeronautical or Aerospace Engineering application may be a seminar topic.

The seminar may be based on proposed project work also.

Seminar Load:-

Maximum 9-10 students in one batch, Maximum 9-10 students shall work under one Faculty Member Group of one student is not allowed under any circumstances

Seminar Term:
Seminar report should be of 25 to 35 pages. For standardization of the seminar reports the following format should be strictly followed

1. page Size : Trimmed A4
2. Top Margin : 1.00 Inches
3. Bottom Margin: 1.32 Inches
4. Left Margin : 1.5 Inches
5. Right Margin : 1.0 Inches
6. Para Text : Font - Times New Roman, 12 Point
7. Line Spacing : 1.5 Lines
8. Page Numbers : Right Aligned and in Footer.
9. Headings : Font Times New Roman, 12 Point
   : Times New Roman, 14 Point, Boldface
10. Certificate : All students should attach standard format of certificate

The entire seminar should be documented as one chapter. References should have the following format

For Books:
1. “Title of Book”; Authors; Publisher; Edition;

For Papers:
1. “Title of Paper”; Authors; Journal/Conference Details; Year.

All students have to present their seminars individually in front of the faculties

SHIVAJI UNIVERSITY, KOLHAPUR
T.E. (Aeronautical Engineering) Semester VI

8. Mini Project-II

Teaching scheme:
Practical: 1Hr / week

Examination scheme:
Term Work : 25 Marks
Practical and Oral Exam : 25 Marks

Course Objectives:
The course aims to:

1. Give the student a complete idea of interacting with industry
2. Understand the requirements of Industry and meeting them.

Course Outcomes:
Upon successful completion of this course, the student will be able to:

1. Approach an Industry of their interest.
2. Write the Industry about how he could go there to work on their core areas of competence and interest, mutually.
3. Work in Industry according to their standards and meeting the requirements at the end in a given time line.

Topics:

Relevant topics in Industry which are current and in-demand and expected to be in current scenario not out-dated and up to date in trend (in all sense by material used, technology, by cause and reason for doing project)

Guidelines:
Students should carry out this Mini-Project in **'INDUSTRY'** under a guide or a supervisor there.

[Or]

Students could carry out this Mini-Project under the guidance of any faculty ONLY as a remote guide partially as a co-supervisor at the Department of Aeronautical Engineering provided the student already got the needed values or readings and want to formally complete analysis.

In either of the above cases work at **INDUSTRY**, coordination is **MUST**.

Duration: Should not be less than 2 weeks and **not exceeding 3 weeks**.