FACULTY OF ENGINEERING, TECHNOLOGY AND MANAGEMENT SCIENCES

VINAYAKA MISSION'S RESEARCH FOUNDATION
(Deemed to be University)
SALEM (TAMILNADU)

REGULATION - 2016

B.E AERONAUTICAL ENGINEERING (REGULAR) - CBCS

VINAYAKA MISSIONS KIRUPANANDA VARIYAR ENGINEERING COLLEGE, SALEM

VINAYAKA MISSSION'S KIRUPANANDA VARIYAR ENGINEERNG COLLEGESALEM

SCHOOL OF MECHANICAL SCIENCES

BOARD : **MECHANICAL SCIENCES**

REGULATION : **2016**

PROGRAM : **B.E – AERONAUTICAL ENGINEERING - FULL TIME**

CURRICULUM & SYLLABUS

SEMESTER	THEORY SUBJECTS	PRACTICALS	CREDIT
I	5	4	24
II	5	4	25
III	6	4	28
IV	6	4	30
V	6	4	27
VI	6	4	26
VII	6	3	25
VIII	3	1	15
TOTAL	**43**	**28**	**200**

SEMESTER I

SL. No	COURSE CODE	COURSE TITLE	DEPARTMENT	L	T	P	C
THEORY							
1		Calculus For Engineers	MATHS	3	1	0	4
2		EnglishFor Engineers	ENG	3	0	0	3
3		Physics For Engineers	PHY	3	0	0	3
4		Essentials of Computer Science and Engineering	CSE	3	0	0	3
5		Essentials of Electrical and Electronics Engineering	EEE	3	0	0	3
PRACTICAL							
1		Electrical and Electronics Engineering Lab	EEE	0	0	3	2
2		Physics Lab	PHY	0	0	3	2
3		Computer Science Lab	CSE	0	0	3	2
4		Workshop Practices	CSE	0	0	3	2
			TOTAL	**15**	**1**	**12**	**24**

SEMESTER II

SL. No	COURSE CODE	COURSE TITLE	DEPARTMENT	L	T	P	C
THEORY							
1		Transforms and Matrices	MATHS	3	1	0	4
2		Business English	ENG	3	0	0	3
3		Chemistry For Engineers	CHEM	3	0	0	3
4		C - Programming	CSE	3	1	0	4
5		Engineering Mechanics	MECH	3	1	0	4
PRACTICAL							
1		C - Programming Lab	CSE	0	0	3	2
2		Engineering Graphics Lab	MECH	0	0	3	2
3		Chemistry Lab	CHEM	0	0	3	2
4		Yoga and Meditation		0	0	3	2
			TOTAL	**15**	**3**	**12**	**26**

SEMESTER III

SL. No	COURSE CODE	COURSE TITLE	DEPARTMENT	L	T	P	C
THEORY							
1		Mathematics for Mechanical Sciences	MATHS	3	1	0	4
2		Strength of Materials	MECH	3	1	0	4
3		Principles of Flight	AERO	3	0	0	3
4		Aircraft Systems and Instruments	AERO	3	0	0	3
5		Engineering Thermodynamics	MECH	3	1	0	4
6		Fluid Mechanics and Machinery	MECH	3	0	0	3
PRACTICAL							
1		Fluid Mechanics and Strength of Materials Lab	MECH	0	0	3	2
2		Thermodynamics Lab	MECH	0	0	3	2
3		Aircraft Systems Lab	AERO	0	0	3	2
4		VALUE ADDED COURSE - I	MECH	0	0	2	1
			TOTAL	**18**	**3**	**10**	**28**

SEMESTER IV

SL. No	COURSE CODE	COURSE TITLE	DEPARTMENT	L	T	P	C
THEORY							
1		Numerical Methods	MATHS	3	1	0	4
2		Aerodynamics – I	AERO	3	1	0	4
3		Propulsion – I	AERO	3	1	0	4
4		Aircraft Structures – I	AERO	3	1	0	4
5		Mechanics of Machines	MECH	3	1	0	4
6		Disaster Mitigation and Management	MECH	3	0	0	3
PRACTICAL							
1		Aircraft Structures - I Lab	AERO	0	0	3	2
2		Aero Engine Lab	AERO	0	0	3	2
3		Aerodynamics Lab	AERO	0	0	3	2
4		VALUE ADDED COURSE - II	MECH	0	0	2	**1**
			TOTAL	**18**	**5**	**12**	**30**

SEMESTER V

SL. No	COURSE CODE	COURSE TITLE	DEPARTMENT	L	T	P	C
THEORY							
1		Aerodynamics – II	AERO	3	1	0	4
2		Propulsion – II	AERO	3	1	0	4
3		Aircraft Structures – II	AERO	3	1	0	4
4		Aircraft Performance	AERO	3	0	0	3
5		Manufacturing Technology	MECH	3	0	0	3
6		Elective – I		3	0	0	3
PRACTICAL							
1		Aircraft Structures - II Lab	AERO	0	0	3	2
2		Propulsion Lab	AERO	0	0	3	2
3		Manufacturing TechnologyLab	MECH	0	0	3	1
4		VALUE ADDED COURSE - III	MECH	0	0	2	**1**
			TOTAL	**18**	**3**	**12**	**27**

SEMESTER VI

SL. No	COURSE CODE	COURSE TITLE	DEPARTMENT	L	T	P	C
THEORY							
1		Aircraft Stability and Control	AERO	3	1	0	4
2		Heat and Mass Transfer	MECH	3	1	0	4
3		Aircraft Materials and Processes	AERO	3	0	0	3
4		Environmental Science and Engineering	CHEM	3	0	0	3
5		Aircraft General Engineering and Maintenance Practices	AERO	3	0	0	3
6		Elective – II		3	0	0	3
PRACTICAL							
1		Heat Transfer Lab	AERO	0	0	3	2
2		Airframe Lab	AERO	0	0	3	2
3		Aircraft Design Project	AERO	0	0	3	1
4		VALUE ADDED COURSE - IV	MECH	0	0	2	**1**
			TOTAL	**18**	**2**	**12**	**26**

SEMESTER VII

SL. No	COURSE CODE	COURSE TITLE	DEPARTMENT	L	T	P	C
THEORY							
1		Composite Materials	AERO	3	0	0	3
2		Finite Element Analysis	MECH	3	1	0	4
3		Avionics	AERO	3	0	0	3
4		Wind Tunnel Techniques	AERO	3	0	0	3
5		Elective – III		3	0	0	3
6		Elective – IV		3	0	0	3
PRACTICAL							
1		Finite Element Analysis Lab	MECH	0	0	3	2
2		Computer Aided Design and Drafting Lab	AERO	0	0	3	2
3		MINI PROJECT	AERO	0	0	3	**2**
			TOTAL	**18**	**1**	**9**	**25**

SEMESTER VIII

SL. No	COURSE CODE	COURSE TITLE	DEPARTMENT	L	T	P	C
THEORY							
1		Elective – V		3	0	0	3
2		Elective –VI		3	0	0	3
3		Elective – VII		3	0	0	3
PRACTICAL							
1		PROJECT WORK AND VIVA VOCE	AERO	0	0	8	6
			TOTAL	**9**	**0**	**8**	**15**

Total Credits:200

LIST OF ELECTIVE COURSES

SL. No	COURSE CODE	COURSE TITLE	DEPARTMENT	L	T	P	C
THEORY							
1		Theory of Elasticity	AERO	3	0	0	3
2		Space Mechanics	AERO	3	0	0	3
3		Vibration and Aero Elasticity	AERO	3	0	0	3
4		Airframe Maintenance and Repair	AERO	3	0	0	3
5		Theory of Plates and Shells	AERO	3	0	0	3
6		Combustion Engineering	MECH	3	0	0	3
7		Air Transportation and Aircraft Maintenance Management	AERO	3	0	0	3
8		Helicopter Maintenance	AERO	3	0	0	3
9		Air Traffic Control and Aerodrome Design	AERO	3	0	0	3
10		Aircraft Design	AERO	3	0	0	3
11		Unmanned Aircraft Systems	AERO	3	0	0	3
12		Cryogenic Engineering	AERO	3	0	0	3
13		Computational Fluid Dynamics	AERO	3	0	0	3
14		Hypersonic Aerodynamics	AERO	3	0	0	3
15		Industrial Aerodynamics	AERO	3	0	0	3
16		Experimental Stress Analysis	AERO	3	0	0	3
17		Rockets and Missiles	AERO	3	0	0	3
18		High Temperature Materials	MECH	3	0	0	3
19		Nano Technology	MECH	3	0	0	3
20		Total Quality Management	MGT	3	0	0	3
21		Entrepreneurial Skills Development for Engineers	MGT	3	0	0	3
22		Principles of Management	MGT	3	0	0	3
23		Cyber Security	CSE	3	0	0	3
24		Industrial Robotics	MECH	3	0	0	3
25		Marketing Techniques For Engineers	MECH	3	0	0	3

SEMESTER	SUBJECT	L	T	P	C
I	**CALCULUS FOR ENGINEERS** **(COMMON TO THE BRANCHES MECH, ECE, CSE, CSSE, EEE, EIE,CIVIL,IT,MECHTRONICS, AERONAUCTICAL ,ETC, AUTOMOBILE)**	3	1	0	4

AIM: To impart analytical ability in solving mathematical problems as applied to the respective branches of Engineering.

OBJECTIVES:

To provide students with mathematical knowledge and skills needed to support their concurrent and subsequent engineering and science studies

- To improve their ability in solving geometrical applications of differential calculus problems
- To equip themselves familiar with the functions of several variables.
- To have knowledge in multiple calculus
- To improve their ability in Vector calculus

OUTCOME:

To impart analytical ability in solving Mathematical problems as applied as the respective branches of Engineering.

UNIT I APPLICATION OF DIFFERENTIAL CALCULUS

Curvature – Cartesian and Parametric Co-ordinates – Centre and radius of curvature – Circle of curvature – Evolute

UNIT II FUNCTIONS OF SEVERAL VARIABLES

Partial Derivatives – Total Differential - Maxima and Minima – constrained Maxima and Minima by Lagrangian Multiplier Method.

UNIT III INTEGRATION

Concept of integration-Integration of Rational andTrigonometric functions – Using Partial Fractions – Integration by parts.

UNIT IV MULTIPLE INTEGRAL

Double integration –change of order of integration- Cartesian and polar coordinates –Area as a double integral – Triple integration.

UNIT V VECTOR CALCULUS

Directional derivatives – Gradient, Divergence and Curl – Irrotational and solenoidal- vector fields – Vector integration – Green‟s theorem, Gauss divergence theorem and Stoke‟s theorem (excluding proof).

TEXT BOOK:

1. **“**Engineering Mathematics**”** by Department of Mathematics, VMU
2. Veerarajan, T., “Engineering Mathematics”, Tata McGraw Hill Publishing Co., NewDelhi, 2006.
3. Dr.A .Singaravelu , Engineering Mathematics Volume I & Volume II by Meenakshi Publications.

REFERENCES:

1. Grewal, B.S., “Higher Engineering Mathematics” (36th Edition), Khanna Publishers, Delhi 2001.
2. Kreyszig, E., “Advanced Engineering Mathematics” (8th Edition), John Wiley and Sons (Asia) Pvt Ltd., Singapore, 2001.
3. Kandasamy .P.,Thilagavathy. K., and Gunavathy. K., “Engineering Mathematics”, Volumes I & II (4th edition), S.Chand& Co., New Delhi., 2001.
4. T. Veerarajan, “Engineering Mathematics” (for semester III), Third Edition Tata McGraw- Hill Publishing Company limited.

SEMESTER	SUBJECT	L	T	P	C
I	**ENGLISH FOR ENGINEERS** **(Common for all branches)**	3	0	0	3

AIM: To Strengthen the basic LSRW (Listening, Speaking, Reading and Writing) skills.

OBJECTIVES:

1. To enable students to develop LSRW skills in English.
2. To become effective communicators in English.
3. To ensure that learners use Electronic media materials for developing language skills.

OUTCOME:

Out come of the revised English for Engineers syllabus for the first semester UG engineering students for the academic year 2015- 2016.

1. By teaching this syllabus, our UG Engineering graduates will enable to enhance wide range vocabulary to use at right place in right time.
2. Students who undergo this syllabus will fulfill practice in professional writing and comprehension skill and meet the industry requirements.

Unit – I

Self introduction - Simulations using E Materials - Whatsapp, Face book, Hiker, Twitter- Effective Communication with Minimum Words - Interpretation of Images and Films - Identify the different parts of speech– Common Errors in English – Scientific Vocabulary, (definition and meaning) - Listening Skills- passive and active listening, Listening to native speakers, , guided note taking - Characteristics of a good listener– Telephonic conversation with dialogue.

Unit – II

Articles - Phonetics (Vowels, Consonants and Diphthongs) – Pronunciation Guidelines –Listening to Indian speakers from different regions, intrusion of mother tongue – Homophones – Homonyms, Note taking and Note making - Difference between Spoken and Written English- Use of appropriate language - Listening and Responding to Video Lectures (Green India, environment, social talks) - Extempore.

Unit – III

Tense forms- Verbal &Non verbal communication – Describing objects – Process Description- Speaking Practice – Paragraph Writing on any given topic (My favourite place, games / Hobbies / School life, etc.) –Types of paragraphs- Telephone Etiquettes.

Unit – IV

Impersonal Passive Voice- Conditional Sentences – Technical &Non technical Report Writing (Attend a technical seminar & submit a report) – News Letters & Editing –Skimming & Scanning - How to Improve Reading Speed – Designing Invitations & Poster Preparation.

Unit – V

Sentence Pattern (SVOCA) - Statement of Comparison - Transcoding – Informal letters - SWOT analysis– Resume Writing- Difference –Bio – data, Resume and CV.

References:

1. Practical English Usage- Michael Swan (III edition), Oxford University Press
2. Grammar Builder- I, II, III, and Cambridge University Press.

SEMESTER	SUBJECT	L	T	P	C
I	**PHYSICS FOR ENGINEERS (COMMON TO ALL BRANCHES)**	3	0	0	3

AIM: To Strengthens the fundamental knowledge in physics will improve the scientific thinking of students.

OBJECTIVE: The fundamental knowledge in physics will improve the scientific thinking of students.

OUTCOME: To understatnd the elastic properties of materials.

To understatnd the properties of crystals.

To understatnd the significance of laser and its applications in technology.

To understatnd the basic principles of optical fibres and their applications.

To understatnd the Non-Destructive Testing techniques.

UNIT I –Properties of matter **9**

Elasticity – Hooke's law – Stress-strain diagram - Relationship between three moduli of elasticity (qualitative) - Poisson's ratio – Young's modulus by uniform bending and non-uniform bending – Experimental determination of rigidity modulus – I-shaped girders.

UNIT II – Crystal Physics **9**

Unit cell – Bravais lattice – Miller indices – Calculation of number of atoms per unit cell – atomic radius – coordination number – packing factor for SC, BCC, FCC, HCP structures – Crystal imperfections – point, line, surface and volume defects.

UNIT III – Lasers **9**

Laser characteristics - Stimulated Emission – Population Inversion - Einstein coefficients – Lasing action – Types of Laser – Nd:YAG laser, CO_2 laser, GaAs laser – Applications of Laser – Holography – construction and reconstruction of a hologram

UNIT IV – Fibre Optics **9**

Principle and propagation of light in optical fibres – numerical aperture and acceptance angle – types of optical fibres (material, refractive index, mode) – Applications: Fibre optic communication system – fibre optic displacement sensor and pressure sensor.

UNIT V - Non – Destructive Testing **9**

Introduction – Types of NDT - Liquid penetrant method – characteristics of penetrant and developer - ultrasonic flaw detector – Ultrasonic scanning methods - X-ray Radiography: displacement method – X-ray Fluoroscopy.

Total hours : 45

TEXT BOOK

"Engineering Physics", compiled by Department of Physics, Vinayaka Missions University, Salem.

REFERENCE BOOKS

1. Beiser, Arthur, "Concepts of Modern Physics", 5th Ed., McGraw-Hill, 2009.

2. Halliday.D, Resnick.R, Walker.J, Fundamentals of Physics, Wiley & sons, 2013.

3.Gaur R. K. and Gupta S. L., "Engineering Physics", DhanpatRai publishers, New Delhi, 2001.

4. Avanadhanulu.M.N., ArunMurthy.T.V.S, Engineering Physics Vol. I, S.Chand, 2014.

5. Rajendran. V, "Engineering Physics", Tata McGraw Hill Publication and Co., New Delhi, 2009.

SEMESTER	SUBJECT	L	T	P	C
I	**ESSENTIALS OF COMPUTER SCIENCE AND ENGINEERING (COMMON TO ALL BRANCHES)**	**3**	**0**	**0**	**3**

AIM: To study the basics of Computer, Hardware, Software Applications, Algorithms and Problem solving methodologies.

OBJECTIVES:

- To provide basic knowledge on hardware and software components of computers.
- To introduce and demonstrate various software applications
- To introduce Problem solving methodologies
- To learn about Implementation of Algorithms
- To learn about HTML

OUTCOME:

At the end of this course, student shall be able to:

Do Problem Solving using Programming and algorithms, Describe working of Internet based applications, Document artifacts using common quality standards, Design simple data store using DBMS concepts and implement, Develop a working website with all above learning

UNIT I - Basics of Computer and Information Technology 10

Computer – Generations, Types of Computers, Block diagram of a computer- Components of a computer system - Hardware and software definitions - Categories of software – Booting - Installing and Uninstalling a Software - Software piracy - Software terminologies - Applications of Computer - Role of Information Technology - History of Internet - Internet Services.

UNIT II - Software Applications (Practical Learning) 7

Office Automation: Application Packages - Word processing (MS Word) - Spread sheet (MS Excel) – Presentation (MS PowerPoint).

UNIT III - Problem Solving Methodologies 10

Problems Solving Techniques - Program Development Cycle – Algorithm Development - Flow chart generation – Programming Constructs (Sequential, Decision-Making, Iteration) - Types and generation of programming languages

UNIT IV Implementation of Algorithms 9

Implementation of Algorithms-program verification-The efficiency of algorithms-The analysis of algorithms-Fundamental Algorithms

UNIT V HTML 9

Basics of HTML – Applications of HTML – HTML Fonts – anchor tag and its attributes – Using images in HTML programs – list tag - Table tag – HTML forms

TOTAL HOURS: 45

TEXT BOOKS

1. Essentials of Computer Science and Engineering – by VMU

SEMESTER	SUBJECT	L	T	P	C
I	**ESSENTIALS OF ELECTRICAL AND ELECTRONICS ENGINEERING (COMMON TO AERO, AUTO, CIVIL, MECH)**	3	0	0	3

AIM: To study about the basics of EEE

OBJECTIVE:

To provide an understanding of fundamentals of Electrical and Electronics Engineering.

OUTCOME:

The student will be able to identify and understand the operation of electrical and electronic components and design circuits**.**

A) ELECTRICAL ENGINEERING

UNIT I Electrical Circuits & Meters 9

Definition of electromotive force, current, power and energy-InternationalSystem of units-Ohm's law and Kirchhoff's laws-solution of series and parallel Circuits.

Generation of alternating voltage-average and RMS values-solution of simple R,RL,RC and RLC circuits- Calculation of power and power factor in ACcircuits.

Construction and principles of operation of moving coil,moving iron anddynamometer instruments.

UNIT II DC Machines (Qualitative Treatment Only) 8

Dc machines –parts-DC generator-EMF equation-Different types of DCgenerators and their applications-DC motors and their applications-different types-speed control-Starters.

UNIT III AC Machines (Qualitative Treatment Only) 6

Construction & principle of operation of transformers-Single phase & Three phasetransformers-Construction and operation of AC motors-Single phase and three phase Induction motors-applications-construction, principles of operation and application of synchronous motors.

B) BASIC ELECTRONICS ENGINEERING

UNIT I: SEMICONDUCTOR DEVICES 8

Passive and Active Components - Resistors, Inductors, Capacitors, Characteristics of PN Junction Diode - Zener Diode and its Characteristics - Half wave and Full waveRectifiers - Voltage Regulation. Bipolar Junction Transistor, FET, MOSFET & UJT.

UNIT II: DIGITAL FUNDAMENTALS 8

Number Systems – Binary, Octal, Decimal and Hexa-Decimal – Conversion from one to another – Logic Gates – AND, OR, NOT, XOR, Universal Gates – Adders, Multiplexer, De Multiplexer, Encoder, Decoder – Memories – PAL, PLA.

UNIT III: COMMUNICATION AND ADVANCED GADGETS 8

Modulation andDemodulation – AM, FM, PM – RADAR – Satellite Communication – Optical Fibre Communication, Mobile Communication, Digital TV, HD Video Camera, Smart Phones – Block diagrams Only.

TEXT BOOKS

1. "Basic Electrical and Electronics Engineering", compiled by Department of EEE&ECE faculty of Engineering & technology, VMRFDU, Anuradha Agencies,2006.
2. Edward Hughes, "Electrical and Electronics Technology", Pearson Education Limited, Ninth edition,2005.
3. "Basic Electrical and Electronics Engineering", Compiled by Department of EEE & ECE, Faculty of Engineering and Technology, VMRFDU, Anuradha agencies,2006.
4. Edward Hughes, "Electrical and Electronics Technology",Pearson Education Limited, Ninth edition, 2005.
5. "Basic Electrical and Electronics Engineering", Compiled byDepartment of EEE & ECE, Faculty of Engineering and Technology, VMRFDU, Anuradha agencies,2006

REFERENCES

1. B.R. Guptha, “Principles of Electrical Engineering “ ,S.Chand& Co,2002.
2. I.J.Nagrath, “Elements of Electrical Engineering”, Tata McGraw Hill Publishing Co.,2002.
3. H.Cotton.” Advanced Electrical Technology”, Wheeler,1983.
4. Principles of Communication Engineering, S.Chand& Co, 1994.
5. John Kennedy "Electronics Communication System" TataMcGraw Hill, 2003
6. Millman and Halkias, "Electronic Devices and Circuits", TataMcGraw hill.

SEMESTER	SUBJECT	L	T	P	C
I	**PHYSICS LAB (REAL AND VIRTUAL) (COMMON TO ALL BRANCHES)**	**0**	**0**	**3**	**2**

AIM: To provide the knowledge about basics of physics

OBJECTIVE: Students will have the knowledge of taking measurements precisely.

OUTCOME: To understand the experiments through online virtual demonstration followed by real hands-on experience.

List of Experiments

1. Young's modulus of a bar - Non-uniform bending
2. Rigidity modulus of a wire - Torsional Pendulum
3. Viscosity of a liquid - Poiseuille's method
4. Velocity of ultrasonic waves in liquids - Ultrasonic Interferometer
5. Particle size determination using Laser
6. Wavelength of spectral lines – grating - Spectrometer
7. Thickness of a wire - Air wedge Method
8. Thermal conductivity of a bad conductor - Lee's disc
9. Band gap determination of a thermistor - Post Office Box
10. Specific resistance of a wire – Potentiometer

SEMESTER	SUBJECT	L	T	P	C
I	**ELECTRICAL AND ELECTRONICS ENGINEERING LAB (COMMON TO CIVIL, AUTO , AERO, MECH)**	**3**	**0**	**0**	**2**

AIM: To provide the basic skills of EEE

OBJECTIVE:

To provide exposure to the students with hands on experience on various basic Engineering practices in Electrical and Electronics Engineering.

OUTCOME:

Development of skills in electrical and electronic devices.

LIST OF EXPERIMENTS

A) ELECTRICAL ENGINEERING LAB

1. Residential house wiring using switches, fuse, indicator, lamp and energy meter.
2. Fluorescent lamp wiring.
3. Stair case wiring
4. Measurement of electrical quantities – voltage, current, power & power factor in RLC circuit.
5. Measurement of energy using single phase energy meter.
6. Measurement of resistance to earth of an electrical equipment.

B) ELECTRONICS ENGINEERING LAB

1. Characteristics of PN junction Diode.
2. Characteristics of Zener diode.
3. Input, Output characteristics of BJT.
4. Transfer characteristics of JFET.
5. Amplitude Modulation
6. Frequency Modulation.

SEMESTER	SUBJECT	L	T	P	C
I	**COMPUTER SCIENCE LAB (COMMON TO ALL BRANCHES)**	**0**	**0**	**3**	**2**

AIM:

To practice the basics of office automation application, SQL and basic HTML coding

OBJECTIVE:

To familiarize students with the basic tools of computer and their application in engineering & technology

OUTCOME:

At the end of the course, the students would have develop their skills for Office automation, SQL queries and Html

1. Implement Mail Merge in MS-Word and send letters to parents regarding the semester fee structure of the student.
2. Using MS-Word, create a leave letter addressed to your faculty advisor
3. A) Using MS-Word, create a table for a list of students with different font sizes and colours
   B) Using MS-Word, create a flow-chart using the basic shapes available. Use page border, a watermark, header and footer
4. Using MS-PowerPoint, create a presentation about the university
5. Using MS-PowerPoint, create a story line with various animations and transition effects.
6. Using MS-Excel, Analyze Students performance using MS-Excel and prepare a chart type report.
7. Using MS-Excel, create a pivot table
8. Using MS-Excel, create look-up tables
9. Using MS-Excel, create graphs for the weather condition in various cities of India
10. Create an HTML page Create an HTML page to
    a) Click on a link and go to the bottom of the page using <a href>
    b) Display an image.
11. Create an HTML page to
    a) Display ordered and unordered lists of your friends names and sports persons
    b) Display a table with 3 columns and 4 rows.

SEMESTER	SUBJECT	L	T	P	C
I	**WORKSHOP PRACTICES LAB (COMMON TO ALL BRANCHESEXCEPT BIO-TECH)**	**0**	**0**	**3**	**2**

AIM:

The aim of the lab to learn Business fitting, Carpentry and welding technics.

OBJECTIVE:

To learn the experience of practice in basic sections of the workshop namely fitting, Carpentry and welding in order to know the various methods involved in making parts of the various machines.

OUTCOME:

The students would have been completely exposed to the various basic methods that are going to play in the manufacture of even very heavy machines.

FITTING

1. Square Joint
2. Dove Tail Joint

CARPENTRY

1. Half Lap Joint
2. Dove Tail Joint

WELDING

1. Arc Welding of butt Joint.
2. Arc Welding of Lap Joint

CASTING

1. Foundry – Mould Preparation using single piece pattern

DEMONSTRATION

1. Sheet Metal – Fabrication of cone
2. Black Smithy – Round to square rod

Reference:

1."Basic Workshop Practice", Department of Mechanical Engineering, Vinayaka Missions University

SEMESTER	SUBJECT	L	T	P	C
II	**TRANSFORMS AND MATRICES** **(COMMON TO THE BRANCHES MECH, ECE, CSE, CSSE, EEE, EIE,CIVIL,IT,MECHTRONICS, AERONAUCTICAL ,ETC, AUTOMOBILE)**	3	1	0	4

AIM: To provide students with mathematical knowledge and skills needed to support their concurrent and subsequent engineering and science studies

OBJECTIVES:

The syllabus for the Engineering Mathematics I have been framed catering to the needs of the Engineering students. It is purely applications oriented. To mention a few

- To utilize the powerful features of MATLAB one has to be an expert in Matrix theory
- The matrix theory plays a vital role in simplifying large arrays of equation and in determining their solution.
- Partial differential equation frequently occurred in the theory of elasticity and Hydraulics.
- In circuit branches the current flow can be calculated by using Laplace transform when EMF, resistance and inductions are known.

OUTCOME:

- At the end of this course the students will be in a position to apply the knowledge of Mathematics in the respective Engineering branches.

UNIT I
MATRICES

Characteristic equation – Eigen values and eigenvectors of a real matrix – Properties of eigenvalues and eigenvectors (Without proof) – Cayley-Hamilton theorem (excluding proof) – Orthogonal transformation of a symmetric matrix to diagonal form.

UNIT II
LAPLACE TRANSFORMS

Laplace transform – transform of elementary functions – basic properties – derivatives and integrals of transforms – transforms of derivatives and integrals – initial and final value theorems – Transform of periodic functions.

UNIT III
INVERSE LAPLACE TRANSFORMS & APPLICATIONS

Inverse Laplace transform – Convolution theorem – Initial and Final value theorem-Solution of linear ODE of second order with constant coefficients and first order simultaneous equation with constant coefficients using Laplace transforms.

UNIT IV
FOURIER TRANSFORMS

Fourier transform pairs - Fourier Sine and Cosine transforms – Properties - Transforms of simple functions - Convolution theorem - Parseval's identity.

UNIT V
Z-TRANSFORMS

Z-Transform – Elementary Properties – Inverse Z-Transform – Convolution Theorem – Formation of Difference Equations – Solution of Difference Equations using Z-Transform.

TEXT BOOKS

1. **"**Engineering Mathematics**"** by Department of Mathematics, VMU
2. Veerarajan, T., "Engineering Mathematics", Tata McGraw Hill Publishing Co., NewDelhi, 2006.
3. Dr.A .Singaravelu , Engineering Mathematics Volume I & Volume II by Meenakshi Publications.
4. A.Singaravelu,"Transforms and Partial Differential Equations", MeenakshiAgencies,Chennai

REFERENCE BOOKS

1. Grewal, B.S., "Higher Engineering Mathematics" (36th Edition), KhannaPublishers,Delhi 2001.
2. Kreyszig, E., "Advanced Engineering Mathematics" (8th Edition), John Wiley and Sons (Asia) Pvt Ltd., Singapore, 2001.
3. Kandasamy .P.,Thilagavathy. K., and Gunavathy. K., "Engineering Mathematics",Volumes I,II & III (4th edition), S.Chand& Co., New Delhi., 2001

SEMESTER	SUBJECT	L	T	P	C
II	**BUSINESS ENGLISH** **(Common for all branches)**	3	0	0	3

AIM: To provide the basic knowledge of business english

OBJECTIVES:

1. To impart and enhance corporate communication.
2. To enable learners to develop presentation skills.
3. To build confidence in learners to use English in Business contexts.

OUTCOME:

Out come of the revised Business English syllabus for the second semester UG engineering students for the academic year 2015-2016.

1. It is hoped that this syllabus will able to communicate with a range of formal and informal context.
2. This syllabus will enable the students to undergo in activities, demonstrating interaction skills and consider how own communication is adjusted in different scenario.

Unit – I

Subject and verb agreement (Concord) – Preposition and Relative Pronoun – Cause and effect- Phrasal Verbs – Idioms and Phrases – Listening comprehension - Listening to Audio Files and Answering Questions – Framing Questions – Negotiation skills, Persuasion Skills and Debating skills.

Unit – II

Stress (Word stress and Sentence stress) – Intonation – Difference between British and American English– Vocabulary – Indianism - Compound Words(including technical terminology).

Unit – III

Reading Skills – Understanding ideas and making inferences – Group Discussion – Types of Interviews, FAQs – e- mail Netiquette, Sample e-mails – Watching Documentary Films and responding to questions.

Unit – IV

Corporate communication – Recommendation - Instruction – Check List- circulars- Inter office memo – Minutes of meeting and Writing agenda – Discourse Markers- Rearranging the jumbled sentences – Technical Articles – Project Proposals, Making Presentations on given topics – Preparing Power Point Presentations.

Unit – V

Critical Reading – Book Review - Finding Key Information and Sifting Facts from Opinions – Business letters (Calling for Quotation, Placing orders and Complaint letters) – Expansion of an Idea. – Creative Writing.

References:

1. Grammar Builder- I, II, III -Cambridge University Press.
2. Technical English-Writing, Reading and Speaking- Pickett and Lester, Harper and Row publication

SEMESTER	SUBJECT	L	T	P	C
II	**CHEMISTRY FOR ENGINEERS** **(COMMON TO ALL BRANCHES)**	3	0	0	3

AIM:

To impart in basic knowledge in chemistry so that the student will understand the engineering concept and they can face the competitive examinations effectively.

OBJECTIVE:

With a solid foundation in basic scientific and engineering principles, while allowing specialization in Engineering chemistry and ability to assess the impact of engineering solutions in a global and societal context.

OUTCOME:

The student will come out with the ability to assess the impact of engineering solutions.

UNIT I : ELECTROCHEMISTRY, BATTERIES AND FUEL CELLS 9 Hrs

Ostwald Law and Debye Huckle's law - Electrode potential - Nernst equation – Electrodes (SHE, Calomel and Glass)- cells - EMF measurement-emf and galvanic series.

Primary battery (Daniel and dry cell) – secondary battery (lead Acid storage battery and Nickel-Cadmium battery) – Fuel cell (H_2-O_2 fuel cell)

UNIT II : WATER TECHNOLOGY & CORROSION 9 Hrs

Sources of water – impurities – Hardness and its determination (problems to be avoided) – boiler troubles – water softening (zeolite &Demineralisation) – Domestic water treatment – Desalination (Electrodialysis& Reverse Osmosis).

Corrosion – Types – principles – corrosion control methods (Electroplating,Electroless plating, Sacrificial anode and Impressed current method).

UNIT III: CHEMISTRY OF ADVANCED MATERIALS 9 Hrs

Refractories – properties and uses, Portland cement –manufacturing, setting and hardening –Special cement, ceramics.

Organic electronic material, shape memory alloys, smart materials,polymers(PVC,Teflon, Bakelite)-fibers(optical fibre) & composites (FRP,MMC & PMC)

UNIT IV : PHASE EQUILIBRIA & NUCLEAR CHEMISTRY 9 Hrs

Phase rule: statement and explanation of terms involved – One component system (water) – Condensed phase rule – Two component system (Lead-silver) .

Nuclear Chemistry – Fission – Fusion – working of nuclear reactor – Radiations and harmful effects.

UNIT V : CHROMATOGRAPHY AND SPECTROSCOPY 9 Hrs

Chromatography — classification (Paper, Column, Thin Layer, Gas, HPLC). Principle and applications.

Spectroscopy – Electromagnetic radiation – Beer Lambert's law – UV – Visible – IR – Atomic absorption & flame emission spectroscopy (Principle,Instrumentation, block diagram).

TEXT BOOK: Engineering Chemistry by VMU.

References:

1. A text book of Engineering Chemistry by S.S. Dara, S.Chand& company Ltd., New Delhi
2. Engineering Chemistry by Jain & Jain, 15th edition Dhanpatrai Publishing Company (P) Ltd., New Delhi
3. A text book of Engineering Chemistry by ShashiChawla,Edition 2012 Dhanpatrai& Co., New Delhi.
4. Engineering Chemistry by Dr.A.Ravikrishnan,Sri Krishna Publications, Chennai.

SEMESTER	SUBJECT	L	T	P	C
II	**C - PROGRAMMING (COMMON TO ALL BRANCHES)**	3	0	0	3

AIM:

The aim is to introduce C programming to the students.

OBJECTIVES:

- To introduce Basics of C
- To understand Control Structures & Arrays
- To learn about String concept, Structure and Union in C
- To introduce the concepts of Functions and Pointers
- To introduce Memory and File management concepts in C

OUTCOME:

At the end of this course, student shall be able to know the concepts of C programming techniques.

UNIT I - Basics of C **9**

Identifiers, variables, expression, keywords, data types, constants, scope of variables. Operators: arithmetic, logical, relational, conditional and bitwise operators - Special operators: size of () & comma (,) operator - Precedence and associatively of operators - Type conversion in expressions.

UNIT II - Control Structures & Arrays **9**

Basic input/output and library functions: Single character input/output i.e. getch(), getchar(), getche(), putchar() - Formatted input/output: printf() and scanf() – Library functions (mathematical and character functions). Decision Making and Branching – Looping statements. Arrays – Initialization – Declaration – One dimensional and two dimensional arrays.

UNIT III String, Structure & Union **9**

Strings: Declaration-Initialization and string handling functions. Structure and Union: structure declaration and definition – Accessing a Structure variable – Structure within a structure – Union.

UNIT IV Functions and Pointers **9**

Function –Function Declaration–function definition- Pass by value – Pass by reference – Recursive function – Pointers - Definition – Initialization – & and * operators - Pointer to functions-Function returning pointers – Pointers and arrays

UNIT V Memory and File management **9**

Static and dynamic memory allocation - Storage class specifier - Preprocessor directives. File handling concepts – File read – write- Functions for file manipulation: fopen, fclose, gets, puts, fprintf, fscan, getw, putw, fputs, fgets, fread, fwrite - Random access to files: fseek, ftell, rewind - File name as Command Line Argument.

TOTAL HOURS: 45

TEXT BOOKS:

1. Balaguruswami.E, “Programming in C”, TMH Publications,1997

REFERENCE BOOKS:

1. Behrouz A. Forouzan& Richard F. Gilberg, “Computer Science A Structured Programming using C”, Cengage Learning, 3rd Edition, 2007
2. Gottfried , “Programming with C”, schaums outline series, TMH publications,1997
3. Mahapatra , “Thinking in C”, PHI publications, 2nd Edition, 1998.

SEMESTER	SUBJECT	L	T	P	C
II	ENGINEERING MECHANICS (COMMON TO AERO, AUTO, CIVIL, MECH)	3	0	0	3

AIM:

The aim is to introduce basics of solid mechanics to the students.

OBJECTIVES:

To create and understanding of statics and dynamics of bodies in rest or in motion.

OUTCOME:

At the end of this course, student will be in a position to design mechanical systems independently.

UNIT 1. BASICS & STATICS OF PARTICLES 9

Introduction - Units and Dimensions - Laws of Mechanics - Lame's theorem. Parallelogram and triangular law of forces - Coplanar Forces - Resolution and Composition of forces - Equilibrium of a particle - Forces in space - Equilibrium of a particle in space - Equivalent systems of forces - Principle of transmissibility - Single equivalent force.

UNIT 2. EQUILIBRIUM OF RIGID BODIES 9

Free body diagram - Types of supports and their reactions - requirements of stable equilibrium - Moments and Couples - Moment of a force about a point and about an axis - Vectorialrepresentaion of moments and couples - Scalar components of a moment - Varignon's theorem - Equilibrium of Rigid bodies in two dimension - Equilibrium of Rigid bodies in three dimensions.

UNIT 3. PROPERTIES OF SURFACES AND SOLIDS 9

Determination of Areas and Volumes - First moment of area the Centroid of sections - Rectangle, circle, triangle from integration - T section, I section, Angle section, Hollow section by using standard formula - second and product moments of plane area - Rectangle, triangle, circle from integration - T section, I section, Angle section, Hollow section by using standard formula - Parallel axis theorem and perpendicular axis theorem - Polar moment of inertia - Principle moments of inertia of plane areas - Principle axes of inertia - Mass moment of inertia.

UNIT 4. FRICTION AND ELEMENTS OF RIGID BODY DYNAMICS 9

Frictional force - Laws of Coloumb friction - simple contact friction - Rolling resistance - Belt friction. Translation and Rotation of Rigid Bodies - Velocity and acceleration - General Plane motion.

UNIT 5. DYNAMICS OF PARTICLES 9

Displacement, Velocity and acceleration, their relationship - Relative motion - Curvilinear motion - Newton's law - Work Energy equation of particles - Impulse and Momentum - Impact of elastic bodies.

TOTAL: 45 PERIODS

TEXT BOOKS :

1. Beer & Johnson, Vector Mechanics for Engineers. Vol.I Statics and Vol. II Dynamics, McGraw Hill International Edition, 1995.
2. KottiswaranN,Engineering Mechanics-Statics &Dynamics,SriBalaji Publications,2014.
3. Meriam, Engineering Mechanics, Vol. I Statics & Vol. II Dynamics 2/e, Wiley Intl., 1998.

REFERENCE BOOKS :

1. Rajasekaran.S, and Sankara Subramanian G, “Engineering Mechanics”, Vikas Publishing Co. New Delhi.
2. Irving H. Sharma, Engineering Mechanics - Statics & Dynamics, III Edition, Prentice Hall of India Pvt. Ltd., 1993.
3. K.L.Kumar, Engineering Mechanics III Edition, Tata McGraw Hill Publishing Co. Ltd., 1998

SEMESTER	SUBJECT	L	T	P	C
II	**C – PROGRAMMING LAB (COMMON TO ALL BRANCHES)**	0	0	3	2

AIM:

To practice and develop applications using C Programming languages.

OBJECTIVE:

To make the students to develop program in C languages.

OUTCOME:

At the end of the course, the students will be able to develop applications using C Programming languages.

1. Write a C Program to Implementation of Sine and cosine series
2. Write a C Program to calculate Simple Interest
3. Write a C Program to generate Fibonacci Series using for loop
4. Write a C program to calculate factorial using while loop
5. Write a C Program to
   a) Find the greatest of three numbers using if condition.

   b) Find the greatest of three numbers using conditional operator.
6. Write a C program for finding the roots of a given quadratic equation using conditional control statements
7. Write a C program to
   a) Compute matrix multiplication using the concept of arrays.
   b) Illustrate the concept of string handling functions.
8. Write a C program to
   a) Find the largest element in an array using pointers.
   b) Convert a binary number to decimal or decimal to binary using functions.
9. Write a C program to read data from keyboard, write it to a file named student again read the same data from student file and write it into data file.
10. Write a C program to store employee details using the concept of structures.

SEMESTER	SUBJECT	L	T	P	C
II	**ENGINEERING GRAPHICS LAB (COMMON TO ALL BRANCHES EXCEPT BIO-TECH))**	3	0	0	2

AIM: An introduction of cad software and its utilities in engineering fields.

OBJECTIVES:

1. To improve imagination skills.
2. Increase ability to communicate with people.
3. Learn to sketch and take field dimensions.
4. Learn to take data and transform it into graphic drawings.
5. Learn basic engineering drawing formats.
6. Prepare the student for future Engineering positions.

OUTCOMES:

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

1. Get acquainted with the knowledge of various lines, geometrical constructions and construction of various kinds of scales, and Ellipse.
2. Improve their imagination skills by gaining knowledge about points, lines and planes.
3. Become proficient in drawing the projections of various solids. 4. Gain knowledge about orthographic and isometric projections.

Concepts and conventions (Not for Examination)

Importance of graphics in engineering applications – Use of drafting instruments – BIS conventions and specifications – Size, layout and folding of drawing sheets – Lettering and dimensioning.

UNIT I PLANE CURVES AND FREE HAND SKETCHING 9

Conics – Construction of ellipse-Free hand sketching-Representation of Three Dimensional objects – General principles of orthographic projection – Need for importance of multiple views and their placement – First angle projection – layout views – Developing visualization skills through free hand sketching of multiple views from pictorial views of objects.

UNIT II PROJECTION OF POINTS, LINES 9

Projection of points, Projection of straight lines located in the first quadrant: inclined to both planes – Determination of true lengths and true inclinations – rotating line method only.

UNIT III PROJECTION OF SOLIDS 9

Projection of simple solids like prisms, pyramids, cylinder and cone when the axis is inclined to one reference plane by change of position method.

UNIT IV SECTION OF SOLIDS AND DEVELOPMENT OF SURFACES 9

Sectioning of above solids in simple vertical position by cutting planes inclined to one reference plane and perpendicular to the other – Obtaining true shape of section. Development of lateral surfaces of simple and truncated solids – Prisms, pyramids, cylinders and cones

UNIT V ISOMETRIC VIEW AND PERSPECTIVE PROJECTION 9

Principles of isometric View – isometric scale – isometric view of simple solids- Introduction to Perspective projection

TEXT BOOKS:

1. N.D. Bhatt, “Engineering Drawing” Charotar Publishing House, 46th Edition, (2003).
2. K. V. Natarajan, “A text book of Engineering Graphics”, Dhanalakshmi Publishers, Chennai (2006).

REFERENCES:

1. M.S. Kumar, “Engineering Graphics”, D.D. Publications, (2007).
2. K. Venugopal& V. Prabhu Raja, “Engineering Graphics”, New Age International (P) Limited.
3. M.B. Shah and B.C. Rana, “Engineering Drawing”, Pearson Education (2005).
4. K. R. Gopalakrishnana, “Engineering Drawing” (Vol.I&II), Subhas Publications (1998).

SEMESTER	SUBJECT	L	T	P	C
II	**ENGINEERING CHEMISTRY LAB (REAL & VIRTUAL) (COMMON TO ALL BRANCHES EXCEPT BIO-TECH)**	0	0	3	2

AIM:

To impart in basic knowledge in chemistry so that the student will understand the engineering concept.

OBJECTIVE:

To learn the relevant experience using laboratory experiments

OUTCOME:

The student will have the experience in handling the instruments relevant to his/her theory.

1. Estimation of total hardness of water sample by EDTA method.
2. Estimation of dissolved oxygen by Winkler's method.
3. Estimation of ferrous ion by Potentiometry.
4. Precipitation reaction by Conductometry.
5. Acid base reaction by pH metry.
6. Estimation of copper from its ore.
7. Estimation of iron by spectrophotometer.
8. Estimation of sodium by flame photometer.
9. Separation of mixture of components using thin layer chromatography.
10. Corrosion experiment by weight loss methods.

SEMESTER	SUBJECT	L	T	P	C
III	**MATHEMATICS FOR MECHANICAL SCIENCES**	3	1	0	4

AIM: To Study and understand the basics of partial differential equations which is used to solve many engineering aspects.

OBJECTIVE:

- Partial differential equations arises in most of the Engineering discipline when the number of independent variables in the given problem under discussion is two or more
- Fourier series is used to express even a periodic function interns of periodic function making them numerable for further processing
- Fourier series has the wide application in the field of heat diffusion, wave propagation and in signal and system analysis

OUTCOME:

- With this student studied the calculations on Boundary value problems and the Mean Variance and Problems and the partial differential equations.

UNIT-I PARTIAL DIFFERENTIAL EQUATIONS

Formation - Solutions of standard types f(p, q)=0, clairauts form, f(z,p,q)=0, f(p,x)=g(q,y) of first order equations - Lagrange's Linear equation - Linear partial differential equations of second and higher order with constant coefficients.

UNIT-II FOURIER SERIES

Dirichlet's conditions - General Fourier series - Half-range Sine and Cosine series - Parseval's identity – Harmonic Analysis.

UNIT-III BOUNDARY VALUE PROBLEMS

Classification of second order linear partial differential equations - Solutions of one - dimensional wave equation, one-dimensional heat equation - Steady state solution of two-dimensional heat equation - Fourier series solutions in Cartesian coordinates.

UNIT-IV STANDARD DISTRIBUTIONS

Binomial – Poisson- Geometric –Uniform – Exponential - Gamma and Normal Distributions and their MGF and Properties (Mean Variance and Problems).

UNIT-V STATISTICS

Measures of central tendency, Curve fitting - Straight line and Parabola by least square method, Correlation, Rank correlation and Regression.

Lecture Hrs: 45 Tutorial Hrs : 15 Total Hrs : 60

TEXT BOOKS:

1. A.Singaravelu, “Transforms and Partial Differential Equations”, Meenakshi Agencies,Chennai.
2. A.Singaravelu, “Probability and Statistics”, Meenakshi Agencies,Chennai.
3. S.C.Gupta,V.K.Kapoor, “Fundamentals of mathematical statistics”,Sultan Chand&Sons.

REFERENCES

1. T. Veerarajan, “Engineering Mathematics” (for semester III), Third Edition Tata McGraw- Hill Publishing Company limited.
2. Grewal, B.S., “Higher Engineering Mathematics” (35th Edition), Khanna Publishers,Delhi 2000.
3. Kreyszig, E., “Advanced Engineering Mathematics” (8th Edition), John Wiley and Sons,(Asia) Pte Ltd.,Singapore, 2000.
4. T.Veerarajan, “Probability, Statistics and Random processes” (Second Edition), Tata McGraw-Hill Publishing Company Ltd., New Delhi (2006).
5. Johnson. R.A., “Miller & Freund’s Probability and Statistics for Engineers”, Sixth Edition, Pearson education, Delhi, 2000. (Chapters 7,8,9,12)

SEMESTER	SUBJECT	L	T	P	C
III	STRENGTH OF MATERIALS	3	1	0	4

AIM	The aim of the subject is to provide a fundamental knowledge in strength of materials
OBJECTIVE	1. To understand basic mechanical forces acting on rigid and deformable bodies. 2. To learn to draw shear force and bending moment diagram for various types of beams. 3. To learn the torsional effects on circular bars, shafts, helical spring. 4. To learn the deflection equations of beams and columns for different end conditions. 5. To learn the two dimensional stresses and deformation of cylinders and spherical shells.
OUTCOME	The students would understand the basic properties of materials and their testing methodologies.

UNIT –I -STRESS- STRAIN AND DEFORMATION OF SOLIDS 9

Properties of material, Concept of Stress and Strain, Hook's Law, Stress Strain Diagram for structural steel and Non-ferrous materials.Poisson's Ratio & principles of superposition, Total elongation of tapering bars of circular and rectangular cross-sections.Elongation due to self-weight, volumetric strain. Expression for Volumetric strain, Elastic constants, relationship among elastic constants, compound bars Rigid and Deformable bodies – Strength- Stiffness and Stability – Stresses; Tensile- Compressive and Shear – Elastic constants – Strain energy and unit strain energy – Strain energy in uniaxial loads.

UNIT –II -BEAMS - LOADS AND STRESSES 9

Types of beams: Supports and Loads – Shear force and Bending Moment in beams – Cantilever- Simply supported and Overhanging beams – Stresses in beams – Theory of simple bending – Stress variation along the length and in the beam section – Shear stresses in beams.

UNIT –III –TORSION 9

Analysis of torsion of circular bars – Shear stress distribution – Bars of Solid and hollow circular section – Stepped shaft – Twist and torsion stiffness – Compound shafts – Fixed and simply supported shafts – Application to close-coiled helical springs – Maximum shear stress in spring section including Wahl Factor – Deflection of helical coil springs under axial loads – Design of helical coil springs.

UNIT –IV -DEFLECTION OF BEAMS 9

Elastic curve of Neutral axis of the beam under normal loads – Evaluation of beam deflection and slope: Double integration method- Macaulay Method- and Moment-area Method –Columns – End conditions – Equivalent length of a column – Euler equation – Slenderness ratio – Rankine formula for columns – Introduction to curved beams.

UNIT –V -ANALYSIS OF STRESSES IN TWO DIMENSIONS 9

Biaxial state of stresses – Thin cylindrical and spherical shells – Deformation in thin cylindrical and spherical shells – Biaxial stresses at a point – Stresses on inclined plane – Principal planes and stresses – Mohr's circle for biaxial stresses – Maximum shear stress - Strain energy in bending and torsion.

TUTORIAL : 15 TOTAL HOURS : 60

TEXT BOOKS

1. Ramamrutham.S- Strength of Materials- S.Chand&B Co. - New Delhi-2007.
2. Beer F. P. and Johnston R- "Mechanics of Materials"- McGraw-Hill Book Co- Third Edition- 2008.

REFERENCES

1.Nash W.A- "Theory and problems in Strength of Materials"- Schaum Outline Series-, McGraw-Hill Book Co- New York- 2005
2. Ryder G.H- "Strength of Materials"- Macmillan India Ltd.- Third Edition- 2007
3. Ray Hulse- Keith Sherwin & Jack Cain- "Solid Mechanics"- Palgrave ANE Books- 2006.
4. Singh D.K "Mechanics of Solids" Pearson Education 2009.

SEMESTER	SUBJECT	L	T	P	C
III	PRINCIPLES OF FLIGHT	3	0	0	3

AIM: To introduce the basic concepts of aerospace engineering and the current developments in the field.

OBJECTIVE:

- To have a great knowledge about the history of flights.
- To understand the basics of flight mechanics.
- To understand the types of components and controls in aircraft.
- To have a knowledge about the various structures and materials used in the aircraft.
- To understand the various types of power plant, components and about their operation.

OUTCOMES

- Identify the component of Flight
- Identify suitable materials for Aircraft structure
- Perform basic calculation on Mechanics using Newton law for lift, drag and moment.

UNIT I HISTORY OF FLIGHT 8

Early airplanes by Wright Brothers, biplanes and monoplanes, Developments in aerodynamics, materials, structures and propulsion over the years – Balloon Flight - Ornithopters.

UNIT II BASICS OF FLIGHT MECHANICS 9

Physical properties and structure of the atmosphere, Temperature, pressure and altitude relationships, Newton's Laws of Motions applied to Aeronautics -Evolution of lift, drag and moment -Aerofoils, Mach number, Maneuvers.

UNIT III AIRCRAFT CONFIGURATIONS 10

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

UNIT IV AIRPLANE STRUCTURES AND MATERIALS 9

General types of construction, Monocoque, semi-monocoque and geodesic construction, Typical wing and fuselage structure. Metallic and non-metallic materials, Use of aluminium alloy, titanium, stainless steel and composite materials – Stresses and Strains – Hooke's law – Stress-Strain Diagrams – Elastic Constants..

UNIT V POWER PLANTS 9

Basic ideas about piston, turboprop and jet engines, Use of propeller and jets for thrust production. Comparative merits, Principles of operation of rocket, types of rockets and typical applications, Exploration into space.

TOTAL : 45 Periods

TEXT BOOKS:

1. Anderson, J.D., "Introduction to Flight", McGraw-Hill, 1995.
2. Stephen. A. Brandt, "Introduction to Aeronautics: A design perspective" American Institute of Aeronautics & Astronautics,1997

REFERENCES:

1. Kermode, A.C., "Mechanics of Flight", Himalayan Book, 1997

SEMESTER	SUBJECT	L	T	P	C
III	AIRCRAFT SYSTEMS AND INSTRUMENTS	3	0	0	3

AIM: To make the student to understand the principle and working of aircraft systems and Instruments.

OBJECTIVE:

- To know the various types of Airplanes control systems, its components & its applications.
- Study of piston and gas turbine engine system and the various components of engines.
- To understand the purpose of hydraulic system & its component requirement in a modern aircraft.
- To know the various auxiliary system used in the modern Jet aircraft & its purpose.
- To study the various instruments used in a modern aircraft and its purpose**.**

OUTCOME: The student can understood the aircraft systems and the various instruments.

UNIT I AIRCRAFT SYSTEMS 9

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

UNIT II ENGINE SYSTEMS 9

Fuel systems - Piston and jet engines, - Components - Multi engines Fuel Systems, Lubricatingsystems for Piston and Jet engines - Starting and Ignition systems for Piston and Jetengines.

UNIT III AIRPLANE CONTROL SYSTEMS 9

Conventional Systems - Power assisted and fully powered flight controls - Power actuated systems - Engine control systems - Push pull rod system-Operating Principles - Modern control systems - Digital fly by wire systems - Auto pilot system active control Technology.

UNIT IV AIRCONDITIONING AND PRESSURISATION SYSTEM 9

Basic Air Cycle Systems – Vapour Cycle Systems – Boot Strap Air Cycle System – Evaporative Vapour Cycle Systems - Evaporative Air Cycle Systems – oxygen Systems – Fire Protection Systems – Deicing and anti-icing Systems.

UNIT V AIRCRAFT INSTRUMENTS SYSTEM 9

Flight Instruments,– Gyroscope – Auto pilot system – Data recorder- Black box- accelerometers, Air speed Indicators – TAS, EAS- Mach Meters - Altimeters - Principles and operation - Study of various types of engine instruments - Tachometers - Temperature gauges - Pressure gauges - Operation and Principles.

Outcome: student will have a clear idea about the various systems and the instruments used in the aircraft and about their working principle.

Total: 45 Periods

TEXT BOOKS:

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

REFERENCES:

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

SEMESTER	SUBJECT	L	T	P	C
III	**ENGINEERING THERMODYNAMICS** (Common to MECH,AUTO and AERO)	3	1	0	4

AIM	The aim of the subject is to provide a fundamental knowledge of thermodynamics.
OBJECTIVE	1. To achieve an understanding of fundamentals of thermodynamic systems and first law of thermodynamics. 2. To provide an in-depth study of availability and second law of thermodynamics. 3. To understand the concept of working fluid and its properties. 4. To provide in-depth study of power cycles applying the different working fluids studied in the previous chapter. 5. To understand the Thermodynamic Relations and also to understand combustion equations.
OUTCOME	The students would understand the basic fundamentals in thermodynamics and its applications.

UNIT –I BASIC CONCEPTS AND FIRST LAW OF THERMODYNAMICS 9

Thermodynamic systems, Concepts of continuum, Thermodynamic properties, Equilibrium, Processes , cycle, Work, temperature, Zeroth law of Thermodynamics.First law of thermodynamics – Applications to closed and open systems, Internal energy, Specific heats, Enthalpy, Steady and unsteady flow conditions.Problems.

UNIT –II SECOND LAW OF THERMODYNAMICS 9

Statements, Reversibility, Causes of irreversibility, Carnot cycle, Reversed Carnot cycle, Heat engines, refrigerators, Heat pumps.Clausius inequality, Entropy, Principles of increase in entropy, Carnot theorem, Available and non-available energy, Availability. – Problems. Comment.

UNIT –III WORKING FLUIDS 9

Definition of working fluid, Thermodynamic properties of pure substances, property diagram, PVT surface of water and other substances, calculation of properties.First law and second law analysis using tables and charts.Properties of ideal and Real gases, Equation of state, Gas laws, Vanderwaal's equation of state, Compressibility, Compressibility charts, Dalton's law of partial pressures, Internal energy, enthalpy, Heat and molecular weight of gas mixtures. .

UNIT –IV POWER CYCLES 9

Gas Power Cycles – Otto, Diesel, Dual and Brayton cycles – Problems, Vapour Power Cycles – Rankine, Modified Rankine, Reheat & Regeneration Cycles, Binary vapour power cycles– Problems. Comment.

UNIT –V THERMODYNAMIC RELATIONS AND COMBUSTION OF FUELS 9

Exact differentials, T-Ds relations, Maxwell relations, ClausiusClapeyron equations, Joule- Thomson coefficient. Heat value of fuels, Combustion equations, Theoretical and excess air, Air fuel ratio, exhaust gas analysis, Problems.

TUTORIAL : 15 PERIODS TOTAL HOURS : 60 PERIODS

TEXT BOOKS

1. Nag.P.K. - "Engineering Thermodynamics", IV Edition, Tata McGraw-Hill- New Delhi- 2008.
2. Rajput. R.K., "A Textbook of Engineering Thermodynamics", Third Edition, Laxmi Publications, New Delhi, 2005.

REFERENCES

1. Yunus.A.Cengel, Michael A.Boles, Thermodynamics: An Engineering Approach, McGraw-Hill, 2011.
2. Spalding & Cole., Engineering Thermodynamics, ELBS.
3. Van Wylen& Sonntag., Fundamentals of Classical Thermodynamics – Tata McGraw Hill.
4. Rogers & Mayhew, Engineering Thermodynamics – Addision Wesley.

Content beyond the syllabus

- Statistical thermodynamics
- Ericsson, Stirling, Lenoir and Atkinson cycles.

SEMESTER	SUBJECT	L	T	P	C
III	**FLUID MECHANICS AND MACHINERY** (Common to MECH, MECT, & AERO)	3	0	0	3

AIM	The aim of the subject is to provide a fundamental knowledge in fluid mechanics and machinery.
OBJECTIVE	1. To learn the fundamentals in Fluid Mechanics 2. To understand the kinematics of the fluid flow. 3. To understand the fluid flow concepts 4. To learn the working principle, applications & design of various hydraulic turbines. 5. To learn the working principle, applications &, design of various hydraulic pumps.
OUTCOME	The students would be able to understand the basic fluid properties and could understand the working principle of pumps.

UNIT –I - BASIC CONCEPTS AND PROPERTIES 9

Fluid – Definition - solid and fluid - Units and dimensions - Properties of fluids – Temperature - Viscosity - Compressibility - Vapour pressure - Capillary and surface tension - Fluid statics: concept of fluid static pressure - Pressure measurements by manometers and pressure gauges. Introduction to CFD, geophysical fluid dynamics.Velocity and density measurement methods.

UNIT –II - FLUID KINEMATICS AND SIMILARITIES 9

Fluid Kinematics - Flow visualization - Lines of flow - Types of flow - Velocity field and acceleration - Continuity equation (one and three dimensional differential forms)- Equation of streamline - Stream function - Velocity potential function - Circulation - Flow net – Fluid dynamics - Equations of motion - Euler's equation along a streamline - Bernoulli's equation – Applications - Venturi meter - Orifice meter - Pitot tube - Dimensional analysis - Buckingham's π theorem- Applications - Similarity laws and models.

UNIT –III - INCOMPRESSIBLE FLUID FLOW 9

Viscous flow - Navier-Stoke's equation - Shear stress - Pressure gradient relationship - Laminar flow between parallel plates - Laminar flow through circular tubes (Hagen poiseulle's) - Hydraulic and energy gradient - Flow through pipes - Darcy - Weisbagh's equation - Pipe roughness -Friction factor- Moody's diagram - Minor losses - Flow through pipes in series and in parallel - Power transmission - Boundary layer flows - Boundary layer thickness - Boundary layer separation - Drag and lift coefficients. Major losses-design aspect in application of drags and lift coefficients.Piping Engineering-Introduction and Applications.

UNIT –IV - HYDRAULIC TURBINES 9

Fluid machines: definition and classification - Exchange of energy - Euler's equation for turbo machines - Construction of velocity vector diagrams - Head and specific work - Components of energy transfer - Degree of reaction. Hydro turbines: definition and classifications - Pelton turbine - Francis turbine - propeller turbine - Kaplan turbine - Working principles - Velocity triangles - Work done - Specific speed - Efficiencies - Performance curve for turbines. Energy saving design requirements for turbine.

UNIT –V - HYDRAULIC PUMPS 9

Pumps: definition and classifications - Centrifugal pump: classifications - Working principle- velocity triangles - Specific speed - Efficiency and performance curves - Reciprocating pump: classification - Working principle - Indicator diagram -Work saved by air vessels and performance curves - Cavitations in pumps - Rotary pumps- Applications.

TOTAL HOURS : 45 HOURS

TEXT BOOKS

1. Bansal- R.K. - "Fluid Mechanics and Hydraulics Machines"- (5^{th} edition) - Laxmi publications (P) Ltd- New Delhi- 2005.
2. Modi.P.N. &Seth.S.M., a Textbook on Fluid Mechanics, Standard Publishers Ltd.

REFERENCES

1. White- F.M. - "Fluid Mechanics"- Tata McGraw-Hill- 5^{th} Edition- New Delhi- 2003.
2. Ramamurtham. S- "Fluid Mechanics and Hydraulics & Fluid Machines"-DhanpatRai& Sons, Delhi- 2003.

SEMESTER	SUBJECT	L	T	P	C
III	**FLUID MECHANICS AND STRENGTH OF MATERIALS LAB** (Common to MECT and AUTO& AERO)	0	0	4	2

AIM: The main objective of this lab is to practice the mechanisms behind fluid flow and understand the property measurement and strength of materials.

OBJECTIVE:
1. To get practice in fluid flow measurement and losses.
2. To understand the operation of pumps.
3. To get practice in material property measurement.

OUTCOME: 1. The student will undergo training in the fluids and materials mechanisms and properties.

LIST OF EXPERIMENTS:

1. A comparative analysis of Coefficient of discharge using Orifice meter & venturimeter.
2. Determination of pipe loses-major & minor.
3. Demonstration of centrifugal pump/submersible pump/jet pump/reciprocating pump.
4. Determination of Tensile strength and Compression strength on a given specimen.
5. Determination of shear strength of Mild steel and Aluminium rods
6. Determination of Torsional strength of mild steel rod
7. Determination of Impact strength
8. Conduct of Hardness test on metals - Brinell and Rockwell Hardness.
9. Conduct of Deflection test on beams

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TOTAL: 30 HOURS

SEMESTER	SUBJECT	L	T	P	C
III	THERMODYNAMICS LABORATORY	0	0	3	2

AIM: To make the students understand the basics of Thermodynamics and carry out various experiments on Heat exchanger and stroke engines.
OBJECTIVE: To enrich the student knowledge with working of various types of engines and their cycles.
OUTCOME: The student can able to understand the working of various engines.

LIST OF EXPERIMENTS

1. Performance test on a 4-stroke engine
2. Valve timing of a 4 – stroke engine and port timing of a 2 stroke engine
3. Determination of effectiveness of a parallel flow heat exchanger
4. Determination of effectiveness of a counter flow heat exchanger
5. Determination of the viscosity coefficient of a given liquid
6. COP test on a vapour compression refrigeration test rig
7. COP test on a vapour compression air-conditioning test rig
8. Study of a Gas Turbine Engine.
9. Determination of Conductive Heat Transfer Coefficient.
10. Determination of Thermal Resistance of a Composite wall.

TOTAL: 60 **Periods**

LIST OF EQUIPMENTS (for a batch of 30 students)

Sl.No	Details of Equipments	Qty Req.	Experiment No.
1.	4 stroke twin cylinder diesel engine	1	1
2.	Cut section model of 4 stroke kirloskar diesel engine and cut section model of 2 stroke petrol engine	1	2
3.	Parallel and counter flow heat exchanger test rig	1	3,4
4.	Red wood viscometer	1	5
5.	Vapour compression refrigeration test rig	1	6
6.	Vapour compression air-conditioning test rig	1	7
7.	Gas Turbine Engine	1	8
8.	Conductive Heat Transfer set up	1	9
9.	Composite wall	1	10

SEMESTER	SUBJECT	L	T	P	C
III	AIRCRAFT SYSTEMS LABORATORY	0	0	3	2

AIM: The aim of the subject is to provide the students to understand the basic procedures of aircraft maintenance.

OBJECTIVE: To train the students "ON HAND" experience in maintenance of various air frame systems in aircraft and rectification of common snags.

OUTCOME: The students can perform various maintenance procedures.

LIST OF EXPERIMENTS

1. Aircraft "Jacking Up" procedure
2. Aircraft "Levelling" procedure
3. Control System "Rigging check" procedure
4. Aircraft "Symmetry Check" procedure
5. "Flow test" to assess of filter element clogging
6. "Pressure Test" To assess hydraulic External/Internal Leakage
7. "Functional Test" to adjust operating pressure
8. "Pressure Test" procedure on fuel system components
9. "Brake Torque Load Test" on wheel brake units
10. Maintenance and rectification of snags in hydraulic and fuel systems.

TOTAL : 60 Periods

LIST OF EQUIPMENTS

(for a batch of 30 students)

S.No.	Items	Quantity	Experiment No.
1.	Serviceable aircraft with all above systems	1	1,2,3,4,5,6,7,8,9,10
2.	Hydraulic Jacks (Screw Jack)	5	1,2,4,8
3.	Trestle adjustable	5	1,2,4,8
4.	Spirit Level	2	8
5.	Levelling Boards	2	8
6.	Cable Tensiometer	1	8
7.	Adjustable Spirit Level	1	8
8.	Plumb Bob	1	8

SEMESTER	SUBJECT	L	T	P	C
IV	**NUMERICAL METHODS (COMMON TO MECH, AERO, AUTO, MECT, CIVIL, EIE & EEE)**	3	1	0	4

AIM: To learn the various problem solving technique onEigen value problems, approximation, initial value problems of ode.

OBJECTIVES:

- Computing the trajectory of a spacecraft requires the accurate numerical solution of a system of ordinary differential equations.
- It is used in Kinematics Simulation, Complex System Optimization
- Car companies can improve the crash safety of their vehicles by using computer simulations of car crashes. Such simulations essentially consist of solving partial differential equations numerically.
- Numerical linear algebra is important for data analysis.
- Airlines use sophisticated optimization algorithms to decide ticket prices, airplane and crew assignments and fuel needs. Historically, such algorithms were developed within the overlapping field of operations research.

OUTCOME: the student can able to solve the various problems on Eigen value problems, approximation, initial value problems of ode.

1. SOLUTION OF EQUATIONS AND EIGEN VALUE PROBLEMS 12

Method of false position, Newton-Raphson method for single variable, Solutions of a linear system by Gaussian, Gauss-Jordan, Jacobian and Gauss- Seidel methods.Inverse of a matrix by Gauss-Jordan method.Eigen value of a matrix by Power Method.

2. INTERPOLATION AND APPROXIMATION 12

Interpolation with Newton's divided differences, Lagrange's polynomial, Newton forward and backward differences, central difference Formula (Stirling's and Bessel's).

3. NUMERICAL DIFFERENTIATION AND INTEGRATION 12

Numerical differentiation with interpolation polynomials, Numerical integration by Trapezoidal and Simpson's (both $1/3^{rd}$ and $3/8^{th)}$ rules. Rombergs rule, Two and Three point Gaussian quadrature formula. Double integrals using Trapezoidal and Simpson's rule.

4. INITIAL VALUE PROBLEMS OF ODE 12

Solution of equations related to simple harmonic motion, Oscillations of a spring mass system, Simple pendulum, Oscillatory electrical circuit and Deflection of beams with initial conditions - using Taylor series. Euler, Modified Euler and Runge-Kutta methods.

5. BOUNDARY VALUE PROBLEMS FOR ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS 12

Finite difference solution for the second order ordinary differential equations, Finite difference solution for one dimensional heat equation (both implicit and explicit).One dimensional wave equation and two dimensional Laplace and Poisson equations.

Lecture Hours : 45 Tutorial hours : 15 Total hours: 60

TEXT BOOK

1. N.Subramanian, “Numerical Methods” ,SCM Publishers,Erode.
2. B.S.Grewal, “Higher Engineering Mathematics”, Khanna Publishers, New Delhi.

REFERENCES

1. Sastry, S.S., “Introductory Methods of Numerical Analysis (Third Edition)”, Printice Hall of India, New Delhi, 1998.
2. T.Veerarajan, T.Ramachandran, “Numerical Methods with Programs in C and C++”, Tata McGraw-Hill (2004).
3. Grewal, B.S. and Grewal, J.S., “Numerical Methods in Engineering and Science”, Khanna Publishers, New Delhi, 1999.
4. A. Singaravelu, “Numerical Methods”, Meenakshi Agency, Chennai

SEMESTER	SUBJECT	L	T	P	C
IV	AERODYNAMICS – I	3	1	0	4

AIM: To study aerodynamic concepts and understanding motion of air around an object enables the calculation of forces and moments acting on the object.

OBJECTIVE:

- To understand the fluid mechanics concepts for advanced applications.
- To study two dimensional flows in aerodynamics.
- To integrate the mathematics with aerodynamics.
- To study ideal flows over wings.
- To study real time viscous flows.

OUTCOMES:

- 1. Ability to apply airfoil theory to predict air foil perform.
- 2. Knowledge of incompressible flow.
- 3. Knowledge of Boundary layer theory.

UNIT I INTRODUCTION TO LOW SPEED FLOW 9

Euler equation, incompressible Bernoulli's equation.circulation and vorticity, Green's Lemma andStoke's theorem, Barotropic flow, Kelvin's theorem, streamline, stream function, irrotational flow,potential function, Equi-potential lines, elementary flows and their combinations.

UNIT II TWO DIMENSIONAL INVISCID INCOMPRESSIBLE FLOW 9

Ideal Flow over a circular cylinder, D'Alembert's paradox, Magnus effect, Kutta-Joukowski's theorem,starting vortex, Kutta condition, real flow over smooth and rough cylinder.

UNIT III AIRFOIL THEORY 9

Cauchy-Riemann relations, complex potential, methodology of conformal transformation, Kutta-Joukowskitransformation and its applications, thin airfoil theory and its applications.

UNIT IV SUBSONIC WING THEORY 9

Vortex filament, Biot and Savart law, bound vortex and trailing vortex, horse shoe vortex, lifting linetheory and its limitations.

UNIT V INTRODUCTION TO BOUNDARY LAYER THEORY 9

Boundary layer and boundary layer thickness, displacement thickness, momentum thickness, energythickness, shape parameter, boundary layer equations for a steady, two dimensional incompressibleflow, boundary layer growth over a flat plate, critical Reynolds number, Blasius solution, basics ofturbulent flow.

TUTORIAL : 15 TOTAL: 60 PERIODS

TEXT BOOKS:

1. Houghton, E.L., and Caruthers, N.B., "Aerodynamics for Engineering students", Edward ArnoldPublishers Ltd., London, 1989.
2. Anderson, J.D., "Fundamentals of Aerodynamics", MaGraw Hill Book Co., 1999

REFERENCES:

1. Milne Thomson, L.H., "Theoretical Aerodynamics", Macmillan, 1985
2. John J Bertin., "Aerodynamics for Engineers", Pearson Education Inc, 2002
3. Clancey, L J.," Aerodynamics", Pitman, 1986
4. Kuethe, A.M and Chow, C.Y, "Foundations of Aerodynamics", Fifth Edition, John Wiley & Sons,2000.

SEMESTER	SUBJECT	L	T	P	C
IV	PROPULSION – I	3	1	0	4

AIM: To study in detail about fundamentals of aircraft propulsion, advanced propulsion systems in gas turbine engine. To understand the principles of operation and design of aircraft power plants.

OBJECTIVE:

- To know the fundamentals of gas turbines and its components.
- To study the types of nozzles and flow properties in nozzles.
- To study the types of compressors and their working principles.
- To study the types of turbine and their working principles.

OUTCOME: The student would able to understand the operation and the working of propulsion and the propulsion system.

Unit I FUNDAMENTALS OF GAS TURBINE ENGINES 9

Operating principles of piston engines – thermal efficiency calculations – classification of pistonengines - 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 thrustaugmentation – characteristics of turboprop, turbofan and turbojet – performance characteristics.

UNIT II INLETS, NOZZLES AND COMBUSTION CHAMBERS FOR JET ENGINES 10

Internal flow and Stall in subsonic inlets – relation between minimum area ratio and externaldeceleration ratio – diffuser performance – supersonic inlets – starting problem on supersonic inlets –shock swallowing by area variation – . real flow in nozzles and nozzle efficiency – losses in nozzles – equilibrium flow and frozen flow in nozzles- two phase flow in nozzles – ejector and variable areanozzles - interaction of nozzle flow with adjacent surfaces – thrust reversal- classification ofcombustion chambers – combustion chamber performance – effect of operating variables onperformance – flame stabilization.

UNIT III COMPRESSORS FOR JET ENGINES 9

Principle of operation of centrifugal compressor and axial flow compressor– Work done and pressurerise – velocity diagrams – degree of reaction – free vortex and constant reaction designs of axial flowcompressor – performance characteristics of centrifugal and axial flow compressors– stage efficiencycalculations - cascade testing

UNIT IV TURBINES FOR JET ENGINES 9

Principle of operation of axial flow turbines– limitations of radial flow turbines- Work done andpressure rise – Velocity diagrams – degree of reaction – free vortex and constant nozzle angledesigns – performance characteristics of axial flow turbine– turbine blade cooling methods – stageefficiency calculations – basic blade profile design considerations – matching of compressor andturbine.

UNIT V RAMJET PROPULSION 9

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

Text books:

1. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Addison – Wesley Longman INC, 1999.
2. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H. "Gas Turbine Theory",Longman, 1989.

References:

1. Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAAEducation Series, New York, 1985.
2. "Rolls Royce Jet Engine" – Third Edition – 1983.
3. Mathur, M.L. and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion",Standard Publishers & Distributors, Delhi, 1999.

SEMESTER	SUBJECT	L	T	P	C
IV	AIRCRAFT STRUCTURES – I	3	1	0	4

AIM: Analysis and design of simple aircraft structural components.

OBJECTIVES:

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

OUTCOMES:

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

UNIT I STATICALLY DETERMINATE & INDETERMINATE STRUCTURES 9

Plane truss analysis – method of joints – method of sections – method of shear – 3-D trusses –principle of super position, Clapeyron's 3 moment equation and moment distribution method forindeterminate beams.

UNIT II ENERGY METHODS 10

Strain Energy in axial, bending, torsion and shear loadings. Castigliano's theorems and theirapplications. Energy theorems – dummy load & unit load methods – energy methods applied tostatically determinate and indeterminate beams, frames, rings & trusses.

UNIT III COLUMNS 10

Euler's column curve – inelastic buckling – effect of initial curvature – the Southwell plot – columnswith eccentricity – use of energy methods – theory of beam columns – beam columns with differentend conditions – stresses in beam columns.

UNIT IV FAILURE THEORIES 9

Ductile and brittle materials – Maximum principal stress theory - Maximum principal strain theory - Maximum shear stress theory - Distortion energy theory – Octahedral shear stress theory.

UNIT V INDUCED STRESSES 7

Thermal stresses – impact loading – Fatigue – Creep - Stress Relaxation.

TUTORIAL : 15 TOTAL: 60 PERIODS

TEXT BOOKS:

1. Timoshenko and Gere, "Mechanics of Materials", Tata McGraw Hill, 1993.
2. Megson T M G, "Aircraft Structures for Engineering students" Elsevier Science and Technology, 2007
3. Peery and Azar, "Aircraft Structures"

REFERENCES:

1. Donaldson, B.K., "Analysis of Aircraft Structures - An Introduction", McGraw Hill, 1993.
2. Bruhn E F, "Analysis and Design of Flight Vehicle Structures", Tri-State Off-set Company, USA, 1985
3. Peery, D.J. and Azar,J.J., "Aircraft Structures", 2nd Edition, McGraw – Hill, N.Y, 1999.

SEMESTER	SUBJECT	L	T	P	C
IV	**MECHANICS OF MACHINES** (Common to AUTO & AERO)	3	1	0	4

AIM: To expose the students the different mechanisms, their method of working, Forces involved and consequent vibration during working.

OBJECTIVE:

- To understand the Kinematic analysis of simple mechanisms and its velocity and accelerations.
- To understand the working principle, applications, design of various hydraulic pumps.
- To know the Gear and cam profile and geometry.
- To study the Static and dynamic balancing of the various masses.

OUTCOME: The students would be able to understand themethod of working, Forces involved and consequent vibration during working.

UNIT I KINEMATIC OF MECHANICS **10**

Mechanisms – Terminology and definitions – kinematics inversions of 4 bar and slide crank chain – kinematics analysis in simple mechanisms – velocity and acceleration polygons – Analytical methods– computer approach – cams – classifications – displacement diagrams - layout of plate cam profiles– derivatives of followers motion – circular arc and tangent cams.

UNIT II GEARS and GEAR TRAINS **9**

Spur gear – law of toothed gearing – involute gearing – Interchangeable gears – Gear tooth action - interference and undercutting – nonstandard teeth – gear trains – parallel axis gears trains – epicyclicgear trains – automotive transmission gear trains.

UNIT III FRICTION **8**

Sliding and Rolling Friction angle – friction in threads – Friction Drives – Friction clutches – Belt andrope drives – brakes – Tractive resistance.

UNIT IV FORCE ANALYSIS **9**

Applied and Constrained Forces – Free body diagrams – static Equilibrium conditions – Two, Threeand four members – Static Force analysis in simple machine members – Dynamic Force Analysis –Inertia Forces and Inertia Torque – D'Alembert's principle – superposition principle – dynamic ForceAnalysis in simple machine members.

UNIT V BALANCING AND VIBRATION **9**

Static and Dynamic balancing – Balancing of revolving and reciprocating masses – Balancingmachines – free vibrations – Equations of motion – natural Frequency – Damped Vibration – bendingcritical speed of simple shaft – Torsional vibration – Forced vibration – harmonic Forcing – Vibration isolation.

TUTORIAL : 15 **TOTAL: 60 PERIODS**

TEXT BOOKS

1. Ambekar A.G., "Mechanism and Machine Theory" Prentice Hall of India, New Delhi, 2007
2. Shigley J.E., Pennock G.R and Uicker J.J., "Theory of Machines and Mechanisms", OxfordUniversity Press, 2003

REFERENCES

1. Thomas Bevan, "Theory of Machines", CBS Publishers and Distributors, 1984.
2. Ghosh.A, and A.K.Mallick, "Theory and Machine", Affiliated East-West Pvt. Ltd., New Delhi, 1988.
3. Rao.J.S. andDukkipatti R.V. "Mechanisms and Machines", Wiley-Eastern Ltd., New Delhi, 1992.
4. Ramamurthi. V, "Mechanisms of Machine", Narosa Publishing House, 2002.
5. Robert L. Norton, "Design of Machinery", McGraw-Hill, 2004.

SEMESTER	SUBJECT	L	T	P	C
IV	DISASTER MITIGATION AND MANAGEMENT	3	0	0	3

AIM	To impart awareness on disasters and preparedness during disasters
OBJECTIVE	1.To Understand basic concepts in Disaster Management 2. To Understand Definitions and Terminologies used in Disaster Management 3. To Understand the Challenges posed by Disasters 4. To understand Impacts of Disasters
OUTCOME	The students would be able to understand the various aspects of disasters and trained to face its challenges.

UNIT 1 INTRODUCTION **9**

Concept of disaster; Different approaches; Concept of Risk; Levels of disasters; Disaster phenomena and events (Global, national and regional); Natural and man-made hazards

UNIT 2 RISK ASSESSMENT AND VULNERABILITY ANALYSIS **9**

Response t

ime, frequency and forewarning levels of different hazards; Characteristics and damage potential of natural hazards; hazard assessment ;Dimensions of vulnerability factors; vulnerability assessment; Vulnerability and disaster risk; Vulnerabilities to flood and earthquake hazards

UNIT 3 DISASTER MANAGEMENT MECHANISM **9**

Concepts of risk management and crisis management -Disaster management cycle ;Response and Recovery ; Development, Prevention, Mitigation and Preparedness-Planning for relief

UNIT 4 DISASTER RESPONSE **9**

Mass media and disaster management-Disaster Response Plan; Communication, Participation, and Activation of Emergency Preparedness Plan-Logistics Management-Psychological Response-Trauma and Stress Management-Rumour and Panic Management-Minimum Standards of Relief-Managing Relief-Funding

UNIT 5 DISASTER MANAGEMENT IN INDIA **9**

Strategies for disaster management planning; Steps for formulating a disaster risk reduction plan; Disaster management Act and Policy in India; Organisational structure for disaster management in India; Preparation of state and district disaster management plans

Text books

1. Alexander, D. Natural Disasters, ULC press Ltd, London, 1993.
2. Carter, W. N. Disaster Management: A Disaster Management Handbook, Asian Development Bank, Bangkok, 1991.
3. Chakrabarty, U. K. Industrial Disaster Management and Emergency Response, Asian Books Pvt. Ltd., New Delhi 2007.

References

1. Abarquez I. &Murshed Z. Community Based Disaster Risk Management: Field Practitioner's Handbook, ADPC, Bangkok, 2004.
2. Goudie, A. Geomorphological Techniques,Unwin Hyman, London 1990.
3. Goswami, S. C. Remote Sensing Application in North East India,PurbanchalPrakesh, Guwahati, 1997.
4. Manual on Natural Disaster Management in India, NCDM, New Delhi, 2001.
5. Disaster Management in India, Ministry of Home Affairs, Government of India, New Delhi, 2011.
6. National Policy on Disaster Management, NDMA, New Delhi, 2009.
7. Disaster Management Act. (2005), Ministry of Home Affairs, Government of India, New Delhi, 2005.

SEMESTER	SUBJECT	L	T	P	C
IV	AIRCRAFT STRUCTURES I – LABORATORY	0	0	3	2

AIM: The aim of the subject is to provide the knowledge in aircraft structural analyses.

OBJECTIVE: The objective of conducting the Aircraft structure laboratory is to make the students understand and appreciate various principle and theorems involved in the theory of aircraft structures, vibrations and experimental stress analyzing the results. This will immensely help the students to enrich their knowledge in the design of various aircraft structural components, namely, wings, fuselage, landing gear, control surfaces, etc.

OUTCOME: The students would be able to get hands on training of the operations in aircraft structural analyses.

LIST OF EXPERIMENTS

1. Determination of Young's modulus of steel using mechanical extensometers.
2. Determination of Young's modulus of aluminum using electrical extensometers.
3. Determination of fracture strength and fracture pattern of ductile materials.
4. Determination of fracture strength and fracture pattern of brittle materials.
5. Stress Strain curve for various engineering materials.
6. Deflection of beams with various end conditions.
7. Verification of Maxwell's Reciprocal theorem & principle of superposition.
8. Column – Testing.
9. South – well's plot.
10. Riveted Joints.

TOTAL: 60Periods

LIST OF EQUIPMENTS (for a batch of 30 students)

Sl. No.	Equipments	Qty	Experiments No.
1.	Universal Testing Machine	1	1,2,3,4,5,10
2.	Mechanical Extensometer	1	1
3.	Electrical stain gauge	10	2
4.	Stain indicator	1	2
5.	Dial Gauges	12	3,4
6.	Beam Test set up with various end conditions	2	3,4
7.	Weight 1 Kg	10	3,4
8.	Weight 2 Kg	10	3,4
9.	Weight Pans	6	3,4
10.	Column Test Apparatus	1	5,6
11.	Rivet	30	10

SEMESTER	SUBJECT	L	T	P	C
IV	AERO ENGINE LABORATORY	0	0	3	2

AIM: The aim of the subject is to provide knowledge in the aircraft engines.

OBJECTIVE: To introduce the knowledge of the maintenance and repair of both piston and jet aero engines and the procedures followed for overhaul of aero engines.

OUTCOME: The students would be able to get hands on training of the inlet, compressor, combustion chamber and turbine..

LIST OF EXPERIMENTS

1. Stripping of a piston engine
2. Engine (Piston Engine) – cleaning, visual inspection, NDT checks.
3. Study of Camshaft operation, firing order and magneto, valve timing.
4. Study of lubrication and cooling system
5. Study of auxillary systems, pumps and carburettor -Piston – Engine reassembly.
6. Stripping of a jet engine
7. Jet Engine – identification of components & defects.
8. Jet Engine – NDT checks and dimensional checks
9. Jet Engine – reassembly.
10. Engine starting procedures.

TOTAL: 60 Periods

LIST OF EQUIPMENTS
(for a batch of 30 students)

Sl.No	Equipments	Qty	Experiments No.
1	Piston Engines	2	1,2,3,4
2	Jet Aero Engines	2	6,7,8,9
3	Propeller pitch setting stand	1	5
4	Aircraft with serviceable stand	1	1 to 10
5	Precision instruments (Vernier Caliper, Micro meter, Cylinder bore gauge, depth gauge, Bevel Protector and DTI	2 each	3,5,8
6	NDT Equipments (Defectoscope, Dyepenetrant method, Hot oil Chalk Method	1 each	2,8

SEMESTER	SUBJECT	L	T	P	C
IV	AERODYNAMICS LABORATORY	0	0	3	2

AIM: The aim of the subject is to provide knowledge in wind tunnel testing.
OBJECTIVE: To study experimentally the aerodynamic forces on different bodies at low speeds.
OUTCOME: The students would be able to get hands on training of the operations various shapes analyses and performing various experiments in wind tunnel.

LIST OF EXPERIMENTS

1. Application of Bernoulli's Equation – venturimeter and orifice meter.
2. Frictional loss in laminar flow through pipes.
3. Frictional loss in turbulent flow through pipes.
4. Calibration of a subsonic Wind tunnel.
5. Determination of lift for the given airfoil section.
6. Pressure distribution over a smooth circular cylinder.
7. Pressure distribution over a rough circular cylinder.
8. Pressure distribution over a symmetric aerofoil.
9. Pressure distribution over a cambered aerofoil.
10. Flow visualization studies in subsonic flows.

TOTAL: 60 Periods

LIST OF EQUIPMENT (for a batch of 30 students)

Sl. No.	Items	Quantity	Experiment No.
1.	Wind Tunnel test section size around 300 x 300 mm with test section flow speed of 60 m/s.	1 No.	1, 2,3,4,5
2.	Wings of various airfoil sections (Symmetrical & cambered airfoils)	2 Nos. each	3, 4
3.	Angle of incidence changing mechanism	1 No.	3, 4
4.	Multiple Manometer stands with 20 – 30 manometer tubes	4 Nos.	2,3,4
5.	U-Tube Manometer	1 No.	1,2,3,4
6.	Static Pressure Probes	4 Nos.	1,2,3,4
7.	Total Pressure Probest	4 Nos.	1,2,3,4
8.	Pitot-Static Tubes	4 Nos.	1,2,3,4
9.	Wooden Models of Three Dimensional bodies (eg. Cylinder etc.,)	2 Nos. each	2
10.	Wind Tunnel balances (3 or 5 or 6 components)	1 No.	5
11.	Pressure Transducers with digital display	1 No.	1,2,3,4
12.	Hele-Shaw apparatus, Smoke Tunnel, Water flow channel	1 each	6,7,8
13.	Supersonic Wind tunnel of test section size 100 x 100 mm with storage tank capacity of 500ft^2 at 20 bar	1 No.	9,10
14.	Wooden models of cone, wedge and blunt body configurations of suitable size for flow visualization in a supersonic wind tunnel test section	1 No.	9,10
15.	Schlieren System	1 No.	9,10

SEMESTER	SUBJECT	L	T	P	C
V	AERODYNAMICS – II	3	1	0	4

AIM: To understand the behaviour of airflow both internal and external in compressible flow regime with particular emphasis on supersonic flows.

OBJECTIVE:

- Understand the Fundamentals of compressible flow.
- Study the shock and expansion waves.
- Study the two dimensional compressible flow.
- Study the high speed flows over airfoils, wings and airplane configurations.
- Study the boundary layer interaction.

OUTCOME: The student would be able to understand the concepts of flow and effects of flow on the aircraft.

UNIT I FUNDAMENTAL ASPECTS OF COMPRESSIBLE FLOW 9

Compressibility, continuity, momentum and energy equations for steady one dimensional flow,compressible Bernoulli's equation, area – mach number – velocity relation, mach cone, mach angle,one dimensional isentropic flow through variable area duct, critical conditions, characteristic machnumber, area-mach number relation, maximum discharge velocity – operating characteristics ofnozzles- introduction to hypersonic flows

UNIT II SHOCK AND EXPANSION WAVES 10

Normal shock relations, Prandtl's relation, Hugoniot equation, Rayleigh Supersonic Pitot tubeequation, Moving normal shock waves, Oblique shocks, $\vartheta - \beta - M$ relation, Shock Polar, Reflection ofoblique shocks, left running and right running waves, Interaction of oblique shock waves, slip line,shock-boundary layer interaction – transonic lambda shock – compression corner effect – incidentshock interaction - Rayleigh flow, Fanno flow, Expansion waves, Prandtl-Meyer expansion, Maximumturning angle, Simple and non-simple regions.

UNIT III TWO DIMENSIONAL COMPRESSIBLE FLOW 9

Potential equation for 2-dimensional compressible flow, Linearisation of potential equation,perturbation potential, Linearised Pressure Coefficient, Linearised subsonic flow, Prandtl-Glauert rule,

Linearised supersonic flow, Method of characteristics.

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

Critical Mach number, Drag divergence Mach number, Shock Stall, Supercritical Airfoil Sections,Transonic area rule, Swept wing, Airfoils for supersonic flows, Lift, drag, Pitching moment and Centreof pressure for supersonic profiles, Shock-expansion theory, wave drag, supersonic wings, Designconsiderations for supersonic aircraft- aerodynamic heating.

UNIT V EXPERIMENTAL TECHNIQUES FOR HIGH SPEED FLOWS 8

Wind tunnels for transonic, Supersonic and hypersonic flows, shock tube, Gun tunnels-peculiarproblems in the operation of hypersonic tunnels - Supersonic flow visualization methods

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

TEXT BOOKS

1. Anderson, J. D, Modern Compressible Flow, McGraw-Hill & Co., 2002.
2. Rathakrishnan., E, Gas Dynamics, Prentice Hall of India, 2004.

REFERENCES

1. Shapiro, A. H., Dynamics and Thermodynamics of Compressible Fluid Flow, Ronald Press, 1982.
2. Zucrow, M. J. and Anderson, J. D., Elements of Gas Dynamics, McGraw- Hill & Co., 1989.
3. Oosthuizen,P.H., &Carscallen,W.E., Compressible Fluid Flow, McGraw- Hill & Co., 1997.

SEMESTER	SUBJECT	L	T	P	C
V	PROPULSION – II	3	1	0	4

AIM: The aim of the subject is to provide detailed knowledge in Aircraft Propulsion systems.

OBJECTIVES:

To impart knowledge in non-air-breathing and hypersonic propulsion methods to students so that they are familiar with various propulsion technologies associated with space launch vehicles, missiles and space probes.

OUTCOME: The students would be able to understand the various types of propulsion system and its operation in aircraft.

Unit I HYPERSONIC AIRBREATHING PROPULSION 8

Introduction to hypersonic air breathing propulsion, hypersonic vehicles and supersonic combustionneedfor supersonic combustion for hypersonic propulsion – salient features of scramjet engine andits applications for hypersonic vehicles – problems associated with supersonic combustion – engine/airframe integration aspects of hypersonic vehicles – various types scramjet combustors – fuelinjection schemes in scramjet combustors – one dimensional models for supersonic combustion usingmethod of influence coefficients.

UNIT II FUNDAMENTALS OF CHEMICAL ROCKET PROPULSION 9

Operating principle – specific impulse of a rocket – internal ballistics – performance considerations of rockets – types of igniters- preliminary concepts in nozzle-less propulsion – air augmented rockets – pulse rocket motors – static testing of rockets & instrumentation –safety considerations.

UNIT III SOLID ROCKET PROPULSION 10

Salient features of solid propellant rockets – selection criteria of solid propellants – estimation of solid propellant adiabatic flame temperature - propellant grain design considerations – erosive burning in solid propellant rockets – combustion instability – strand burner and T-burner – applications and advantages of solid propellant rockets.

UNIT IV LIQUID AND HYBRID ROCKET PROPULSION 10

Salient features of liquid propellant rockets – selection of liquid propellants – various feed systems and injectors for liquid propellant rockets -thrust control and cooling in liquid propellant rockets and the associated heat transfer problems – combustion instability in liquid propellant rockets – peculiar problems associated with operation of cryogenic engines - Introduction to hybrid rocket propulsion – standard and reverse hybrid systems- combustion mechanism in hybrid propellant rockets – applications and limitations.

UNIT V ADVANCED PROPULSION TECHNIQUES 8

Electric rocket propulsion– types of electric propulsion techniques - Ion propulsion – Nuclear rocket – comparison of performance of these propulsion systems with chemical rocket propulsion systems – future applications of electric propulsion systems - Solar sail.

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

TEXT BOOKS:

1. Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 5th Edition, 1993.
2. Mathur, M.L., and Sharma, R.P., “Gas Turbine, Jet and Rocket Propulsion”, Standard Publishers and Distributors, Delhi, 1988.

REFERENCES:

1. David H. Heiter and David T. Pratt., “Hypersonic Airbreathing Propulsion”, AIAA Education Series, 1999.
2. James Award, "Aerospace Propulsion System".

SEMESTER	SUBJECT	L	T	P	C
V	AIRCRAFT STRUCTURES – II	3	1	0	4

AIM: The aim of the subject is to provide Detailed knowledge in shear flow, bending moment, and various forces in aircraft structures.

OBJECTIVES:

To provide knowledge to students about thebehaviour of major aircraft structural components like wings and fuselage under various loading conditions.

OUTCOME: The students would be able to Solve the various problems on the structures based on the various loads.

Unit I UNSYMMETRICAL BENDING 9

Bending of symmetric beams subject to skew loads - bending stresses in beams of unsymmetricalsections – generalized 'K' method, neutral axis method, principal axis method.

Unit II SHEAR FLOW IN OPEN SECTIONS 9

Thin walled beams – concept of shear flow – the shear centre and its determination – shear flowdistribution in symmetrical and unsymmetrical thin-walled sections – structural idealization – shearflow variation in idealized sections.

Unit III SHEAR FLOW IN CLOSED SECTIONS 9

Bredt - Batho theory – single-cell and multi-cell tubes subject to torsion – shear flow distribution inthin-walled single & multi-cell structures subject to combined bending torsion – with walls effective andineffective in bending – shear centre of closed sections.

Unit IV BUCKLING OF PLATES 8

Bending of thin plates – rectangular sheets under compression - local buckling stress of thin walledsections – crippling strength estimation – thin-walled column strength – load carrying capacity of sheet

stiffener panels – effective width.

Unit V STRESS ANALYSIS OF WING AND FUSELAGE 10

Loads on an aircraft –V-n diagram – shear force and bending moment distribution over theaircraft wing and fuselage – shear flow in thin-webbed beams with parallel and non-parallel flanges –complete tension field beams – semi-tension field beam theory.

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

TEXT BOOKS:

1. Megson T M G , "Aircraft Structures for Engineering Students", Elsevier Ltd, 2007

2. Peery, D.J., and Azar, J.J., "Aircraft Structures", 2nd edition, McGraw – Hill, N.Y., 1999

3. Bruhn. E.H., "Analysis and Design of Flight Vehicles Structures", Tri-state off-set Company, USA, 1985.

REFERENCES:

1. Rivello, R.M., "Theory and Analysis of Flight Structures", McGraw Hill, 1993.

2. Howard D Curtis, "Fundamentals of Aircraft Structural Analysis", WCB-McGraw Hill, 1997

SEMESTER	SUBJECT	L	T	P	C
V	AIRCRAFT PERFORMANCE	3	0	0	3

AIM: To introduce the concepts of Dynamics of Airplanes. Pre-requisite: Basics of Aerodynamics.

OBJECTIVE: To make the student understand performance of airplanes under various flight conditions like take off, cruise, landing, climbing, gliding, turning etc.
OUTCOME: The students would be able to understand the behavior of aircraft with various types of forces acting on it.

UNIT I GENERAL CONCEPTS 9
International Standard atmosphere, IAS, EAS, TAS, Propeller theory- Froude momentum and blade element theories, Propeller co-efficients, Use of propeller charts, Performance of fixed and variable pitch propellers, High lift devices, Thrust augmentation

UNIT II DRAG OF BODIES 8
Streamlined and bluff body, Types of drag, Effect of Reynold's number on skin friction and pressure drag, Drag reduction of airplanes, Dragpolar, Effect of Mach number on drag polar

UNIT III STEADY LEVEL FLIGHT 10
Steady level flight, Thrust required and Power required, Thrust available and Power available for propeller driven and jet powered aircraft, Effect of altitude, maximum level flight speed, conditions for minimum drag and minimum power required, Effect of drag divergence on maximum velocity, Range and Endurance of Propeller and Jet airplanes.

UNIT IV GLIDING AND CLIMBING FLIGHT 9
Shallow and steep angles of climb, Rate of climb, Climb hodograph, Maximum Climb angle and Maximum Rate of climb- Effect of design parameters for propeller and jet aircrafts, Absolute and service ceiling, Cruise climb, Gliding flight, Glide hodograph

UNIT V ACCELERATD FLIGHT 9
Estimation of take-off and landing distances, Methods of reducing landing distance, level turn, minimum turn radius, bank angle and load factor, Constraints on load factor, Pull up and pull down maneuvers, maximum turn rate, V-n diagram.

TOTAL: 45 Periods

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

REFERENCES:
1. Kuethe, A.M. and Chow, C.Y., Foundations of Aerodynamics, John Wiley & Sons, 1982.
2. J.J.Bertin, Aerodynamics for Engineers, Prentice-Hall, 1988.
3. L.J. Clancey, Aerodynamics, Pitman, 1986
4. Anderson, Jr., J.D. Introduction to Flight, McGraw-Hill International Edition, 1999

SEMESTER	SUBJECT	L	T	P	C
V	MANUFACTURING TECHNOLOGY	3	0	0	3

AIM	The aim of the subject is to provide a fundamental knowledge in manufacturing sector.
OBJECTIVE	1. To acquire the knowledge about mould making, metal melting and casting process. 2. To acquire the knowledge about various metal joining processes. 3. To acquire the knowledge about various hot and cold working processes. 4. To acquire the knowledge about various sheet metal forming processes. 5. To acquire the knowledge about various plastic processing.
OUTCOME	The students would understand the basic working principle of joining and cutting operations and can perform casting and welding process.

UNIT I CASTING **8**

Casting types, procedure to make sand mould, types of core making, moulding tools, machinemoulding, special moulding processes – CO2 moulding; shell moulding, investment moulding,permanent mould casting, pressure die casting, centrifugal casting, continuous casting, castingdefects.

UNIT II WELDING **8**

Classification of welding processes. Principles of Oxy-acetylene gas welding. A.C metal arc welding,resistance welding, submerged arc welding, tungsten inert gas welding, metal inert gas welding,plasma arc welding, thermit welding, electron beam welding, laser beam welding, defects in welding,soldering and brazing.

UNIT III MACHINING **13**

General principles (with schematic diagrams only) of working and commonly performed operations in the following machines: Lathe, Shaper, Planer, Horizontal milling machine, Universal drilling machine, Cylindrical grinding machine, Capstan and Turret lathe.Basics of CNC machines. General principlesand applications of the following processes: Abrasive jet machining, Ultrasonic machining, Electricdischarge machining, Electro chemical machining, Plasma arc machining, Electron beam machiningand Laser beam machining.

UNIT IV FORMING AND SHAPING OF PLASTICS **7**

Types of plastics - Characteristics of the forming and shaping processes – Moulding ofThermoplastics – Working principles and typical applications of - Injection moulding – Plunger andscrew machines – Blow moulding – Rotational moulding – Film blowing – Extrusion - Typical industrialapplications – Thermoforming – Processing of Thermosets – Working principles and typicalapplications - Compression moulding – Transfer moulding – Bonding of Thermoplastics – Fusion andsolvent methods – Induction and Ultrasonic methods

UNIT V METAL FORMING AND POWDER METALLURGY **9**

Principles and applications of the following processes: Forging, Rolling, Extrusion, Wire drawing and Spinning, Powder metallurgy – Principal steps involved advantages, disadvantages and limitations of powder metallurgy.

TOTAL: 45 Periods

TEXT BOOKS

1. HajraChoudhury, "Elements of Workshop Technology", Vol.I and II, Media Promoters andPublishers Pvt., Ltd., Mumbai, 2005.
2. NagendraParashar B.S. and Mittal R.K., "Elements of Manufacturing Processes", Prentice-Hallof India Private Limited, 2007.

REFERENCES

1. SeropeKalpajian, Steven R.Schmid, "Manufacturing Processes for Engineering Materials",Fourth Edition, Pearson Education, Inc. 2007.
2. Jain. R.K. and S.C. Gupta, "Production Technology", Khanna Publishers. 16th Edition,2001.
3. "H.M.T. Production Technology – Handbook", Tata McGraw-Hill, 2000.
4. Roy. A. Linberg, "Process and Materials of Manufacture", PHI, 2000.
5. Adithan. M and Gupta. A.B., "Manufacturing Technology", New Age, 2006.

SEMESTER	SUBJECT	L	T	P	C
V	AIRCRAFT STRUCTURES – IILABORATORY	0	0	3	2

AIM: The aim of the subject is to provide knowledge inthe aircraft structural analyses.
OBJECTIVE : To experimentally study the unsymmetrical bending of beams, find the location of shear centre , obtain the stresses in circular discs and beams using photoelastic techniques, calibration of photo – elastic materials and study on vibration of beams.
Outcome: The students would be able to understand the working principle of various equipment's and their applications.

LIST OF EXPERIMENTS

1. Unsymmetrical bending of beams
2. Shear centre location for open sections
3. Shear centre location for closed sections
4. Constant strength beam
5. Flexibility matrix for cantilever beam
6. Beam with combined loading
7. Calibration of Photo- elastic materials
8. Stresses in circular discs and beams using photoelastic techniques
9. Vibrations of beams
10. Wagner beam – Tension field beam

TOTAL: 60 **Periods**

LIST OF EQUIPMENT
(for a batch of 30 students)

Sl.No.	Name of the Equipment	Qty	Experiments Number
1	Beam Test set –up	2	1, 2, 3,4
2	Unsymmetrical sections like 'Z' sections	2	1, 2, 3
3	Channel section and angle section	2	1, 2, 3
4	Dial gauges	12	1, 2, 3
5	Weights 1Kg	10	1, 2, 3
6	Weights 2 Kg	10	1, 2, 3
7	Beam Test Set – up	2	3, 4
8	Strain indicator and strain gauges	One set	4,5,6
9	Photo – elastic apparatus	1	7,8
10	Amplifier	2	9
11	Exciter	2	9
12	Pick – up	2	9
13	Oscilloscope	2	9
14	Wagner beam	1	10
15.	Hydraulic Jack	1	10

SEMESTER	SUBJECT	L	T	P	C
V	PROPULSION LABORATORY	0	0	3	1

AIM: The aim of the subject is to provide basic knowledge in working with propulsion systems of aircraft.
OBJECTIVE: To understand the basic concepts and carryout experiments in Aerospace Propulsion.
OUTCOME: The students would be able to understand the working principle of variousengines and their working.

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. Study of free convective heat transfer over a flat plate
5. Cascade testing of a model of axial compressor blade row.
6. Study of performance of a propeller.
7. Determination of heat of combustion of aviation fuel.
8. Combustion performance studies in a jet engine combustion chamber.
9. Study of free jet.
10. Study of wall jet.

TOTAL: 60 Periods

LIST OF EQUIPMENTS

(for a batch of 30 students)

Sl.No	Equipments	Qty	Experiments No.
1	Piston engines	2	1
2	Jet Engine /Engine model	1	2
3	Forced Convective apparatus	1	3
4	Free Convective apparatus	1	4
5	Axial compressor blade row model with pressure tapping	1	5
6	Watertube manometers (20 tubes)	2	5,8,9
7	Subsonic wind tunnel	1	4
8	Propeller model static and total pressure probes	4	8,9
9	2-D travers in mechanism	2	8
10.	Freejet test setup	1	9
11.	Aluminium plates with deflection mechanisms	1	10

SEMESTER	SUBJECT	L	T	P	C
V	MANUFACTURING TECHNOLOGY LABORATORY	0	0	4	2

AIM	The aim of the subject is to provide make the students to understand the basic operations of lathe machine and drilling machine
OBJECTIVE	To practice the various operations in lathe and drilling machine
OUTCOME	The students can perform operations in lathe and drilling machine.

LIST OF EXPERIMENTS

1. Design and modeling of rectangular plate with hole.
2. Design and modeling of spar components.
3. Design and modeling of aerofoil sections.
4. Design and modeling of cut section for wings.
5. Design and modeling of machine component.
6. Design and modeling of bulk head.
7. Design and analysis of a truss.
8. Design and analysis of beam distributed load.
9. Facing and Turning (Taper, Step) operations in CNC.
10. Drilling operations in CNC.

TOTAL: 45 PERIODS

LIST OF EQUIPMENTS

(for a batch of 30 students)

Sl.No	Equipments	Qty	Experiments No.
1	Computer nodes	30	1 to 8
2	Modeling Packages	30 Licences	1 to 6
3	FEA & CAM SOFTWARE	30 Licences	7 & 8
4	UPS	1	1 to 8
5	CNC Machine	1	9,10
6	Printer	2	All

SEMESTER	SUBJECT	L	T	P	C
VI	AIRCRAFT STABILITY AND CONTROL	3	1	0	4

AIM: To introduce the concepts of stability and control of airplanes.

OBJECTIVE:

- To provide an in-depth study of longitudinal static stability and its control.
- To provide an in-depth study of directional static stability and its control.
- To provide an in-depth study of lateralstatic stability and its control.
- To provide an in-depth study of disturbance theory and stability derivatives.
- To understand the Stability derivatives for lateral and directional dynamics.

OUTCOME: The student would be able to understand the varies stability criteria's in aircraft.

UNIT I STATIC LONGITUDINAL STABILITY AND CONTROL 12

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

UNIT II STATIC DIRECTIONAL STABILITY AND CONTROL 10

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

UNIT III STATIC LATERAL STABILTY AND CONTROL 8

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

UNIT IV DYNAMIC LONGITUDINAL STABILITY 9

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

UNIT V DYNAMIC LATERAL AND DIRECTIONAL STABILITY 6

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

Tutorial : 15 TOTAL: 60 Periods

TEXT BOOKS

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

REFERENCES

1. McCormick, B.W. Aerodynamics, Aeronautics & Flight Mechanics John Wiley, 1995.
2. Babister, A.W. Aircraft Stability and response, Pergamon Press, 1980
3. Etkin, B., Dynamics of Flight Stability and Control, John Wiley, New York, 1982.
4. Pamadi, B.N. Performnce, Stability, Dynamics, and Control of Airplanes, AIAA Education Series, 2004.

SEMESTER	SUBJECT	L	T	P	C
VI	HEAT AND MASS TRANSFER (COMMON TO MECH & AERO)	3	1	0	4

(Use of approved Design Data Book is permitted in the University examination)

AIM	The aim of the subject is to provide knowledge in heat and mass transfer
OBJECTIVE	1. To study about conduction mode of heat transfer. 2. To study about transient mode of heat transfer. 3. To study about convection mode of Heat transfer 4. To study about radiation mode of heat transfer and heat exchanger 5. To study heat transfer with mass transfer
OUTCOME	The students would be able to understand the basic concepts in heat power systems, integration of thermodynamics in heat power systems.

UNIT –I CONDUCTION - I **9**

Fourier law of conduction, General equation in Cartesian, Cylindrical and Spherical coordinates one dimensional steady state conduction across plane wall- composite wall – Composite cylinder – Composite sphere with convection boundaries, overall heat transfer coefficients, and critical thickness of insulation, conduction with generation, thermal contact resistance, and variable conductivity.

UNIT –II CONDUCTION - II **9**

Fins or extended surfaces- Pin fins, annular fins, longitudinal fins.Unsteady state conduction – lumped capacity system, semi – infinite solids and multi dimensional systems, numerical solutions of two-dimensional steady and unsteady conduction.

UNIT –III CONVECTION **9**

Hydrodynamic and thermal boundary layers – Principles and governing equations, forced convection – external flow over a Flat plate, cylinder, sphere and non-circular ducts, internal flow through pipes – annular spaces and noncircular conducts. Natural convection from vertical, inclined and horizontal surfaces.Problems.Boiling – Pool Boiling and regimes flow boiling through horizontal and vertical pipes. Condensation – Film and dropwise - derivation of the basic equations.

UNIT –IV RADIATION AND HEAT EXCHANGERS **9**

Electromagnetic spectrum, black body emission, Emissive power, Laws of radiation, radiation shape factor, electrical analogy, Radiation shields, gas radiation.Heat exchangers – types of derivation of LMTD and NTU – effectiveness equation, Fouling factor, Compact heat exchangers.

UNIT –V MASS TRANSFER AND HEAT PIPES **9**

Fick's law, Equimolar diffusion, Stefan's law, mass transfer coefficient, non-dimensional number used in mass transfer, atmospheric evaporation. Problems.Heat pipes – Introduction, Types and applications.

TUTORIAL HOURS : 15 TOTAL HOURS : 60

TEXT BOOKS

1. KOTHANDARAMAN C.P "Fundamentals of Heat and Mass Transfer" New Age International-New Delhi- 1998
2. SACHDEVA R C- "Fundamentals of Engineering Heat and Mass Transfer" New Age International- 1995

REFERENCES

1. OZISIK M.N- "Heat Transfer"- McGraw-Hill Book Co. - 1994.
2. NAG P.K- "Heat Transfer"- Tata McGraw-Hill- New Delhi- 2002
3. HOLMAN J.P "Heat and Mass Transfer" Tata McGraw-Hill- 2000.
4. INCROPRA and DEWITE, Heat Transfer – John Wiley.

SEMESTER	SUBJECT	L	T	P	C
VI	AIRCRAFT MATERIALS AND PROCESSES	3	0	0	3

AIM	The aim of the subject is to provide basic knowledge in materials behavior and metallurgy.
OBJECTIVE	To study the types of mechanical behaviour of materials for aircraft applications.
OUTCOME	1. Role of corrosion and heat treatment processes of aircraft materials 2. Knowledge in usage of composite materials in aircraft component design. 3. Exposure to high temperature materials for space applications

UNIT I ELEMENTS OF AEROSPACE MATERIALS 9

Structure of solid materials – Atomic structure of materials – crystal structure – miller indices – density – packing factor – space lattices – x-ray diffraction – imperfection in crystals – physical metallurgy - general requirements of materials for aerospace applications.

UNIT II MECHANICAL BEHAVIOUR OF MATERIALS 9

Linear and non linear elastic properties – Yielding, strain hardening, fracture, Bauchinger's effect – Notch effect testing and flaw detection of materials and components – creep and fatigue -comparative study of metals, ceramics plastics and composites.

UNIT III CORROSION & HEAT TREATMENT OF METALS AND ALLOYS 10

Types of corrosion – effect of corrosion on mechanical properties – stress corrosion cracking –corrosion resistance materials used for space vehicles heat treatment of carbon steels – aluminiumalloys, magnesium alloys and titanium alloys – effect of alloying treatment, heat resistance alloys –tool and die steels, magnetic alloys,

UNIT IV CERAMICS AND COMPOSITES 9

Introduction – powder metallurgy - modern ceramic materials – cermets - cutting tools – glassceramic – production of semi fabricated forms - plastics and rubber – carbon/carbon composites,fabrication processes involved in metal matrix composites - shape memory alloys – applications inaerospace vehicle design, open and close mould processes.

UNIT V HIGH TEMPERATURE MATERIALS CHARACTERIZATION 8

Classification, production and characteristics – methods and testing – determination of mechanicaland thermal properties of materials at elevated temperatures – application of these materials inthermal protection systems of aerospace vehicles – super alloys – high temperature materialcharacterization.

TOTAL: 45 PERIODS

TEXT BOOK

1. Titterton.G., "Aircraft Materials and Processes", V Edition, Pitman Publishing Co., 1995.

REFERENCES

1. Martin, J.W., "Engineering Materials, Their properties and Applications", Wykedham Publications (London) Ltd., 1987.
2. Van Vlack.L.H., "Materials Science for Engineers", Addison Wesley, 1985.
3. Raghavan.V., "Materials Science and Engineering", Prentice Hall of India, New Delhi, 1993.

SEMESTER	SUBJECT	L	T	P	C
VI	ENVIRONMENTAL SCIENCE AND ENGINEERING	3	0	0	3

AIM: The aim of the subject is to provide knowledge in environmental science and engineering.

OBJECTIVE: To create awareness on the various pollutions and their impact.

- To provide comprehensive insight in natural resources.
- To educate the ways and means to protect natural resources.
- To impart fundamental knowledge on human welfare measures.

OUTCOME: The students would be able to understand the human population and environment,environmental pollution.

UNIT - I - ENVIRONMENT AND NATURAL RESOURCES 9 hrs

Environment - Definition, scope & importance - Public awareness- Forest resources, mineral resources , water resources, food resources , energy resources (uses, over -exploitation & adverse effects in each case) - Scope & role of environmental engineers in conservation of natural resources - Sustainability development.

UNIT - II - ECOSYSTEMS AND BIO – DIVERSITY 9 hrs

Ecosystem - Definition, structure and function - Energy flow -Ecological succession - food chain, food web, ecological pyramids- Introduction, types, characteristics, structure and function of forest, grassland, desert and Aquatic ecosystems - Bio - Diversity :values and uses, hotspots, threats and conservation.

UNIT - III - ENVIRONMENTAL POLLUTION

Pollution - Definition , man made impacts and control measures of air, water and land pollution - Water quality standards & characterization - Importance of sanitation -Nuclear hazards – Hazardous waste management : Solid waste, waste water and biomedical waste - Prevention of pollution and role of individual – Disasters management : Floods, earthquake, cyclone and land slides - Clean technology options.

UNIT - IV - SOCIAL ISSUES AND ENVIRONMENT 9 hrs

Urban problems related to energy - Water conservation – Resettlement and rehabilitation of people - Environmental ethics - Climate change - Global warming - Acid rain - Ozone depletion-
Waste land reclamation, Environment Protection Act for air, water, wild life and forests - Pollution Control Board.

UNIT - V - HUMAN POPULATION AND ENVIRONMENT 9 hrs

Population growth - Population explosion - Family welfare programme - Environment & human health - Human rights – Value education - Women and child welfare, Role of information techno8logy in environment and human health.

Total: 45 hours

TEXT BOOKS :

1. Environmental Science and Engineering by Dr.A. Ravikrishnan, Sri Krishna Publications, Chennai.

REFERENCES :

1. Wager K.D. "Environmental Management", W.B. Saunders Co. Philadelphia, USA, 1998.
2. Bharucha Erach "The Biodiversity of India" Mapin Publishing Pvt Ltd, Ahmedabad, India
3. Trivedi R.K. " Handbook of Environmental Laws", Rules, Guidelines,Compliances and Standards Vol I & II, Enviro media.
4. Environmental Science and Engineering by Dr. J. Meenambal ,MJP Publication , Chennai Gilbert M. Masters : Introduction to Environmental Engineering and Science , Pearson Education PvtLtd., II Edition, ISBN 81-297-0277-0, 2004
5. Miller T.G. Jr Environmental Science Wadsworth Publishing Co.
6. Townsend C. Harper J. and Michael Begon, Essentials of Ecology,Blackwell Science.

SEMESTER	SUBJECT	L	T	P	C
VI	AIRCRAFT GENERAL ENGINEERING AND MAINTENANCE PRACTICES	3	0	0	3

AIM: The aim of the subject is to provide knowledge in aircraft general engineering and maintenance practices.

OBJECTIVES:

To teach the students about the basic concepts of aircraft general engineering andmaintenance practices.

OUTCOME:

- Knowledge of various ground support system for aircraft operations
- Ability to carryout ground servicing of critical aircraft systems
- Knowledge of specifications standards of aircraft hardware systems.

UNIT I AIRCRAFT GROUND HANDLING AND SUPPORT EQUIPMENT 10

Mooring, jacking, leveling and towing operations – Preparation – Equipment – precautions – Engine starting procedures – Piston engine, turboprops and turbojets – Engine fire extinguishing – Groundpower unit.

UNIT II GROUND SERVICING OF VARIOUS SUB SYSTEMS 8

Air conditioning and pressurization – Oxygen and oil systems – Ground units and their maintenance.

UNIT III MAINTENANCE OF SAFETY 5

Shop safety – Environmental cleanliness – Precautions

UNIT IV INSPECTION 10

Process – Purpose – Types – Inspection intervals – Techniques – Checklist – Special inspection – Publications, bulletins, various manuals – FAR Air worthiness directives – Type certificate Data sheets – ATA Specifications

UNIT V AIRCRAFT HARDWARE, MATERIALS, SYSTEM PROCESSES 12

Hand tools – Precision instruments – Special tools and equipments in an airplane maintenance shop– Identifiation terminology – Specification and correct use of various aircraft hardware (i.e. nuts, bolts,rivets, screws etc) – American and British systems of specifications – Threads, gears, bearings, etc –Drills, tapes and reamers – Identification of all types of fluid line fittings. Materials, metallic and non - metallic Plumbing connectors – Cables – Swaging procedures, tests, Advantages of swaging oversplicing.

TOTAL :45 PERIODS

TEXT BOOK

1. Kroes Watkins Delp, "Aircraft Maintenance and Repair", McGraw Hill, New York, 1993

REFERENCES

1. A&P Mechanics, "Aircraft Hand Book", FAA Himalayan Book House, New Delhi, 1996
2. A&P Mechanics," General Hand Book", FAA Himalayan Bok House, New Delhi, 1996

SEMESTER	SUBJECT	L	T	P	C
VI	**HEAT TRANSFER LAB** **(COMMON TO MECH AND AERO)**	**0**	**0**	**3**	**2**

AIM	The aim of the subject is to provide basic knowledge in heat transfer systems..
OBJECTIVE	To gain knowledge in various heat transmissions systems and modes viz, conduction, convection and radiation.
OUTCOME	The students would be able to understand the modes of heat transfer with hands on training.

1. To determine the thermal conductivity of a lagged pipe.
2. To determine the thermal conductivity of a solid by the guarded hot plate method.
3. To determine the heat transfer through composite wall apparatus.
4. To find the effectiveness of a pin fin in a rectangular duct under natural convective & forced convective condition and plot temperature distribution along its length.
5. To determine the surface heat transfer coefficient for a heated vertical tube under natural convection and plot the variation of local heat transfer coefficient along the length of the tube. Also compare the results with those of the correlation.
6. To determine average heat transfer coefficient for an externally heated horizontal pipe under forced convection & plot Reynolds and Nusselt numbers along the length of pipe. Also compare the results with those of the correlations.
7. To measure the emissivity of the gray body (plate) at different temperature and plot the variation of emissivity with surface temperature.
8. To find overall heat transfer coefficient and effectiveness of a heat exchange under parallel & counter flow conditions. Also plot the temperature distribution in both the cases along the length of heat of heat exchanger.
9. To verify the Stefan-Boltzmann constant for thermal radiation.
10. Study and demonstration of boiler.

SEMESTER	SUBJECT	L	T	P	C
VI	AIRFRAME LABORATORY	0	0	3	2

AIM: The aim of the subject is to provide basic knowledge in working with airframe..
OBJECTIVE: To give training on riveting, patchwork, welding and carpentry.
OUTCOME: The students would be able to work with the repairing of aircraft frames.

LIST OF EXPERIMENTS

1. Aircraft wood gluing-single & double scarf joints.
2. Welded single & double V-joints.
3. Fabric Patch repair.
4. Riveted patch repairs.
5. Tube bending and flaring.
6. Sheet metal forming.
7. Repair of composites.
8. Repair of Sandwich panels.
9. Preparation of glass epoxy of composite laminates and specimens.
10. Control cable inspection and repair.

TOTAL: 60 Periods

LIST OF EQUIPMENT
(for a batch of 30 students)

Sl.No.	Name of the Equipment	Quantity	Experiment No.
1	Shear cutter pedestal type	1	4,6
2	Drilling Machine	1	4,5,6
3	Bench Vices	1	1,5,6
4	Radius Bend bars	1	2,3
5	Pipe Flaring Tools	1	9
6	Carbide Gas Plant	1	4
7	MIG Weld Plant	1	3
8	TIG Weld Plant	1	2

SEMESTER	SUBJECT	L	T	P	C
VI	AIRCRAFT DESIGN PROJECT	0	0	3	2

AIM: The aim of the subject is to provide basic knowledge in aircraft design.
OBJECTIVE: To introduce and develop the basic concept of aircraft design.
OUTCOME: The students would be able to do the basic calculation on preliminary stage of aircraft design.

Each student is assigned with the design of an Airplane (or Helicopter or any other flight vehicle), for given preliminary specifications. The following are the assignments to be carried out:

LIST OF ASSIGNMENTS

1. Comparative configuration study of different types of airplanes
2. Comparative study on specification and performance details of aircraft
3. Preparation of comparative data sheets
4. Work sheet layout procedures
5. Comparative graphs preparation and selection of main parameters for the design
6. Preliminary weight estimations, selection of main parameters,
7. Power plant selection, aerofoil selection, wing tail and control surfaces
8. Preparation of layouts of balance diagram and three view drawings
9. Drag estimation
10. Detailed performance calculations and stability estimates

TOTAL: 60 Periods

LIST OF EQUIPMENTS

(for a batch of 30 students)

S.No.	Items	Quantity	Experiment No.
1.	Drawing Board	30	4 and 5
2.	Drawing Instrument	20	4 and 5

SEMESTER	SUBJECT	L	T	P	C
VII	COMPOSITE MATERIALS	3	0	0	3

AIM: To make the student understand the analysis of composite laminates under different loadingconditions and different environmental conditions.

OBJECTIVE:

- To know the types of composites.
- To understand the need for stress strain relation.
- To understand the fabrication methods.
- To understand the laminated plates.
- To study and understand the different methods & analysis of composite materials.

OUTCOME: The students would be able to understand the various types of composites used in the manufacturing of aircrafts.

UNIT I MICROMECHANICS **10**

Introduction - advantages and application of composite materials – types of reinforcements andmatrices - micro mechanics – mechanics of materials approach, elasticity approach- boundingtechniques – fiber volume ratio – mass fraction – density of composites, effect of voids in composites.

UNIT II MACROMECHANICS **10**

Generalized Hooke's Law - elastic constants for anisotropic, orthotropic and isotropic materials -macro mechanics – stress-strain relations with respect to natural axis, arbitrary axis – determination ofin plane strengths of a lamina - experimental characterization of lamina, failure theories of a lamina, hygrothermal effects on lamina.

UNIT III LAMINATED PLATE THEORY **10**

Governing differential equation for a laminate, stress – strain relations for alaminate, different types of Laminates, in plane and flexural constants of a laminate, hygrothermal stresses and strains in alaminate, failure analysis of a laminate, impact resistance and interlaminar stresses, netting analysis.

UNIT IV FABRICATION PROCESS AND REPAIR METHODS **8**

Various open and closed mould processes, manufacture of fibers, importance of repair and differenttypes of repair techniques in composites – autoclave and non-autoclave methods.

UNIT V SANDWICH CONSTRUCTIONS **7**

Basic design concepts of sandwich construction - materials used for sandwich construction – failuremodes of sandwich panels - bending stress and shear flow in composite beams.

TOTAL: 45 Periods

TEXT BOOKS:

1. Dam Ishai., "Mechanics of Composite Materials,"
2. Autar K Kaw, 'Mechanics of Composite Materials', CRC Press, 1997.
3. MadhujiMukhopadhyay, Mechanics of Composite Materials and Structures, University Press, 2004

REFERENCES:

1. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites," John Wileyand sons. Inc., New York, 1995.
2. Lubin, G., "Handbook on Advanced Plastics and Fibre Glass", Von Nostrand Reinhold Co., NewYork, 1989.
3. Calcote, L R. "The Analysis of laminated Composite Structures", Von – Nostrand ReinholdCompany, New York 1998.
4. Allen Baker, "Composite Materials for Aircraft Structures", AIAA Series, II Edition, 1999.

SEMESTER	SUBJECT	L	T	P	C
VII	FINITE ELEMENT ANALYSIS (Common to Mech. and Aero)	3	1	0	4

AIM	The aim of the subject is to provide knowledge in finite element analysis.
OBJECTIVE	1. To understand the basics of Finite element techniques and 1D element equation formulation 2. To gain knowledge about 2D problems in structural and Thermal 3. To enable student to learn about Natural coordinates and Iso-Parametric Elements 4. To understand about Elasticity concepts and Virtual work 5. To study about dynamic analysis
OUTCOME	The students would be able to understand the basic concepts in mathematical problem analysis.

UNIT I 1D FINIT EELEMENT ANALYSIS 12

Historical Background – Weighted Residual Methods – Basic Concepts of FEM – Variational Formulation of B.V.P – Ritz Method – Finite Element Modeling – Element Equations – Linear and Quadratic Shape functions -Bar, Beam Elements – Applications to Heat Transfer.

UNIT II FEA OF 2D PROBLEMS 12

Basic Boundary Value Problems in 2 Dimensions – Triangular, quadrilateral, higher order elements – Poissons and Laplace Equations – Weak Formulation – Elements Matrices and Vectors – Application to Solid mechanics, Heat transfer, Fluid Mechanics.

UNIT III ISOPARAMETRIC FORMULATION 12

Natural Co-ordinate System – Lagrangian Interpolation Polynomials – Iso-parametric Elements – Formulation – Numerical Integration – 1D -2D Triangular elements – rectangular elements – Illustrative Examples.

UNIT IV SOLUTION TOPLANE ELASTICITY PROBLEMS 12

Introduction to Theory of Elasticity – Plane Stress – Plane Strain and Axisymmetric Formulation – Principle of virtual work – Element matrices using energy approach

UNI TV DYNAMIC ANALYSIS 12

Dynamic Analysis – Equation of Motion – Mass Matrices – Free Vibration analysis – Natural frequencies of Longitudinal – Transverse and torsional vibration – Introduction to transient field problems. Non linear analysis.Use of software – h & p elements – special element formulation.

TUTORIAL HOURS :15 TOTAL HOURS :60

Text Books:

1. Chandrupatla&Belagundu, “Finite Elements in Engineering”, Prentice Hall of India Private Ltd., 1997.
2. Rao S.S., “Finite Element Method in Engineering” , Pergamon Press, 1989

REFERENCE BOOKS:

1. Reddy J.N. “An Introduction to the Finite Element Method”, McGraw Hill, International Edition, 1993.
2. Segerlind L.J., “Applied Finite Element Analysis”, John Wiley, 1984.

SEMESTER	SUBJECT	L	T	P	C
VII	AVIONICS	3	0	0	3

AIM: The aim of the subject is to provide knowledge inaircrafts avionics.

OBJECTIVE:

- To familiarize with Importance and role of avionics.
- To familiarize with modern data buses.
- To familiarize with navigation and global positioning systems.
- To familiarize with flight control systems.
- To familiarize with various display systems.

OUTCOME: The students would be able to understand the basic concept on the various electronic equipment's on aircraft.

UNIT I INTRODUCTION TO AVIONICS 9

Need for avionics in civil and military aircraft and space systems – integrated avionics and weaponsystems – typical avionics subsystems, design, technologies – Introduction to digital computer andmemories.

UNIT II DIGITAL AVIONICS ARCHITECTURE 9

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

UNIT III FLIGHT DECKS AND COCKPITS 9

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

UNIT IV INTRODUCTION TO NAVIGATION SYSTEMS 9

Radio navigation – ADF, DME, VOR, LORAN, DECCA, OMEGA, ILS, MLS – Inertial NavigationSystems (INS) – Inertial sensors, INS block diagram – Satellite navigation systems – GPS.

UNIT V AIR DATA SYSTEMS AND AUTO PILOT 9

Air data quantities – Altitude, Air speed, Vertical speed, Mach Number, Total air temperature, Machwarning, Altitude warning – Auto pilot – Basic principles, Longitudinal and lateral auto pilot.

TOTAL= 45 PERIODS

TEXTBOOKS:

1. Albert Helfrick. D, 'Principles of Avionics', Avionics communications Inc., 2004
2. Collinson, R.P.G, 'Introduction to Avionics', Chapman and Hall, 1996.

REFERENCES:

1. Middleton, D.H, 'Avionics Systems', Longman Scientific and Technical, Longman Group UK Ltd, England, 1989.
2. Spitzer, C.R. 'Digital Avionics Systems', Prentice Hall, Englewood Cliffs, N.J., USA1993.
3. Spitzer, C.R, 'The Avionics Handbook', CRC Press, 2000.
4. Pallet, E.H.J, 'Aircraft Instruments and Integrated Systems', Longman Scientific, 1992

SEMESTER	SUBJECT	L	T	P	C
VII	WIND TUNNEL TECHNIQUES	3	0	0	3

AIM: The students would be able to understand the basic concepts inwind tunnel techniques.

OBJECTIVES:

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

OUTCOME: The students would be able to understand the basic concepts in Wind tunnel and the basic balancing And smock generation methods on wind tunnel.

UNIT I PRINCIPLES OF MODEL TESTING 6

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

UNIT II TYPES AND FUNCTIONS OF WIND TUNNELS 6

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

UNIT III CALIBRATION OF WIND TUNNELS 9

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

UNIT IV CONVENTIONAL MEASUREMENT TECHNIQUES 12

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

UNIT V SPECIAL WIND TUNNEL TECHNIQUES 12

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

TOTAL: 45 PERIODS

TEXT BOOKS:

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

REFERENCES:

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

SEMESTER	SUBJECT	L	T	P	C
VII	FINITE ELEMENT ANALYSIS LAB	0	0	3	2

AIM	The aim of the subject is to provide hands on experience in finite element analysis software
OBJECTIVE	To gain knowledge in various procedures in drafting and analysing a component using FEA software.
OUTCOME	The students would be able to understand and analyse any component using software.

LIST OF EXPERIMENTS

1. Study of analysis and its benefits
2. Application of distributed loads
3. Nonlinear analysis of a cantilever beam
4. Buckling analysis
5. Stress analysis of cantilever beam
6. Stress analysis of axi-symmetry vessels
7. Stress analysis of two dimensional truss
8. Transient thermal conduction
9. Simple conduction
10. Plane stress bracket
11. Modal analysis of a cantilever beam
12. Harmonic analysis of a cantilever beam

LIST OF EQUIPMENT (for a batch of 30 students)

Sl.No	Equipments	Quantity	Experiments No.
1	PC WITH ANSYS LOADED	30	1 - 10

SEMESTER	SUBJECT	L	T	P	C
VII	COMPUTER AIDED DESIGN AND DRAFTING LABORATORY	0	0	3	2

AIM: To introduce the concept of design of basic structural components and to draft bothmanually and using modelling package.

OBJECTIVE:

- The Subject should enable the student to:
- Understand the design of riveted joints (Lap joint), learn the advantages and disadvantages.
- Understand the design of riveted joints (Butt joint); learn the advantages and disadvantages and types of riveted joints.
- Understand the design of the welded joint.
- Understand Layout of typical wing Structure.
- Understand Layout of typical fuselage structure.
- Understand the Computer aided modelling of typical aircraft wing.
- Understand the Computer aided modelling of typical fuselage structure.
- Understand the Computer aided modelling of landing gear.
- Understand the design of three view diagram of a typical aircraft.
- Understand the concepts and design of control system.

OUTCOME: The students would be able to understand and Design various components using software.

LIST OF EXERCISES

1. Design of riveted joints (Lap joint).
2. Design of riveted joints (Butt joint with single and double straps).
3. Design of welded joints.
4. Layout of typical wing structure.
5. Layout of typical fuselage structure.
6. Computer aided modeling of typical aircraft wing.
7. Computer aided modeling of typical fuselage structure.
8. Computer aided modeling of landing gear
9. Three view diagram of a typical aircraft
10. Layout of control systems

TOTAL: 45 Periods

LIST OF EQUIPMENT (for a batch of 30 students)

Sl.No	Equipments	Quantity	Experiments No.
1	Drawing Boards, Drafting machines	30	1- 5, 9,10
2	Computer and modeling software	Pentium IV PC's, - 30 Nos. License of Software – 30	6-8

SEMESTER	SUBJECT	L	T	P	C
VII	MINI PROJECT	0	0	3	2

AIM: To develop a mini project related to aeronautical stream.
OBJECTIVE:

- The objective of the mini project work is to enable the students to form the groups of not more than 4 members on a project involving the activity based learning concept and to design a model / mechanism related to the branch of study.

- Formation of Group as follows
  - Category A : 8.5CGPA and above
  - Category B : 7 to 8.49 CGPA
  - Category C : 5 to 6.9 CGPA

  A group will be formed with atleast one student from each category.

- Every mini project work shall have a guide who is the member of the faculty of the institution. Three periods per week shall be allotted in the time table and this time shall be utilized by the students to receive the directions from the guide, on library reading, laboratory work, computer analysis or field work as assigned by the guide and also to present in periodical seminars on the progress made in the mini project.

OUTCOME: The students would be able to produce their own aero models**.**

SEMESTER	SUBJECT	L	T	P	C
VIII	ELECTIVE - V	3	0	0	3

SEMESTER	SUBJECT	L	T	P	C
VIII	ELECTIVE - VI	3	0	0	3

SEMESTER	SUBJECT	L	T	P	C
VIII	ELECTIVE - VII	3	0	0	3

SEMESTER	SUBJECT	L	T	P	C
VIII	PROJECT WORK AND VIVA - VOCE	0	0	8	6

Students in a group of two or three will be assigned a project involving – design – fabrication - theoretical studies - experimental studies on some problem related to Aerospace Engineering. Continuous internal assessment marks for the project will be given during project review meetings. The student has to prepare and present a detailed project report at the end of the semester and give a talk about the work done. End semester examination marks will be based on viva voce examination.

LIST OF ELECTIVES

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	THEORY OF ELASTICITY	3	0	0	3

UNIT I ASSUMPTIONS IN ELASTICITY 5

Definitions- notations and sign conventions for stress and strain, Equations of equilibrium.

UNIT II BASIC EQUATIONS OF ELASTICITY 12

Strain – displacement relations, Stress – strain relations, Lame's constant – cubical dilation, Compressibility of material, bulk modulus, Shear modulus, Compatibility equations for stresses and strains, Principal stresses and principal strains, Mohr's circle, Saint Venant's principle.

UNIT III PLANE STRESS AND PLANE STRAIN PROBLEMS 8

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

UNIT IV POLAR COORDINATES 10

Equations of equilibrium, Strain displacement relations, Stress – strain relations, Axi – symmetric problems, Kirsch, Michell's and Boussinesque problems.

UNIT V TORSION 10

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

TOTAL: 45 Periods

TEXT BOOK

1. Timoshenko, S., and Goodier, T.N., "Theory of Elasticity", McGraw–Hill Ltd., Tokyo, 1990.

REFERENCES

1. Enrico Volterra& J.H. Caines, "Advanced Strength of Materials", Prentice Hall New Jersey, 1991.
2. Wng, C.T., "Applied Elasticity", McGraw–Hill Co., New York, 1993.
3. Sokolnikoff, I.S., "Mathematical Theory of Elasticity", McGraw–Hill New York, 1978.

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	SPACE MECHANICS	3	0	0	3

Aim: To study the basic concepts of orbital Mechanics with particular emphasis on interplanetary trajectories.

UNIT I BASIC CONCEPTS 4

The Solar System – References Frames and Coordinate Systems – The Celestial Sphere – The Ecliptic – Motion of Vernal Equinox – Sidereal Time – Solar Time – Standard Time – The Earth's Atmosphere.

UNIT II THE GENERAL N-BODY PROBLEM 10

The many body Problem – Lagrange – Jacobian Identity –The Circular Restricted Three Body Problem – Libration Points- Relative Motion in the N-body Problem –Two –Body Problem – Satellite Orbits – Relations Between Position and Time – Orbital Elements.

UNIT III SATELLITE INJECTION AND SATELLITE ORBIT PERTURBATIONS 12

General Aspects of satellite Injections – Satellite Orbit Transfer –Various Cases – Orbit Deviations Due to Injection Errors – Special and General Perturbations – Cowell's Method – Encke's Method – Method of vibrations of Orbital Elements – General Perturbations Approach.

UNIT IV INTERPLANETARY TRAJECTORIES 6

Two Dimensional Interplanetary Trajectories –Fast Interplanetary Trajectories – Three Dimensional Interplanetary Trajectories – Launch if Interplanetary Spacecraft –Trajectory about the Target Planet.

UNIT V BALLISTIC MISSILE TRAJECTORIES AND MATERIALS 13

The Boost Phase – The Ballistic Phase –Trajectory Geometry- Optimal Flights – Time of Flight – Re – entry Phase – The Position of the Impact Point – Influence Coefficients. Space Environment – Peculiarities – Effect of Space Environment on the Selection of Spacecraft Material.

TOTAL :45 Periods

TEXT BOOK

1. Cornelisse, J.W., "Rocket Propulsion and Space Dynamics", W.H. Freeman & Co., 1984.

REFERENCES

1. Sutton, G.P., "Rocket Propulsion Elements", John Wiley, 1993.
2. Van de Kamp, P., "Elements of Astromechanics", Pitman, 1979.
3. Parker E.R., "Materials for Missiles and Spacecraft", McGraw-Hill Book Co. Inc., 1982.

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	VIBRATION AND AEROELASTICITY	3	0	0	3

AIM: To study the dynamic behaviour of different aircraft components and the interaction among the aerodynamic, elastic and inertia forces.

UNIT I BASIC MOTIONS 8

Simple harmonic motion – Terminologies – Newton's Law – D' Alembert's principle – Energy Methods

UNIT II SINGLE DEGREE OF FREEDOM SYSTEMS 12

Free vibrations – Damped vibrations – Forced Vibrations, with and without damping – support excitation – Vibration measuring instruments.

UNIT III MULTI DEGREES OF FREEDOM SYSTEMS 10

Two degrees of freedom systems – Static and Dynamic couplings vibration absorber- Principal co-ordinates, Principal modes and orthogonal condition – Eigen value problems.Hamilton's principle-Lagrangean equation and application – Vibration of elastic bodies- Vibration of strings- Longitudinal, Lateral and Torsional vibrations.

UNIT IV APPROXIMATE METHODS 5

Rayleigh's and Holzer Methods to find natural frequencies.

UNIT V ELEMENTS OF AEROELASTICITY 10

Concepts – Coupling – Aero elastic instabilities and their prevention – Basic ideas on wing divergence, loss and reversal of aileron control – Flutter and its prevention.

TOTAL : 45 Periods

TEXT BOOKS

1. TIMOSHENKO S., "Vibration Problems in Engineering"– John Wiley and Sons, New York, 1993.
2. FUNG Y.C., "An Introduction to the Theory of Aeroelasticity" – John Wiley & Sons, New York, 1995.

REFERENCES

1. BISPLINGHOFF R.L., ASHELY H and HOGMAN R.L., "Aeroelasticity" – Addision Wesley Publication, New York, 1983.
2. TSE. F.S., MORSE, I.F., HUNKLE, R.T., "Mechanical Vibrations", – Prentice Hall, New York, 1984.
3. SCANLAN R.H. & ROSENBAUM R., "Introduction to the study of Aircraft Vibration & Flutter", John Wiley and Sons. New York, 1982.

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	AIRFRAME MAINTENANCE AND REPAIR	3	0	0	3

AIM: To study the maintenance aspect of airframe systems and rectification of snags.

UNIT I WELDING IN AIRCRAFT STRUCTURAL COMPONENTS 10

Equipments used in welding shop and their maintenance – Ensuring quality welds – Welding jigs and fixtures – Soldering and brazing - 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 II PLASTICS AND COMPOSITES IN AIRCRAFT 10

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

UNIT III AIRCRAFT JACKING, ASSEMBLY AND RIGGING 8

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

UNIT IV REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM 10

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

UNIT V SAFETY PRACTICES 7

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

TOTAL : 45 Periods

TEXT BOOK

1. KROES, WATKINS, DELP, “Aircraft Maintenance and Repair”, McGraw-Hill, New York, 1992.

REFERENCES

1. LARRY REITHMEIR, “Aircraft Repair Manual”, Palamar Books, Marquette, 1992.
2. BRIMM D.J. BOGGES H.E., “Aircraft Maintenance”, Pitman Publishing corp. New York, 1940

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	THEORY OF PLATES AND SHELLS	3	0	0	3

OBJECTIVE

To study the behaviour of the plates and shells with different geometry under various types of loads.

UNIT I CLASSICAL PLATE THEORY 3

Classical Plate Theory – Assumptions – Differential Equation – Boundary Conditions.

UNIT II PLATES OF VARIOUS SHADES 15

Navier's Method of Solution for Simply Supported Rectangular Plates – Leavy's Method of Solution for Rectangular Plates under Different Boundary Conditions. Governing Equation – Solution for Axi-symmetric loading – Annular Plates – Plates of other shapes.

UNIT III EIGEN VALUE ANALYSIS 8

Stability and free Vibration Analysis of Rectangular Plates.

UNIT IV APPROXIMATE METHODS 10

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

UNIT V SHELLS 9

Basic Concepts of Shell Type of Structures – Membrane and Bending Theories for Circular Cylindrical Shells.

TOTAL : 45 Periods

TEXT BOOK

1. Timoshenko, S.P. Winowsky. S., and Kreger, "Theory of Plates and Shells", McGraw-Hill Book Co. 1990.

REFERENCES

1. Flugge, W. "Stresses in Shells", Springer – Verlag, 1985.
2. Timoshenko, S.P. and Gere, J.M., "Theory of Elastic Stability", McGraw-Hill Book Co. 1986.

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	COMBUSTION ENGINEERING (COMMON TO MECH AND AERO)	3	0	0	3

Objectives:

1. To know about the combustion process.
2. To explain about the thermo chemistry.
3. To explain about the kinetics of combustion.
4. To explain about various flames.
5. To know the combustion process in an engine.

UNIT I COMBUSTION OF FUELS 9

Combustion equations- Theoretical air- excess air- air fuel ratio- equivalence ratio- exhaust gas composition- Air- fuel ratio from exhaust gas composition- heating value of fuels.

UNIT II THERMODYNAMICS OF COMBUSTION 9

Thermo-chemistry- First law analysis of reacting systems- Adiabatic combustion temperature- Second law analysis of reacting systems- criterion for chemical equilibrium- Equilibrium constant for gaseous mixtures- Evaluation of equilibrium composition- chemical availability.

UNIT III KINETICS OF COMBUSTION 9

Rates of reaction- Reaction order and molecularity complex reactions- chain reactions- Arrhenius rate equation- Collection theory- activated complex theory- Explosive and general oxidative characteristics of fueled.

UNIT IV FLAMES 9

Laminar and Turbulent flames- Premixed and Diffusion flames- Burning velocity and its determination- Factors affecting burning velocity- Quenching- Flammability and Ignition- Flame stabilization in open burners.

UNIT V ENGINE COMBUSTION 9

Combustion in SI and CI engines- stages of combustion in SI and CI engines- Normal combustion and abnormal combustion- Emissions from premixed combustion- Emission from Non-premixed combustion- Control of emissions

TOTAL HOURS : 45

TEXT BOOK:

1. Stephen R.Turns-"An Introduction to Combustion"-McGraw Hill, 1996.

REFERENCES:

1. Irwin Glassman- “Combustion "- Third Edition- Academic Press, 1996.
2. S.P. Sharma and Chandra Mohan- “Fuels and Combustion "- Tata McGraw Hill Book Co. - 1984.
3. Samir Sarkar- “Fuels and Combustion "- Orient Longman- 1984.
4. K.K.Kuo- “Principles of Combustion "- John Wiley & Sons- 1984.
5. J.B. Heywood- “Internal Combustion Engine Fundamentals "- MccGraw Hill Book Co. -1988

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	AIR TRANSPORTAION AND AIRCRAFT MAINTENANCEMANAGEMENT	3	0	0	3

AIM: To study the concepts of air transportation and the maintenance management of aircraft.

UNIT I INTRODUCTION 8

Development of air transportation, comparison with other modes of transport – Role of IATA, ICAO – The general aviation industry airline – Factors affecting general aviation, use of aircraft, airport: airline management and organisation – levels of management, functions of management, Principles of organisation planning the organisation – chart, staff departments & line departments.

UNIT II AIRLINE ECONOMICS 10

Forecasting – Fleet size, Fleet planning, the aircraft selection process, operating cost, passenger capacity, load factor etc. – Passenger fare and tariffs – Influence of geographical, economic & political factors on routes and route selection.Fleet Planning- The aircraft selection process – Fleet commonality, factors affecting choice of fleet, route selection and Capitol acquisition – Valuation & Depreciation – Budgeting, Cost planning – Aircrew evaluation – Route analysis – Aircraft evaluation.

UNITIII PRINCIPLES OF AIRLINES SCHEDULING 10

Equipment maintenance, Flight operations and crew scheduling, Ground operations and facility limitations, equipments and types of schedule – hub & spoke scheduling, advantages / disadvantages & preparing flight plans – Aircraft scheduling in line with aircraft maintenance practices.

UNIT IV AIRCRAFT RELIABILITY 9

Aircraft reliability – The maintenance schedule & its determinations – Condition monitoring maintenance – Extended range operations (EROPS) & ETOPS – Ageing aircraft maintenance production.

UNIT V TECHNOLOGY IN AIRCRAFT MAINTENANCE 8

Airlines scheduling (with reference to engineering) – Product support and spares – Maintenance sharing – Equipments and tools for aircraft maintenance – Aircraft weight control – Budgetary control.On board maintenance systems – Engine monitoring – Turbine engine oil maintenance – Turbine engine vibration monitoring in aircraft – Life usage monitoring – Current capabilities of NDT – Helicopter maintenance – Future of aircraft maintenance.

TOTAL : 45 Periods

TEXT BOOKS

1. FEDRIC J.H., “Airport Management”, 2000.
2. C.H. FRIEND, “Aircraft Maintenance Management”, 2000.

REFERENCES

1. GENE KROPF, “Airline Procedures”.
2. WILSON & BRYON, “Air Transportation”.
3. PHILIP LOCKLIN D, “Economics of Transportation”.
4. “Indian Aircraft manual” – DGCA Pub.
5. ALEXANDER T WELLS, “Air Transportation”, Wadsworth Publishing Company, California, 1993.

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	HELICOPTER MAINTENANCE	3	0	0	3

OBJECTIVE

To study the procedure adopted for the maintenance of helicopter.

UNIT I FUNDAMENTALS OF A HELICOPTER 5

Basic directions – Ground handling, bearing – Gears.

UNIT II MAIN ROTOR SYSTEM 9

Head maintenance – blade alignment – Static main rotor balance – Vibration – Tracking – Span wise dynamic balance – Blade sweeping –Electronic balancing – Dampener maintenance – Counter weight adjustment – Auto rotation adjustments – Mast & Flight Control Rotor - Mast – Stabilizer, dampeners – Swash plate flight control systems collective – Cyclic – Push pull tubes – Torque tubes – Bell cranks – Mixer box – Gradient unit control boosts – Maintenance & Inspection control rigging.

UNIT III MAIN ROTOR TRANSMISSIONS 12

Engine transmission coupling – Drive shaft – Maintenance clutch – Free wheeling units – Spray clutch – Roller unit – Torque meter – Rotor brake – Maintenance of these components – vibrations – Mounting systems – Transmissions.

UNIT IV POWER PLANTS & TAIL ROTORS 12

Fixed wing power plant modifications – Installation – Different types of power plant maintenance.
Tail rotor system – Servicing tail rotor track – System rigging.

UNIT V AIRFRAMES AND RELATED SYSTEMS 7

Fuselage maintenance – Airframe Systems – Special purpose equipment.

TOTAL : 45 Periods

TEXT BOOK

1. JEPPESEN, “Helicopter Maintenance”, Jeppesons and Sons Inc., 2000.

REFERENCES

1. “Civil Aircraft Inspection Procedures”, Part I and II, CAA, English Book House, New Delhi, 1986.
2. LARRY REITHMIER, “Aircraft Repair Manual”, Palamar Books Marquette, 1992.

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	AIR TRAFFIC CONTROL AND AERODROME DESIGN	3	0	0	3

AIM: To study the procedure of the formation of aerodrome and its design and air traffic control.

UNIT I BASIC CONCEPTS 9

Objectives of ATS - Parts of ATC service – Scope and Provision of ATCs – VFR & IFR operations – Classification of ATS air spaces – Varies kinds of separation – Altimeter setting procedures – Establishment, designation and identification of units providing ATS – Division of responsibility of control.

UNIT II AIR TRAFFIC SERVICES 9

Area control service, assignment of cruising levels minimum flight altitude ATS routes and significant points – RNAV and RNP – Vertical, lateral and longitudinal separations based on time / distance –ATC clearances – Flight plans – position report

UNIT III FLIGHT INFORMATION ALERTING SERVICES, COORDINATION, EMERGENCY PROCEDURES AND RULES OF THE AIR 10

Radar service, Basic radar terminology – Identification procedures using primary / secondary radar – performance checks – use of radar in area and approach control services – assurance control and co-ordination between radar / non radar control – emergencies – Flight information and advisory service – Alerting service – Co-ordination and emergency procedures – Rules of the air.

UNIT IV AERODROME DATA, PHYSICAL CHARACTERISTICS AND OBSTACLE RESTRICTION 9

Aerodrome data - Basic terminology – Aerodrome reference code – Aerodrome reference point – Aerodrome elevation – Aerodrome reference temperature – Instrument runway, physical Characteristics; length of primary / secondary runway – Width of runways – Minimum distance between parallel runways etc. – obstacles restriction.

UNIT V VISUAL AIDS FOR NAVIGATION, VISUAL AIDS FOR DENOTING OBSTACLES EMERGENCY AND OTHER SERVICES 8

Visual aids for navigation Wind direction indicator – Landing direction indicator – Location and characteristics of signal area – Markings, general requirements – Various markings – Lights, general requirements – Aerodrome beacon, identification beacon – Simple approach lighting system and various lighting systems – VASI & PAPI - Visual aids for denoting obstacles; object to be marked and lighter – Emergency and other services.

TOTAL : 45 Periods

TEXT BOOK

1. AIP (India) Vol. I & II, “The English Book Store”, 17-1, Connaught Circus, New Delhi.

REFERENCES

1. “Aircraft Manual (India) Volume I”, latest Edition – The English Book Store, 17-1, Connaught Circus, New Delhi.
2. “PANS – RAC – ICAO DOC 4444”, Latest Edition, The English Book Store, 17-1, Connaught Circus, New Delhi.

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	AIRCRAFT DESIGN	3	0	0	3

UNIT I REVIEW OF DEVELOPMENTS IN AVIATION 9

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

UNIT II POWER PLANT TYPES AND CHARACTERISTICS 9

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

UNIT III PRELIMINARY DESIGN 9

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

UNIT IV SPECIAL PROBLEMS 9

Layout peculiarities of subsonic and supersonic aircraft – optimisation of wing loading to achieve desiredPerformance – loads on undercarriages and design requirements.

UNIT V STRUCTURAL DESIGNS 9

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

TOTAL : 45 Periods

TEXT BOOKS

1. D.P. Raymer, “Aircraft Conceptual design”, AIAA Series, 1988.
2. G. Corning, “Supersonic & Subsonic Airplane Design”, II Edition, Edwards Brothers Inc., Michigan, 1953.
3. E.F. Bruhn, “Analysis and Design of Flight Vehicle Structures”, Tristate Offset Co., U.S.A., 1980.

REFERENCES

1. E. Torenbeek, “Synthesis of Subsonic Airplane Design”, Delft University Press, London, 1976.
2. H.N.Kota, Integrated design approach to Design fly by wire” Lecture notes Interline Pub. Bangalore, 1992.
3. A.A. Lebedenski, “Notes on airplane design”, Part-I, I.I.Sc., Bangalore

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	UNMANNED AIRCRAFT SYSTEMS	3	0	0	3

UNIT I INTRODUCTION TO UAS 9

History of unmanned aerial vehicles- types- Introduction to Unmanned aircraft systems-Unmanned aerial vehicles –Micro aerial vehicles definitions, history, classification- applications-recent research and development in civil and defense applications – autonomous vehicles -future research in autonomous vehicles – design standards and regulatory aspects introduction to design and selection of systems

UNIT II ASPECTS OF UAS SYSTEMS 9

Involvement of different aspects in the development of UAV-aerodynamic configurations -Aspects of airframe design- Stealth design, payload types, communication, navigations & guidance systems, control & stability, launch, recovery and support systems, reliability design

UNIT III MODELING AND CONTROL HELICOPTER MODEL 9

Modeling and control of small and miniature unmanned helicopters –single rotor helicopter design – coaxial rotor helicopter design - autonomous control of a mini quadrotor vehicle using LQG controllers – linearization and identification of helicopter model

UNIT IV UAV DESIGN MODELING & CONTROL 9

Development of autonomous quad tilt wing – advanced flight control systems for rotorcraft UAV and MAV – mathematical modeling and non- linear control of VTOL aerial vehicles

UNIT V DEPLOYMENT OF UAS/UAV SYSTEMS 9

Only application point of view of various UAS roles played in civil, defense applications -vision based navigation company trails- certification of UAS/UAV/MAV systems

TOTAL : 45 Periods

REFERENCES:

1. Reg Austin, Unmanned Aircraft Systems: UAVS Design, Development and Deployment John Wiley, UK,2010
2. KenzoNonami, FaridKendoul, Satoshi Suzuki, Wei Wang, Daisuke Nakazawa, Modeling and Control of Unmanned Small Scale Rotorcraft Uavs& Mavs, Springer, New York, 2010
3. Laurence R. Newcome, Unmanned aviation: a brief history of unmanned aerial vehicles, American Institute of Aeronautics and Astronautics, New York, 2004
4. KimonValavanis, Advances in unmanned aerial vehicles, Springer, Netherlands, 2007
5. Elizabeth Bone, Christopher Bolkcom, Unmanned aerial vehicles, Novinka Books, United Kingdom 2004
6. Rogelio Lozano, Unmanned Aerial Vehicles Embedded Control, John Wiley & Sons, 2010
7. Pedro Castillo, Rogelio Lozano, Alejandro E. Dzul, Modelling and control of mini-flying machines, Advances in industrial control (AIC), Springer-Verlag, London,2005
8. Bernard Mettler, Identification modeling and characteristics of miniature rotorcraft, Kluwer Publishers, USA, 2003.

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	CRYOGENICENGINEERING (COMMON TO MECH AND AERO)	3	0	0	3

Objectives:

1. To introduce the importance of cryogenic engineering.
2. To study the low temperature refrigeration system.
3. To study the gas separation systems.
4. To know the vacuum technology.
5. To understand about cryogenic storage.

UNIT 1 CONSTRUCTION DETAILS AND HEAT TRANSFER 9

Introduction to Cryogenic Systems Low Temperature properties of Engineering Materials.Cryogenic fluids and their properties. Applications in space- Food Processing- super Conductivity- Electrical Power- Biologyedicine- Electronics and Cutting Tool Industry.

UNIT II LIQUEFACTION AND LOW TEMPERATURE REFRIGERATION 9

Liquefaction systems ideal system- Joule Thomson expansion- Adiabatic expansion- LindeHampson a Cycle- Claude & Cascaded System- Magnetic Cooling- Stirling Cycle Cryo Coolers.

UNIT 1II SEPARATION AND PURIFICATION SYSTEMS 9

General characteristics of mixtures-composition diagrams.Gas separation-principles of rectification-flash calculations - Rectification column analysis- Flash calculations.

UNIT IV INSULATION AND VACUUM TECHNOLOGY 9

Thermal insulation and their performance at cryogenic temperatures- Super Insulations- Vacuum insulation- Powder insulation- Cryo pumping Applications.

UNIT V STORAGE AND INSTRUMENTATION 9

Cryogenic Storage vessels and Transportation- Transfer devices.Pressure flow-level and temperature measurements.

TOTAL HOURS :45

TEXT BOOK:

1. Klaus D.Timmerhaus and Thomas M.Flynn- “Cryogenic Process Engineering “Plenum Press-New York- 1989.

REFERENCES:

1. Randal Barron- “Cryogenic Systems "- McGrawHill- 1986.
2. R.B.Scoott- “Cryogenic engineering "- Van Nostrand Company Inc. - 1985.
3. J.H.Bell- “Cryogenic Engineering "- Prentice Hall Inc. - 1963.

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	COMPUTATIONAL FLUID DYNAMICS (COMMON TO MECH AND AERO)	3	0	0	3

Objectives:

1. To understand the basics of governing equations and boundary conditions
2. To gain knowledge about finite difference method
3. To enable student to learn about FVM – Diffusion.
4. To inherit knowledge about FVM-Convection diffusion.
5. To elaborate about FVM flow field calculation

UNIT I GOVERNING EQUATIONS AND BOUNDARY CONDITIONS 9

Basics of computational fluid dynamics – Governing equations of fluid dynamics –continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behavior of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

UNIT II FINITE DIFFERENCE METHOD 9

Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – solution methods for finite difference equations – Elliptic equations – Iterative solution Methods – Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations.

UNIT III FINITE VOLUME METHOD (FVM) FOR DIFFUSION 9

Finite volume formulation for steady state One, Two and Three -dimensional diffusion problems.One dimensional unsteady heat conduction through Explicit, Crank – Nicolson and fully implicit schemes.

UNIT IV FINITE VOLUME METHOD FOR CONVECTION DIFFUSION 9

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes-properties of discretization schemes – Conservativeness, Boundedness, Trasnportiveness, Hybrid, Power-law, QUICK Schemes.

UNIT V CALCULATION FLOW FIELD BY FVM 9

Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, simple algorithm and its variants. Turbulence models, mixing length model, two equation (k-Є) models – High and low Reynolds number models

TOTAL HOURS :45

TEXT BOOKS:

1. T.J. Chung, Computational Fluid Dynamics, CambridgeUniversity, Press, 2002.
2. Versteeg, H.K., and Malalasekera, W., An Introduction to Computational Fluid Dynamics: The finite volume Method, Longman, 1998.
3. Ghoshdastidar , P.S., Computer Simulation of flow and heat transfer, Tata McGraw

REFERENCES:

1. Patankar, S.V. Numerical Heat Transfer and Fluid Flow, Hemisphere Publishing Corporation, 2004.
2. Muralidhar, K., and Sundararajan, T., computational Fluid Flow and Heat Transfer, Narosa Publishing House, New Delhi, 1995.
3. Ghoshdastidar P.S., Heat Transfer, Oxford University Press, 2005.
4. ProdipNiyogi, Chakrabarty .S.K., Laha .M.K. Introduction to Computational Fluid Dynamics, Pearson Education, 2005.
5. Introduction to Computational Fluid Dynamics Anil W. DateCambridgeUniversity Press, 2005.

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	HYPERSONIC AERODYNAMICS	3	0	0	3

AIM : To introduce fundamental concepts and features peculiar to hypersonic flow to students tofamiliarize them with the aerodynamics aspects of hypersonic vehicles and the generalhypersonic flow theory.

UNIT I FUNDAMENTALS OF HYPERSONIC AERODYNAMICS 9

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

UNIT II SIMPLE SOLUTION METHODS FOR HYPERSONICINVISCID FLOWS 9

Local surface inclination methods – Newtonian theory – modified Newtonian law – tangent wedge and tangent cone and shock expansion methods – approximate methods - hypersonic small disturbancetheory – thin shock layer theory.

UNIT III VISCOUS HYPERSONIC FLOW THEORY 9

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

UNIT IV VISCOUS INTERACTIONS IN HYPERSONIC FLOWS 9

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

UNIT V HIGH TEMPERATURE EFFECTS in HYPERSONIC FLOWS 9

Nature of high temperature flows – chemical effects in air – real and perfect gases – Gibb's freeenergy and entropy - chemically reacting boundary layers – recombination and dissociation.

TOTAL: 45 Periods

TEXT BOOKS

1. John D. Anderson. Jr., "Hypersonic and High Temperature Gas Dynamics", Mc.Graw Hill Series,New York, 1996.

REFERENCES

1. John D. Anderson. Jr., "Modern Compressible flow with historical Perspective", Mc.Graw HillPublishing Company, New York, 1996.
2. John T. Bertin, "Hypersonic Aerothermodynamics", published by AIAA Inc., Washington.D.C.,1994.

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	INDUSTRIAL AERODYNAMICS	3	0	0	3

AIM : To familiarize the learner with non-aeronautical uses of aerodynamics such as road vehicle,building aerodynamics and problems of flow induced vibrations.

UNIT I ATMOSPHERE **9**

Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain ongradient height, Structure of turbulent flows.

UNIT II WIND ENERGY COLLECTORS **9**

Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory.

UNIT III VEHICLE AERODYNAMICS **9**

Power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of trains and Hovercraft.

UNIT IV BUILDING AERODYNAMICS **9**

Pressure distribution on low rise buildings, wind forces on buildings.Environmental winds in cityblocks, Special problems of tall buildings, Building codes, Building ventilation and architecturalaerodynamics.

UNIT V FLOW INDUCED VIBRATIONS **9**

Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter.

TOTAL: 45 Periods

TEXT BOOKS:

1. M.Sovran (Ed), “Aerodynamics and drag mechanisms of bluff bodies and Road vehicles”, Plenum press, New York, 1978.
2. Sachs. P., “Winds forces in Engineering”, Pergamon Press, 1978.

REFERENCES:

1. Blevins. R.D., “Flow Induced Vibrations”, Van Nostrand, 1990.
2. Calvent. N.G., “Wind Power Principles”, Charles Griffin & Co., London, 1979.

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	EXPERIMENTAL STRESS ANALYSIS	3	0	0	3

AIM : To study the various experimental techniques involved for measuring displacements, stresses,strains in structural components.

UNIT I EXTENSOMETERS AND DISPLACEMENT SENSORS 8

Principles of measurements, Accuracy, Sensitivity and range of measurements, Mechanical, Optical,Acoustical and Electrical extensometers and their uses, Advantages and disadvantages**,** Capacitancegauges, Laser displacement sensors.

UNIT II ELECTRICAL RESISTANCE STRAIN GAUGES 12

Principle of operation and requirements, Types and their uses, Materials for strain gauges, Calibration and temperature compensation, cross sensitivity, Wheatstone bridge and potentiometer circuits forstatic and dynamic strain measurements, strain indicators, Rosette analysis, stress gauges, load cells,Data acquisition, six component balance.

UNIT III PHOTOELASTICITY 11

Two dimensional photo elasticity, Photo elastic materials, Concept of light - photoelastic effects,stress optic law, Transmission photoelasticity, Jones calculus, plane and circular polariscopes,Interpretation of fringe pattern, Calibration of photoelastic materials, Compensation and separationtechniques, Introduction to three dimensional photo elasticity.

UNIT IV BRITTLE COATING AND MOIRE TECHNIQUES 7

Relation between stresses in coating and specimen, use of failure theories in brittle coating, Moiremethod of strain analysis.

UNIT V NON – DESTRUCTIVE TESTING 7

Fundamentals of NDT, Acoustic Emission Technique, Radiography, Thermography, Ultrasonics, Eddy Current testing, Fluorescent Penetrant Testing,

TOTAL: 45 Periods

TEXT BOOKS:

1. Dally, J.W., and Riley, W.F., "Experimental Stress Analysis", McGraw Hill Inc., New York 1998.
2. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K.,"Experimental Stress Analysis", Tata McGraw Hill, New Delhi, 1984.
3. Sadhu Singh, "Experimental Stress Analysis", Khanna Publishers, New Delhi, 1996.

REFERENCES:

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

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	ROCKETS AND MISSILES	3	1	0	4

AIM: To give exposure on important topics like rocket motion, rocket aerodynamics and staging &control of rockets to students to enrich their knowledge in the area of missile flight.

UNIT I CLASSIFICATION OF ROCKETS AND MISSILES 9

Various methods of classification of missiles and rockets – Basic aerodynamic characteristics ofsurface to surface, surface to air, air to surface and air to air missiles – Examples of various Indianspace launch vehicles and missiles – Current status of Indian rocket programme with respect tointernational scenario

UNIT II AERODYNAMICS OF ROCKETS AND MISSILES 10

Airframe components of rockets and missiles – forces acting on a missile while passing throughatmosphere – classification of missiles – slender body aerodynamics – method of describing forcesand moments – lift force and lateral moment –lateral aerodynamic damping moment – longitudinalmoment – drag estimation – upwash and downwash in missile bodies – rocket dispersion.

UNIT III ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD 10

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

UNIT IV STAGING OF ROCKETS AND MISSILES 8

Design philosophy behind multistaging of launch vehicles and ballistic missiles – optimization ofmultistage vehicles – stage separation techniques in atmosphere and in space – stage separationdynamics and lateral separation characteristics.

UNIT V CONTROL OF ROCKETS AND MISSILES 8

Introduction to aerodynamic and jet control methods – various types of aerodynamic control methodsfor tactical and short range missiles- aerodynamic characteristics - various types of thrust vectorcontrol methods including secondary injection thrust vector control for launch vehicles and ballisticmissiles

TOTAL: 45 Periods

TEXT BOOKS:

1. Cornelisse, J.W., "Rocket Propulsion and Space Dynamics", J.W. Freeman & Co., Ltd, London,1982
2. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edition, 1993.

REFERENCES:

1. Parker, E.R., "Materials for Missiles and Spacecraft", McGraw Hill Book Co. Inc. 1982.
2. Mathur, M.L., and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishersand Distributors, Delhi, 1988.

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	HIGH TEMPERATURE MATERIALS	3	0	0	3

AIM : To learn damage mechanism and failure of components at elevated temperatures.

UNIT I CREEP 9

Factors influencing functional life of components at elevated temperatures, definition of creep curve, various stages of creep, metallurgical factors influencing various stages, effect of stress, temperature and strain rate.

UNIT II DESIGN FOR CREEP RESISTANCE 9

Design of transient creep time, hardening, strain hardening, expressions of rupture life of creep, ductile and brittle materials, Monkman-Grant relationship.

UNIT III FRACTURE 9

Various types of fracture, brittle to ductile from low temperature to high temperature, cleavage fracture, ductile fracture due to micro void coalescence-diffusion controlled void growth; fracture maps for different alloys and oxides.

UNIT IV OXIDATION AND HOT CORROSION 9

Oxidation, Pilling, Bedworth ratio, kinetic laws of oxidation- defect structure and control of oxidation by alloy additions, hot gas corrosion deposit, modified hot gas corrosion, fluxing mechanisms, effect of alloying elements on hot corrosion, interaction of hot corrosion and creep, methods of combat hot corrosion.

UNIT V SUPERALLOYS AND OTHER MATERIALS 9

Iron base, Nickel base and Cobalt base super alloys, composition control, solid solution strengthening, precipitation hardening by gamma prime, grain boundary strengthening, TCP phase, Embrittlement, solidification of single crystals, Inter-metallics, high temperature ceramics.

TOTAL: 45 Periods

TEXT BOOKS

1. Raj. R., “Flow and Fracture at Elevated Temperatures”, American Society for Metals, USA, 1985.
2. Hertzberg R. W., “Deformation and Fracture Mechanics of Engineering materials”, 4th Edition, John Wiley, USA, 1996.
3. Courtney T.H, “Mechanical Behavior of Materials”, McGraw-Hill, USA, 1990.

REFERENCES

1. Boyle J.T, Spencer J, “Stress Analysis for Creep”, Butterworths, UK, 1983.
2. Bressers. J., “Creep and Fatigue in High Temperature Alloys”, Applied Science, 1981.
3. McLean D., “Directionally Solidified Materials for High Temperature Service”, The Metals Society, USA, 1985.

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	NANO TECHNOLOGY (COMMON TO MECH AND AERO)	3	0	0	3

Objectives:

1. To understand the basic fundamentals of Nanotechnology and applications.
2. To understand the basic fundamentals of Nanoparticles and applications.
3. To understand the various properties of nanomaterials.
4. To understand the basic fundamentals of Nanopowders.
5. To understand the recent developments in Nanotechnology and latest applications.

UNIT I INTRODUCTION AND DEFINITION OF NANOTECHNOLOGY 9

Introduction, Definition, Length scales, Importance of Nanoscale and Technology, History of Nanotechnology, Future of Nanotechnology: Nanotechnology Revolution, Silicon based Technology, Benefits and challenges in Molecular manufacturing, The Molecular assembler concept, Controversies and confusions, Understanding advanced capabilities, Visions and Objective of Nanotechnology, Nanotechnology in Different Fields: Automobile, Electronics, Nano biotechnology, Materials, Medicine, Dental care, Nano computers, Power storage, Nanotechnology products.

UNIT-II NANO PARTICLES 9

Introduction, Types of Nanoparticles, Pure Metal, Gold, Silicon, Silver, Cobalt, Metal Oxides, Silica, Zinc oxide, Iron oxide, Alumina, Titania, Techniques to Synthesize Nanoparticles, Characterization of Nanoparticles, Applications, Toxic effects of Nanomaterials, Significance of Nanoparticles.

UNIT-III PROPERTIES 9

Mechanical properties: Strength of Nano crystalline SiC, Preparation for strength measurements, Mechanical properties, Magnetic properties. Electrical properties: Switching glasses with nanoparticles, Electronic conduction with nanoparticles. Optical properties: Optical properties, special properties and the coloured glasses

UNIT-IV NANO-POWDERS 9

Process of synthesis of Nano powders, Electro deposition, Important Nanomaterials

UNIT -V LATEST DEVELOPMENTS IN NANOTECHNOLOGY & APPLICATIONS 9

Introduction, Current situation, Future Assumptions, Latest Developments, Nano copters, Nanotubes, Biosensors, Nano structure fluid, Computers, Plastic electronics, Light emitting diodes, Solar cells, Nanotechnology in Mechanical Industries, Nanotechnology in Health and Life Sciences, Nanotechnology in Smart Materials, Nanotechnology in Defense, Nanotechnology in Optics, Optical industry, Metrology, Nanotechnology in Environment.

TOTAL: 45 Periods

TEXT BOOKS:

1. Nano Materials- A.K.Bandyopadhyay, New Age Publishers
2. Nano Essentials- T.Pradeep, TMH
3. Springer Handbook of Nanotechnology - Bharat Bhusan

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	TOTAL QUALITY MANAGEMENT (COMMON TO MECH, AUTO & AERO)	3	0	0	3

UNIT –I INTRODUCTION **9**

Definition of Quality- Dimensions of Quality- Quality Planning- Quality costs – Analysis Techniques for Quality Costs- Basic concepts of Total Quality Management- Historical Review- Principles of TQM- Leadership – Concepts- Role of Senior Management- Quality Council- Quality Statements- Strategic Planning- Deming Philosophy- Barriers to TQM Implementation.

UNIT –II - TQM PRINCIPLES **9**

Customer satisfaction – Customer Perception of Quality- Customer Complaints- Service Quality- Customer Retention- Employee Involvement – Motivation- Empowerment- Teams- Recognition and Reward- Performance Appraisal- Benefits- Continuous Process Improvement – Juran Trilogy- PDSA Cycle- 5S- Kaizen-Basic Concepts- Strategy- Performance Measure.

UNIT –III - STATISTICAL PROCESS CONTROL (SPC) **9**

The seven tools of quality- Statistical Fundamentals – Measures of central Tendency and Dispersion- Population and Sample- Normal Curve- Control Charts for variables and attributes- Process capability- Concept of six sigma- New seven Management tools.

UNIT –IV - TQM TOOLS **9**

Benchmarking – Reasons to Benchmark- Benchmarking Process- Quality Function Deployment (QFD) – House of Quality- QFD Process- Benefits- Taguchi Quality Loss Function- Total Productive Maintenance (TPM) – Concept- Improvement Needs- FMEA – Stages of FMEA.

UNIT –V - QUALITY SYSTEMS **9**

Need for ISO 9000 and Other Quality Systems- ISO 9000:2000 Quality System – Elements- Implementation of Quality System- Documentation- Quality Auditing- QS 9000- ISO 14000 – Concept- Requirements and Benefits.

Total Hours : 45

TEXT BOOK:

1. Dale H.Besterfiled- et at. - Total Quality Management- PHI-1999. (Indian reprint 2002).
2. Feigenbaum.A.V. "Total Quality Management- McGraw-Hill- 1991.

REFERENCES:

1. James R.Evans& William M.Lidsay- The Management and Control of Quality- (5^{th} Edition)- South-Western (Thomson Learning)- 2002 (ISBN 0-324-06680-5).
2. Oakland.J.S. "Total Quality Management Butterworth – Hcinemann Ltd.-Oxford. 1989.
3. Narayana V. and Sreenivasan-N.S. Quality Management – Concepts and Tasks- New Age International 1996.

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	ENTREPRENEURIAL SKILLS DEVELOPMENT FOR ENGINEERS (COMMON TO MECH & AERO)	3	0	0	3

Objectives:

1. To understand the importance of entrepreneurship for engineering students.
2. To inculcate entrepreneurship skills for engineering students.
3. To create awareness of business and train in preparing the project report and crate awareness for engineering students
4. To understand the importance of finance and its transactions.
5. To develop the skills of consequences of business sickness and take corrective measures.

UNIT I ENTREPRENEURSHIP 9

Entrepreneur –Definition-Evolution and importance of entrepreneurship-Views and Theories of Entrepreneurship-Traits of Entrepreneurs- Types of Entrepreneurs – Risks and Rewards-Entrepreneur - Technocrat –Manager -Comparison–Role of Entrepreneurship in Economic Development- Factors affecting Entrepreneurial Growth-Engineers as Entrepreneurs-Ten commandments for the beginning entrepreneur.

UNIT 2 MOTIVATION 9

Motivation-Definition and objectives-Types of motivation-Theories of Motivation- Achievement Motivation Training- Self Rating- Business games- Thematic Apperception Test - Stress Management. Entrepreneurship Development Programmes - Need- objectives.

UNIT 3 BUSINESS AND ENTERPRISE MANAGEMENT 9

Business-definition- Classification –Small Enterprises- Characteristics- ownership structure-Various types of ownership-Project Formulation – Steps involved in setting up a Business - Market survey and Research- Techno economic Feasibility Report - Preliminary Project Report-Importance of Project Appraisal-Sources of information-Classification of needs and Agencies – Intellectual Property Rights.

UNIT 4 FINANCIAL MANAGEMENT 9

Need and objectives of financial management for engineers-Sources of Finance- Term Loans- Capital structure- Financial Institutions- Management of working capital- Costing - Break Even Analysis-Managerial uses of Breakeven analysis-Network analysis Techniques –Problems on PERT &CPM – Taxation

UNIT 5 BUSINESS SICKNESS AND GROWTH STRATEGIES 9

Sickness in small Business –Definition of sick unit- Symptoms of Sickness- Magnitude- Causes and Consequences-Preventive and Corrective measures - Institutional Support to Entrepreneurs-Government Policy for small Enterprises - Growth strategies in small Industry - Expansion-Diversification- Joint venture- Merger- sub-contracting.

TOTAL HOURS :45

TEXT BOOKS:

1. S.S. Khanka- Entrepreneurial Development- Chand & Co. Ltd- Ram Nagar - New Delhi- 2005.
2. BhramarbarBadhai-"Entrepreneurship for Engineers"-DhanpatRai&co (P) ltd, Delhi-2001.

REFERENCES:

1. EDII - "A manual for Entrepreneurs"- Entrepreneurship Development Institute of India, Ahmedabad-Tata McGrawHill-2006...
2. MSME-'A guide book for new entrepreneurs'-2nd edition-2010.
3. Lawrence R.Jauch, Rajiv Gupta,WilliamF.Glueck-"Business Policy & Strategic Management"- 7th edition-Frank Bros&co.(publishers) ltd,.2007
4. Robert DHisrich, Michael P Peters &Dean A Shepherd-"Entrepreneurship"-TataMcGrawHill, 2008.
5. Mary K Coulter, "Entrepreneurship in Action", Prentice Hall-2006.

SEMESTER	SUBJECT	L	T	P	C

ELECTIVE	**PRINCIPLES OF MANAGEMENT**	**3**	**0**	**0**	**3**

AIM: To enable the students to study the evolution of Management, to study the functions andprinciples of management and to learn the application of the principles in an organization .

UNIT I INTRODUCTION TO MANAGEMENT AND ORGANIZATIONS 9

Definition of Management – Science or Art – Manager Vs Entrepreneur - types of managers -managerial roles and skills – Evolution of Management – Scientific, human relations , system andcontingency approaches – Types of Business organization - Sole proprietorship, partnership,company-public and private sector enterprises - Organization culture and Environment – Currenttrends and issues in Management.

UNIT II PLANNING 9

Nature and purpose of planning – planning process – types of planning – objectives – settingobjectives – policies – Planning premises – Strategic Management – Planning Tools and Techniques– Decision making steps and process.

UNIT III ORGANISING 9

Nature and purpose – Formal and informal organization – organization chart – organization structure – types – Line and staff authority – departmentalization – delegation of authority – centralization and decentralization – Job Design - Human Resource Management – HR Planning, Recruitment,selection, Training and Development, Performance Management , Career planning and management.

UNIT IV DIRECTING 9

Foundations of individual and group behaviour – motivation – motivation theories – motivationaltechniques – job satisfaction – job enrichment – leadership – types and theories of leadership –communication – process of communication – barrier in communication – effective communication –communication and IT.

UNIT V CONTROLLING 9

System and process of controlling – budgetary and non-budgetary control techniques – use ofcomputers and IT in Management control – Productivity problems and management – control andperformance – direct and preventive control – reporting.

TOTAL : 45 Periods

TEXTBOOKS:

1. Stephen P. Robbins & Mary Coulter, “Management”, 10th Edition, Prentice Hall (India) Pvt. Ltd.,2009.
2. JAF Stoner, Freeman R.E and Daniel R Gilbert “Management”, 6th Edition, Pearson Education,2004.

REFERENCES:

1. Stephen A. Robbins & David A. Decenzo& Mary Coulter, “Fundamentals of Management”7th Edition, Pearson Education, 2011.
2. Robert Kreitner&MamataMohapatra, “Management”, Biztantra, 2008.
3. Harold Koontz & Heinz Weihrich “Essentials of management” Tata McGraw Hill, 1998.
4. Tripathy PC & Reddy PN, “Principles of Management”, Tata McGraw Hill, 1999.

SEMESTER	SUBJECT	L	T	P	C
ELECTIVE	INDUSTRIAL ROBOTICS (COMMON TO MECH & AERO)	3	0	0	3

Objectives:

1. To learn the basics about Robotics and Robot manipulation in space.
2. To understand the controlling of Robots and devices system.
3. To learn the Sensor technology
4. To learn the knowledge of Robot programming and Expert system.
5. To understand about Robot cell design, applications and economics

UNIT I FUNDAMENTALS OF ROBOT 7

Robot – Definition – Robot Anatomy – Co-ordinate Systems, Work Envelope, types and classification – Specifications – Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load – Robot Parts and Functions – Need for Robots – Different Applications.

UNIT II ROBOT DRIVE SYSTEMS AND END EFFECTORS 10

Pneumatic Drives – Hydraulic Drives – Mechanical Drives – Electrical Drives – D.C.Servo Motors, Stepper Motor, A.C. Servo Motors – Salient Features, Applications and Comparison of Drives. End Effectors – Grippers – Mechanical Grippers, Pneumatic and Hydraulic Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

UNIT III ROBOT SENSORS 9

Transducers and sensors – Sensors in robot – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image processing and analysis – Image segmentation – Pattern recognition – Training of vision system

UNIT IV ROBOT KINEMATICS AND ROBOT PROGRAMMING 10

Forward Kinematics, Inverse Kinematics and Differences; Forward Kinematics and Reverse Kinematics of Manipulators with Two, Three Degrees of Freedom (In 2 Dimensional), Four Degrees of Freedom (In 3 Dimensional) – Deviations and Problems. Teach Pendant Programming, Lead through programming, Robot programming Languages – VAL Programming – Motion Commands, Sensor Commands, End Effectors commands and simple programs.

UNIT V CELL DESIGN APPLICATIONS AND ECONOMICS OF ROBOTICS 9

Robot work cell design and control – Safety in Robotics – Robot cell layouts – Multiple robots and machine interference – Robot cycle time analysis – Industrial applications of robots.

Economic Analysis of Robots – Pay back Method, EUAC Method, and Rate of Return Method.

TOTAL HOURS : 45

Text Books:

1. Mikell, P. Groover, Mitchell Weis, Roger, N. Nagel, Nicholas G. Odrey "Industrial Robotics Technology, Programming and Applications", McGraw Hill, Int., 1986.
2. Fu. K.S., Cgonzalez R. and Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence" McGraw hill , 1987

Reference Books:

1. Richar. D., Klafter, Thomas, A, Chmielewski, "Machine Negin Robotics Engineering – An Integrated Approach", Prentice Hall of India Pvt., Ltd., 1984.
2. Kozyrey, Yu. "Industrial Robotics" MIR Publishers Moscow, 1985.
3. Deb, S.R. "Robotics Technology and Flexible Automation", Tata McGraw Hill, 1994.
4. Timothy Jordonidesetal, "Expert Systems and Robotics", Springer – Verlag, New York, May 1991.

SEMESTER	SUBJECT	L	T	P	C

ELECTIVE	**MARKETING TECHNIQUES FOR ENGINEERS**	**3**	**0**	**0**	**3**

Objectives:

1. To learn marketing skills for engineering students.
2. To understand the behaviourial pattern of customers
3. To learn marketing research and develop skills of sales forecasting.
4. To learn the skills of developing a market plan and formulation of strategies.
5. To understand various promotion mix details.

UNIT I MARKETING ENGINEERING APPROACH 9

Definition and introduction to Marketing Process- The emerging marketing decision environment-Trends that favour marketing engineering-Examples of Marketing success- Tools for marketing engineering-Business values of marketing engineering-B2B marketing-Dynamics- Selling Vs. Marketing- Marketing segmentation and targeting-Positioning approach.

UNIT II BUYING BEHAVIOUR & MARKET SEGMENTATION 9

Customer value assessment and valuing customers- Understanding customer needs and wants-Customer Buying behavior- Motives- types- Buying decisions- segmentation factors- Demographic-Psychographic & Geographic Segmentation- Buying Patterns-Social and Ethical considerations .

UNIT III MARKETING RESEARCH& SALES FORECASTING 9

Objectives and Process of Marketing Research-Forecasting Methods-Judgment Methods-Time series-Product Life cycle-Forecasting methods for new products –Models.

UNIT IV MARKETING PLANNING & STRATEGY FORMULATION 9

Components of a marketing plan- strategy formulation –New Product and Service Design-New product development process-Models for idea generation and evaluation-implementation- Portfolio analysis-Marketing Mix- Pricing Decisions and Pricing methods- Pricing Management. Introduction- Uses.

UNIT V POSITIONING AND PROMOTION MIX 9

Characteristics- Impact- goals- types- Sales promotion-Brand Positioning- Brand Management-Distribution channels. Characteristics- Wholesaling- Retailing- channel design- logistics- Modern Trends in retailing.

TOTAL HOURS :45

TEXT BOOKS:

1. Gary. L. Lillian, ArvindRangaswamy, Arnaud DeBrriyn-"Principles of Marketing Engineering"-2nd edition-Decision Pro.inc. PA16801.
2. Patric Forsyth-"Demystifying Marketing-A Guide to the fundamentals for Engineers",-The institution of engineering and technology, London, UK-2007.

REFERENCES:

1. Brian Richardson-"Marketing for Architects and Engineers-A New Approach"-Chapman and Hall India-1996.
2. Ramaswamy.V.S. and S.Namakumari- " Marketing Environment: Planning- Implementation and Control the Indian Context "- 1990.
3. Jean PlerreJannet Hubert D Hennessey Global Marketing Strategies.
4. Govindarajan.M. 'Modern Marketing Management'- Narosa Publishing House- New Delhi- 1999.
5. Philip Kotler- " Marketing Management: Analysis- Planning- Implementation and Control "- 1998.