MANGALORE INSTITUTE OF TECHNOLOGY AND ENGINEERING
(An ISO 9001:2015 Certified Institution)

1.3.2. Average percentage of courses that include experiential learning through project work/field work/internship during last five years

ACADEMIC YEAR 2016-17

AERONAUTICAL ENGINEERING

Documents contains list and syllabus of courses that includes experiential learning through project works, internships and field work for the department.

Documents Enclosed

Sl. No	Particulars	Page Nos
1.	List of course that include experiential learning through project works, internships and field work	1-2
2.	Syllabus of the courses mapped	3-121

LIST OF COURSES THAT INCLUDE EXPERIENTIAL LEARNING THROUGH PROJECT WORKS, INTERNSHIPS AND FIELD WORK

Total number of courses mapped: 52

SL. NO	COURSE CODE	COURSE NAME
1	15PHY12	ENGINEERING PHYSICS
2	15CIV13	ELEMENTS OF CIVIL ENGG. & MECHANICS
3	15EME14	ELEMENTS OF MECHANICAL ENGG
4	15ELE15	BASIC ELECTRICAL ENGG
5	15WSL16	WORKSHOP PRACTICE
6	15PCD23	PROGRAMMING IN C & DATA STRUCTURES
7	15CED24	COMPUTER AIDED ENGINEERING DRAWING
8	15ELN25	BASIC ELECTRONICS
9	15CPL26	COMPUTER PROGRAMMING LAB
10	15AE32	ELEMENTS OF AERONAUTICS
11	15AE33	AERO THERMODYNA MICS
12	15AE34	MECHANICS OF MATERIALS
13	15AE35	MECHANICS OF FLUIDS
14	15AE36	MEASUREMEN T & METROLOGY
15	15AEL37A	MEASUREMEN T AND METROLOGY LAB
16	15AEL38	MACHINE SHOP LAB
17	15MAT 41	ENGINEERING MATHEMATICS-IV
18	15AE42	AERODYNAMICS - I
19	15AE43	AIRCRAFT PROPULSION
20	15AE44	MECHANISMS AND MACHINE THEORY
21	15AE45	AIRCRAFT MATERIAL SCIENCE
22	15AE46	TURBOMACHINES
23	15AEL48	COMPUTER AIDED AIRCRAFT DRAWING
24	15AEL47B	MATERIAL TESTING LAB
25	10AL51	MANAGEMENT AND ENTREPRENEURSHIP
26	10AE52	INTRODUCTION TO COMPOSITE MATERIALS
27	10AE53	DYNAMICS OF MACHINES
28	10AE54	AERODYNAMICS – I
29	10AE55	AIRCRAFT PROPULSION
30	10AE56	AIRCRAFT STRUCTURES – I
31	10AEL57	AERODYNAMICS LAB.

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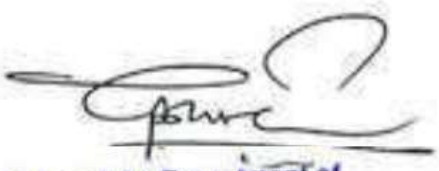
32	10AEL58	ENERGY CONVERSION LAB
33	10AE61	APPLIED GAS DYNAMICS
34	10AE62	AIRCRAFT PERFORMANCE
35	10AE63	AERODYNAMICS – II
36	10AE64	FINITE ELEMENT ANALYSIS
37	10AE65	THEORY OF VIBRATIONS
38	10AE666	ROCKETS AND MISSILES
39	10AEL67	STRUCTURES LAB.
40	10AEL68	PROPULSION LABORATORY
41	10AE71	CONTROL ENGINEERING
42	10AE72	AIRCRAFT STRUCTURES - II
43	10AE73	AIRCRAFT STABILITY AND CONTROL
44	10AE74	GAS TURBINE TECHNOLOGY
45	10AE752	COMPUTATIONAL FLUID DYNAMICS
46	10AE762	HELICOPTER DYNAMICS
47	10AEL77	DESIGN, MODELING AND ANALYSIS LABORATORY
48	10AEL78	SIMULATION LABORATORY
49	10AE81	FLIGHT VEHICLE DESIGN
50	10AE82	AVIONICS
51	10AE831	FLIGHT TESTING
52	10AE848	AIRCRAFT SYSTEMS AND INSTRUMENTATION



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SYLLABUS OF THE COURSES MAPPED

ENGINEERING PHYSICS

[As per Choice Based Credit System (CBCS) scheme]

(Effective from the academic year 2015 -2016) SEMESTER - I/II

Subject Code	15PHY12/15PHY22	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS - 04

COURSE OBJECTIVES:

The Objective of this course is to make students learn and understand basic concepts and principles of physics to analyze practical engineering problems and apply its solutions effectively and meaningfully. To understand building up of models, design issues, practical oriented skills and problem solving challenges are the great task of the course. To know about shock waves and practical applications is the prime motto to introduce new technology at the initial stage of Engineering.

Module -1	**Teaching Hours**

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Modern Physics and Quantum Mechanics	10 Hours
Black body radiation spectrum, Assumptions of quantum theory of radiation, Plank's law, Weins law and Rayleigh Jeans law, for shorter and longer wavelength limits. Wave Particle dualism, deBroglie hypothesis. Compton Effect. Matter waves and their Characteristic properties, Definition of Phase velocity and group velocity, Relation between phase velocity and group velocity, Relation between group velocity and particle velocity. Heisenberg's uncertainity principle and its application, (Non-existence of electron in the nucleus).Wave function, Properties and physical significance of wave function, Probability density and Normalization of wave function. Setting up of one dimensional time independent Schrodinger wave equation. Eigen values and Eigen functions. Application of Schrodinger wave equation for a particle in a potential well of infinite depth and for free particle.	
Module -2	

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Electrical Properties of Materials Free–electron concept (Drift velocity, Thermal velocity, Mean collision time, Mean free path, relaxation time). Failure of classical free electron theory. Quantum free electron theory, Assumptions, Fermi factor, density of states (qualitative only) Fermi–Dirac Statistics. Expression for electrical conductivity based on quantum free electron theory, Merits of quantum free electron theory. Conductivity of Semi conducting materials, Concentration of electrons and holes in intrinsic semiconductors, law of mass action. Temperature dependence of resistivity in metals and superconducting materials. Effect of magnetic field (Meissner effect). Type I and Type II superconductors–Temperature dependence of critical field. BCS theory (qualitative). High temperature superconductors. Applications of superconductors –. Maglev vehicles.	**10 Hours**
Module – 3	
Lasers and Optical Fibers Einstein's coefficients (expression for energy density). Requisites of a Laser system. Condition for laser action. Principle, Construction and working of CO_2 laser and semiconductor Laser. Applications of Laser – Laser welding, cutting and drilling. Measurement of atmospheric pollutants. Holography–Principle of Recording and reconstruction of images. Propagation mechanism in optical fibers. Angle of acceptance. Numerical aperture. Types of optical fibers and modes of propagation. Attenuation, Block diagram discussion of point to point communication, applications.	**10 Hours**
Module-4	

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Crystal Structure Space lattice, Bravais lattice–Unit cell, primitive cell. Lattice parameters. Crystal systems. Direction and planes in a crystal. Miller indices. Expression for inter – planar spacing. Co-ordination number. Atomic packing factors (SC,FCC,BCC). Bragg's law, Determination of crystal structure using Bragg's X–ray difractometer. Polymarphism and Allotropy. Crystal Structure of Diamond, qualitative discussion of Pervoskites.	**10 Hours**
Module-5	
Shock waves and Science of Nano Materials Definition of Mach number, distinctions between- acoustic, ultrasonic, subsonic and supersonic waves. Description of a shock wave and its applications. Basics of conservation of mass, momentum and energy. Normal shock equations (Rankine-Hugonit equations). Method of creating shock waves in the laboratory using a shock tube, description of hand operated Reddy shock tube and its characteristics. Introduction to Nano Science, Density of states in 1D, 2D and 3D structures. Synthesis : Top–down and Bottom–up approach, Ball Milling and Sol–Gel methods. CNT – Properties, synthesis: Arc discharge, Pyrolysis methods, Applications. Scanning Electron microscope: Principle, working and applications.	**10 Hours**
Course outcomes: On Completion of this course, students are able to – • Learn and understand more about basic principles and to develop problem solving skills and implementation in technology.	

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- Gain Knowledge about Modern physics and quantum mechanics will update the basic concepts to implement the skills.
- Study of material properties and their applications is the prime role to understand and use in engineering applications and studies.
- Study Lasers and Optical fibers and its applications are to import knowledge and to develop skills and to use modern instruments in the engineering applications.
- Understand Crystal structure and applications are to boost the technical skills and its applications.
- Expose shock waves concept and its applications will bring latest technology to the students at the first year level to develop research orientation programs at higher semester level.
- Understand basic concepts of nano science and technology.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be **2** full questions(with a **maximum** of **four** sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer **5** full questions, selecting one full question from each module.

Text Books:

1. Wiley precise Text, **Engineering Physics,** Wiley India Private Ltd., New Delhi. Book series – 2014,
2. Dr. M.N. Avadhanulu, Dr. P.G.Kshirsagar, **Text Book of Engineering Physics,** S Chand Publishing, New Delhi - 2012

Reference Books:

1. S.O.Pillai, **Solid State Physics, New** Age International. Sixth Edition.
2. Chintoo S Kumar ,K Takayana and K P J Reddy, **Shock waves made simple,** Willey India Pvt. Ltd. New Delhi,2014

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3. A Marikani, **Engineering Physics,** PHI Learning Private Limited, Delhi - 2013
4. Prof. S. P. Basavaraju, **Engineering Physics,** Subhas Stores, Bangalore – 2
5. V Rajendran ,**Engineering Physics,** Tata Mc.Graw Hill Company Ltd., New Delhi - 2012
6. S Mani Naidu, **Engineering Physics,** Pearson India Limited - 2014

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ELEMENTS OF CIVIL ENGINEERING AND ENGINEERING MECHANICS

[As per Choice Based Credit System (CBCS) scheme]
(Effective from the academic year 2015 -2016) SEMESTER - I/II

Subject Code	15CIV13/23	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS - 04

COURSE OBJECTIVES:

The objectives of this course is to make students to learn basics of Civil Engineering concepts and infrastructure development, solve problems involving Forces, loads and Moments and know their applications in allied subjects. It is a pre-requisite for several courses involving Forces, Moments, Centroids, Moment of inertia and Kinematics.

Particulars	**Hours**
Module 1: Introduction to Civil Engineering &Engineering Mechanics	**10**
Introduction to Civil Engineering Scope of different fields of Civil Engineering - Surveying, Building Materials, Construction Technology, Geotechnical Engineering, Structural Engineering, Hydraulics, WaterResources and Irrigation Engineering, Transportation Engineering, Environmental Engineering.	01
Infrastructure: Types of infrastructure, Role of Civil Engineer in theInfrastructural Development, Effect of the infrastructural facilities onsocio-economic development of a country.	01
Roads: Classification of Roads and their functions, Comparison of Flexible and Rigid Pavements (Advantages and Limitations)	01

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Bridges: Types of Bridges and Culverts, RCC, Steel and Composite Bridges	01
Dams: Different types of Dams based on Material, Structural behavior and functionality with simple sketches.	01
Introduction to Engineering Mechanics: Basic idealizations - Particle, Continuum and Rigid body; Newton's lawsBForce and its characteristics, types of forces-Gravity, Lateral and its distribution on surfaces, Classification of force systems, Principle of physical independence, superposition, transmissibility of forces, , Introduction to SI units. Couple, Moment of a couple, Characteristics of couple, Moment of a force, Equivalent force - Couple system; Numerical problems on moment of forces and couples, on equivalent force - couple system.	 02 03
Module 2: Analysis of Concurrent Force Systems	**10**
Concepts: Resultants and Equilibrium Composition of forces - Definition of Resultant; Composition of coplanar - concurrent force system, Parallelogram Law of forces, Principle of resolved parts;	03
Numerical problems on composition of coplanar concurrent force systems. Equilibrium of forces - Definition of Equilibrant; Conditions of static equilibrium for different force systems, Lami's theorem; Numerical problems on equilibrium of coplanar – concurrent and non-concurrent force systems.	03
Application- Static Friction in rigid bodies in contact Types of friction, Laws of static friction, Limiting friction, Angle of friction, angle of repose; Impending motion on horizontal and inclined planes; Numerical Problems on single and two blocks on inclined planes	02 02
Module - 3 Analysis of Non-Concurrent Force Systems	**10**

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Concepts: Resultants and Equilibrium Composition of coplanar - non-concurrent force system, Varignon's principle of moments; Numerical problems on composition of coplanar non-concurrent Force system.	05
Application-Support Reaction in beams Types of Loads and Supports, statically determinate beams, Numerical problems onsupport reactions for statically determinate beams with Point load (Normal and inclined) and uniformly distributed and uniformly varying loads and Moments.	05
Module 4 Centroids and Moments of Inertia of Engineering Sections:	**10**
Centroids Introduction to the concept, centroid of line and area, centroid of basic geometrical figures, computing centroid for– T, L, I, Z and full/quadrant circular sections and their built up sections. Numerical problems **Moment of Inertia** Introduction to the concept, Radius of gyration, Parallel axis theorem, Perpendicular axis theorem, Moment of Inertia of basic planar figures, computing moment of Inertia for – T, L, I, Z and full/quadrant circular sections and their built up sections. Numerical problems	05 05
Module 5: Kinematics	**10**
Concepts and Applications Definitions – Displacement – Average velocity – Instantaneous velocity – Speed – Acceleration - Average acceleration – Variable acceleration – Acceleration due to gravity – Newton's Laws of Motion.	02
Rectilinear Motion–Numerical problems.	02
Curvilinear Motion – Super elevation – ProjectileMotion – Relative motion – Numerical problems.	03
Motion under gravity – Numerical problems.	03
COURSE OUTCOMES After a successful completion of the course, the student will be able to: 1. Know basics of Civil Engineering, its scope of study, knowledge about Roads, Bridges and Dams;	

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2. Comprehend the action of Forces, Moments and other loads on systems of rigid bodies;
3. Compute the reactive forces and the effects that develop as a result of the external loads;
4. Locate the Centroid and compute the Moment of Inertia of regular crosssections.
5. Express the relationship between the motion of bodies and
6. Equipped to pursue studies in allied courses in Mechanics.

Question Paper Pattern:

- 10 Questions are to be set such that 2 questions are selected from each module.
- 2 Questions are to be set under respective modules.
- Intra module questions are to be set such that the questions should cover the entire module and further, should be answerable for the set marks.
- Each question should be set for 16 marks (Preferably 8 marks each)
- Not more than 3 sub questions are to be set under any main question
- Students should answer 5 full questions selecting at least 1 from each module.

TEXT BOOKS

1. Elements of Civil Engineering and Engineering Mechanics by M.N. Shesha Prakash and Ganesh. B. Mogaveer, PHI Learning, 3rd Revised edition (2014)
2. Engineering Mechanics-Statics and Dynamics by A Nelson, Tata McGraw Hill Education Private Ltd, New Delhi, 2009.
3. Elements of Civil Engineering (IV Edition) by S.S. Bhavikatti, New Age International Publisher, New Delhi, 3rd edition 2009.

REFERENCES

1. Engineering Mechanics by S.Timoshenko,D.H.Young, and J.V.Rao, TATA McGraw-Hill Book Company, New Delhi
2. Beer FP and Johnson ER, **"Mechanics for Engineers- Dynamics and Statics"**- 3rd SI Metric edition, Tata McGraw Hill. - 2008
3. Shames IH, **"Engineering Mechanics – Statics & Dynamics"**- PHI – 2009

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ELEMENTS OF MECHANICAL ENGINEERING

[As per Choice Based Credit System (CBCS) scheme]

(Effective from the academic year 2015 -2016)

SEMESTER - I/II

Subject Code	15EME14/15EME24	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS - 04

Course objectives:

Students belonging to all branches of Engineering are made to learn certain fundamental topics related to mechanical engineering so that they will have a minimum understanding of mechanical systems, equipment and process.

Module -1	**Teaching Hours**
Energy Resources : Non-renewable and renewable energy resources, **Petroleum based** solid, liquid and gaseous fuels, Calorific values of fuels, Combustion and combustion products of fuels, **Solar Power :** Solar Radiation, Solar constant (definition only), Solar Thermal energy harvesting, ex: liquid flat plate collectors, solar ponds (principle of operation only), Solar photovoltaic principle.**WindPower :**principle of operation of a typical windmill. **Hydro Power :**Principles of electric power generation from hydropowerplants, **Nuclear Power :** Principles of Nuclear power plants, **Bio Fuels :** introduction to bio fuels, examples of various biofuels used in engineering applications, Comparison of biofuels with petroleum fuels in terms of calorific value and emission. **Steam Formation and Properties :** Classification of boilers, Lancashire boiler, Babcock and Wilcox boiler, boiler mountings and accessories (No sketches for mountings and accessories), wet steam, saturated and superheated steam, specific volume, enthalpy andinternal energy. (No numerical problems in this module)	**10 Hours**

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Module -2	
Turbines and IC Engines and Pumps Steam turbines : Classification, Principle of operation of Impulse and reaction turbines, Delaval's turbine, Parson's turbine. (No compounding of turbines). **Gas turbines :**Classification, Working principles and Operations of Open cycle and closed cycle gas turbines. **Water turbines :**Classification, Principles and operations of Pelton wheel, Francis turbine and Kaplan turbine **Internal Combustion Engines :**Classification, I.C. Engines parts, 2 Stroke and 4 stroke Petrol engines, 4 stroke diesel engines. P-V diagrams of Otto and Diesel cycles. Problems on indicated power, brake power, indicated thermal efficiency, brake thermal efficiency, mechanical efficiency, and specific fuel consumption, [numericals on IC Engines].	**10 Hours**
Module - 3	
Machine Tools and Automation Machine Tools Operations : Turning, facing, knurling, Thread cutting, Taper Turning by swivelling the compound rest, Drilling, Boring, Reaming, Tapping, Counter Sinking, Counter Boring, -Plane milling, End milling, Slot milling. (No sketches of Machine tools, sketches to be used only for explaining operations. Students to be shown the available machine tools in the Machine Shop of the college before explaining the operations) **Robotics and Automation :** **Robotics :**Introduction, classification based on robots configuration; Polar, cylindrical, Cartesian Coordinate and spherical. Application, Advantages, and disadvantages **Automation :**Definition, types –Fixed, Programmable & Flexible automation, NC/ CNC machines: Basic elements with simple block diagrams, advantages and disadvantages.	**10 Hours**

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Module-4	
Engineering materials and joining processes : **Engineering Materials :**Types and applications of Ferrous & Nonferrous metals and alloys, **Composites :**Introduction: Definition, Classification and applications (Air craft and Automobiles) **Soldering, Brazing and Welding :** Definitions, classification and method of soldering, Brazing and welding. Differences between soldering, Brazing and Welding. Description of Electric Arc Welding and Oxy-Acetylene Welding.	**10 Hours**
Module-5	
Refrigeration, Air-Conditioning : **Refrigerants :**properties of refrigerants, list of commonly used refrigerants. Refrigeration –Definitions – Refrigerating effect, Ton of Refrigeration, Ice making capacity, COP, Relative COP, unit of Refrigeration. Principle and working of vapor compression refrigeration and vapour absorption refrigeration: Principles and applications of air conditioners, Room air conditioner.	**10 Hours**
Course outcomes: Students shall demonstrate knowledge associated with, 1. Various Energy sources, Boilers, Prime movers such as turbines and IC engines, refrigeration and air-conditioning systems 2. Metal removal process using Lathe, drilling, Milling Robotics and Automation. 3. Fair understanding of application and usage of various engineering materials.	

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Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be **2** full questions(with a **maximum** of **four** sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer **5** full questions, selecting one full question from each module.from each module.
- Each full question will have sub questions covering all the topics under a module.

Text Books:

1. V.K.Manglik, **"Elements of Mechanical Engineering"**, PHI Publications, 2013. (Module-1,2,4,5)
2. MikellP.Groover, **"Automation, Production Systems & CIM"**, 3rd Edition, PHI (Module -3)
3. K.R.Gopalkrishna, **"A text Book of Elements of Mechanical Engineering"**- Subhash Publishers, Bangalore. (Module -1,2,3,4,5)

Reference Books:

1. S.TrymbakaMurthy, **"A Text Book of Elements of Mechanical Engineering"**, 4th Edition 2006, Universities Press (India) Pvt Ltd, Hyderabad.
2. K.P.Roy, S.K.HajraChoudhury, Nirjhar Roy, **"Elements of Mechanical Engineering"**, Media Promoters & Publishers Pvt Ltd,Mumbai,7th Edition,2012
3. Pravin Kumar, **"Basic Mechanical Engineering"**, 2013 Edition, Pearson.

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BASIC ELECTRICAL ENGINEERING

[As per Choice Based Credit System (CBCS) scheme]
(Effective from the academic year 2015 -2016) SEMESTER - I/II

Subject Code	15ELE15/15ELE25	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

Credits - 04

Course objectives:

- Impart a basic knowledge of electrical quantities such as current, voltage, power, energy and frequency to understand the impact of technology in a global and societal context.
- Provide working knowledge for the analysis of basic DC and AC circuits used in electrical and electronic devices.
- Develop selection skill to identify the type of generators or motors required for particular application.
- Highlight the importance of transformers in transmission and distribution of electric power.
- Emphasize the effects of electric shock and precautionary measures.
- Improve the ability to function on multi-disciplinary teams.

Module -1	**Teaching Hours**
D C circuits: Ohm's Law and Kirchhoff's Laws, analysis of series, parallel and series- parallel circuits excited by independent voltage sources. Power and Energy. Illustrative examples.	**5 Hours**

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Electromagnetism: Review of field around a conductor and coil, magnetic flux and flux density, magnetomotive force and magnetic field intensity, reluctance and permeability, definition of magnetic circuit and basic analogy between electric and magnetic circuits. (These topics are not to be considered for setting the examination questions). **Electromagnetic induction:** Definition of Electromagnetic Induction, Faradays Laws, Fleming's right hand rule, Lenz's Law, Statically and dynamically induced emf. Self-inductance, mutual inductance and coefficient of coupling. Energy stored in magnetic field. Illustrative examples. Force on current carrying conductor placed in a magnetic field, Fleming's left hand rule.	**5Hours**

Module -2	
DC Machines: Working principle of DC machine as a generator and a motor. Types and constructional features. Types of armature windings, Emf equation of generator, relation between induced emf and terminal voltage with a mention of brush contact drop and drop due to armature reaction. Illustrative examples, neglecting armature reaction. Operation of DC motor, back emf, torque equation. Types of DC motors, characteristics and applications. Significance of back emf. Necessity of a starter for DC motor. Illustrative examples on back emf and torque.	**7 Hours**
Measuring Instruments: Construction and Principle of operation of dynamometer type wattmeterand single phase induction type energy meter.	**3 Hours**
Module - 3	
Single-phase AC circuits: Generation of sinusoidal voltage, frequency of generated voltage, definition and numerical values of average value, root mean square value, form factor and peak factor of sinusoidally varying quantities, phasor representation of alternating quantities. Analysis, with phasor diagrams, of R, L, C, R-L, R-C and R-L-C circuits and, parallel and series- parallel circuits. Real power, reactive power, apparent power and power factor. Illustrative examples.	**7 Hours**

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Domestic wiring: Service mains, meter board and distribution board. Brief discussion on concealed conduit wiring. Two-way and three-way control. Elementary discussion on Circuit protective devices: fuse and Miniature Circuit Breaker (MCB's). Electric shock, precautions against shock, Objectives of Earthing, types of earthing; pipe and plate earthing, Residual current circuit breaker (RCCB).	**3 Hours**
Module -4	
Three Phase Circuits: Necessity and advantages of three phase systems, generation of three phase power. Definition of Phase sequence, balanced supply and balanced load. Relationship between line and phase values of balanced star and delta connections. Power in balanced three-phase circuits, measurement of power by two-wattmeter method. Determination power factor using wattmeter readings. Illustrative examples.	**6 Hours**
Three PhaseSynchronous Generators: Principle of operation, Types and constructional features, Advantages of rotating field type alternator, Synchronous speed, Frequency of generated voltage, Emf equation. Concept of winding factor (excluding the derivation of distribution and pitch factors). Illustrative examples on calculation of distribution factor, pitch factor and emf equation.	**4 Hours**
Module-5	
Single Phase Transformers: Necessity of transformer, Principle of operation and construction of singlephase transformers (core and shell types). Emf equation, losses, variation losses with respect to load, efficiency, Condition for maximum efficiency, Voltage regulation and its significance (Open Circuit and Short circuit tests, equivalent circuit and phasor diagrams are excluded). Illustrative problems on emf equation and efficiency only.	**6 Hours**
Three Phase Induction Motors: Principle of operation, Concept and production of rotating magnetic field, Synchronous speed, rotor speed, Slip, Frequency of the rotor induced emf, Types and Constructional features. Slip and its significance. Applications of squirrel - cage and slip - ring motors. Necessity of a starter, starting of motor using stars-delta starter. Illustrative examples on slip calculations.	**4 Hours**

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Course outcomes:

After the completion of the course, the student should be able

- To predict the behaviour of electrical and magnetic circuits.
- Select the type of generator / motor required for a particular application.
- Realize the requirement of transformers in transmission and distribution of electric power and other applications.
- Practice Electrical Safety Rules & standards.
- To function on multi-disciplinary teams.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be **2** full questions(with a **maximum** of **four** sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer **5** full questions, selecting one full question from each module.

Text Books

1	Basic Electrical Engineering	D. C. Kulshreshtha	TMH	1st Edition, Revised
2	Electrical Technology	Edward Hughes	Pearson	10th Edition, 2014
	ReferenceBooks			
3	Fundamentals of Electrical Engineering	Rajendra Prasad	PHI	Third Edition 2014
4	Basic Electrical Engineering	AbhijitChakrabarti, Chandan Kumar Chanda, Sudiptanath	TMH,	1st Edition 2010
5	Fundamentals of Electrical Engineering and Electronics	B. L. Theraja	S. Chand & Company Ltd	Reprint Edition 2013

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WORKSHOP PRACTICE

[As per Choice Based Credit System (CBCS) scheme]

(Effective from the academic year 2015 -2016)

SEMESTER - I/II

Subject Code	**15WSL16/15WSL26**	IA Marks	20
Labs / Tutorial Hours/Week	3 (1 hr Tut +2 hrs lab)	Exam Marks	80
Total Number of Lecture Hours	42	Exam Hours	03

CREDITS - 02

Course objectives:

To impart knowledge and skill to use tools, machines, equipment, and measuring instruments.

Educate students of Safe handling of machines and tools.

Module -1	**Teaching Hours**
1. Demonstration on use of Hand Tools: V-block, Marking Gauge, Files, Hack Saw, Drills, Taps.Minimum 3 models involving Dove tail joint,Triangular joint and Semicircular joint. 2. Welding: Study of electric arc welding tools &equipments, Models: Butt Joint, Lap Joint, T joint & L-joint. 3. Sheet Metal & Soldering Work: Development & Soldering of the models: Tray, Frustum of cone, Prism(Hexagon & Pentagon),Truncated Square Pyramid, Funnel.	**3 Hours**

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Course outcomes:

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

1. Demonstrate and produce different types of fitting models.
2. Gain knowledge of development of sheet metal models with an understanding of their applications.
3. Perform soldering and welding of different sheet metal & welded joints.
4. Understand the Basics of Workshop practices.

Ref Books:

1

1. Elements of Workshop Technology:Vol I:Manufacturing Processes, S K Hajra.

Choudhury, A K. Hajra Choudhury,15th Edition Reprinted 2013,Media Promoters &Publishers Pvt Ltd., Mumbai.

Note: ***No mini drafters and drawing boards required. Drawings (Developments) can be doneon sketch sheets using scale , pencil and Geometrical Instruments***

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PROGRAMMING IN C AND DATA STRUCTURES

[As per Choice Based Credit System (CBCS) scheme]

(Effective from the academic year 2015 -2016)

SEMESTER - I/II

Subject Code	15PCD13/23	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS - 04

Course objectives:

The objectives of this course is to make students to learn basic principles of Problem solving, implementing through C programming language and to design & develop programming skills. To gain knowledge of data structures and their applications.

Module -1 : INTRODUCTION TO C LANGUAGE	**Teaching Hours**
Pseudo code solution to problem, Basic concepts in a C program, Declaration, Assignment & Print statements, Data Types, operators and expressions etc, Programming examples and exercise. **Text 1:** Chapter 2, **and** **Text 2:** 1.1, 1.2, 1.3	**10Hours**
Module -2: BRANCHING AND LOOPING	
Two way selection (if, if-else, nested if-else, cascaded if-else), switch statement, ternary operator? Go to, Loops (For, while-do, do-while) in C, break and continue, Programming examples and exercises. **Text 1:** Chapter 3**.** **&** **Text 2:** 4.4.	**10 Hours**
Module – 3: FUNCTIONS, ARRAYS AND STRINGS	
ARRAYS AND STRINGS: Using an array, Using arrays with Functions, Multi-Dimensional arrays. String: Declaring, Initializing, Printing and reading strings, string manipulation functions, String input and output functions, array of strings, Programming examples and Exercises. **Text 1:** 5.7, & **Text 2**: 7.3, 7.4, chapter 9	

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FUNCTIONS: Functions in C, Argument Passing – call by value, call by reference, Functions and program structure, location of functions, void and parameter less Functions, Recursion, Programming examples and exercises. **Text 1:** 1.7, 1.8, Chapter 4. **Text 2:** 5.1 to 5.4.	**10 Hours**

Module-4: STRUCTURES AND FILE MANAGEMENT	
Basic of structures, structures and Functions, Array of structures, structure Data types, type definition, Defining, opening and closing of files, Input and output operations, Programming examples and exercises. **Text 1:** 6.1 to 6.3. **Text 2**: 10.1 to 10.4, Chapter 11.	**10 Hours**
Module-5: POINTERS AND PREPROCESSORS & Data Structures	
Pointers and address, pointers and functions (call by reference) arguments, pointers and arrays, address arithmetic, character pointer and functions, pointers to pointer ,Initialization of pointer arrays, Dynamic memory allocations methods, Introduction to Preprocessors, compiler control Directives, Programming examples and exercises. **Text 1:** 5.1 to 5.6, 5.8. **Text 2: 12.2,** 12.3**, 13.1 to 13.7**. **Introduction to Data Structures**: Primitive and non primitive data types, Abstract data types, Definition and applications of Stacks, Queues, Linked Lists and Trees. **Text 2 : 14.1, 14.2, 14.11, 14.12, 14.13, 14.15, 14.16, 14.17, 15.1**.	**10 Hours**

Course outcomes: On completion of this course, students are able to

- Achieve Knowledge of design and development of C problem solving skills.
- Understand the basic principles of Programming in C language
- Design and develop modular programming skills.
- Effective utilization of memory using pointer technology
- Understands the basic concepts of pointers and data structures.

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Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be **2** full questions(with a **maximum** of **four** sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer **5** full questions, selecting one full question from each module.

Text Books:

1. Brian W. Kernighan and Dennis M. Ritchie: The C Programming Language, 2nd Edition, PHI, 2012.
2. Jacqueline Jones & Keith Harrow: Problem Solving with C, 1st Edition, Pearson 2011.

Reference Books:

1. Vikas Gupta: Computer Concepts and C Programming, Dreamtech Press 2013.
2. R S Bichkar, Programming with C, University Press, 2012.
3. V Rajaraman: Computer Programming in C, PHI, 2013.

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COMPUTER AIDED ENGINEERING DRAWING

[As per Choice Based Credit System (CBCS) scheme]

(Effective from the academic year 2015 -2016)

SEMESTER - I/II

Subject Code	15CED14/15CED24	IA Marks	20
Number of Lecture Hours/Week	6 (2T + 4L)	Exam Marks	80
Total Number of Lecture Hours	84	Exam Hours	03

CREDITS - 04

Course objectives:

Engineering drawing is an important tool for all Engineers and for many others professionals. It is the language of Engineers. Engineering Drawing communicates all needed information from the engineer who designed a part to the workers who will manufacture it.

The aim of the subject is to equip students with the fundamentals of Computer Aided Engineering Drawing and to further the ability to communicate information by graphical means.

Module -1	**Teaching Hours**

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Introduction to Computer Aided Sketching Introduction, Drawing Instruments and their uses, BIS conventions, Lettering, Dimensioning and free hand practicing. Computer screen, layout of the software, standard tool bar/menus and description of most commonly used tool bars, navigational tools. Co-ordinate system and reference planes. of HP, VP, RPP & LPP. of 2D/3D environment. Selection of drawing size and scale. Commands and creation of Lines, Co-ordinate points, axes, poly-lines, square, rectangle, polygons, splines, circles, ellipse, text, move, copy, off-set, mirror, rotate, trim, extend, break, chamfer, fillet, curves, constraints viz. tangency, parallelism, inclination and perpendicularity. Dimensioning, line conventions, material conventions and lettering.	**06 Hours**
Module -2	**Teaching Hours**
Orthographic projections Introduction, Definitions - Planes of projection, reference line and conventions employed, Projections of points in all the four quadrants, Projections of straight lines (located in First quadrant/first angle only), True and apparent lengths, True and apparent inclinations to reference planes (No application problems). Orthographic Projections of Plane Surfaces (First Angle Projection Only) Introduction, Definitions–projections of plane surfaces–triangle, square, rectangle, rhombus, pentagon, hexagon and circle, planes in different positions by change of position method only (No problems on punched plates and composite plates).	**20Hours**
Module-3	

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Projections of Solids (First angle Projection only) Introduction, Definitions – Projections of right regular tetrahedron, hexahedron (cube), prisms, pyramids, cylinders and cones in different positions (No problems on octahedrons and combination solid).	**28 Hours**
Module-4	
Sections And Development of Lateral Surfaces of Solids Introduction, Section planes, Sections, Section views, Sectional views, Apparent shapes and True shapes of Sections of right regular prisms, pyramids, cylinders and cones resting with base on HP. (No problems on sections of solids) Development of lateral surfaces of above solids, their frustums and truncations. (No problems on lateral surfaces of trays, tetrahedrons, spheres and transition pieces).	**15Hours**
Module-5	
Isometric Projection (Using Isometric Scale Only) Introduction, Isometric scale, Isometric projection of simple plane figures, Isometric projection of tetrahedron, hexahedron(cube), right regular prisms, pyramids, cylinders, cones, spheres, cut spheres and combination of solids (Maximum of three solids).	15 Hours
Course outcomes: After studying this course, 1. Students will be able to demonstrate the usage of CAD software. 2. Students will be able to visualize and draw Orthographic projections, Sections of solids and Isometric views of solids. 3. Students are evaluated for their ability in applying various concepts to solve practical problems related to engineering drawing.	

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Question paper pattern:

1. Module -1 is only for practice and Internal Assessment and not for examination.
2. Question paper for each batch of students will be sent online by VTU and has to be downloaded before the commencement of Examination of each batch. The answer sheets will have to be jointly evaluated by the Internal & External examiners.
3. A maximum of **THREE** questions will be set as per the following pattern *(No mixing of questions from different Modules).*

Q. No.	From Chapters	Marks Allotted
1	Module 2(Choice between (Points+Lines or Planes)	25
2	Module 3	30
3	Module 4 or Module 5	25
Total		80

Q. No.	Solutions and Sketching in the Graph Book	Computer Display and Printout	Total Marks
1	10	15	25
2	12	18	30
3	13	12	25
Total Marks	35	45	80

Students have to submit the computer printouts and the sketches drawn on the graph sheets at the end of the examination. Both Internal & External examiners have to jointly evaluate the solutions (sketches) and computer display & printouts of each student for 80 marks (35 marks for solutions & sketches + 45 marks for computer display and printouts) and submit the marks list along with the solution (sketches) on graph sheets & computer printouts in separate covers.

4. Each batch must consist of a minimum of 10 students and a maximum of 12 students.
5. Examination can be conducted in parallel batches, if necessary.

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Text Books:

1) **Engineering Drawing** - N.D. Bhatt & V.M. Panchal, 48th edition, 2005- Charotar Publishing House, Gujarat.

2) "**Computer Aided Engineering Drawing**" by Dr. M H Annaiah, Dr C N Chandrappa and Dr B Sudheer Premkumar Fifth edition, New Age International Publishers.

Reference Books:

1) Computer Aided Engineering Drawing - S. Trymbaka Murthy, - I.K. International Publishing House Pvt. Ltd., New Delhi, 3rd revised edition- 2006.

2) Engineering Graphics - K.R. Gopalakrishna, 32nd edition, 2005- Subash Publishers Bangalore.

3) Fundamentals of Engineering Drawing with an Introduction to Interactive Computer Graphics for Design and Production- Luzadder Warren J., Duff John M., Eastern Economy Edition, 2005- Prentice-Hall of India Pvt. Ltd., New Delhi.

4) A Primer on Computer Aided Engineering Drawing-2006, Published by VTU, Belgaum.

BASIC ELECTRONICS

[As per Choice Based Credit System (CBCS) scheme]

(Effective from the academic year 2015 -2016)

SEMESTER - I/II

Subject Code	15ELN15 / 15ELN25	IA Marks	20
Number of Lecture Hours/Week	04	Exam Marks	80
Total Number of Lecture Hours	50	Exam Hours	03

CREDITS - 04

Course objectives:

The course objective is to make students of all the branches of Engineering to understand the efficacy of Electronic principles which are pervasive in engineering applications

Module -1	**Teaching Hours**
Semiconductor Diodes and Applications (Text-1)**:** p-n junction diode, Characteristics and Parameters, Diode approximations, DC load line analysis, Half-wave rectifier, Two-diode Full-wave rectifier, Bridge rectifier, Capacitor filter circuit (only qualitative approch), Zener diode voltage regulators: Regulator circuit with no load, Loaded Regulator. Numerical examples as applicable. **Bipolar Junction Transistors:** BJT operation, BJT Voltages and Currents, BJT amplification, Common Base, Common Emitter and Common Collector Characteristics, Numerical examples as applicable.	**06 Hours** **04 Hours**

Module -2

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BJT Biasing (Text-1): DC Load line and Bias Point, Base Bias, Voltage divider Bias, Numerical examples as applicable. **Introduction to Operational Amplifiers** (Text-2)**:** Ideal OPAMP, Inverting and Non Inverting OPAMP circuits, OPAMP applications: voltage follower, addition, subtraction, integration, differentiation; Numerical examples as applicable.	**04 Hours** **06 Hours**

Module – 3	
Digital Electronics (Text-2): Introduction, Switching and Logic Levels, Digital Waveform (Sections 9.1to 9.3). Number Systems: Decimal Number System, Binary Number System, Converting Decimal to Binary, Hexadecimal Number System: Converting Binary to Hexadecimal, Hexadecimal to Binary, Converting Hexadecimal to Decimal, Converting Decimal to Hexadecimal, Octal Numbers: Binary to Octal Conversion. Complement of Binary Numbers. Boolean Algebra Theorems, De Morgan's theorem. Digital Circuits: Logic gates, NOT Gate, AND Gate, OR Gate, XOR Gate, NAND Gate, NOR Gate, X-NOR Gate. Algebraic Simplification, NAND and NOR Implementation (Sections 11.7 and 11.8): NAND Implementation, NOR Implementation. Half adder, Full adder.	**10 Hours**
Module-4	
Flip-Flops (Text-2)**:** Introduction to Flip-Flops (Section 12.1), NAND Gate Latch/ NOR Gate Latch, RS Flip-Flop, Gated Flip-Flops: Clocked RS Flip-Flop (Sections 12.3 to 12.5). **Microcontrollers** (Ref.1)**:** Introduction to Microcontrollers, 8051 Microcontroller Architecture and an example of Microcontroller based stepper motor control system (only Block Diagram approach).	**05 Hours** **05 Hours**

Module-5	
Communication Systems (Text-2): Introduction, Elements of Communication Systems, Modulation: Amplitude Modulation, Spectrum Power, AM Detection (Demodulation), Frequency and Phase Modulation. Amplitude and Frequency Modulation: A comparison. **Transducers (**Text-2)**:** Introduction, Passive Electrical Transducers, Resistive Transducers, Resistance Thermometers, Thermistor. Linear Variable Differential Transformer (LVDT). Active Electrical Transducers, Piezoelectric Transducer, Photoelectric Transducer.	**06 Hours** **04 Hours**

Course outcomes:

After studying this course, students will be able to:

- Appreciate the significance of electronics in different applications,
- Understand the applications of diode in rectifiers, filter circuits and wave shaping,
- Apply the concept of diode in rectifiers, filters circuits
- Design simple circuits like amplifiers (inverting and non inverting), comparators, adders, integrator and differentiator using OPAMPS,
- Compile the different building blocks in digital electronics using logic gates and implement simple logic function using basic universal gates, and
- Understand the functioning of a communication system, and different modulation technologies, and
- Understand the basic principles of different types of Transuducers.

Question paper pattern:

- The question paper will have ten questions.
- Each full Question consisting of 16 marks
- There will be **2** full questions(with a **maximum** of **four** sub questions) from each module.

- Each full question will have sub questions covering all the topics under a module.
- The students will have to answer **5** full questions, selecting one full question from each module.

Text Books:

1. David A. Bell, **"Electronic Devices and Circuits"**, Oxford University Press, 5th Edition, 2008.
2. D.P. Kothari, I. J. Nagrath, **"Basic Electronics"**, McGraw Hill Education (India) Private Limited, 2014.

Reference Books: MuhammadAli Mazidi, **"The 8051 Microcontroller and Embedded. Systems. Using Assembly and C."** Second Edition, 2011, Pearson India.

COMPUTER PROGRAMMING LABORATORY [As per Choice Based Credit System (CBCS) scheme] (Effective from the academic year 2015 -2016) SEMESTER - I/II			
Laboratory Code	**15CPL 16 / 15CPL26**	IA Marks	20
Number of Lecture Hours/Week	01Hr Tutorial (Instructions) + 02 Hours Laboratory	Exam Marks	80
Total Number of Lecture Hours	48	Exam Hours	03
CREDITS - 02			

Course objectives: To provide basic principles C programming language. To provide design & develop of C programming skills. To provide practical exposures like designing flowcharts, algorithms, how to debug programs etc**.**

Descriptions (if any):

Demonstration of Personal Computer and its Accessories: Demonstration and Explanation on Disassembly and Assembly of a Personal Computer by the faculty-in-charge. Students have to prepare a write-up on the same and include it in the Lab record and evaluated.

Laboratory Session-1: Write-up on Functional block diagram of Computer, CPU, Buses, Mother Board, Chip sets, Operating System & types of OS, Basics of Networking & Topology and NIC.

Laboratory Session-2: Write-up on RAM, SDRAM, FLASH memory, Hard disks, Optical media, CDROM/R/RW, DVDs, Flash drives, Keyboard, Mouse, Printers and Plotters. Introduction to flowchart, algorithm and pseudo code.

***Note: These* TWO Laboratory sessions** are used to fill the gap between theory classes and practical sessions. Both sessions are to be evaluated as lab experiments.

Laboratory Experiments:

Implement the following programs with WINDOWS / LINUX platform using appropriate C compiler.

1. Design and develop a flowchart or an algorithm that takes three coefficients (***a***, ***b***, and ***c***) of a Quadratic equation ($ax^2+bx+c=0$) as input and compute all possible roots. Implement a C program for the developed flowchart/algorithm and execute the same to output the possible roots for a given set of coefficients with appropriate messages.

2. Design and develop an algorithm to find the ***reverse*** of an integer number **NUM** and check whether it is PALINDROME or NOT. Implement a C program for the developed algorithm that takes an integer number as input and output the reverse of the same with suitable messages. Ex: Num: **2014**, Reverse: **4102**, Not a Palindrome

3.

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3a. Design and develop a flowchart to find the square root of a given number ***N***. Implement a C program for the same and execute for all possible inputs with appropriate messages. Note: **Don't use library function *sqrt(n)*.**

3b. Design and develop a C program to read a ***year*** as an input and find whether it is ***leap year*** or not. Also consider end of the centuries.

4. Design and develop an algorithm to evaluate polynomial $\mathbf{f(x) = a_4x^4 + a_3x^3 + a_2x^2 + a_1x + a_0}$, for a given value of ***x*** and its coefficients using Horner's method. Implement a C program for the same and execute the program with different set of values of coefficients and ***x.***

5. Draw the flowchart and Write a C Program to compute **Sin(x)** using Taylor series approximation given by **$\mathbf{Sin(x) = x - (x^3/3!) + (x^5/5!) - (x^7/7!) + \ldots\ldots}$**
   Compare your result with the built- in Library function. Print both the results with appropriate messages.

6. Develop an algorithm, implement and execute a C program that reads ***N*** integer numbers and arrange them in ascending order using ***Bubble Sort***.

7. Develop, implement and execute a C program that reads two matrices ***A*** (**m x n**) and ***B*** (**p x q**) and Compute product of matrices ***A*** and ***B***. Read matrix ***A*** and matrix ***B*** in row major order and in column major order respectively. Print both the input matrices and resultant matrix with suitable headings and output should be in matrix format only. Program must check the compatibility of orders of the matrices for multiplication. Report appropriate message in case of incompatibility.

8. Develop, implement and execute a C program to search a Name in a list of names using ***Binary searching*** Technique.

9. Write and execute a C program that
   i. Implements string copy operation ***STRCOPY***(str1,str2) that copies a string *str1* to another string *str2* without using library function. ii. Read a *sentence* and print frequency of vowels and total count of consonants.

10.
   a. Design and develop a C function ***RightShift****(x ,n)* that takes two integers *x* and *n* as input and returns value of the integer *x* rotated to the right by *n* positions. Assume the integers are unsigned. Write a C program that invokes this function with different values for *x* and *n* and tabulate the results with suitable headings.

   b. Design and develop a C function ***isprime***(num) that accepts an integer argument and returns 1 if the argument is prime, a 0 otherwise. Write a C program that invokes this function to generate prime numbers between the given range.

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11. Draw the flowchart and write a ***recursive* C** function to find the factorial of a number, ***n*!**, defined by *fact*(*n*)=1, if *n*=0. Otherwise *fact*(*n*)=*n***fact*(*n*-1). Using this function, write a C program to compute the binomial coefficient ${}_nC_r$. Tabulate the results for different values of ***n*** and ***r*** with suitable messages.

12. Given two university information files "**studentname.txt**" and "**usn.txt**" that contains students Name and USN respectively. Write a C program to create a new file called "**output.txt**" and copy the content of files "studentname.txt" and "usn.txt" into output file in the sequence shown below . Display the contents of output file "output.txt" on to the screen.

Heading

Student Name	USN
Name 1	USN1
Name 2	USN2
….	….
….	….

13. Write a C program to maintain a record of **n** student details using an array of structures with four fields (Roll number, Name, Marks, and Grade). Assume appropriate data type for each field. Print the marks of the student, given the student name as input.

14. Write a C program using pointers to compute the sum, mean and standard deviation of all elements stored in an array of **n** real numbers.

Course outcomes:

- **Gaining Knowledge on various parts of a computer.**
- **Able to draw flowcharts and write algorithms**
- **Able design and development of C problem solving skills.**
- **Able design and develop modular programming skills.**
- **Able to trace and debug a program**

Conduction of Practical Examination:

1 . All laboratory experiments (nos) are to be included for practical examination.

2 . Students are allowed to pick one experiment from the lot.

3 . Strictly follow the instructions as printed on the cover page of answer script for breakup of marks

4 . Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

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Elements of Aeronautics [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Subject Code	**15AE32**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
CREDITS – 04			

Course objectives: This course will enable students to

1. To know the history and basic principle of aviation
2. To understand the foundation of flight, aircraft structures, material aircraft propulsion
3. To develop an understanding stability of an aircraft along with its different systems

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **Introduction to Aircrafts** History of aviation; Atmosphere and its properties; Classification of aircrafts; Basic components of an aircraft; structural members; aircraft axis system; aircraft motions; control surfaces and high lift devices; classification of aircraft; conventional design configurations; principle of operation of each major part; Helicopters, their parts and functions. **Aircraft Structures and Materials:** Introduction; general types of construction; monocoque, semimonocoque and geodesic structures; typical wing and fuselage structure; metallic and non-metallic materials for aircraft application.	**10 Hours**	**L1, L2**

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Module -2 **Basic principles of flight** – significance of speed of sound; airspeed and groundspeed; standard atmosphere; Bernoulli's theorem and its application for generation of lift and measurement of airspeed; forces over wing section, aerofoil nomenclature, pressure distribution over a wing section.Lift and drag components – generation of lift and drag; lift curve, drag curve, types of drag, factors affecting lift and drag; centre of pressure and its significance; aerodynamic centre, aspect ratio, Mach number and supersonic flight effects; simple problems on lift and drag.	**10 Hours**	**L1, L2**
Module -3 **Aircraft Propulsion:** Aircraft power plants, classification based on power plant and location and principle of operation. Turboprop, turbojet and turbofan engines; ramjets and scramjets; performance characteristics. Aircraft power	**10 Hours**	**L1, L2, L3**
plants – basic principles of piston, turboprop and jet engines; Brayton cycle and its application to gas turbine engines; use of propellers and jets for production of thrust; comparative merits and limitations of different types of propulsion engines; principle of thrust augmentation.		
Module -4 **Aircraft Stability :** Forces on an aircraft in flight; static and dynamic stability; longitudinal, lateral and roll stability; necessary conditions for longitudinal stability; basics of aircraft control systems. Effect of flaps and stats on lift, control tabs, stalling, gliding, landing, turning, aircraft manoeuvres; stalling, gliding, turning. Simple problems on these. Performance of aircraft – power curves, maximum and minimum speeds for horizontal flight at a given altitude; effect of changes in engine power and altitude on performance; correct and incorrect angles of bank; aerobatics, inverted manoeuvre, manoeuvrability. Simple problems.	**10 Hours**	**L1, L2**

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Module -5 **Aircraft Systems:** Mechanical systems and their components; hydraulic and pneumatic systems; oxygen System; environmental Control System; fuel system. Electrical systems, flight deck and cockpit systems; navigation system, communication system. **Aircraft systems (Mechanical)** – hydraulic and pneumatic systems and their applications; environment control system; fuel system, oxygen system. **Aircraft systems (Electrical)** – flight control system, cockpit instrumentation and displays; communication systems; navigation systems; power generation systems – engine driven alternators, auxiliary power Module, ram air turbine; power conversion, distribution and management.	**10 Hours**	**L1, L2**

Course outcomes:

After studying this course, students will be able to:

1. Appreciate and apply the basic principle of aviation
2. Apply the concepts of fundaments of flight, basics of aircraft structures , aircraft propulsion and aircraft materials during the development of an aircraft
3. Comprehend the complexities involved during development of flight vehicles.

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

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1. John D. Anderson, *"Introduction to Flight",* McGraw-Hill Education, 2011. ISBN 9780071086059.
2. Lalit Gupta and O P Sharma, "*Fundamentals of Flight Vol-I to Vol-IV*", Himalayan Books, 2006, ISBN: 706.

Reference Books:

1. A.C. Kermode, *"Flight without formulae",* Pearson Education India, 1989. ISBN: 9788131713891.
2. Nelson R.C., *"Flight stability and automatic control",* McGraw-Hill International Editions, 1998. ISBN 9780071158381.
3. Ian Moir, Allan Seabridge, *"Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration",* John Wiley & Sons, 2011. ISBN 978111965006.
4. Sutton G.P., "*Rocket Propulsion Elements*", John Wiley, New York, 8th Ed., 2011; ISBH: 1118174208, 9781118174203.

Aerothermodynamics

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Subject Code	**15AE33**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03

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Total Number of Lecture Hours	50	Exam Marks	80

CREDITS – 04

Course objectives: This course will enable students to

1. Understand various concepts and definitions of thermodynamics.
2. Comprehend the I-law and II-law of thermodynamics.
3. Acquire the knowledge of various types of gas cycles

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **Fundamental Concepts & Definitions:** Thermodynamics definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and Modules, intensive and extensive properties. Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and noncyclic ;processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium. Zeroth law of thermodynamics, Temperature; concepts, scales, fixed points and measurements. **Work and Heat:** Mechanics-definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. Other types of work. Heat	**10 Hours**	**L1, L2**
Module -2 **First Law of Thermodynamics:** Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy, pure substance; definition, two-property rule, Specific heat at constant volume, enthalpy, specific heat at constant pressure. Extension of the First law to control volume; steady state-steady flow energy equation, important applications, analysis of unsteady processes such as film and	**10 Hours**	**L1, L2, L3**

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evacuation of vessels with and without heat transfer.		
Module -3 **Second Law of Thermodynamics:** Devices converting heat to work; (a) in a thermodynamic cycle, (b) in a mechanical cycle. Thermal reservoir. Direct heat engine; schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle; reversed heat engine, schematic representation, coefficients of performance. Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Reversible and Irreversible processes; factors that make a process irreversible, reversible heat engines, Carnot cycle, Carnot principles. **Entropy:** Clasius inequality; Statement, proof, application to a reversible cycle. Entropy; definition, a property, change of entropy, principle of increase in entropy, entropy as a quantitative test for irreversibility, calculation of entropy using Tds relations, entropy as a coordinate. Available and unavailable energy.	**10 Hours**	**L1, L2**
Module -4 **Pure Substances & Ideal Gases**: Mixture of ideal gases and real gases, ideal gas equation, compressibility factor use of charts. P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, Saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), TS and H-S diagrams, representation of various processes on these diagrams. **Thermodynamic relations** Maxwells equations, Tds relations, ratio of heat capacities, evaluation of thermodynamic properties from an equation of state	**10 Hours**	**L1, L2, L3**
Module -5 **Gas Cycles:** Efficiency of air standard cycles, Carnot, Otto, Diesel cycles, P-V & T-S diagram, calculation of efficiency; Carnot vapour power cycle, simple Rankine cycle, Analysis and performance of Rankine Cycle, Ideal and practical regenerative Rankine cycles – Reheat and Regenerative Cycles, Binary vapour cycle.	**10 Hours**	**L1, L2, L3**

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Course outcomes:

After studying this course, students will be able to:

1. Apply the concepts and definitions of thermodynamics.
2. Differentiate thermodynamic work and heat and apply I law and II law of thermodynamics to different process.
3. Apply the principles of various gas cycles

Graduate Attributes (as per NBA):

- Engineering Knowledge. ○ Problem Analysis. ○ Design / development of solutions.
- Interpretation of data.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. A Venkatesh, "*Basic Engineering Thermodynamics*", Universities Press, India, 2007, ISBN 13: 9788173715877
2. P K Nag, "*Basic and Applied Thermodynamics*", *2nd Ed.*, Tata McGraw Hill Pub. 2002, ISBN 13: 9780070151314

Reference Books:

1. Yunus A.Cenegal and Michael A.Boles, "*Thermodynamics: An Engineering Approach*", TataMcGraw Hill publications, 2002, ISBN 13: 9780071072540
2. J.B.Jones and G.A.Hawkins, John Wiley and Sons, "*Engineering Thermodynamics*", Wiley 1986, ISBN 13: 9780471812029
3. G.J.Van Wylen and R.E.Sonntag, "*Fundamentals of Classical Thermodynamics*", Wiley Eastern, Wiley, 1985, ISBN 13: 9780471800149
4. Y.V.C.Rao, "*An Introduction to Thermodynamics*", Wiley Eastern, 1993, ISBN 13: 9788173714610.
5. B.K Venkanna, Swati B. Wadavadagi "*Basic Thermodynamics*", PHI, New Delhi, 2010, ISBN 13: 978-8120341128.

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Mechanics of Materials

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Subject Code	**15AE34**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

CREDITS – 04

Course objectives: This course will enable students to

1. Comprehend the basic concepts of strength of materials.
2. Acquire the knowledge of stress, strain under different loadings.
3. Understand the different failure theory.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1		

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Basic equations of linear elasticity: The concept of stress, Analysis of the state of stress at a point, Equilibrium equations, The state of plane stress, The concept of strain, Analysis of the state of strain at a point, Plane strain and plane stress in polar coordinates, Problem featuring cylindrical symmetry. **Constitutive behaviour of materials:** Constitutive laws for isotropic materials, Allowable stress, Yielding under combined loading, Material selection for structural performance, Composite materials, Constitutive laws for anisotropic materials, Strength of a transversely isotropic lamina. **Engineering structural analysis**: Solution approaches, Bar under constant axial force, Pressure vessels.	**10 Hours**	**L1, L2**
Module -2 **Euler-Bernoulli beam theory:** The Euler-Bernoulli assumptions, Implications of the Euler-Bernoulli assumptions, Stress resultants Beams subjected to axial loads, Beams subjected to transverse loads, Beams subjected to combined axial and transverse loads. **Three-dimensional beam theory:** Kinematic description, Sectional constitutive law, Sectional equilibrium equations, Governing equations, Decoupling the three-dimensional problem, The principal centroidal axes of bending. The neutral axis, Evaluation of sectional stiffness.	**10 Hours**	**L1, L2. L3**
Module -3 **Torsion:** Torsion of circular cylinders , Torsion combined with axial force and bending moments, Torsion of bars with arbitrary cross-sections, Torsion of a thin rectangular cross-section, Torsion of thinwalled open sections. **Thin-walled beams:** Basic equations for thin-walled beams, Bending of thin-walled beams, Shearing of thin-walled beams. The shear centre. Torsion of thin-walled beams, Coupled bending-torsion problems Warping of thin-walled beams under torsion. Equivalence of the shear and twist centres, Non-uniform torsion, Structural idealization.	**10 Hours**	**L1, L2, L3**

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Module -4 **Virtual work principles:** Introduction, Equilibrium and work fundamentals, Principle of virtual work, Principle of virtual work applied to mechanical systems, Principle of virtual work applied to truss structures. Principle of complementary virtual work, internal virtual work in beams and solids. **Energy methods:** Conservative forces, Principle of minimum total potential energy, Strain energy in springs, Strain energy in beams, Strain energy in solids, Applications to trusses, Development of a finite element formulation for trusses, Principle of minimum complementary, Energy theorems, Reciprocity theorems, Saint-Venant's principle.	**10 Hours**	**L1, L2, L3, L4**
Module -5 **Yielding:** Yielding under combined loading, Applications of yield criteria to structural, Application to bars, trusses and beams. Buckling of beams: Rigid bar with root torsion spring, buckling of beams, buckling of sandwich beams. Shearing deformations in beams, Shear deformable beams: an energy approach. **Kirchhoff plate theory:** Governing equations of Kirchhoff plate theory, The bending problem, Anisotropic plates, Solution techniques for rectangular plates, Circular, Energy formulation of Kirchhoff plate theory, Buckling of plates.	**10 Hours**	**L1, L2, L3**

Course outcomes:

After studying this course, students will be able to:

1. Apply the basic concepts of strength of materials.
2. Compute stress, strain under different loadings.
3. Distinguish the different failure theories .

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.

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- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. S.S. Bhavaikatii, "*Strength of Materials*", Vikas Publications House, New Delhi, 2012, ISBN13: 978-8125927914.
2. Timoshenko and Young "*Elements of Strength of Materials*', East-West Press, 1976, ISBN 10: 8176710199.

Reference Books:

1. Beer.F.P. and Johnston.R, "*Mechanics of Materials*", McGraw Hill Publishers, 2006, ISBN-13: 978-0073380285.
2. S.Ramamrutham, R Narayanan, "*Strength of Materials"*, Dhanapath Rai Publishing Company, New Delhi, 2012, ISBN 13: 9789384378264
3. Bao Shihua, Gong Yaoqing "*Structural Mechanics*" Wuhan University of Technology Press, 2005, ISBN: 7562924074 9787562924074
4. T.H.G Megson "*Introduction to Aircraft Structural Analysis*", Butterworth-Heinemann Publications, 2007, ISBN 13: 9781856179324

Mechanics of Fluid [As per Choice Based Credit System (CBCS) scheme] SEMESTER – III			
Subject Code	**15AE35**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80
CREDITS – 04			

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Course objectives: This course will enable students to

1. Understand the basic fluid properties.
2. Understand the governing laws of fluid flow.
3. Acquire the knowledge of types of fluid flows.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **Basic Considerations:** Introduction, Dimensions- Modules and physical quantities, Continuum view of gases and liquids, Pressure and Temperature scales, Physical properties of fluids. **Fluid Statics:** Pressure distribution in a static fluid, Pressure and its measurement, hydrostatic forces on plane and curved surfaces, buoyancy, illustration by examples.	**10 Hours**	**L1, L2**
Module -2 **Fluids in motion:** Methods of describing fluid motion, types of fluid flow, continuity equation in 3 dimensions, velocity potential function and stream function. Types of motion, Source sink, doublet , plotting of stream lines and potential lines Numerical problems. **Fluid Kinematics:** Kinematics of fluid motion and the constitutive equations, Integral (global) form of conservation equations (mass, momentum, energy) and applications, Differential form of conservation equations (continuity, Navier-Stokes equations, energy equation).	**10 Hours**	**L1, L2**
Module -3 **Fluid Dynamics:** Equations of motion: Euler's and Bernoulli's equation of motion for ideal and real fluids. Momentum equation, Fluid flow measurements.	**10 Hours**	**L1, L2**

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Numerical problems. **Dimensional analysis and similarity:** Dimensional homogeneity, methods of dimensional analysis, model analysis, types of similarity and similitude. Dimensionless numbers. Model laws. Numerical problems.		
Module -4 **Flow past Immersed bodies:** Introduction to boundary layer, boundary layer thickness, karman's integral momentum theory, drag on a flat plate for laminar and turbulent flow, Drag on immersed bodies. Expression for drag and lift. Kutta – joukowsky theorem; Fundamentals of aerofoil theory Numerical problems.	**10 Hours**	**L1, L2, L3**
Module -5 **Compressible flow and Boundary Layers theory**: Steady, one-dimensional gas dynamics, Propagation of pressure waves in a compressible medium, velocity of sound , Mach number, Mach cone, Stagnation properties , Bernoulli's eqn for isentropic flow, normal shock waves . Numerical Problem; Laminar and turbulent boundary layers.	**10 Hours**	**L1, L2, L3. L4**
Course outcomes: After studying this course, students will be able to: 1. Evaluate the effect of fluid properties. 2. Apply the governing laws of fluid flow. 3. Classify different types of fluid flows.		
Graduate Attributes (as per NBA): • Engineering Knowledge. • Problem Analysis. • Design / development of solutions. • Interpretation of data.		

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Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Bansal, R.K, "*Fluid Mechanics and Hydraulics Machines*", Laxmi Publications (P) Ltd., New Delhi 2015, ISBN-13: 978-8131808153.

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2. Rathakrishnan. E, "*Fluid Mechanics*", Prentice-Hall of India Pvt.Ltd, 2010, ISBN 13: 9788120331839.

Reference Books:

1. Yunus A. Cengel & John M Cimbala, Fluid Mechanics and Applications, McGraw Hill Education; 3rd edition, 2013, ISBN-13: 978-0073380322.
2. Ramamritham. S "*Hydraulic Fluid Mechanics and Fluid Machines*", DhanpatRai& Sons, Delhi, 1988, ISBN 13: 9788187433804.
3. Kumar. K.L., "*Engineering Fluid Mechanics*" (VII Ed.) Eurasia Publishing House (P) Ltd., New Delhi, 1995, ISBN 13: 9788121901000.
4. Streeter. V. L., and Wylie, E.B., "*Fluid Mechanics"*, McGraw Hill, 1983, ISBN 13: 9780070665781

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Measurement and Metrology

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Subject Code	**15AE36**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the standards of measurement, system of limits, fits, tolerances and gauging.
2. Understand the principles of measuring instruments
3. Acquire the knowledge on measurement and measurement systems.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **Standards of measurement:** Definition and Objectives of metrology, Standards of length - International prototype meter, Imperial standard yard, Wave length standard, subdivision of standards, line and end standard, comparison, transfer from line standard to end standard, calibration of end bars (Numerical), Slip gauges, Wringing phenomena, Indian Standards (M-81, M-112), Numerical problems on building of slip gauges.	**10 Hours**	**L1, L2, L3**

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Module -2 **System of limits, Fits, Tolerances and gauging:** Definition of tolerance, Specification in assembly, Principle of inter changeability and selective assembly limits of size, Indian standards, concept of limits of size and tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation (IS 919 -1963), geometrical tolerance, positional - tolerances, hole basis system, shaft basis of system, classification of gauges, brief concept of design of gauges (Taylor's principles), Wear allowance on gauges, Types of gauges -plain plug gauge, ring Gauge, snap gauge, limit gauge and gauge materials.	**10 Hours**	**L1, L2**
Module -3 **Comparators and Angular measurement:** Introduction to Comparator, Characteristics, classification of comparators, mechanical comparators - Sigma Comparators, dial indicator, Optical Comparators principles, Zeiss ultra optimeter, Electric and Electronic Comparators principles, Pneumatic Comparators, back pressure gauges, Solex	**10 Hours**	**L1, L2, L3**
Comparators. Angular measurements, Bevel Protractor, Sine Principle and. use of Sine bars, Sine center, use of angle gauges, Clinometers, **Screw thread gear measurement:** Terminology of screw threads, measurement of major diameter, minor diameter pitch, angle and effective diameter of screw threads by 2-wire and 3-wire methods, Best size wire. Gear tooth vernier.		
Module -4 **Measurements and Measurement systems:** Definition, Significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hystersis, repeatability, linearity, loading effect, system response-times delay. Errors in Measurements, Classification of Errors. Transducers, Transfer efficiency, Primary and Secondary transducers, electrical, Mechanical, electronic transducers, advantages of each type transducers.	**10 Hours**	**L1, L2, L3**

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Module -5	**10 Hours**	**L1, L2, L3**
Measurement of quantities: Principle, analytical balance, platform balance, proving ring, Torque measurement, Prony brake, hydraulic dynamometer. Pressure Measurements, Principle, use of elastic members, Bridgeman gauge, Mcloed gauge, Pirani Gauge. **Temperature and strain measurement:** Resistance thermometers, thermocouple, law of thermocouple, materials used for construction, pyrometer, Optical Pyrometer. Strain Measurements, Strain gauge, preparation and mounting of strain gauges, gauge factor, methods of strain measurement		

Course outcomes:

After studying this course, students will be able to:

1. Apply the standards of measurement, system of limits, fits, tolerances and gauging.
2. Identify and use appropriate measuring instruments.
3. Acquire the knowledge on measurement and measurement systems

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).
- Interpretation of data.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Beckwith Marangoni and Lienhard, John H. Lienhard V "*Mechanical Measurements*" , 6th Ed., 2006, ISBN-13: 978-0201847659.
2. R.K.Jain "*Engineering Metrology*", Khanna Publishers, 1994, ISBN 13: 9788174091536

Reference Books:

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1. I.C.Gupta "*Engineering Metrology*" Dhanpat Rai Publications, Delhi, 2013, ISBN 13: 1234567144039.
2. Alsutko, Jerry. D.Faulk "*Industrial Instrumentation*", Thompson Asia Pvt. Ltd.2002, ISBN-13: 978-0827361256

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MEASUREMENTS AND METROLOGY LAB

[As per Choice Based Credit System (CBCS) scheme]
SEMESTER – III

Subject Code	**15AEL37A**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	42	Exam Marks	80

CREDITS – 04

Course objectives: This course will enable students to

1. Learn the concepts of mechanical measurements and metrology
2. Use the concept of accuracy, error and calibration
3. Use the basic metrological instruments

Modules	**Revised Bloom's Taxonomy (RBT) Level**
1. Calibration of Pressure Gauge	**L1, L2, L3, L4**
2. Calibration of Thermocouple	**L1, L2, L3, L4**
3. Calibration of LVDT	**L1, L2, L3, L4**
4. Calibration of Load cell	**L1, L2, L3, L4**
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.	**L1, L2, L3, L4, L5**
6. Comparison and measurements using vernier caliper and micrometer	**L1, L2, L3, L4**

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7. Measurement of vibration parameters using vibration setup.	**L1, L2, L3, L4**
8. Measurements using Optical Projector / Toolmaker Microscope.	**L1, L2, L3**
9. Measurement of angle using Sine Center / Sine bar / bevel protractor	**L1, L2, L3**
10. Measurement of alignment using Autocollimator / Roller set	**L1, L2, L3**
11. Measurement of Screw thread Parameters using Two-wire or Three-wire method.	**L1, L2, L3**
12. Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator	**L1, L2, L3**
13. Measurement of gear tooth profile using gear tooth vernier /Gear tooth micrometer	**L1, L2, L3**
14. Calibration of Micrometer using slip gauges	**L1, L2, L3**

Course outcomes:

After studying this course, students will be able to:

1. Identify and classify different measuring tools related to experiments.
2. Identify, define, and explain accuracy, precision, and some additional terminology.
3. Conduct, Analyze, interpret, and present measurement data from measurements experiments.

Conduct of Practical Examination:

1 . All laboratory experiments are to be included for practical examination.
2 . Students are allowed to pick one experiment from the lot.
3 . Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions
- Interpretation of data.

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MATERIAL TESTING LAB

[As per Choice Based Credit System (CBCS) scheme] SEMESTER – III

Subject Code	**15AEL37B**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	42	Exam Marks	80

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the relations among materials and their properties.
2. Understand the formation, properties and significance of the alloys through different experiments.
3. Understand the types, advantages and applications of various NDT methods.

Modules	**Revised Bloom's Taxonomy (RBT) Level**
1. Hardness Testing – Vicker's, Brinell, Rockwel	**L1, L2, L3**
2. Tensile Test	**L1, L2, L3, L4, L5**
3. Flexural Test	**L1, L2, L3, L4, L5**

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4. Torsional Test	**L1, L2, L3**
5. Impact Test	**L1, L2, L3**
6. Shear Test	**L1, L2, L3**
7. Fatigue Test	**L1, L2, L3, L4, L5**
8. Preparation of specimen for metallograpic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & metal matrix composites	**L1, L2, L3**
9. Heat treatment: Annealing, normalizing, hardening and tempering of steel. Hardness studies of heat-treated samples.	**L1, L2, L3**
10. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.	**L1, L2, L3**
11. Visual Testing Technique, Dye penetration testing. To study the defects of Cast and Welded specimens.	**L1, L2, L3**
12. Magnetic Particle Inspection.	**L1, L2, L3**
13. Ultrasonic Inspection.	**L1, L2, L3**
14. Eddy Current Inspection	**L1, L2, L3**

Course outcomes:

After studying this course, students will be able to:

1. Apply the relations among materials ~~and their~~ properties.
2. Differentiate the formation, properties and significance of the alloys through different experiments.
3. Differentiate the types, advantages and applications of various NDT methods.

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Conduct of Practical Examination:

1 . All laboratory experiments are to be included for practical examination.
2 . Students are allowed to pick one experiment from the lot.
3 . Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly)
- Interpretation of data.

MACHINE SHOP LAB

[As per Choice Based Credit System (CBCS) scheme] SEMESTER – III

Subject Code	**14AEL38**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	42	Exam Marks	80

CREDITS – 04

Course objectives: This course will enable students to

1. Practice general-purpose machine tools and manufacturing process.
2. Operate the special purpose machine tools
3. Prepare physical models using different manufacturing processes.

Modules	Revised Bloom's Taxonomy (RBT) Level
1. Introduction to Machining operations & tools (i.e. Lath machine & shaper machine etc.)	**L1, L2**
2. Machining and machining time estimation for plain turning, taper turning & step turning.	**L1, L2, L3**

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3. Machining and machining time estimation for thread cutting	**L1, L2, L3**
4. Machining and machining time estimation for knurling	**L1, L2, L3**
5. Machining and machining time estimation for knurling operation	**L1, L2, L3**
6. Machining and machining time estimation for drilling operation	**L1, L2, L3**
7. Machining and machining time estimation for boring operation	**L1, L2, L3**
8. Machining and machining time estimation for internal thread cutting	**L1, L2, L3**
9. Machining and machining time estimation for external thread cutting	**L1, L2, L3**
10. Machining and machining time estimation for eccentric turning	**L1, L2, L3**
11. Machining of hexagon in shaping machine	**L1, L2, L3**
12. Machining of square in shaping machine	**L1, L2, L3**
13. Cutting of gear teeth using milling machine	**L1, L2, L3**
14. Grinding operations using grinding machine.	**L1, L2, L3**

Course outcomes:

After studying this course, students will be able to:

1. Demonstrate the operation of general purpose machine tools and manufacturing process.
2. Identify the special purpose machine tools for specific requirements
3. Develop physical models using different manufacturing processes.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks. 4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Graduate Attributes (as per NBA):

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- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly)
- Interpretation of data.

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VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
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SCHEME OF TEACHING AND EXAMINATION 2015-2016

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VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

Semester IV
Engineering Mathematics IV

Course Code: 15MAT41	**IA Marks: 20**
Hours/Week: 4 hours	**Exam Hours: 03**
Total Hours: 50	**Exam Marks: 80**

Course Learning Objectives:

The objective is to provide students with mathematics fundamental, necessary to formulate, solve and analyze engineering problems by making them to learn the following topics

- Numerical methods to solve ordinary differential equations
- Finite difference method to solve partial differential equations
- Complex analysis
- Sampling theory
- Joint probability distribution and stochastic process

Module 1 — 10 Hrs

Numerical Methods : Numerical solution of ordinary differential equations of first order and first degree, Picard's method, Taylor's series method, modified Euler's method, Runge - Kutta method of fourth order. Milne's and Adams-Bashforth predictor and corrector methods (No derivations of formulae).

Numerical solution of simultaneous first order ordinary differential equations, Picard's method, Runge-Kutta method of fourth order.

Module 2 — 10 Hrs

Numerical Methods : Numerical solution of second order ordinary differential equations, Picard's method, Runge-Kutta method and Milne's method

Special Functions: Bessel's functions- basic properties, recurrence relations, orthogonality and generating functions. Legendre's functions - Legendre's polynomial, Rodrigue's formula, problems.

Module 3 — 10 hrs

Complex Variables: Function of a complex variable, limits, continuity, differentiability,. Analytic functions-Cauchy-Riemann equations in Cartesian and polar forms. Properties and construction of

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analytic functions. Complex line integrals-Cauchy's theorem and Cauchy's integral formula, Residue, poles, Cauchy's Residue theorem with proof and problems.

Transformations: Conformal transformations, discussion of transformations: $w = z^2, w = e^z, w = z + (a^2/z)$ and bilinear transformations.

Module 4 **10 hrs**

Probability Distributions: Random variables(discrete and continuous), probability functions. Binomial distribution, Poisson distribution**,** geometric distribution, uniform distribution, Exponential and normal distributions, Problems.

Joint probability distribution: Joint Probability distribution for two variables, expectation, covariance, correlation coefficient.

Module 5 **10 hrs**

Sampling Theory: Sampling, Sampling distributions, standard error, test of hypothesis for means and proportions, confidence limits for means, student's t-distribution, Chi-square distribution as a test of goodness of fit.

Stochastic process

Stochastic process, probability vector, stochastic matrices, fixed points, regular stochastic matrices, Markov chains, higher transition probability.

Course outcomes:

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

1. Use appropriate numerical methods to solve first and second order ordinary differential equations.
2. Use Bessel's and Legendre's function which often arises when a problem possesses axial and spherical symmetry, such as in quantum mechanics, electromagnetic theory, hydrodynamics and heat conduction.

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3. State and prove Cauchy's theorem and its consequences including Cauchy's integral formula, compute residues and apply the residue theorem to evaluate integrals.
4. Analyze, interpret, and evaluate scientific hypotheses and theories using rigorous statistical methods .

TEXT BOOKS:

1. B.V.Ramana "Higher Engineering Mathematics" Tata Mc Graw-Hill, 2006
2. B.S. Grewal – "Higher Engineering Mathematics", Khanna Publishers, 42nd Edition, 2013,

REFERENCE BOOKS

1. N P Bali and Manish Goyal, "A text book of Engineering mathematics" , Laxmi publications, latest edition.
2. Kreyszig, "Advanced Engineering Mathematics " - 9th edition, Wiley, 2013
3. H. K Dass and Er. Rajnish Verma ,"Higher Engineering Mathematics", S. Chand publishing, 1st edition, 2011.

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Aerodynamics-I

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Subject Code	**15AE42**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the basics of fluid mechanics as a prerequisite to Aerodynamics
2. Acquire knowledge on typical airfoil characteristics and two-dimensional flows over airfoil and study the incompressible over finite wings
3. Assimilate the understanding of application of finite wing theory and high lift systems

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **Review of Basic Fluid Mechanics** Continuity, momentum and energy equation, Control volume approach to Continuity, momentum and energy equation, Types of flow, pathlines, streamlines, and streaklines, units and dimensions, inviscid and viscous flows, compressibility, Mach number regimes. Vorticity, Angular velocity, Stream function, velocity potential function, Circulation, Numericals, Mach cone and Mach angle, Speed of sound.	**10 Hours**	**L1, L2**

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Module -2 **Airfoil Characteristics** Fundamental aerodynamic variables, Airfoil nomenclature, airfoil characteristics. wing planform geometry, aerodynamic forces and moments, centre of pressure, pressure coefficient, aerodynamic center, calculation of airfoil lift and drag from measured surface pressure distributions, typical airfoil aerodynamic characteristics at low speeds. Types of drag-Definitions.	**10 Hours**	**L1, L2**
Module -3 **Two Dimensional Flows & Incompressible Flow Over Airfoil** Uniform flow, Source flow, Sink flow, Combination of a uniform flow with source and sink. Doublet flow . Non-lifting flow over a circular cylinder. Vortex flow. Lifting flow over a circular cylinder. Kutta-Joukowski theorem	**10 Hours**	**L1, L2, L3, L4, L5**
and generation of Lift, D'Alembert's paradox, Numericals, **Incompressible flow over airfoils:** Kelvin's circulation theorem and the starting vortex, vortex sheet, Kutta condition, Classical thin airfoil theory for symmetric and cambered airfoils. Kutta-Joukowski theorem and generation of Lift, Numericals.		
Module -4 **Incompressible Flow Over Finite Wings** Biot-Savart law and Helmholtz's theorems, Vortex filament: Infinite and semi-infinite vortex filament, Induced velocity. Prandtl's classical lifting line theory: Downwash and induced drag. Elliptical and modified elliptical lift distribution. Lift distribution on wings. Limitations of Prandtl's lifting line theory. Extended lifting line theory- lifting surface theory, vortex lattice method for wings. Lift, drag and moment characteristics of complete airplane.	**10 Hours**	**L1, L2**

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Module -5	**10 Hours**	**L1, L2, L3**
Applications of Finite Wing Theory & High Lift Systems Simplified horse-shoe vortex model, formation flight, influence of downwash on tail plane, ground effects. Swept wings: Introduction to sweep effects, swept wings, pressure coefficient, typical aerodynamic characteristics, Subsonic and Supersonic leading edges. Introduction to high-lift systems, flaps, leading-edge slats and typical high – lift characteristics. critical Mach numbers, Lift and drag divergence, shock induced separation, Effects of thickness, camber and aspect ratio of wings, Transonic area rule, Tip effects. Introduction to Source panel & vortex latice method.		

Course outcomes:

After studying this course, students will be able to:

1. Evaluate typical airfoil characteristics and two-dimensional flows over airfoil
2. Compute and analyse the incompressible flow over finite wings
3. Apply finite wing theory and design high lift systems from the aerodynamics view point

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).
- Interpretation of data.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

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Text Books:

1. Anderson J .D, "*Fundamental of Aerodynamics*", 5th edition, McGraw-Hill International Edition, New York **(**2011), ISBN-13: 978-0073398105. 2. E. L. Houghton, P.W. Carpenter, "Aerodynamics for Engineering Students", 5th edition, Elsevier, New York. (2010), ISBN-13: 978-0080966328

Reference Books:

1. Clancy L. J. "*Aerodynamics*", Sterling book house, New Delhi. (2006), ISBN 13: 9780582988804
2. Louis M. Milne-Thomson, "*Theoretical Aerodynamics*", Imported Edition, Dover Publications, USA (2011), ISBN 9780486619804.

Aircraft Propulsion

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Subject Code	**15AE43**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the basic principle and theory of aircraft propulsion.
2. Understand the purpose of a centrifugal, axial compressors , axial and radial turbines
3. Acquire knowledge of importance of nozzles & inlets and combustion chamber

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Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **Introduction:** Review of thermodynamic principles, Principles of aircraft propulsion, Types of power plants, Working principles of internal combustion engine, Two – stroke and four – stroke piston engines, Gas-turbine engines, Cycle analysis of reciprocating engines and jet engines , advantages and disadvantages.	**10 Hours**	**L1, L2**
Module -2 **Propeller Theories & Jet propulsion** Types of propeller, Propeller thrust: momentum theory, Blade element theories, propeller blade design, propeller selection. **Jet Propulsion:** Illustration of working of gas turbine engine – The thrust equation – Factors affecting thrust – Effect of pressure, velocity and temperature changes of air entering compressor – Methods of thrust augmentation – Characteristics of turboprop, turbofan and turbojet – Performance characteristics.	**10 Hours**	**L1, L2, L3, L4**
Module -3 **Inlets & Nozzles**	**10 Hours**	**L1, L2**

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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. **Nozzles:** Theory of flow in isentropic nozzles, Convergent nozzles and nozzle choking, Nozzle throat conditions. Nozzle efficiency, Losses in nozzles. Overexpanded and under-expanded nozzles, Ejector and variable area nozzles, Thrust reversal.		
Module -4 **Gas Turbine Engine Compressors** **Centrifugal compressors:** Principle of operation of centrifugal compressors. Work done and pressure rise -Velocity diagrams, Diffuser vane design considerations. performance characteristics. Concept of Pre-whirl, 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. Axial compressor performance characteristics.	**10 Hours**	**L1, L2, L3, L4**

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Module -5 **Combustion chambers and Turbines** Classification of combustion chambers, important factors affecting combustion chamber design, Combustion process, Combustion chamber performance Effect of operating variables on performance – Flame tube cooling – Flame stabilization – Use of flame holders **Axial Flow Turbines:** Introduction, Turbine stage, Multi-staging of turbine, Exit flow conditions, Turbine cooling, Heat transfer in turbine cooling.	**10 Hours**	**L1, L2, L3, L4**
Radial turbine: Introduction, Thermodynamics of radial turbines, Losses and efficiency		

Course outcomes:

After studying this course, students will be able to:

1. Apply the basic principle and theory of aircraft propulsion.
2. Explain the functions of centrifugal, axial compressors , axial and radial turbines
3. Analyse the performance of nozzles & inlets and combustion chamber

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).
- Interpretation of data.

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Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. Bhaskar Roy, "*Aircraft propulsion*", Elsevier (2011), ISBN-13: 9788131214213
2. V. Ganesan, "*Gas Turbines*", Tata McGraw-Hill, 2010, New Delhi, India, ISBN: 0070681929, 9780070681927

Reference Books:

1. Hill, P.G. & Peterson, C.R., "*Mechanics & Thermodynamics of Propulsion*" Addison –

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Wesley Longman INC, 1999, ISBN-13: 978-0201146592.

2. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H., "*Gas Turbine Theory*", Longman, 1989, ISBN 13: 9780582236325.
3. Irwin E. Treager, "*Gas Turbine Engine Technology*" GLENCOE Aviation Technology Series, 7th Edition, Tata McGraw Hill PublishingCo.Ltd. Print 2003, ISBN-13: 978-0028018287
4. S. M. Yahya(2010), "*Fundamentals of Compressible Flow with Aircraft and Rocket propulsion*", 4th Edition, New Age International Publications, New Delhi 2014, ISBN 13: 9788122426687.

Mechanisms and Machine Theory

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Subject Code	**15AE44**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the theory of mechanisms including velocity, acceleration and static force analysis.
2. Acquire knowledge of spur gears, gear train, balancing of rotating and reciprocating masses.
3. Understand the concept of governors and gyroscope

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1		

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Introduction to Mechanisms: Types of constrained motion, Link and its types, joints and its types, kinematic pair and its types, degrees of freedom, Grubler's criterion, Types of kinematic chains and inversions: Inversions of Four bar chain: Beam engine, coupling rod of a locomotive, Watt's indicator mechanism. Inversions of Single Slider Crank Chain: Pendulum pump or Bull engine, Oscillating cylinder engine, Rotary internal combustion engine, Crank and slotted lever quick return motion mechanism, Whitworth quick return motion mechanism. Inversions of Double Slider Crank Chain: Elliptical trammels, Scotch yoke mechanism, Oldham's coupling. Straight line motion mechanisms: Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms: Geneva wheel mechanism and Ratchet and Pawl mechanism, Ackerman steering gear mechanism.	**10 Hours**	**L1, L2**
Module -2 **Velocity, Acceleration and static force analysis of Mechanisms (Graphical Methods):** Velocity and acceleration analysis of Four Bar mechanism, slider crank mechanism and Simple Mechanisms by vector polygons. **Static force analysis:** Introduction: Static equilibrium, Equilibrium of two and three force members. Members with two forces and torque. Free body diagrams, principle of virtual work. Static force analysis of four bar mechanism and slider-crank mechanism with and without friction.	**10 Hours**	**L1, L2, L3, L4**

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Module -3 **Spur Gears and Gear Trains** **Spur Gears:** Gear terminology, law of gearing, Path of contact, Arc of contact, Contact ratio of spur gear, Interference in involute gears, Methods of avoiding interference. **Gear Trains:** Simple gear trains, Compound gear trains, Reverted gear trains, Epicyclic gear trains, Analysis of epicyclic gear train (Algebraic and tabular methods), torques in epicyclic trains.	**10 Hours**	**L1, L2, L3, L4**
Module -4 **Balancing of Rotating and Reciprocating Masses** **Balancing of Rotating Masses:** Balancing of Several Masses Rotating in the Same Plane, Balancing of Several Masses Rotating in Different Planes (only Graphical Methods). **Balancing of Reciprocating Masses:** Primary and Secondary Unbalanced Forces of Reciprocating Masses, Partial Balancing of Unbalanced Primary Force in a Reciprocating Engine, Balancing of Primary and secondary Forces of	**10 Hours**	**L1, L2, L3, L4**
Multi-cylinder In-line Engines, Balancing of Radial Engines (only Graphical Methods)		

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Module -5 **Governors and Gyroscope** **Governors:** Types of governors; force analysis of Porter and Hartnell governors, Controlling force, stability, sensitiveness, isochronism, effort and power of Porter and Hartnell governors. **Gyroscopes:** Vectorial representation of angular motion, gyroscopic couple, effect of gyroscopic couple on plane disc and aeroplane	**10 Hours**	**L1, L2, L3, L4**

Course outcomes:

After studying this course, students will be able to:

1. Apply the theory of velocity, acceleration and static force analysis to design of mechanisms.
2. Design spur gears, gear train, balancing of rotating and reciprocating masses.
3. Apply governors and gyroscope

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly). □ Interpretation of data.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module.
- Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

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Text Books:

1. **Rattan S.S**, "*Theory of Machines*", Tata McGraw-Hill Publishing Company Ltd., New Delhi, and 3rd edition -2009, ISBN: 007014477X, 9780070144774.
2. **J.J. Uicker, G.R. Pennock, J.E. Shigley.** "*Theory of Machines & Mechanisms*", OXFORD 3rd Ed. 2009, ISBN-13: 978-0195371239

Reference Books:

1. **R. S. Khurmi, J.K. Gupta,** "*Theory of Machines*", Eurasia Publishing House, 2008, ISBN 13: 9788121925242.
2. **Robert L Norton,** "*Design of Machinery*" by McGraw Hill, 2001, **ISBN-13:** 978-0077421717.
3. Ambekar, "*Mechanism and Machine theory*", PHI Learning Pvt. Ltd., 2007, ISBN 13: 9788120331341

Aircraft Material Science

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Subject Code	**15AE45**	IA Marks	20
Number of Lecture Hours/Week	04	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

CREDITS – 04

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Course objectives: This course will enable students to

1. Acquire knowledge on aircraft materials- metallic and non-metallic
2. Understand the properties of super alloys, ablative materials and high energy material.
3. Study material corrosion and prevention

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **Introduction to Aircraft Materials** General properties of materials, Definition of terms, Requirements of aircraft materials, Testing of aircraft materials, Inspection methods, Application and trends in usage in aircraft structures and engines, Selection of materials for use in aircraft. **Aircraft Metal Alloys** Aluminum alloys, Magnesium alloys, Titanium alloys, Plain carbon and Low carbon Steels, Corrosion and Heat resistant steels, Maraging steels, Copper alloys, Producibility and Surface treatments aspects for each of the above;	**10 Hours**	**L1, L2**
Module -2	**10 Hours**	**L1, L2**

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Super Alloys General introduction to super alloys, Nickel based super alloys, Cobalt based super alloys, and Iron based super alloys, manufacturing processes associated with super alloys, Heat treatment and surface treatment of super alloys. **Composite Materials:** Definition and comparison of composites with conventional monolithic materials, Reinforcing fibers and Matrix materials, Fabrication of composites and quality control aspects, Carbon-Carbon Composites production, properties and applications, inter metallic matrix composites, ablative composites based on polymers, ceramic matrix, metal matrix composites based on aluminum, magnesium, titanium and nickel based composites for engines.		
Module -3 **Polymers, Polymeric Materials & Plastics and Ceramics & Glass** Knowledge and identification of physical characteristics of commonly used polymeric material: plastics and its categories, properties and applications; commonly used ceramic, glass and transparent plastics, properties and applications, adhesives and sealants and their applications in aircraft.	**10 Hours**	**L1, L2**

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Module -4 **Ablative Materials** Ablation process, ablative materials and applications in aerospace. **Aircraft Wood, Rubber, Fabrics & Dope And Paint:** Classification and properties of wood, Seasoning of wood, Aircraft woods, their properties and applications, Joining processes for wood, Plywood; Characteristics and definition of terminologies pertaining to aircraft fabrics and their applications, Purpose of doping and commonly used dopes; Purpose of painting, Types of aircraft paints, Aircraft painting process.	**10 Hours**	**L1, L2**
Module -5 **Corrosion and its Prevention**	**10 Hours**	**L1, L2**
Knowledge of the various methods used for removal of corrosion from common aircraft metals and methods employed to prevent corrosion. **High Energy Materials:** Materials for rockets and missiles. Types of propellants and its general and desirable properties, insulating materials for cryogenic engines. Types of solid propellants: Mechanical characterization of solid propellants using uni-axial, strip-biaxial and tubular tests.		
Course outcomes: After studying this course, students will be able to: 1. Identify appropriate aircraft materials for a given application. 2. Explain the properties of super alloys, ablative materials and high energy material. 3. Understand material corrosion process and apply prevention technique.		

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Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).
- Interpretation of data.

Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. **Titterton G F** , "*Aircraft Material and Processes*", English Book Store, New Delhi, 1998, ISBN 13: 9788175980136

2. **H Buhl**, "*Advanced Aerospace Material*", Spring Berlin 1992, ISBN: 978-3-642-50161-6

Reference Books:

1. **C G Krishnadas Nair,** "*Handbook of Aircraft materials*", Interline publishers, Bangalore, 1993, ISBN 13: 9788172960032.
2. **Balram Gupta, S**, "*Aerospace material"* Vol. 1,2,3 ARDB, Chand & Co 1996, ISBN: 9788121922005
3. **Parker E R**, "*Materials for Missiles and Space*", John Wiley, McGraw-Hill, 1963,
4. 4.**Hill E T**, The "*Materials of Aircraft Construction*", Pitman London.

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Turbomachines

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Subject Code	**15AE46**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	50	Exam Marks	80

CREDITS – 04

Course objectives: This course will enable students to

1. Understand the basics of turbomachines, the energy transfer and energy transformation in them.
2. Acquire the knowledge on design of centrifugal and axial turbomachines 3. Study hydraulic pumps and turbines.

Modules	Teaching Hours	Revised Bloom's Taxonomy (RBT) Level
Module -1 **Introduction to turbomachines:** Classification and parts of a turbo machines; comparison with positive displacement machines; dimensionless parameters and their physical significance; specific speed; illustrative examples on dimensional analysis and model studies. **Energy transfer in turbomachines:** Basic Euler turbine equation and its alternate form; components of energy transfer; general expression for degree of reaction; construction of velocity triangles for different values of degree of reaction. .	**10 Hours**	**L1, L2**

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Module -2 **Compression process:** Overall isentropic efficiency of compression; stage efficiency; comparison and relation between overall efficiency and stage efficiency;	**10 Hours**	**L1, L2, L3, L4**
polytropic efficiency; pre heat factor. **Expansion process :** Overall isentropic efficiency for a turbine; stage efficiency for a turbine; comparison and relation between stage efficiency and overall efficiency, polytropic efficiency; reheat factor for expansion process.		
Module -3 **Design and performance analysis of Centrifugal compressors:** Types, design parameters, flow analysis in impeller blades, volutes and diffusers, losses, slip factor, characteristic curves, surging, choking. Construction details. **Design and performance analysis of axial fans and compressors:** Stage velocity diagrams, enthalpy-entropy diagrams, stage losses and efficiency, work done, simple stage design problems, performance characteristics, instability in axial compressors. Construction details.	**10 Hours**	**L1, L2, L3, L4**
Module -4 **Design and performance analysis of axial flow turbines:** Turbine stage, work done, degree of reaction, losses and efficiency, flow passage; subsonic, transonic and supersonic turbines, multi-staging of turbine; exit flow conditions; turbine cooling **Design and performance analysis of radial turbines:** Thermodynamics and aerodynamics of radial turbines; radial turbine characteristics; losses and efficiency; design of radial turbine.	**10 Hours**	**L1, L2, L3, L4**

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Module -5 **Hydraulic pumps:** Centrifugal and axial pumps. Manometric head, suction head, delivery head; manometric efficiency, hydraulic efficiency, volumetric efficiency, overall efficiency; multi stage pumps. Characteristics of pumps. **Hydraulic turbines:** Classification; Module quantities; Pelton wheel, Francis turbine, Kaplan turbine and their velocity triangles. Draft tubes and their function.	**10 Hours**	**L1, L2, L3, L4, L5**
Characteristics of hydraulic turbines.		

Course outcomes:

After studying this course, students will be able to:

1. Compute the energy transfer and energy transformation in turbomachines.
2. Analyse the design of turbomachine blades.
3. Apply hydraulic pumps and turbines for specific requirements

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly).
- Interpretation of data.

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Question paper pattern:

- The question paper will have ten questions.
- Each full question consists of 16 marks.
- There will be 2 full questions (with a maximum of four sub questions) from each module. Each full question will have sub questions covering all the topics under a module.

The students will have to answer 5 full questions, selecting one full question from each module.

Text Books:

1. S.M. Yahya, *"Turbines, Compressors & Fans"*, Tata-McGraw Hill Co., 2nd Edition (2002), ISBN 13: 9780070707023.
2. D.G. Shephered, *"Principles of Turbo Machinery"*, The Macmillan Company (1964), ISBN-13: 978-0024096609.

Reference Books:

1. V.Kadambi and Manohar Prasad, *"An introduction to Energy conversion, Volume III, Turbo machinery ",* Wiley Eastern Ltd. (1977), ISBN: 9780852264539.

MATERIAL TESTING LAB

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Subject Code	**15AEL47A**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	42	Exam Marks	80

CREDITS – 04

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Course objectives: This course will enable students to

1. Understand the relations among materials and their properties.
2. Understand the formation, properties and significance of the alloys through different experiments.
3. Understand the types, advantages and applications of various NDT methods.

MODULES	Revised Bloom's Taxonomy (RBT) Level
PART-A: MATERIAL TESTING	
1. Hardness Testing – Vicker's, Brinell, Rockwel	**L1, L2, L3**
2. Tensile Test	**L1, L2, L3, L4, L5**
3. Flexural Test	**L1, L2, L3, L4, L5**
4. Tensional Test	**L1, L2, L3**
5. Impact Test	**L1, L2, L3**
6. Shear Test	**L1, L2, L3**
7. Fatigue Test	**L1, L2, L3, L4, L5**
PART-B: METALLOGRAPHY	
8. Preparation of specimen for metallographic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & metal matrix composites	**L1, L2, L3**
9. Heat treatment: Annealing, normalizing, hardening and tempering of steel. Hardness studies of heat-treated samples.	**L1, L2, L3**
10. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.	**L1, L2, L3**
11. Visual Testing Technique, Dye penetration testing. To study the defects of Cast and Welded specimens.	**L1, L2, L3**
12. Magnetic Particle Inspection.	**L1, L2, L3**
13. Ultrasonic Inspection.	**L1, L2, L3**
14. Eddy Current Inspection	**L1, L2, L3**

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Course outcomes:

After studying this course, students will be able to:

1. Apply the relations among materials and their properties.
2. Differentiate the formation, properties and significance of the alloys through different experiments.
3. Understand the different types, advantages and applications of various NDT methods

Conduct of Practical Examination:

1 . All laboratory experiments are to be included for practical examination.
2 . Students are allowed to pick one experiment from the lot.
3 . Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Scheme of Examination:

One question from PART A:	**1 x 30 =**	**30 Marks**
One question from PART B:	**1 x 40 =**	**40 Marks**
Viva-Voce :		**10 Marks**
Total	**=**	**80 Marks**

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly) Interpretation of data.

MEASUREMENTS AND METROLOGY LAB

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Subject Code	**15AEL47B**	IA Marks	20

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VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2015-2016

Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	42	Exam Marks	80
CREDITS – 04			

Course objectives: This course will enable students to

1. Learn the concepts of mechanical measurements and metrology
2. Use the concept of accuracy, error and calibration
3. Use the basic metrological instruments

Modules	Revised Bloom's Taxonomy (RBT) Level
PART-A: MEASUREMENTS	
1. Calibration of Pressure Gauge	**L1, L2, L3, L4**
2. Calibration of Thermocouple	**L1, L2, L3, L4**
3. Calibration of LVDT	**L1, L2, L3, L4**
4. Calibration of Load cell	**L1, L2, L3, L4**
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.	**L1, L2, L3, L4, L5**
PART-B: METROLOGY	
6. Comparison and measurements using vernier caliper and micrometer	**L1, L2, L3, L4**
7. Measurement of vibration parameters using vibration setup.	**L1, L2, L3, L4**
8. Measurements using Optical Projector / Toolmaker Microscope.	**L1, L2, L3**
9. Measurement of angle using Sine Center / Sine bar / bevel protractor	**L1, L2, L3**
10. Measurement of alignment using Autocollimator / Roller set	**L1, L2, L3**
11. Measurement of Screw thread Parameters using Two-wire or Three-wire method.	**L1, L2, L3**

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12. Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator	**L1, L2, L3**
13. Measurement of gear tooth profile using gear tooth vernier /Gear tooth micrometer	**L1, L2, L3**
14. Calibration of Micrometer using slip gauges	**L1, L2, L3**

Course outcomes:

After studying this course, students will be able to:

1. Identify and classify different measuring tools related to experiments.
2. Identify, define, and explain accuracy, resolution, precision, and some additional terminology.
3. Conduct, Analyze, interpret, and present measurement data from measurements experiments.

Conduct of Practical Examination:

1 . All laboratory experiments are to be included for practical examination.
2 . Students are allowed to pick one experiment from the lot.
3 . Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Scheme of Examination:

One question from PART A:	**1 x 30 =**	**30 Marks**
One question from PART B:	**1 x 40 =**	**40 Marks**
Viva-Voce :		**10 Marks**
	Total	**= 80 Marks**

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly) Interpretation of data.

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COMPUTER AIDED AIRCRAFT DRAWING

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER – IV

Subject Code	**15AEL48**	IA Marks	20
Number of Lecture Hours/Week	03	Exam Hours	03
Total Number of Lecture Hours	42	Exam Marks	80

CREDITS – 04

Course objectives: This course will enable students to

1. Understand and interpret drawings of machine and aircraft components
2. Prepare assembly drawings either manually or by using standard CAD packages.
3. Familiarize with standard components and their assembly of an aircraft.

Modules	Revised Bloom's Taxonomy (RBT) Level
PART A	
1. Sections of Solids: Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on axis inclinations, spheres and hollow solids). True shape of sections.	**L1, L2, L3, L6**
2. **Orthographic Views:** Conversion of pictorial views into orthographic projections of **simple machine parts** with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines.	**L1, L2, L3**
PART B	
3.Thread Forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread.	**L1, L2, L3**
4.Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.	**L1, L2, L3**

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5.Keys & Joints: Parallel key, Taper key, Feather key, Gibhead key and Woodruff key	**L1, L2, L3**
6.Riveted Joints: Single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets). Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods.	**L1, L2, L3**
7. Couplings:	**L1, L2, L3**
Split Muff coupling, protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint)	
PART C	
8. Design of propeller and hub assembly	**L1, L2, L3**
9. Design of wing assembly	**L1, L2, L3**
10. Design of fuselage assembly	**L1, L2, L3**
11. Design of Engine Mounts	**L1, L2, L3**
12. Design of main rotor blade assembly of helicopter	**L1, L2, L3, L4, L5, L6**
13. Design of UAV assembly	**L1, L2, L3, L4, L5, L6**
14. Design of Landing Gear Assembly	**L1, L2, L3, L4, L5, L6**

Course outcomes:

After studying this course, students will be able to:

1. Distinguish drawings of machine and aircraft components
2. Identify assembly drawings either manually or by using standard CAD packages.
3. Practise with standard components and their assembly of an aircraft..

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Conduct of Practical Examination:

Internal Assessment: 20 Marks

Sketches shall be in sketch books and drawing shall be drawn through the use of software on A3/A4 sheets. Sketch book and all the drawing printouts shall be submitted.

Scheme of Evaluation for Internal Assessment (20 Marks)

(a) Class work (Sketching and Computer Aided Aircraft Drawing printouts in A4/A3 size sheets): 10Marks.

(b) Internal Assessment test in the same pattern as that of the main examination (Better of the two Tests): 10 marks.

Scheme of Examination:

Two questions are to be set from each Part-A, Part-B and Part-C.

Student has to answer one question each from Part A and Part B for 15 marks each and one question from Part C for 50 marks.

i.e. **Part A 1 x 15 = 15 Marks**

Part B 1 x 15 = 15 Marks

Part C 1 x 50 = 50 Marks

Total = 80 Marks

INSTRUCTION FOR COMPUTER AIDED AIRCRAFT DRAWING (**15AEL48**) EXAMINATION

1. There is no restriction of timing for sketching/ computerization of solutions. The total duration is 3 hours.
2. It is desirable to do sketching of all the solutions before computerization.
3. Drawing instruments may be used for sketching.
4. For Part A and Part B 2D drafting environment should be used.
5. For Part C 3D part environment should be used for parts assembly drawing and extract 2D views.

Graduate Attributes (as per NBA):

- Engineering Knowledge.
- Problem Analysis.
- Design / development of solutions (partly) Interpretation of data.

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V SEMESTER
MANAGEMENT & ENTREPRENEURSHIP

Sub Code	:	10AL51	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART – A
MANAGEMENT

UNIT - 1

MANAGEMENT: Introduction - Meaning - nature and characteristics of Management, Scope and Functional areas of management - Management as a science, art of profession - Management & Administration - Roles of Management, Levels of Management, Development of Management Thought - early management approaches - Modern management approaches.

7 Hours

UNIT - 2

PLANNING: Nature, importance and purpose of planning process Objectives - Types of plans (Meaning Only) - Decision making Importance of planning - steps in planning & planning premises - Hierarchy of plans. **6 Hours**

UNIT - 3

ORGANIZING AND STAFFING: Nature and purpose of organization Principles of organization - Types of organization - Departmentation Committees- Centralization Vs Decentralization of authority. and responsibility - Span of control - MBO and MBE (Meaning Only) Nature and importance of staffing— :Process of Selection & Recruitment (in brief). **6 Hours**

UNIT - 4

DIRECTING & CONTROLLING: Meaning and nature of directing Leadership styles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of Co Ordination. Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief): **7 Hours**

PART-B
ENTREPRENEURSHIP

UNIT - 5

ENTREPRENEUR: Meaning of Entrepreneur; Evolution of .the Concept; Functions of an Entrepreneur, Types of Entrepreneur, Entrepreneur - an emerging. Class. Concept of Entrepreneurship - Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of

entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship - its Barriers. **6 Hours**

UNIT – 6

SMALL SCALE INDUSTRIES: Definition; Characteristics; Need and rationale; Objectives; Scope; role of SSI in Economic Development. Advantages of SSI Steps to start and SSI - Government policy towards SSI; Different Policies of SSI; Government Support for SSI during 5 year plans. Impact of Liberalization, Privatization, Globalization on SSI Effect of WTO/GA TT Supporting Agencies of Government for SSI, Meaning, Nature of support; Objectives; Functions; Types of Help; Ancillary Industry and Tiny Industry (Definition Only)

7 Hours

UNIT - 7

INSTITUTIONAL SUPPORT: Different Schemes; TECKSOK; KIADB; KSSIDC; KSIMC; DIC Single Window Agency; SISI; NSIC; SIDBI; KSFC.

7 Hours

UNIT - 8

PREPARATION OF PROJECT: Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study.

7 Hours

Text Books:

1. **Principles of Management** – P. C.Tripathi, P.N. Reddy – Tata McGraw Hill,
2. **Dynamics of Entrepreneurial Development & Management** Vasant Desai - Himalaya Publishing House
3. **Entrepreneurship Development** – Poornima. M. Charantimath Small Business Enterprises - Pearson Education - 2006 (2 & 4).

Reference Books:

1. **Management Fundamentals** - Concepts, Application, Skill Development - Robers Lusier - Thomson
2. **Entrepreneurship Development** - S.S.Khanka - S.Chand & Co.
3. **Management** - Stephen Robbins - Pearson Education/PHI - 17th Edition, 2003.

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INTRODUCTION TO COMPOSITE MATERIALS

Sub Code	:	10AE52	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Introduction To Composite Materials:
Definition, classification and characteristics of composite materials – fibrous composites, laminated. Matrix materials

Unit 2. **06 Hrs**

Fiber Reinforced Plastic Processing:
Lay up and curing, fabricating process - open and closed mould process - hand lay up techniques structural laminate bag molding, production procedures for bag molding.

Unit 3. **08 Hrs**

Advanced Processing Techniques and Application Of Composites:
Filament winding, pultrusion, pulforming, thermo - forming, injection, injection molding, liquid molding, blow molding, Automobile, Aircrafts, missiles, Space hardware, Electrical and electronics, marine, recreational and Sports equipment, future potential of composites.

Unit 4. **06 Hrs**

Fabrication Of Composite Structures:
Cutting, machining, drilling, mechanical fasteners and adhesive bonding, joining, computer-aided design and manufacturing, tooling, fabrication equipment.

PART B

Unit 5. **06 Hrs**

Macro-Mechanical Behavior of a Lamina:
Stress-strain relation for an orthotropic lamina- Restriction on elastic constants- Strengths of an orthotropic lamina and Failure theories for an orthotropic lamina.

Unit 6. **06 Hrs**

Micro-Mechanical Behavior of a Lamina:
Determination of elastic constants-Rule of mixtures, transformation of coordinates, micro-mechanics based analysis and experimental determination of material constants.

Unit 7. **06 Hrs**

Macro-Mechanical Behavior of a Laminate:
Classical plate theory- Stress and strain variation in a laminate- Resultant forces and moments- A B & D matrices- Strength analysis of a laminate

Unit 8. **08 Hrs**

Metal Matrix Composites:

Reinforcement materials, types, characteristics and selection of base metals. Application ofMMC's.

Text Books:

1. Composites Science and Engineering, K.K Chawla, Springer Verlag, 1998
2. R M Jones, " Mechanics of Composite Materials", McGraw-Hill, New York, 1975

Reference:

1. Meing Schwaitz, "Composite materials hand book", McGraw Hill Book Company. 1984
2. Introduction to Composite materials, Hull and Clyne, Cambridge University Press, 2nd Edition, 1990.
3. Forming Metal handbook, 9th edition, ASM handbook, V15. 1988, P327 338.
4. Mechanics of composites by Artar Kaw, CRC Press. 2002.

DYNAMICS OF MACHINERY

Sub Code	:	10AE53	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Static Force Analysis: Static force analysis: Introduction: Static equilibrium. Equilibrium of two and three force members. Members with two forces and torque, Free body diagrams, principle of virtual work. Static force analysis of four bar mechanism and slider-crank mechanism with and without friction.

Unit 2. **06 Hrs**

Dynamic Force Analysis: D'Alembert's principle, Inertia force, inertia torque,

Back to Index

Dynamic force analysis of four-bar mechanism and slider crank mechanism. Dynamically equivalent systems. Turning moment diagrams and flywheels, Fluctuation of Energy. Determination of size of flywheels.

Unit 3. **08 Hrs**

Friction and Belt Drives: Definitions: Types of friction: laws of friction, Friction in pivot and collar bearings. Belt drives: Flat belt drives, ratio of belt tensions, centrifugal tension, power transmitted.

Unit 4. **06 Hrs**

Balancing of Rotating Masses: Static and dynamic balancing, Balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes.

PART B

Unit 5. **08 Hrs**

Balancing of Reciprocating Masses: Inertia effect of crank and connecting rod, single cylinder engine, balancing in multi cylinder-inline engine primary & Secondary forces, V-type engine; Radial engine – Direct and reverse crank method.

Unit 6. **06 Hrs**

Governors: Types of governors; force analysis of Porter and Hartnell governors. Controlling force, stability, sensitiveness, isochronism, effort and power

Unit 7. **06 Hrs**

Gyroscope: Vectorial representation of angular motion, Gyroscopic couple. Effect of gyroscopic couple on ship, plane disc, aeroplane, stability of two wheelers and four wheelers.

Unit 8. **06 Hrs**

Analysis of CAMS: Analysis of Tangent cam with roller follower and Circular arc cam operating flat faced and roller followers, Undercutting in Cams.

Text Books:

1. Theory of Machines: Sadhu Singh, Pearson Education, 2nd edition, 2007.
2. Theory of Machines: Rattan S.S. Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition, 2006.

Reference:

1. Theory of Machines by Thomas Bevan, CBS Publication 1984.
2. Design of Machinery by Robert L. Norton, McGraw Hill, 2001.
3. Mechanisms and Dynamics of Machinery by J. Srinivas, Scitech Publications, Chennai, 2002.
4. Dynamics of machinery by J. B. K. Das & P. L. S. Murthy.

Scheme of examination:

One Question to be set from each unit. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

AERODYNAMICS – I

Sub Code	:	10AE54	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **4 Hrs.**

Review of Basic Fluid Mechanics

Continuity, momentum and energy equation, units and dimensions, inviscid and viscous flows, compressibility, Mach number regimes.

Unit 2. **6 Hrs.**

Description of Fluid Motion

Euler and Lagrangian descriptions, control volume approach to continuity and momentum equations, pathlines, streamlines and streaklines, angular velocity, vorticity, circulation, stream function, velocity potential and relationship between them.

Unit 3. **6 Hrs.**

Airfoil Characteristics

Fundamental aerodynamic variables, airfoil section geometry and wing planform geometry, aerodynamic forces and moments, centre of pressure, pressure coefficient, calculation of airfoil lift and drag from measured surface pressure distributions, typical airfoil aerodynamic characteristics at low speeds.

Unit 4. **10 Hrs**

Two-Dimensional Inviscid Incompressible Flows

Bernoulli's equation, pitot-tube measurement of airspeed, condition on velocity

Back to Index

for incompressible flow, Eulers equations of motion, Governing equations for irrotational, incompressible flow, Laplace equation and boundary conditions. Two-dimensional source, sink and doublet flows, non-lifting flow over a two-dimensional circular cylinder and vortex flow.

PART B

Unit 5. **06 Hrs**

Flow Over Circular Cylinders

Non-lifting flow over a two-dimensional circular cylinder, Lifting flow over a two-dimensionalcircular cylinder, Kutta-Joukowski theorem and generation of lift, D'Alembert's paradox.

Unit 6. **06 Hrs**

Incompressible Flow Over Airfoils

Kelvin's circulation theorem and the starting vortex, vortex sheet, Kutta condition, Classical thin airfoil theory for symmetric and cambered airfoils.

Unit 7. **06 Hrs**

Introduction to Viscous Flows

Navier-Stokes equations, boundary layer concept, displacement, momentum thickness and wall skin friction, viscous flow over two-dimensional streamlined and bluff bodies and drag characteristics, aspects of boundary layer separation and airfoil stall.

Unit 8. **08 Hrs**

Introduction to Aerodynamic Testing

Principles of wind tunnel flow simulation, open and closed circuit wind tunnels, and Major features of low speed, transonic and supersonic wind tunnels, smoke and tuft flow visualization techniques, Pressure and Aerodynamic load measurements on a model, total drag determination of two-dimensional bodies using wake survey at low speeds.

Text Books

1. Anderson, Jr. J.D. "Fundamentals of Aerodynamics", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2007. (Special Indian Edition).
2. Houghton E.L and Carpenter P.W. "Aerodynamics for Engineering Students, CBS Publications and Distributors, 1993. (4th Edition).

References :

1. Pope A. and Harper, J J.,"Low Speed Wind Tunnel testing", John Wiley Inc. New York, 1966

2. Anderson, Jr. J.D. "Introduction to Flight", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2007. (Special Indian Edition).
3. Schlichting, H. "Boundary Layer Theory" Mc Graw Hill, New York, 2004
4. Duncan WJ, Thom AS and Young AD., "Mechanics of Fluids", Second Edition, Edward Arnold Printers Ltd, London, 1981
5. Pope A. and Goin, KL. "High Speed Wind Tunnel Testing", John Wiley & Sons Inc. New York, 1965

Scheme of examination:

One Question to be set from each unit. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

AIRCRAFT PROPULSION

Sub Code	:	10AE55	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Introduction

Introduction: Review of thermodynamic principles, Principles of aircraft propulsion, Types of power plants, Basics of heat transfer; conduction, convection, radiation, diffusion mass transfer basic concepts and governing equations.

Unit 2. **07 Hrs**

Fundamentals of Gas Turbine Engines

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

Unit 3. **07 Hrs**

Subsonic and Supersonic Inlets for Jet Engines

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

Unit 4. **06 Hrs**

Combustion Chambers and Nozzles

Classification of combustion chambers – Important factors affecting combustion chamber design – Combustion process – Combustion chamber performance – Effect of operating variables on performance – Flame tube cooling – Flame stabilization – Use of flame holders – .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.

PART B

Unit 5. **07 Hrs**

Compressors

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

Unit 6. **07 Hrs**

Intoduction to Turbines:

Types of turbines-Operating Priciple-Design consideration – Velocity triangles – degree of reaction -performance parameters – Basics of blade design principles

Unit 7. **06 Hrs**

Ramjet Propulsion:

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

Unit 8. **06 Hrs**

Fundamentals of Rocket Propulsion

Types and Classification of rockets Operating principle – Specific impulse of a rocket – Rocket nozzle classification – Rocket performance considerations

Text Books

1. V. Ganesan, " Gas Turbine", Tata McGraw Hill Pub. Co. Ltd., 1996
2. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Addison – Wesley Longman INC, 1999.

References

1. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H. "Gas Turbine Theory", Longman,
2. 1989.
3. Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAA Education Series, New York, 1985.
4. "Rolls Royce Jet Engine" – Third Edition – 1983.
5. Mathur, M.L. and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers & Distributors, Delhi, 1999.
6. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edn., 1993.
7. Heat & mass transfer by Domkundwar

Scheme of examination:

One Question to be set from each unit. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

AIRCRAFT STRUCTURES – I

Sub Code	:	10AE56	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Loads On Aircraft

Structural nomenclature – Types of loads – load factor – Aerodynamics loads – Symmetric manoeuvre loads – Velocity diagram – Function of structural components.

Unit 2. **06 Hrs**

Materials for Aircraft Structures

Metallic and non-metallic materials, Use of Aluminium alloy, titanium, stainless steel and composite materials. Desirable properties for aircraft application

Unit 3. **06 Hrs**

Mechanical Properties of Material

Stress – Strain - Tensile properties – Compression properties – Shear properties – Bearing properties – Creep and Stress properties – Fracture properties –Fatigue properties.

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Unit 4 **08 Hrs**

Statically Determinate And Interdeterminate Structures

Analysis of plane truss – Method of joints – 3 D Truss - Plane frames, Composite beam - Clapeyron's Three Moment Equation - Moment Distribution Method.

PART B

Unit 5. **06 Hrs**

Energy Methods Strain

Energy due to axial, bending and Torsional loads - Castigliano's theorem - Maxwell's Reciprocal theorem, Unit load method - application to beams, trusses, frames, rings, etc.

Unit 6. **06 Hrs**

Columns

Columns with various end conditions – Euler's Column curve – Rankine's formula - Column with initial curvature - Eccentric loading – South well plot – Beam column.

Unit 7. **08 Hrs**

Theory of Elasticity

Concept of stress and strain, derivation of Equilibrium equations, strain-displacement relation, compatibility conditions and boundary conditions. Plane stress and Plane strain problems in 2D elasticity and Airy's Stress function

Unit 8. **06 Hrs**

Failure Theory

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

Text Book

1. Mechanics of Materials, Dr.BC Punmia, Ashoak Kumar Jain, Arun Kumar Jain, Lakshmi Publication
2. Megson, T.M.G., "Aircraft Structures for Engineering Students", Edward Arnold, 1995.
3. Timoshenko and Goodier," Theory of Elasticity' Mc Graw Hill Co.

Reference

1. Donaldson, B.K., "Analysis of Aircraft Structures – An Introduction", McGraw-Hill, 1993.
2. Timoshenko, S., "Strength of Materials", Vol. I and II, Princeton D. Von Nostrand Co, 1990

Scheme of Examination:

One Question to be set from each unit. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least TWO questions from Part A and TWO questions from Part B.

AERODYNAMICS LABORATORY

Sub Code	:	10AEL57	IA Marks	:	25
Hrs/ Week	:	03	Exam Hours	:	03
Total Hours	:	42	Exam Marks	:	50

LIST OF EXPERIMENTS

1. Calibration of a subsonic wind tunnel
2. Smoke flow visualization studies on a two-dimensional circular cylinder at low speeds.
3. Smoke flow visualization studies on a two dimensional airfoil at different angles of incidence at low speeds
4. Tuft flow visualization on a wing model at different angles of incidence at low speeds: identify zones of attached and separated flows.
5. Surface pressure distributions on a two-dimensional circular cylinder at low speeds and calculation of pressure drag.
6. Surface pressure distributions on a two-dimensional symmetric airfoil at zero incidences at low speeds.
7. Surface pressure distributions on a two-dimensional cambered airfoil at different angles of incidence and calculation of lift and pressure drag.
8. Calculation of total drag of a two-dimensional circular cylinder at low speeds using pitot-static probe wake survey.
9. Calculation of total drag of a two-dimensional cambered airfoil at low speeds at incidence using pitot-static probe wake survey.
10. Measurement of a typical boundary layer velocity profile on the tunnel wall (at low speeds) using a pitot probe and calculation of boundary layer displacement and momentum thickness.

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ENERGY CONVERSION LABORATORY

Sub Code	:	10AEL58	IA Marks	:	25
Hrs/ Week	:	03	Exam Hours	:	03
Total Hours	:	42	Exam Marks	:	50

PART – A
(Individual Experiments)

21 Hrs

1. Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Pensky Martins Apparatus.
2. Determination of Calorific value of solid, liquid and gaseous fuels
3. Determination of Viscosity of lubricating oil using Redwood, Saybolt Viscometer and Torsion viscometers.
4. Valve Timing/port opening diagram of an I.C. engine (4 stroke/ 2stroke).
5. Use of planimeter.

PART – B
(Group Experiments)

21 Hrs

1. Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiencies, SFC, FP, heat balance sheet for
   (a) Four stroke Diesel Engine
   (b) Four stroke Petrol Engine
   (c) Multi-cylinder Diesel/Petrol Engine, (Morse test)
   (d) Two stroke Petrol Engine
   (e) Variable Compression Ratio I.C. Engine

VI SEMESTER
APPLIED GAS DYNAMICS

Sub Code	:	10AE61	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **07 Hrs**

Basics of Compressible Flow

Basics of thermodynamics-definition and basic relation, Energy Equation- For flow and non-flow process, adiabatic energy equation, stagnation pressure, temperature, density, reference velocities, Bernoulli's equation, Effect of Mach number on Compressibility, Isentropic flow with variable area-Area ratio as a function of Mach number, Impulse function, Mass flow rate, Flow through nozzles and diffusers

Unit 2. **07 Hrs**

Normal, Oblique Shocks and Expansion Waves

Governing Equations of Normal Shock Wave. Prandtl relation and Rankine - Hugoniot equation. Oblique shocks and corresponding relations. Shock polar & Hodograph plane. Supersonic flow over a wedge. Supersonic compression and supersonic expansion. Detached shocks. Mach reflection. Intersection of waves of same and opposite families.

Unit 3. **06Hrs**

Fanno Flow

Flow with friction in constant area duct. Fanno lines. Fanno equation. Definition of friction constant, Friction loss. Effect of wall friction on flow properties. Friction parameter. Local flow properties in terms of local Mach number.

Unit 4. **06 Hrs**

Rayleigh Flow

Flow with heating or cooling in ducts. Governing equations. Heating relations for a perfect gas. Slope of Rayleigh line. Entropy considerations. Maximum heat transfer.

PART B

Unit 5. **07 Hrs**

Differential Equations of Motion for Steady Compressible Flows Basic potential equations for compressible flow. Linearisation of potential equation-small perturbation theory. Methods for solution of nonlinear potential equation -Introduction. Boundary conditions. Pressure coefficient expression.

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Unit 6. **06 Hrs**

Similarity Rules

Two-dimensional linearized flow. Prandtl - Glauert rule and Gotherts rule. Von-Karman rule for transonic flow. Application to wings of finite span. Aerodynamic characteristics for actual and transformed bodies.

Unit 7. **06 Hrs**

Flow of Real Fluids.

Shock Wave – Boundary layer interaction. Experimental characteristics of airfoils in compressible flow. Nature of pressure distribution.

Unit 8. **07 Hrs**

Measurements in Compressible Flow

Types of Wind tunnel. Optical methods of flow visualization-shadow technique, Mach zender interferometer, Schileren technique. Wind tunnel Instrumentation and measurements-Pressure, Temperature, Flow rate, Hot-wire anemometer, Velocity measurements.

Text Books:

1. Radhakrishnan, E., "Gas Dynamics", Prentice Hall of India.1995 edition.
2. Yahya, S.M., "Fundamentals of Compressible flow", Wiley Eastern, 2003.

Reference Books:

1. John D Anderson, "Modern Compressible Flow", Mc Graw Hill 1999.
2. Ascher.H.Saphiro, "Dynamics and Thermodynamics of Compressible fluid flow", Ronald Press,1953.
3. H.W. Liepmann and A.Roshko, "Elements of Gas Dynamics"

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

AIRCRAFT PERFORMANCE

Sub Code	:	10AE62	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Introduction:

The evolution of the airplane and the performance- a short history; The standard atmosphere; The Drag polar- source of aerodynamic force-lift, drag and moments; aerodynamic coefficients-Variation of lift, drag and moment coefficient with

angle of attack and Mach number Components of drag; Aerodynamic center; Equilibrium conditions; Variation of thrust, power and SFC with velocity and altitudes for air breathing engines..

Unit 2. **07 Hrs**

The Equations of Motion Steady Unaccelerated Flight:

Introduction, Four forces of flight, General equation of motion, Power available and power required curves. Thrust available and thrust required curves. Conditions for power required and thrust required minimum. Thrust available and maximum velocity, Power available and maximum velocity, Altitude effects on power available and power required; thrust available and thrust required.

Unit 3. **07 Hrs**

Steady Performance – Level Flight, Climb & Glide:

Equation of motion for steady level flight, Performance of airplane in level flight. Maximum speed in level flight. Climb Performance: Equation of motion for Rate of climb- graphical and analytical approach -Absolute ceiling, Service ceiling, Time to climb – graphical and analytical approach , climb performance graph (hodograph diagram); maximum climb angle and rate of climb Gliding flight, Range during glide, minimum rate of sink and shallowest angle of glide.

Unit 4. **06 Hrs**

Fundamental Airplane Performance Parameters:

The fundamental Parameters: Thrust – to – weight ratio, Wing loading, Drag polar, and lift-to – drag ratio. Minimum velocity: Stall and High lift devices, Nature of stall – flow separation, High lift deices, Aerodynamic relations associated with lift-to-drag ratio.

PART B

Unit 5. **07 Hrs**

Range And Endurance:

Propeller driven Airplane: Physical consideration, Quantitative formulation, Breguet equation for Range and Endurance, Conditions for maximum range and endurance.

Jet Airplane: Physical consideration, Quantitative formulation, Equation for Range and Endurance, Conditions for maximum range and endurance, Effect of head wind tail wind

Unit 6. **06 Hrs**

Aircraft Performance In Accelerated Flight

Take-off Performance: Calculation of Ground roll, Calculation of distance while airborne to clear obstacle, Balanced field length

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Unit 7. **06 Hrs**

Landing Performance and Accelerated Climb:

Calculation of approach distance, Calculation of flare distance, Calculation of ground roll, ground effects. Acceleration in climb.

Unit 8. **07 Hrs**

Manouver Performance:

Turning performance: Level turn, load factor, Constraints on load factor, Minimum turn radius, Maximum turn rate. Pull-up and Pull-down maneuvers: (Turning rate, turn radius). Limiting case for large load factor. The V-n diagram. Limitations of pull up and push over.

Text Books:

1. John D. Anderson, Jr. "Aircraft Performance and Design", McGraw-Hill International Editions, Aerospace Science/ Technology Editions, 1999
2. John D. Anderson, Jr., "Introduction to flight" McGraw-Hill International Editions, Aerospace Science/ Technology Editions, 2000

References

1. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley Son Inc, New York, 1988.
2. Barnes W. McCormick, ' Aerodynamics, Aeronautics, and Flight Mechanics', John Wiley & Sons, Inc. 1995.

Scheme of Examination: Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B

AERODYNAMICS – II

Sub Code	:	10AE63	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs.**

Introduction To Two-Dimensional Panel Methods

Non-lifting flows over arbitrary bodies, source panel method, lifting flows over arbitrary bodies, vortex panel method, some examples

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Unit 2. **08 Hrs.**

Incompressible Flows Over Finite Wings

Downwash, Induced drag, vortex filament, the Biot-Savart Law, Prandtl's lifting line theory and its limitations, Elliptic lift distribution.

Unit 3. **06 Hrs.**

Subsonic linearized flow over airfoils

Full velocity potential equation, linearized velocity potential equation and boundary condition, Prandtl-Glauret compressibility correction.

Unit 4. **06 Hrs.**

Effects Of Compressibility

Basics of speed of sound, Mach waves, Normal shock waves, Oblique shock waves, Expansion fan, Prandtl – Meyer expansion, Critical Mach number; Drag-divergence Mach number, Sound Barrier, Transonic area rule,.

PART B

Unit 5. **06 Hrs.**

Applications Of Finite Wing Theory

Simplified horse-shoe vortex model, formation flight, influence of downwash on tail plane, ground effects.

Unit 6. **06 Hrs.**

Bodies Of Revolution

Introduction to slender body theory, cylindrical coordinates, boundary conditions, pressure coefficient, Subsonic flow past a axially symmetric body at zero incidence and solution for a slender cone.

Unit 7. **06 Hrs.**

Swept Wings And High-Lift Systems

Introduction to sweep effects, swept wings, pressure coefficient, typical aerodynamic characteristics, Subsonic and Supersonic leading edges. Introduction to high-lift systems, flaps, leading-edge slats and typical high - lift characteristics.

Unit 8. **08 Hrs.**

Viscous Flows

Derivation of Navier-Stokes equation for two-dimensional flows, boundary approximations, laminar boundary equations and boundary conditions, Blasius solution, qualitative features of boundary layer flow under pressure gradients, Integral method, aspects of transition to turbulence, turbulent boundary layer properties over a flat plate at low speeds.

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Text Books:

1. Anderson, Jr. J.D. "Fundamentals of Aerodynamics", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2007. (Special Indian Edition).
2. H.W. Liepmann and A.Roshko, "Elements of Gas Dynamics"
3. Schlichting, H, "Boundary layer theory", McGraw Hill, New York 2004

Reference:

1. Bertin, John J., "Aerodynamics for Engineers". Pearson Education Inc., 2002.
2. White, F.M., " Fluid Mechanics", Mc Graw Hill Inc. New York, 1986
3. Houghton E.L and Carpenter P.W. "Aerodynamics for Engineering Students", CBS Publications and Distributors,8 1993. (4th Edition).
4. Anderson, Jr. J.D. "Introduction to Flight", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2007. (Special Indian Edition).

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

FINITE ELEMENT ANALYSIS

Sub Code	:	10AE64	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **08 Hrs.**

Introduction: Basic Concepts, Background Review:

Stresses and Equilibrium, Plane stress, Plane strain, Potential energy and Equilibrium. Rayleigh - Ritz Method, Galerkin's Method, Simple applications in structural Analysis. Construction or discrete models - sub domains and nodes - simple elements for the FEM - Simplex, complex and multiples elements Polynomial selection -illustrative examples

Unit 2 **06 Hrs**

Fundamentals of Finite Element Method:

Elements and shape functions and natural coordinates, Use of local and natural coordinates, compatibility and convergence requirements of shape functions, Construction of shape functions for bar element and beam element

Unit 3 **06 Hrs**

Analysis of Discrete Elements:

Bar elements, uniform bar elements, uniform section, mechanical and thermal

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loading, varying section, truss analysis, Frame element, Beam element, problems for various loadings and boundary conditions.

Unit 4 **06 Hrs**

Analysis of Two dimensional Elements:

Shape functions of Triangular, Rectangular and Quadrilateral elements, different types of higher order elements, constant and linear strain triangular elements, stiffness matrix

PART B

Unit 5 **06 Hrs**

Analysis of Three dimensional elements:

Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 8), Tetrahedral elements, Hexahedral elements: Serendipity family, Hexahedral elements: Lagrange family.

Unit 6 **06 Hrs**

Theory of Isoparametric Elements:

Isoparametric, sub parametric and super-parametric elements, characteristics of Isoparametric quadrilateral elements, structure of computer program for FEM analysis, description of different modules, pre and post processing.

Unit 7 **06 Hrs**

Axisymmetric solids subjected to axisymmetric loading:

Axisymmetric formulation, finite element modeling of triangular and quadrilateral element

Unit 8 **08 Hrs**

Field Problems:

Heat transfer problems, Steady state fin problems, 1D heat conduction governing equation, Derivation of element matrices for two dimensional problems, Dynamic consideration- Formulation-Hamilton's principle, Element mass matrices.

Text Books:

1. Chandrupatla T. R., "Finite Elements in engineering"- 2nd Edition, PHI, 2007.
2. C.S. Krishnamurthy - "Finite Element analysis - Theory and Programming", Tata McGraw Hill Co. Ltd, New Delhi
3. Bhavikatti, Finite element Analysis, New Age International

Reference Books:

1. Rajasekharan. S - "Finite element analysis in engineering design", Wheeler Publishers
2. Bathe. KJ - "Finite Element Procedures", PHI Pvt. Ltd., New Delhi

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4. Zienkiewicz. O.C. - "The Finite Element Method", Tata McGraw Hill Co. Ltd, New Delhi
5. Rao S. S. "Finite Elements Method in Engineering"- 4th Edition, Elsevier, 2006

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

THEORY OF VIBRATIONS

Sub Code	:	10AE65	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1 **06 Hrs**
Introduction
Types of vibrations, S.H.M, principle of super position applied to Simple Harmonic Motions. Beats, Fourier theorem and simple problems.

Unit 2 **07 Hrs**
Undamped Free Vibrations
Single degree of freedom systems. Undamped free vibration,natural frequency of free vibration, Spring and Mass elements, effect of mass of spring, Compound Pendulum.

Unit 3 **07 Hrs**
Damped Free Vibrations
Single degree of freedom systems, different types of damping, concept of critical damping and its importance, study of response of viscous damped systems for cases of under damping, critical and over damping, Logarithmic decrement.

Unit 4 **06 Hrs**
Forced Vibration
Single degree of freedom systems, steady state solution with viscous damping due to harmonic force. Solution by Complex algebra, reciprocating and rotating unbalance, vibration isolation, transmissibility ratio. due to harmonic exitation and support motion.

PART B

Unit 5 **06 Hrs**
Vibration Measuring Instruments & Whirling Of Shafts
Vibration of elastic bodies – Vibration of strings – Longitudinal, lateral and torsional Vibrations

Unit 6. **08 Hrs**
Systems With Two Degrees Of Freedom
Introduction, principle modes and Normal modes of vibration, co-ordinate coupling, generalized and principal co-ordinates, Free vibration in terms of initial conditions. Geared systems. Forced Oscillations-Harmonic excitation. Applications:
a) Vehicle suspension.
b) Dynamic vibration absorber.
c) Dynamics of reciprocating Engines.

Unit 7 **06 Hrs**
Continuous Systems
Introduction, vibration of string, longitudinal vibration of rods, Torsional vibration of rods, Euler's equation for beams.

Unit 8 **06 Hrs**
Numerical Methods For Multi-Degree Freedom Systems
Introduction, Influence coefficients, Maxwell reciprocal theorem, Dunkerley's equation. Orthogonality of principal modes, Method of matrix iteration-Method of determination of all the natural frequencies using sweeping matrix and Orthogonality principle. Holzer's method, Stodola method.

Text Books:
1. Theory of Vibration with Applications: W.T. Thomson and Marie Dillon Dahleh, Pearson Education 5th edition, 2007.
2. Mechanical Vibrations: V.P. Singh, Dhanpat Rai & Company Pvt. Ltd., 3rd edition, 2006

Reference Books:
1. Mechanical Vibrations: S.S. Rao, Pearson Education Inc, 4th Edition, 2003.
2. Mechanical Vibrations: S. Graham Kelly, Schaum's Outline Series, Tata McGraw Hill, Special Indian edition, 2007.
3. Theory & Practice of Mechanical vibrations: J.S. Rao & K. Gupta, New Age International Publications, New Delhi, 2001.
4. Elements of Vibrations Analysis: Leonanrd Meirovitch, Tata McGraw Hill, Special Indian edition, 2007.

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B

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ELECTIVE - I (Group A)
NUMERICAL METHODS

Sub Code	:	10AE661	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1 **06Hrs**

Numerical Computation

Motivation and Objectives/ Number Representation/ Machine Precision/ Round-off Error/ Truncation Error/ Random Number Generation.

Unit 2 **06 Hrs**

Linear Algebraic Systems

Motivation and Objectives/ Gauss-Jordan Elimination/Gaussian Elimination/ LU Decomposition/ III- Conditioned Systems/ Iterative Methods.

Unit 3 **06 Hrs**

Interpolation and Approximation

Lagrangian Polynomials - Divided differences Interpolating with a cubic spline - Newton's forward and backward difference formulas.

Unit 4 **08 Hrs**

Eigen Values and Eigen vectors

Motivation and Objectives/ The characteristics Polynominal/ Power Methods / Jacobi's Method/ Householder Transformation/ QR Method/ Danilevsky's Method/ Polynominal Roots.

PART B

Unit 5 **08 Hrs**

Numerical Differentiation and Integration

Derivative from difference tables - Divided differences and finite differences - Numerical integration by trapezoidal and Simpson's 1/3 and 3/8 rules - Two and Three point Gaussian quadrature formulas - Double integrals using trapezoidal and Simpson's rules.

Unit 6 **06 Hrs**

Curve Fitting

Motivation and objectives/ Interpolation/ Newton's Difference Formula/ Cubic Splines/ Least Square/ Two-Dimensional Interpolation.

Unit 7 **06 Hrs**

Root Finding

Motivation and Objectives/ Bracketing methods/ Contraction Mapping Method/ Se cant Method/ Muller's Method/ Newton's Method/ Polynomial Roots/ Nonlinear Systems of Equations.

Unit 8 **06 Hrs**

Optimization

Motivation and Objectives/ Local and Global Minima/ Line Searches/ Steepest Descent Method/ Conjugate-Gradient Method/ Quasi-Newton Methods/ Penalty Functions/ Simulated Annealing.

Text Book:

1. Applied Numerical methods for Engineers Using Mat Lab and C-Robert Schilling and Sandra Harris, Thomson Learning, 2002.
2. Applied Numerical Analysis – Gerald and Wheatley, Pearson Education, 2002.

Reference Books:

1 Numerical Recipes in C – William Press et. Al., 2e, Cambridge University Press.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B

AIRCRAFT MATERIALS

Sub Code	:	10AE662	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit – 1 **06 Hrs**

Introduction To Aircraft Materials:

General properties of materials, Definition of terms, Requirements of aircraft materials, Testing of aircraft materials, Inspection methods, Application and trends in usage in aircraft structures and engines, Introduction to smart materials and nanomaterials; Selection of materials for use in aircraft.

Back to Index

Unit – 2 **08 Hrs**

Aircraft Metal Alloys And Superalloys:

Aluminum alloys, Magnesium alloys, Titanium alloys, Plain carbon and Low carbon Steels, Corrosion and Heat resistant steels, Maraging steels, Copper alloys, Producibility and Surface treatments aspects for each of the above; General introduction to superalloys, Nickel based superalloys, Cobalt based superalloys, and Iron based superalloys, manufacturing processes associated with superalloys, Heat treatment and surface treatment of superalloys.

Unit – 3 **06 Hrs**

Composite Materials:

Definition and comparison of composites with conventional monolithic materials, Reinforcing fibers and Matrix materials, Fabrication of composites and quality control aspects, Carbon-Carbon Composites production, properties and applications, inter metallic matrix composites, ablative composites based on polymers, ceramic matrix, metal matrix composites based on aluminum, magnesium, titanium and nickel based composites for engines.

Unit – 4 **06 Hrs**

Polymers, Polymeric Materials & Plastics and Ceramics & Glass:

Knowledge and identification of physical characteristics of commonly used polymeric material: plastics and its categories, properties and applications; commonly used ceramic, glass and transparent plastics, properties and applications, adhesives and sealants and their applications in aircraft.

PART B

Unit – 5 **06 Hrs**

Ablative and Super Conducting Materials:

Ablation process, ablative materials and applications in aerospace; Phenomenon of super conduction, super conducting materials and applications in aerospace.

Unit – 6 **07 Hrs**

Aircraft Wood, Rubber, Fabrics & Dope And Paint:

Classification and properties of wood, Seasoning of wood, Aircraft woods, their properties and applications, Joining processes for wood, Plywood; Characteristics and definition of terminologies pertaining to aircraft fabrics and their applications, Purpose of doping and commonly used dopes; Purpose of painting, Types of aircraft paints, Aircraft painting process.

Unit – 7 **06 Hrs**

Corrosion and Its Prevention:

Knowledge of the various methods used for removal of corrosion from common aircraft metals and methods employed to prevent corrosion.

Unit – 8 **07 Hrs**

High Energy Materials:

Materials for rockets and missiles. Types of propellants and its general and desirable properties, insulating materials for cryogenic engines. Types of solid propellants: Mechanical characterization of solid propellants using uni-axial, strip-biaxial and tubular tests.

Text Books:

1. Handbook of Aircraft materials Interline publishers, C G Krishnadas Nair, , Bangalore, 1993.
2. Aicraft Material and Processes, Titterton G F, , English Book Store, New Delhi, 1998

Reference:

1. Advanced Aerospace Material, H Buhl, Spring Berlin 1992
2. Aerospace material Vol. 1,2,3 ARDB, Balram Gupta, S Chand & Co 1996
3. Materials for Missiles and Space, Parker E R, John Wiley.
4. The Materials of Aircraft Construction, Hill E T, Pitman London.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B

COMBUSTION

Sub Code	:	10AE663	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit – 1 **06 Hrs**

Review of Basic Concepts:

Laws of thermodynamics, simple thermo chemical equations, and heat of combustion, properties of real gases, Rankine-Hugoniot curves, ideas of deflagration and detonation.

Unit – 2 **06 Hrs**

Chemical Equilibrium And Kinetics:

Concept of chemical equilibrium, Elements of adiabatic flame temperature calculation, Chemical kinetics – rates and order of reactions, Reaction mechanism and chain reactions.

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Unit – 3 **08 Hrs**

Premixed Flames:

Mechanistic description of premixed flames, Burning velocity and parametric dependences, Experimental methods of measuring burning velocity, One dimensional Conservation Equations, Simple one-dimensional thermal theory of flame, concepts of minimum ignition energy, quenching distance, stability limits and flame stabilization.

Unit – 4 **06 Hrs**

Diffusion Flames:

Differences between premixed and diffusion flames, gas diffusion flames in parallel flow – jet flames and Burke Schumann flames, Liquid droplet combustion.

PART B

Unit – 5 **06 Hrs**

Combustion in Piston Engines:

Review of operation of reciprocating engines, Description of the combustion process in piston engines, Combustion efficiency and factors affecting it, detonation in reciprocating engines and preventive methods.

Unit – 6 **07 Hrs**

Combustion in Gas-Turbine Engines:

Description of different types of combustion chambers in gas-turbine engines, primary requirements of the combustor, Flow structure, recirculation and flame stabilization in main combustion chamber, afterburners.

Unit – 7 **07 Hrs**

Combustion in Rocket Engines:

Combustion of carbon particle, boundary layer combustion, basic principles of combustion solid propellants, extension of droplet combustion to liquid propellant rockets.

Unit – 8 **06 Hrs**

Emissions:

Flame radiation, pollutants - unburnt hydrocarbons, oxides of nitrogen and carbon monoxide, methods of reducing pollutants, Principle of exhaust gas analysis.

Text Books:

1. Introduction to Combustion by Stephen Turns.
2. Combustion fundamentals by Roger Strehlow

Reference Books:

1. Industrial Combustion by Charles E. Baukal.
2. Heat Transfer in Industrial Combustion by CE Baukal Jr
3. Combustion, Fossil Power Systems by G. Singer. 4th Ed. 1966 Ed Pub.

4. Fuels and Combustion, Sharma, S.P., and Chandra Mohan , Tata Mc. Graw Hill Publishing Co.,Ltd., New Delhi, 1987.
5. Gas Turbine, Jet and Rocket Propulsion, Mathur, M.L., and Sharma, R.P., ,' Standard Publishers and Distributors, Delhi, 1988

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B

RELIABILITY ENGINEERING

Sub Code	:	10AE664	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1 **07 Hrs**

Introduction

Reliability concepts and definitions, probability distribution functions and their application in reliability Evaluation,Reliability Evaluation in Engineering systems using Markov Models

Unit 2 **07 Hrs**

Failure analysis

Causes of failure, concept of hazard failure models, Bath Tub curve, MTTF, MTBF

Unit 3 **06 Hrs**

Reliability Modeling

System reliability for various configurations and combinational aspects, Weibull analysis On reliability

Unit 4 **06 Hrs**

Reliability Studies:

Reliability improvement, redundancy, reliability-cost trade-off

PART B

Unit 5 **06 Hrs**

Maintainability and Availability concepts

System Safety analysis

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Unit 6 **07 Hrs**

Maintenance concepts

Types of Maintenance, Modern trends in Maintenance Philosophy like BITE, **IRAN,** HUM, TPM etc.

Unit 7 **06 Hrs**

Failure Investigation Process and Methodologies like FTA, FMEA

Unit 8 **07 Hrs**

Reliability and Quality Improvement techniques like, Bench Marking, JIT, Quality Circles, Quality Audit, TQM, Kaizan etc.

Text Book:

1. Introduction to Reliability Engineering, E.E. Lewis, John Wiley.

Reference Books:

1. Probability and statistics with Reliability, Queuing and Computer, K.S. Trivedi,
2. Science Applications, PHI.
3. Reliability Engineering, E Balagurswamy, Tata McGraw Hill Publications.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

INDUSTRIAL MANAGEMENT

Sub Code	:	10AE665	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART - A

Unit – 1 **06 Hrs**

Introduction: Historical perspective, contribution of Taylor, Henry Fayol, Gilbert, Charles Babbage, Henry Gantt to the evolution of management science in the Indian context. Ownership of Industries Proprietorship, partnership, joint stock companies, public and private undertakings, co-operative organizations

Unit – 2 **08 Hrs**

Quality Philosophy: The Meaning of Quality and Quality Improvement; Brief History of Quality Methodology; Statistical Methods for Quality Control and

Improvement; Total Quality Management (quality philosophy, links between quality and productivity, quality costs legal aspects of quality implementing quality improvement). Definitions and aims of standardizations, techniques for standardization (Statistical Principles, Codification system, variety control and value Engineering).

Unit – 3 **06 Hrs**

Statistical Process Control: Chance and assignable causes, Statistical Basis of the Control Charts -basic principles, choices of control limits, significance of control limits, control limits, analysis of pattern on Variable attribute control charts (no numericals)

Unit – 4 **06 Hrs**

Work Study, Incentives, Health And Safety: Work study-Motion study and Method time study, principles of motion economy, charts and diagrams, Job evaluation systems, Multi skilling, Wage payment and plans, Incentive schemes, Training and Development, Safety Regulations and safe practices.

PART - B

Unit – 5 **06 Hrs**

Motivation And Behavior: Hawthorns studies and its findings Maslows theory X and Y theory, Immaturity theory motivation hygiene theory, Pretence of needs and satisfaction of needs, goal oriented behavior, integration of organizational goals and needs of employee.

Unit – 6 **06 Hrs**

Management And Behavioral Approach: Contribution of Elton Mayo and Skinner to behavior sciences. Skills of a manager at various levels in an organization and inter-related systems, understanding past behavior, predicting future behavior, directing, changing and controlling behavior.

Unit – 7 **07 Hrs**

Process Management: Definition of process management. Major process decisions-process choice, vertical integration, resource flexibility, customer involvement, capital intensity, relationships between decisions, service operation, economics of scoop and gaining focus. Designing process-process rearranging and process improvement

Unit – 8 **07 Hrs**

Management Of Technology: Meaning and role of technology-primary areas of technology management, management of technology and its role in improving

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business performance. Creating and applying technology-R and D stages and technology fusion. Technology strategy. Implementation guidelines.

Text Books:

1. **Principles of Management**, Koontz O Donnel,"Mc.Graw Hill Intl.Book Co.
2. **Statistical Quality Control:** E.L. Grant and R.S. Leavenworth, 7th edition, McGraw- Hill publisher

Reference Books:

1. **Essentials of management,** Koontz Weirich,TATA McGraw Hill Intl. Book Co., 7th Edition.
2. **Management of Organizational Behaviour,** Hersey Paul and Kenneth H," PHI.
3. **Operations management-strategy and analysis,**Lee J.Krajewski and Larry P. Ritzman, Fifth Edition Addison-Wiley.
4. **Organizational Behaviour,** Stephen P Robbins, 9th Edition, Pearson Education Publications, ISBN-81-7808-561-5 2002

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

ROCKETS AND MISSILES

Sub Code	:	10AE666	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART-A

Unit-1 **06 Hrs**
Rockets Classification and Definitions, Rocket propulsion, nuclear rocket engine, electric rocket propulsion, other rocket propulsion concepts. Application of rocket propulsion. Total impulse, exhaust velocity, energy and efficiency, acceleration in multiple of earth gravity or thrust to vehicle weight ratio.

Unit-2 **06 Hrs**
Nozzle Theory and Flight Performance, Ideal rocket thrust and thrust coefficient, characteristics velocity and specific impulse. Principal losses in real nozzles. Nozzle alignment, Gravity free, drag free space flight, forces acting on a vehicle in atmospheric space flight.

Unit-3 **06 Hrs**
Rocket Propellant ; Propellant - Desirable Physical Properties. Liquid Oxidizers, Liquid mono propellants. Solid Propellant Classification. Propellant characteristics. Aging and useful life. Typical ingredients of composite solid propellants. Hybrid Rocket Propellant –Introduction, Application, Grain Configuration.

Unit-4 **08 Hrs**
Selection of Rocket Propulsion System. Idealized process for selecting propulsion system. Advantages and disadvantages of solid and liquid propellant rockets. Criteria for selection.

PART-B

Unit-5 **08 Hrs**
Missile Aerodynamics. Theory of bodies of revolution. Lift and moment of slender bodies of revolution. Pressure distribution and loading of slender bodies of revolution. Planar W-B Interference. Generalized nature of Aerodynamic forces and stability derivatives.

Unit-6 **06 Hrs**
Missile Aerodynamic Control; Types of Controls-Conventions. Change in Missile Attitude due to Impulsive Pitch Control. Altitude effects. Equations of motion for missile pitch control. All moving control for Cruciform Controls.

Unit-7 **06 Hrs**
Thrust Vector Control: Thrust Vector Control Mechanism-advantages and disadvantages. TVC with multiple thrust chamber or nozzle. Testing, Integration with Vehicle.

Unit-8 **06 Hrs**
Rocket Testing Different types of tests, Test facility and safe guards. Instrumentation and data management Flight testing & post accident procedure.

Text Books:

1. George P Sutton and Oscar Biblarz, 'Rocket Propulsion Element', John Wiley and Sons Inc 2001
2. Jack N Neilson, 'Missile Aerodynamics', McGraw hill Book Company, Inc 1960

Reference Books:

1. S S Chin, 'Missile Configuration Design

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Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

STRUCTURES LABORATORY

Sub Code	:	10AEL67	IA Marks	:	25
Hrs/ Week	:	03	Exam Hours	:	03
Total Hours	:	42	Exam Marks	:	50

List of Experiments

1. Deflection of a Simply Supported Beam.
2. Verification of Maxwell's Reciprocal Theorem..
3. Determination of Young's Modulus using strain gages.
4. Poisson Ratio Determination
5. Buckling load of slender Eccentric Columns and Construction of Southwell Plot
6. Shear Failure of Bolted and Riveted Joints
7. Bending Modulus of sandwich Beam
8. Verification of Superposition Theorem
9. Determination of fundamental frequency of a cantilever beam and harmonics.
10. Frequency spectrum analysis for a cantilever beam.

PROPULSION LABORATORY

Sub Code	:	10AEL68	IA Marks	:	25
Hrs/ Week	:	03	Exam Hours	:	03
Total Hours	:	42	Exam Marks	:	50

List Of Experiments

1. Study of an aircraft piston engine. (Includes study of assembly of sub systems, various components, their functions and operating principles)
2. Study of an aircraft jet engine (Includes study of assembly of sub systems, various components, their functions and operating principles)
3. Study of forced convective heat transfer over a flat plate.
4. Cascade testing of a model of axial compressor blade row.
5. Study of performance of a propeller.
6. Determination of heat of combustion of aviation fuel.
7. Study of free jet
8. Measurement of burning velocity of a premixed flame.
9. Fuel-injection characteristics
10. Measurement of nozzle flow.

VII SEMESTER
CONTROL ENGINEERING

Sub Code	:	10AE71	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART - A

UNIT - 1
Introduction: Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system, Types of controllers- Proportional, Integral Proportional Integral, Proportional Integral Differential controllers. **07 Hrs**

UNIT- 2
Mathematical Models: Transfer function models, models of mechanical systems, models of electrical circuits, DC and AC motors in control systems, models of thermal systems, models of hydraulic systems, pneumatic system, Analogous systems: Force voltage, Force current. **06 Hrs**

UNIT - 3
Block Diagrams and Signal Flow Graphs: Transfer Functions definition, function, block representation of systems elements, reduction of block diagrams, Signal flow graphs: Mason's gain formula. **07 Hrs**

UNIT- 4
Transient and Steady State Response Analysis: Introduction, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response. System stability: Routh's-Hurwitz Criterion. **06 Hrs**

PART -B

UNIT - 5
Frequency Response Analysis: Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin, M&N circles. **06 Hrs**

UNIT - 6
Frequency Response Analysis Using Bode Plots: Bode attenuation diagrams, Stability analysis using Bode plots, Simplified Bode Diagrams. **07 Hrs**

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UNIT - 7

Root Locus Plots: Definition of root loci, General rules for constructing root loci, Analysis using root locus plots. **06 Hrs**

UNIT 8

System Compensation and State Variable Characteristics of Linear Systems: Series and feedback compensation, Introduction to state concepts, state equation of linear continuous data system. Matrix representation of state equations, controllability and observability, Kalman and Gilberts test. **07 Hrs**

Text Books :

1. **Modern Control Engineering,** Katsuhiko Ogatta, Pearson Education,2004.
2. **Control Systems Principles and Design,** M.Gopal, 3rd Ed., TMH,2000.

Reference Books :

1. **Modern Control Systems,** Richard.C.Dorf and Robert.H.Bishop, Addison Wesley,1999
2. **System dynamics & control,** Eronini-Umez, Thomson Asia pte Ltd. singapore, 2002.
3. **Feedback Control System,** Schaum's series. 2001.

AIRCRAFT STRUCTURES - II

Sub Code	:	10AE72	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Introduction to Aircraft Structural Design:

Structural layout of the Airplane and components, Structural design V-n diagram,loads acting on major components such as wing, fuselage, tails, landing gear etc.,Concept of allowable stress and margin of safety.

Unit 2. **06 Hrs**

Unsymmetrical Bending:

Bending stresses in beams of unsymmetrical sections – Bending of symmetric sections with skew loads

Unit 3. **06 Hrs**

Shear Flow in Open Sections:

Thin walled beams, Concept of shear flow, shear centre, Elastic axis. With one axis of symmetry, with wall effective and ineffective in bending, unsymmetrical beam sections.

Unit 4. **08 Hrs**

Shear Flow in Closed Sections:

Bredt – Batho formula, Single and multi – cell structures, Approximate methods, Shear flow in single & multi-cell structures under torsion. Shear flow in single and multi-cell under bending with walls effective and ineffective.

PART B

Unit 5. **06 Hrs**

Buckling of Plates:

Rectangular sheets under compression, Local buckling stress of thin walled sections, Crippling stresses by Needham's and Gerard's methods, Thin walled column strength. Sheet – stiffener panels. Effective width, inter rivet and sheet wrinkling failures.

Unit 6. **08 Hrs**

Stress Analysis in Wing And Fuselage:

Procedure – Shear and bending moment distribution for semi cantilever and other types of wings and fuselage, thin webbed beam. With parallel and non parallel flanges, Shear resistant web beams, Tension field web beams (Wagner's).

Unit 7. **06 Hrs**

Design of Aircraft Structure:

Design criteria – Safety Factor – Design life criteria – Analysis method – Life Assessment procedures – Design Principle – Future Airworthiness Requirements– Two bay crack criteria – Widespread Fatigue damage.

Unit 8. **06 Hrs**

Joints and Fittings And Introduction to Post Buckling:

General theory for the design of fittings, Estimation of fitting design loads, design of riveted, bolted and welding joints, post buckling of structures, concept of effective width.

Text Books:

1. Megson, T.M.G., "Aircraft Structures for Engineering Students", Edward Arnold,1995.

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2. Peery, D.J., and Azar, J.J., "Aircraft Structures", 2nd edition, McGraw–Hill, N.Y., 1993.

Reference:

1. Bruhn. E.H. "Analysis and Design of Flight vehicles Structures", Tri – state off set company, USA, 1985.
2. Rivello, R.M., "Theory and Analysis of Flight Structures", McGraw-Hill, 1993.
3. D Williams & Edward Arnold, An Introduction to the Theory of Aircraft Structures.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

AIRCRAFT STABILITY AND CONTROL

Sub Code	:	10AE73	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Static Longitudinal Stability:

Historical perspective, Aerodynamic Nomenclature, Equilibrium conditions, Definition of static stability, Definition of longitudinal static stability, stability criteria, Contribution of airframe components: Wing contribution, Tail contribution, Fuselage contribution, Power effects- Propeller airplane and Jet airplane

Unit 2. **07 Hrs**

Static Longitudinal Stability and Control-Stick Fixed

Introduction, Trim condition. Static margin. stick fixed neutral points. Longitudinal control, Elevator power, Elevator angle versus equilibrium lift coefficient, Elevator required for landing, Restriction on forward C.G. range,

Unit 3. **07 Hrs**

Static Longitudinal Stability and Control-Stick Free

Introduction, Hinge moment parameters, Control surface floating characteristics

and aerodynamic balance, Estimation of hinge moment parameters, The trim tabs, Stick-free Neutral point, Stick force gradient in unaccelerated flight, Restriction on aft C.G.

Unit 4. **06 Hrs**

Static Directional Stability and Control

Introduction, Definition of directional stability, Static directional stability rudder fixed, Contribution of airframe components, Directional control. Rudder power, Stick-free directional stability, Requirements for directional control, Rudder lock, Dorsal fin. One engine inoperative condition.. Weather cocking effect.

PART B

Unit 5. **06 Hrs**

Static Lateral Stability And Control

Introduction, definition of Roll stability. Estimation of dihedral effect., Effect of wing sweep, flaps, and power, Lateral control, Estimation of lateral control power, Aileron control forces, Balancing the aileron. Coupling between rolling and yawing moments. Adverse yaw effects. Aileron reversal.

Unit 6. **07 Hrs**

Dynamic Longitudinal Stability

Definition of Dynamic longitudinal stability: types of modes of motion: long or phugoid motion, short period motion. Airplane Equations of longitudinal motion, Derivation of rigid body equations of motion, Orientation and position of the airplane, gravitational and thrust forces, Small disturbance theory.

Unit 7. **07 Hrs**

Estimation of Dynamic Derivatives:

Aerodynamic force and moment representation, Derivatives due to change in forward speed, Derivatives due to the pitching velocity, Derivatives due to the time rate of change of angle of attack, Derivatives due to rolling rate, Derivatives due to yawing rate

Unit 8. **06 Hrs**

Dynamic Lateral and Directional Stability

Routh's criteria. Factors affecting period and damping of oscillations. Effect of wind shear. Flying qualities in pitch. Cooper-Harper Scale. Response to aileron step-function, side-slip excursion. Dutch roll and Spiral instability. Auto- rotation and spin. Stability derivatives for lateral and directional dynamics. Roll-Pitch-Yaw Inertial coupling.

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Text Books:

1. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 2007.
2. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley Son Inc, New York, 1988.

References

1. Bernard Etkin, " Dynamics of Flight Stability and Control", John Wiley & Sons, Second Edition, 1982.
2. Bandu N. Pamadi, ' Performance, Stability, Dynamics and Control of Airplanes', AIAA 2nd Edition Series, 2004.
3. Barnes W. McCormick, ' Aerodynamics, Aeronautics, and Flight Mechanics', John Wiley & Sons, Inc. 1995.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B

GAS TURBINE TECHNOLOGY

Sub Code	:	10AE74	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART-A

Unit 1. **06 Hrs**

Types, Variation & Applications

Types of engines showing arrangement of parts. Operating parameters. Energy distribution of turbojet, turboprop and turbofan engines. Comparison of thrust and specific fuel consumption. Thrust, pressure and velocity diagrams.

Unit 2. **07 Hrs**

Engine Parts

Compressor assembly, types of burners: advantages and disadvantages. Influence of design factors on burner performance. Effect of operating variables on burner performance. Performance requirements of combustion chambers. Construction of nozzles. Impulse turbine and reaction turbine. Exhaust system, sound suppression. Thrust reversal: types, design & systems. Methods of thrust augmentation, afterburner system.

Unit 3. **06 Hrs**

Materials and Manufacturing

Criteria for selection of materials. Heat ranges of metals, high temperature strength. surface finishing. Powder metallurgy. Use of composites and Ceramics. Superalloys for Turbines.

Unit 4. **07 Hrs**

Systems

Fuel systems and components. Sensors and Controls. FADEC interface with engine. Typical fuel system. Oil system components. Typical oil system. Starting systems. Typical starting characteristics. Various gas turbine starters.

PART – B

Unit 5. **06 Hrs**

Engine Performance

Design & off-design Performance. Surge margin requirements, surge margin stack up. Transient performance. Qualitative characteristics quantities. Transient working lines. Starting process & Wind milling of Engines. Thrust engine start envelope. Starting torque and speed requirements Calculations for design and off-design performance from given test data – (case study for a single shaft Jet Engine). Engine performance monitoring.

Unit 6. **07 Hrs**

Component Level Testing

Compressor: Compressor MAP. Surge margin, Inlet distortions. Testing and Performance Evaluation. **Combustor:** Combustor MAP, Pressure loss, combustion light up test. Testing and Performance Evaluation. **Turbines:** Turbine MAP. Turbine Testing and Performance Evaluation. **Inlet duct & nozzles:** Ram pressure recovery of inlet duct. Propelling nozzles, after burner, maximum mass flow conditions. Testing and Performance Evaluation.

Unit 7. **07 Hrs**

Engine Testing

Proof of Concepts: Design Evaluation tests. Structural Integrity. Environmental Ingestion Capability. Preliminary Flight Rating Test, Qualification Test, Acceptance Test. Reliability figure of merit. Durability and Life Assessment Tests, Reliability Tests. Engine testing with simulated inlet distortions and, surge test. Estimating engine-operating limits. Methods of displacing equilibrium lines.

Types of engine testings: Normally Aspirated Testing, Open Air Test Bed ,Ram Air Testing, Altitude Testing, Altitude test facility, Flying Test Bed, Ground Testing of Engine Installed in Aircraft, Flight testing. Jet thrust measurements in

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flight. Test procedure: Test Schedule Preparation, Test Log Sheets, Test Documents. Type approval.

Unit 8. **06 Hrs**

Test Cells

Factors for design of engine test beds. Test bed calibration. Steps in test bed cross calibration.Measurements and Instrumentation. Data Acquisition system, Measurement of Shaft speed, Torque, Thrust, Pressure, Temperature, Vibration, Stress, Temperature of turbine blading etc. Engine performance trends: Mass and CUSUM plots. Accuracy and Uncertainty in Measurements. Uncertainty analysis. Performance Reduction Methodology.

Text Books:

1. Irwin E. Treager, 'Gas Turbine Engine Technology' , GLENCOE Aviation Technology Series, 7th Edition, Tata McGraw Hill Publishing Co.Ltd. Print 2003.
2. P.P Walsh and P. Peletcher, 'Gas Turbine Performance' Blackwell Science, 1998, ISBN 0632047843.
3. Michael J. Kores , and Thomas W. Wild,' Aircraft Power Plant', GLENCOE Aviation Technology Series, 7th Edition, Tata McGraw Hill Publishing Co.Ltd. 2002.

Reference Books:

1. Advance Aero-Engine Testing, AGARD-59 Publication
2. MIL –5007 E , 'Military Specifications: Engine , Aircraft, Turbo Jet & Turbofan ; General Specification for Advance Aero Engine testing', 15th Oct 1973.
3. J P Holman,' Experimental methods for Engineers', Tata McGraw –Hill Publishing Co. Ltd . ,2007.
4. A S Rangawala-Turbomachinery dynamics-Design and operations, McGraw –Hill Publishing Co. Ltd . ,2007.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B

ELECTIVE - II (Group B)
OPTIMISATION TECHNIQUES

Sub Code	:	10AE751	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Introduction

Non-linear programming. Mathematical fundamentals. Numerical evaluation of gradient.

Unit 2. **06 Hrs**

Unconstrained Optimisation

One dimensional, single variable optimization. Maximum of a function. Unimodal-Fibonacci method. Polynomial based methods.

Unit 3. **07 Hrs**

Unconstrained Minimisation

Multivariable functions. Necessary and sufficient conditions for optimality. Convexity. Steepest Descent Method -Convergence Characteristics. Conjugate Gradient Method. Linear programming -Simplex Method.

Unit 4. **07 Hrs**

Constrained Minimisation

Non-linear programming. Gradient based methods. Rosens's gradient, Zoutendijk's method, Generalised reduced gradient, Sequential quadratic programming. Sufficient condition for optimality.

PART B

Unit 5. **06 Hrs**

Direct Search Methods

Direct search methods for nonlinear optimization. Cyclic coordinate search. Hooke and Jeeves Pattern search method. Generic algorithm.

Unit 6. **06 Hrs**

Discrete And Dynamic Programming

Integer and discrete programming. Branch and bound algorithm for mixed integers. General definition of dynamic programming problem. Problem modeling and computer implementation. Shortest path problem.

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Unit 7. **07 Hrs**

Optimisation Application

Transportation problem. Transportation simplex method. Network problems. Maximum flow in net works. General definition of dynamic programming. Problem modeling and computer implementation.

Unit 8. **07 Hrs**

Finite Element Based Optimisation

Parameter optimization using gradient methods -Derivative calculation. Shape optimisation. Topology optimisation of continuum structures.

Text Books:

1. Ashok D Belegundu and Tirupathi R . Chandrupatla, 'Optimisation Concepts and Applications in Engineering', Pearson Education, In C.,1991.

Reference Books:

1. Fletcher, R., 'Practical Methods of Optimisation', Wiley, New York ,2nd Edition, 1987.
2. Dennis J.E. and Schnabel, R. B., 'Numerical Methods for Unconstrained Optimisation and Nonlinear Equations', Prentice Hall, Engle Wood Cliffs, New Jersey, 1983.
3. S.S. Rao, ' Optimisation -Theory and Application', Wiley Eastern Ltd., 5th Edition.1990.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B

COMPUTATIONAL FLUID DYNAMICS

Sub Code	:	10AE752	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Introduction

Insight into power and philosophy of CFD. CFD ideas to understand. CFD application. Need for parallel computers for CFD algorithms. Models of flows. Substantial derivative, Divergence of velocity.

Unit 2. **07 Hrs**

Governing Equations

Continuity, Momentum and Energy equations; derivation in various forms. Integral versus Differential form of equations. Comments on governing equations. Physical boundary conditions. Forms of the governing equations particularly suited for CFD work: Shock fitting and Shock capturing methods. Generic form of equations.

Unit 3. **06 Hrs**

Mathematical Behavior of Partial Differential Equations:

Classification of partial differential equations. Cramer rule and Eigen value method. Hyperbolic, parabolic and elliptic forms of equations. Impact on physical and computational fluid dynamics; case studies: steady inviscid supersonic flow; unsteady invisid flow; steady boundary layer flow; and unsteady thermal conduction.

Unit 4. **07 Hrs**

Discretization

Essence of discretization. Taylor series approach for the construction of finite-difference quotients. Higher order difference quotients. Up-wind differencing. Midpoint leap frog method. Reflection boundary condition. Difference equations. Explicit and Implicit approach: definition and contrasts. Errors and analysis of stability. Error propagation. Stability properties of Explicit and Implicit methods.

PART B

Unit 5. **07 Hrs**

Grid Generation

Body –fitted coordinate system. Need for grid generation. Essential properties of grids. Types of grids (O-type, C-type and H- type). Various grid generation techniques - Algebraic, and Numerical grid generation. Elliptic grid generation. Structured, Un-structured grids, Adaptive grids, Grid collapse. Multi-Grid methods .Grid accuracies.

Unit 6. **06 Hrs**

Appropriate Transformation

General transformation of equations. Metrics and Jacobians. Generic form of the governing flow equations with strong conservative form in the transformed space. Transformation of continuity equation from physical plane into computational plane; application of Grids stretching .

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Unit 7. **06 Hrs**

Finite Volume Techniques

Finite Volume Discretization - Cell Centered Formulation. High resolution finite volume upwind Scheme. Runge - Kutta Time Stepping . Multi - Time –Step Integration scheme. Cell Vertex Formulation. Numerical dispersion.

Unit 8. **07 Hrs**

CFD Application to Some Problems

Time and space marching. LAX-WENDROFF Technique . Relaxation technique. Point iterative mehod. Successive over-relaxation/under relaxation. Aspects of numerical dissipation and dispersion; artificial viscosity. The Alternating-Direction- (ADI) Implicit Technique. Approximate factorization scheme. Upwind schemes; Flux vector splitting.

Text Books:

1. John D Anderson Jr. Computational Fluid Dynamics, 'The Basics with Applications', McGraw Hill International Edn; 1995 .
2. Tapan K. Sengupta, 'Fundamentals of Computational Fluid Dynamics', Universities Press (India) Private Limited; 2005.

References:

1. F. Wendt (Editor), "Computational Fluid Dynamics - An Introduction", Springer – Verlag, Berlin; 1992.
2. Charles Hirsch, "Numerical Computation of Internal and External Flows", Vols. I and II. John Wiley & Sons, New York; 1988.
3. Jiyuan Tu, Guan Heng Yeoh, and Chaoqun Liu, ' Computational Fluid Dynamics- A Practical Approach', Elsevier Inc; 2008.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

AIRCRAFT MAINTENANCE, REPAIR AND OVERHAUL

Sub Code	:	10AE753	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **07 Hrs**

Welding In Aircraft Structural Components

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

Unit 2. **06 Hrs**

Sheet Metal Repair And Maintenance

Inspection of damage – Classification – Repair or replacement – Sheet metal inspection – N.D.T. Testing – Riveted repair design, Damage investigation – reverse technology.

Unit 3. **07 Hrs**

Plastics and Composites in Aircraft

Review of types of plastics used in airplanes – Maintenance and repair of plastic components – Repair of cracks, holes etc., various repair schemes – Scopes.

Unit 4. **06 Hrs**

Inspection And Repair Of Composite Components:

Inspection and Repair of composite components – Special precautions – Autoclaves.

PART B

Unit 5. **07 Hrs**

Aircraft Jacking, Assembly And Rigging

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

Unit 6. **07 Hrs**

Review of Hydraulic and Pneumatic System

Trouble shooting and maintenance practices – Service and inspection. – Inspection and maintenance of landing gear systems. – Inspection and maintenance of air-conditioning and pressurisation system, water and waste system. Installation and maintenance of Instruments – handling – Testing – Inspection.

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