## **B.TECH COURSE**

## IN

# AERONAUTICAL ENGINEERING

# SCHEME &

# SYLLABUS FOR SEMESTERS III TO VIII

# MAHARSHI DAYANAND UNIVERSITY ROHTAK

EFFECTIVE FROM 2008-09

## M. D UNIVERSITY, ROHTAK SCHEME OF STUDIES & EXAMINATIONS B.E 2<sup>nd</sup> YEAR (SEMESTER – III) AERONAUTICAL ENGINEERING Effective from 2008-09

Course No.	Course Title	Teaching Schedule				Marks For Class Work	Marks for Examination		Total Marks	Duratio n of Exam hr
		L	Т	Р	Total		Theory	Practical		
ME-208 E	Fluid Mechanics	3	1	-	4	50	100		150	3
ME 201 E	Thermodynamics	3	1	-	4	50	100		150	3
ME 203 E	Strength of Material -I	3	1	-	4	50	100		150	3
Math-201 E	Mathematics III	3	1	-	4	50	100	4	150	3
CSE-215	Computer Programming and Network	3	1	-	4	50	100	- 2	150	3
ME-213	Workshop Practice	2		-	2	50	50	1.1	100	3
ME-209 E	SOM-I Lab			2	2	25	-	25	50	3
CSE-217	Computer Programming and Network Lab		5	2	2	25	Ś	25	50	3
ME-215	Workshop Practice Lab			4	4	50	-	50	100	3
ME-214 E	Fluid Mechanics Lab	0	0	2	2	25		25	50	3
AE-201	Introduction to Aerospace Lab	0	0	3	3	50	-	50	100	3
	Total	17	5	13	35	475	550	175	1200	199

Note:

1. Students will be allowed to use Non-Programmable Scientific Calculator. However, sharing of calculator will not be permitted in the examination.

### M. D UNIVERSITY, ROHTAK SCHEME OF STUDIES & EXAMINATIONS B.E 2<sup>nd</sup> YEAR (SEMESTER – IV) AERONAUTICAL ENGINEERING Effective from 2008-09

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Course No.	Course Title	Tea	chin	g Sch	edule	Marks Marks for for Examination Class work			Total Marks	Duration of Exam hr
		L	Т	Р	Total		Theory	Practical		
AE-202	Mechanics	3	1	-	4	50	100	-	150	3
AE-204	Aerodynamics-I	3	1	-	4	50	100		150	3
AE-206	Aircraft Structures-I	3	1	-	4	50	100		150	3
AE-208	Aircraft Materials & Manufacturing Processes	3	1		4	50	100			3
EEE-230	Aircraft Electrical Systems & Instruments	3	1	9	4	50	100	N.N.	150	3
MATH- 212	Computational Numerical Methods	3	1	2	4	50	100		150	3
HUM-214	Principles & Practices of Economics & Management	3	D.		3	50	100		150	3
EEE-232	Aircraft Electrical Systems & Instruments Lab			2	2	25	2	25	50	3
AE-218	Aerodynamics-I Lab	_		3	3	25	-	25	50	3
MATH- 222	MATLAB	7		2	2	25	5	25	50	3
GPAE-224	G P				347	50			50	3
	Total	21	6	9	34	475	700	75	1250	

#### Note:

1. Each student has to undergo Practical training of 6 weeks during summer vacation and its evaluation will be conducted in 5<sup>th</sup> semester.

2. Students will be allowed to use Non-Programmable Scientific Calculator. However, sharing of calculator will not be permitted in the examination.

## M. D UNIVERSITY , ROHTAK SCHEME OF STUDIES & EXAMINATIONS

### AERONAUTICAL ENGINEERING SEMESTER V Effective from 2008-09

	Courses	PE	RIC	DS/	/WEEK		MARK	<s< th=""><th>Duration</th></s<>	Duration
SUBJECT CODE	Course	L	Т	Ρ	TOTAL	INT	EXT	TOTAL	of Ext. Exam
AE-301	Aerodynamics - II	3	1	0	4	50	100	150	3 Hrs
AE-303	Flight Mechanics	3	1	0	4	50	100	150	3 Hrs
AE-305	Aeroelasticity	3	1	0	4	50	100	150	3 Hrs
AE-307	Wind Tunnel Techniques	3	1	0	4	50	100	150	3 Hrs
AE-308	Airplane Propulsion	3	1	0	4	50	100	150	3Hrs
AE-311	Communication and Navigation	3	1	0	4	50	100	150	3 Hrs
AE-313	Aircraft Structure Lab	0	0	3	3	25	25	50	2Hrs.
AE-315	Propulsion Lab	0	0	3	3	25	25	50	2 Hrs
AE-317	Communication and Naviation Lab.	0	0	2	2	25	25	50	2 Hrs
E	Practical Training	2	0	0	2	0	0	0	0
	Total	20	6	8	34	375	675	1050	1

## M. D UNIVERSITY , ROHTAK

## SCHEME OF STUDIES & EXAMINATIONS

## AERONAUTICAL ENGINEERING SEMESTER VI Effective from 2008-09

AE-302	Introduction to Wind Energy	3	1	0	4	50	100	150	3 Hrs
AE-304	Compressible Aerodynamics	3	1	0	4	50	100	150	3 Hrs
AE-306	Aircraft Instruments and Systems	3	1	0	4	50	100	150	3 Hrs
ME-310E	Measurement and Instrument	3	1	0	4	50	100	150	3 Hrs
AE-308	Viscous flow theory	3	1	0	4	50	100	150	3 Hrs
HUM-	Business	3	0	0	3	50	50	100	2 Hrs

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457E	communication								
	Elective-I	3	1	0	4	50	50	100	2 Hrs
ME-318E	Measurement and Instrument Lab	0	0	2	2	25	25	50	2 Hrs
AE-310	Aircraft System Lab	0	0	3	3	50	50	100	3 Hrs
	Total	21	6	5	32	425	675	1100	

Elective - I

ME-306E	Heat Transfer
ME-312E	Industial Engg

ME-308E Automatic Controls

## M. D UNIVERSITY , ROHTAK SCHEME OF STUDIES & EXAMINATIONS AERONAUTICAL ENGINEERING SEMESTER VII Effective from 2008-09

	0	Р	ERI	ODS/	WEEK		MAR	KS	Duration
SUBJECT CODE	Course	L	Т	Р	TOTAL	INT	EXT	TOTAL	of Ext. Exam
AE-401	Helicopter Dynamics	3	1	0	4	50	100	150	3 Hrs
AE-403	Airplane Design	3	1	0	4	50	100	150	3 Hrs
AE-407	Automatic Flight Control	3	1	0	4	50	100	150	3 Hrs
	Elective-I	3	1	0	4	50	100	150	3 Hrs
HUM- 453E	Human Resourse Management	3	0	0	3	50	100	150	3Hrs
AE-409	Aeromodelling Lab	0	0	3	3	50	100	150	3 Hrs
AE-411	Aircraft Maintenance Lab	0	0	3	3	25	25	50	2Hrs.
	Practical Training	2	0	0	2				
	Elective-11	3	1	0	4	50	100	150	3Hrs
	Total	20	5	6	31	375	725	1100	

## Elective - II

ME-405E	Operations Research	IC- 455E	Intelligent Instrumentation for Engineers
ME-407E	Mechanical Vibrations	IT- 471E	Management Information System
ME-451E	Finite Element Methods	CSE- 451E	Artificial Intelligence & Expert Systems

## M. D UNIVERSITY , ROHTAK SCHEME OF STUDIES & EXAMINATIONS

## AERONAUTICAL ENGINEERING SEMESTER VIII Effective from 2008-09

	Course	Р	ERI	ODS/	WEEK		MARI	KS	Duration
SUBJECT CODE	Course	L	Т	Р	TOTAL	INT	EXT	TOTAL	of Ext. Exam
AE-402	Space Dynamics	3	1	0	4	50	100	150	3 Hrs
AE-404	Rocket & Missiles	3	1	0	4	50	100	150	3 Hrs
AE-406	Computational Aerodynamics	3	1	0	4	50	100	150	3 Hrs
	Elective-I	3	1	0	4	50	100	150	3 Hrs
AE-408	Aeromodelling Lab	0	0	3	3	50	100	150	3 Hrs
AE-410	Independent study Seminar	0	0	4	4	50	_	50	2 Hrs
AE-412	Project	0	0	8	8	50	100	150	2 Hrs
GFAE-414	General Fitness for Profession	0	0	0	0	50	100	150	2 Hrs
	Total	12	4	15	31	400	700	1100	

## Elective - I

	Computer Aided
ME-402E	Design
	Erginomics and work
ME-444E	place design
	Modern
	Manufacturing
ME-446E	Processes

Note:-

1. Project load will be treated as 2hrs. Per week for the project coordinator and 1hr. For each participating teacher.

 $\label{eq:project} \mbox{Project involving design, Fabrication , testing , computer simulation , case studies etc. which has been commenced$ 

by students in VII thesemester will be completed in VIIIth Semester.

2. The evaluation of the student for his/herGeneral Fitness for the Profession shall be carried out by a team consisting of

Principal /Director, HOD of concerned dapartment and external eaxminer appointed by university.

3. Students will be allowed to use the nonprogrammable scienticfic calculator. However, sharing of calculator will not be

permitted in the examination.

# **SEMESTER III**

#### **ME-208 E FLUID MECHANICS**

L	Т	Р	Sessional	: 50 Marks
3	1	-	Theory	: 100 Marks
			Total	: 150 Marks
			Duration of Exam	: 3 Hrs.

**Unit I** Fluid Properties and Fluid Statics: Concept of fluid and flow, ideal and real fluids, continuum concept, properties of fluids, Newtonian and non-Newtonian fluids. Pascal's law, hydrostatic equation, hydrostatic forces on plane and curved surfaces, stability of floating and submerged bodies, relative equilibrium. Problems.

**Unit II** Fluid Kinematics: Eulerian and Lagrangian description of fluid flow; stream, streak and path lines; types of flows, flow rate and continuity equation, differential equation of continuity in cylindrical and polar coordinates, rotation, vorticity and circulation, stream and potential functions, flow net. Problems.

**Unit III** Fluid Dynamics: Concept of system and control volume, Euler's equation, Bernoulli's equation, venturimeter, orifices, orificemeter, mouthpieces, kinetic and momentum correction factors, Impulse momentum relationship and its applications. Problems.

**Unit IV** Potential Flow: Uniform and vortex flow, flow past a Rankin half body, source, sink, source-sink pair and doublet, flow past a cylinder with and without circulation. Problems.

**Unit V** Viscous Flow: Flow regimes and Reynold's number, Relationship between shear stress and pressure gradient, uni-directional flow between stationary and moving parallel plates, movement of piston in a dashpot, power absorbed in bearings. Problems.

**Unit VI** Flow Through Pipes: Major and minor losses in pipes, Hagen-Poiseuilli law, hydraulic gradient and total energy lines, series and parallel connection of pipes, branched pipes; equivalent pipe, power transmission through pipes. Problems.

**Unit VII** Boundary Layer Flow: Boundary layer concept, displacement, momentum and energy thickness, von-karman momentum integral equation, laminar and turbulent boundary layer flows, drag on a flat plate, boundary layer separation and control. Streamlined and bluff bodies, lift and drag on a cylinder and an airfoil, Problems.

**Unit VIII** Turbulent Flow: Shear stress in turbulent flow, Prandtl mixing length hypothesis, hydraulically smooth and rough pipes, velocity distribution in pipes, friction coefficients for smooth and rough pipes. Problems.

Text Books:

- 1. Fluid Mechanics Streeter V L and Wylie E B, Mc Graw Hill
- 2. Mechanics of Fluids I H Shames, Mc Graw Hill

References Books:

1. Introduction to Fluid Mechanics and Fluid Machines – S.K. Som and G. Biswas, TMH

2. Fluid Mechanics and Fluid Power Engineering – D.S. Kumar, S.K. Kataria and Sons

3. Fluid Mechanics and Machinery – S.K. Agarwal, TMH, New Delhi

NOTE: In the semester examination, the examiner will set 8 questions in all, at least one question from each unit, and students will be required to attempt only 5 questions.



## ME-201 E THERMODYNAMICS

			Sessional	: 50 Marks
L	Т	Р	Theory	: 100 Marks
3	1	-	Total	: 150 Marks
			Duration of Exam.	: 3 hrs.

**Unit I** Basic Concepts: Macroscopic and Microscopic Approaches, Thermodynamic Systems, Surrounding and Boundary, Thermodynamic Property – Intensive and Extensive, Thermodynamic Equilibrium, State, Path, Process and Cycle, Quasi-static, Reversible and Irreversible Processes, Working Substance. Concept of Thermodynamic Work and Heat, Equality of Temperature, Zeroth Law of Thermodynamic and its utility. Problems.

**Unit II** First Law of Thermodynamics: Energy and its Forms, Energy and 1<sup>st</sup> law of Thermodynamics, Internal Energy and Enthalpy, PMMFK, Steady flow energy equation, 1<sup>st</sup> Law Applied to Non- flow process, Steady Flow Process and Transient Flow Process, Throttling Process and Free Expansion Process. Problems.

**Unit III** Second Law of Thermodynamics: Limitations of First Law, Thermal Reservoir, Heat Source and Heat Sink, Heat Engine, Refrigerator and Heat Pump, Kelvin- Planck and Clausius Statements and their Equivalence, PMMSK. Carnot Cycle, Carnot Heat Engine and Carnot Heat Pump, Carnot Theorem and its Corollaries, Thermodynamic Temperature Scale. Entropy, Clausius Inequality, Principle of Entropy Increase, Temperature Entropy Plot, Entropy Change in Different Processes, Introduction to Third Law of Thermodynamics. Problems.

**Unit IV** Availability and Irreversibility: High and Low Grade Energy, Availability and Unavailable Energy, Loss of Available Energy Due to Heat Transfer Through a Finite Temperature Difference, Dead state of a system, Availability of a Non-Flow or Closed System, Availability of a Steady Flow System, Helmholtz and Gibb's Functions, Effectiveness and Irreversibility, Second law efficiencies of processes & cycles. Problems.

**Unit V** Pure Substance: Pure Substance and its Properties, Phase and Phase Transformation, Vaporization, Evaporation and Boiling, Saturated and Superheat Steam, Solid – Liquid – Vapour Equilibrium, T-V, P-V and P-T Plots During Steam Formation, Properties of Dry, Wet and Superheated Steam, Property Changes During Steam Processes, Temperature – Entropy (T-S) and Enthalpy – Entropy (H-S) Diagrams, Throttling and Measurement of Dryness Fraction of Steam. Problems.

**Unit VI** Ideal and Real Gases: Concept of an Ideal Gas, Basic Gas Laws, Characteristic Gas Equation, Avogadro's law and Universal Gas Constant, P-V-T surface of an Ideal Gas. Vander Waal's Equation of state, Reduced Co-ordinates, Compressibility factor and law of corresponding states. Mixture of Gases, Mass, Mole and Volume Fraction, Gibson Dalton's law, Gas Constant and Specific Heats, Entropy for a mixture of non-reactive gases. Problems.

**Unit VII** Thermodynamic Relations: Maxwell Relations, Clapeyron Equation, Relations for changes in Enthalpy and Internal Energy & Entropy, Specific Heat Capacity Relations, Joule Thomson coefficient & inversion curve.

#### **Text Books:**

- 1. Engineering Thermodynamics Jones and Dugan, PHI, New Delhi.
- 2. Fundamentals of Engineering Thermodynamics E. Radhakrishnan, PHI, New Delhi.

**Reference Books :** 

1. Theory and Problems of Thermodynamics - Y. V.C. Rao, Wiley Eastern Ltd., New Delhi.

2. Engineering Thermodynamics – C P Arora, Tata McGraw Hill

3. Engineering Thermodynamics – P K Nag, Tata McGraw Hill NOTE: In the semester examination, the examiner will set 8 questions in all, at least one question from each unit, and students will be required to attempt only 5 questions.



		Sessional	: 50
LTP	Marks	Theory	: 100
Marks 3 1 -		Total	: 150
Marks		Duration of Exam.	: 3 Hrs.

**Unit 1** Simple Stresses & Strains: Concept & types of Stresses and strains, Poison's ratio, stresses and strain in simple and compound bars under axial loading, stress strain diagrams, Hooks law, elastic constants & their relationships, temperature stress & strain in simple & compound bars under axial loading, Numerical.

**Unit II** Compound Stresses & Strains: Concept of surface and volumetric strains, two dimensional stress system, conjugate shear stress at a point on a plane, principle stresses & strains and principal- planes, Mohr's circle of stresses, Numerical.

**Unit III** Shear Force & Bending Moments: Definitions, SF & BM diagrams for cantilevers, simply supported beams with or without over-hang and calculation of maximum BM & SF and the point of contra-flexure under (i) concentrated loads, (ii) uniformly distributed loads over whole span or a part of it, (iii) combination of concentrated loads and uniformly distributed loads, (iv) uniformly varying loads and (v) application of moments, relation between the rate of loading, the shear force and the bending moments, Problems.

**Unit IV** Torsion Of Circular Members: Torsion of thin circular tube, Solid and hollow circular shafts, tapered shaft, stepped shaft & composite circular shafts, combined bending and torsion, equivalent torque, effect of end thrust. Numericals.

**Unit V** Bending & Shear Stresses in Beams: Bending stresses in beams with derivation & application to beams of circular, rectangular, I,T and channel sections, composite beams, shear stresses in beams with combined bending, torsion & axial loading of beams. Numericals.

**Unit VI** Columns & Struts: Column under axial load, concept of instability and buckling, slenderness ratio, derivation of Euler's formulae for the elastic buckling load, Eulers, Rankine, Gordom's formulae Johnson's empirical formula for axial loading columns and their applications, eccentric compression of a short strut of rectangular & circular sections, Numerical.

**Unit VII** Slope & Deflection: Relationship between bending moment, slope & deflection, Mohr's theorem, moment area method, method of integration, Macaulay's method, calculations for slope and deflection of (i) cantilevers and (ii) simply supported beams with or without overhang under concentrated load, Uniformly distributed loads or combination of concentrated and uniformly distributed loads, Numerical.

**Unit VIII** Fixed Beams: Deflections, reactions and fixing moments with SF & BM calculations & diagrams for fixed beams under (i) concentrated loads, (ii) uniformly distributed load and (iii) a combination of concentrated loads & uniformly distributed load.

#### **Text Books:**

1. Strength of Materials – G.H.Ryder - Macmillan, India

2. Strength of Materials– Andrew Pytel and Fredinand L.Singer, Addison – Wesley **Reference Books :** 

1. Strength of Materials – Popov, PHI, New Delhi.

2. Strength of Materials A Rudimentary Apprach – M.A. Jayaram, Sapna Book House, Bangalore

NOTE: In the semester examination, the examiner will set 8 questions in all, at least one question from each unit, and students will be required to attempt only 5 questions.



#### MATH-201-E : MATHEMATICS-III

LTP	Class Work :	50
Marks 3 1 -	Exam. :	100
Marks		150
Marks		
Hours	Duration of exam. :	3

#### Part-A

Fourier Series and Fourier Transforms : Euler's formulae, conditions for a Fourier expansion, change of interval, Fourier expansion of odd and even functions, Fourier expansion of square wave, rectangular wave, saw-toothed wave, half and full rectified wave, half range sine and consine series.

Fourier integrals, Fourier transforms, Shifting theorem (both on time and frequency axes), Fourier transforms of derivatives, Fourier transforms of integrals, Convolution theorem, Fourier transform of Dirac-delta function.

#### Part-B

Functions of Complex Variable : Definition, Exponential function, Trignometric and Hyperbolic functions, Logrithmic functions. Limit and Continuity of a function, Differnetiability and Analyticity.

Cauchy-Riemann equations, necessary and sufficient conditions for a function to be analytic, polar form of the Cauchy-Riemann equations. Harmonic functions, application to flow problems. Integration of complex functions. Cauchy-Integral theorem and fourmula.

Power series, radius and circle of convergence, Taylor's Maclaurin's and Laurent's series. Zeroes and singularities of complex functions, Residues. Evaluation of real integrals using residues (around unit and semi circle only).

#### Part-C

Probability Distributions and Hypothesis Testing : Conditional probability, Bayes theorem and its applications, expected value of a random variable. Properties and application of Binomial, Poisson and Normal distributions.

Testing of a hypothesis, tests of significance for large samples, Student's t-distribution (applications only), Chi-square test of goodness of fit.

Linear Programming : Linear programming problems formulation, Solving linear programming problems using (i) Graphical method (ii) Simplex method (iii) Dual simplex method.

#### **TEXT BOOKS :**

Advanced Engg. Mathematics : F Kreyszig.
 Higher Engg. Mathematics : B.S. Grewal.
 **REFERENCE BOOKS :**

- 1. Advance Engg. Mathematics : R.K. Jain, S.R.K.Iyenger.
- 2. Advanced Engg. Mathematics : Michael D. Greenberg.
- 3. Operation Research : H.A. Taha.
- 4. Probability and statistics for Engineers : Johnson. PHI.

Note: Examiner will set eight questions, taking two from Part-A, three from Part-B and three from Part-C. Students will be required to attempt five question taking atleast one from each part.



L T P 3 1 - Class Work Exam. Total Duration of exam.

: 50 Marks : 100 Marks : 150 Marks : 3 Hours

## Unit1

## Computer Hardware and Software

Architecture of Computer System, different processors upto PIV systems. Computer Memory and different form of memories, RAM, Cache, secondary memory. Input/output devices and their functions.

Client-server architecture of Operating Systems such as in Linux and Window operating Systems.

Unit 2

Basics of C++ Language :

Introduction to Objects and Object Oriented Programming and basic features of C++ Language: various instructions, Encapsulation, inheritance, reusability and polymorphism. Introduction to Structures, abstraction, Classes: Const(Constant) Object And Const Member Functions, Object as Member of Classes, Friend Function and Friend Classes. Initializing Class Objects: Constructors, Using default arguments with Constructors, Using Destructors.

Unit 3

#### Inheritance

Base Classes and Derived Classes, Protected Members, Casting Base- Class pointers to derived-Class pointers, Using Member Functions, Overriding Base –Class members in a Derived Class; public, protected and private Inheritance; Use of constructors and destructors in derived Classes. Creating sequential access files; Read, write and updating of sequential files.

#### Unit 4

Simple Programs using C + + Structure of a C+ + program, simple problems of conditional and iterative statements. Basics of exceptional handling. Programs based on inheritance and exception handling.

#### Unit 5

#### **Computer Networks & Security**

Introduction to Computer Networks, Example networks ARPANET, Private Networks, Network Topologies: Bus-, Star-, Ring-topologies. Types of Networks : Local Area Networks, Metropolitan Area Networks, Wide Area Networks; Layering architecture of networks, OSI model and functions of each layer; Services and Protocols of each layer. Network security: Various Network security threats: Viruses, Worms, Trojan horses, spam emails. Security techniques: passwords, cryptography, firewalls, anti-viruses.

Text Books:

1 Object Oriented Programming with C++ by E Balagurusanry

2 Computer Fundamentals by PK Sinha

Reference Books:

- 1 Object Oriented Programming i C++ by Robert Lafone
- 2 Computer Networking by Tanenbaun, PHI.
- Computer Architecture and Prganisation by Morris Mano.
  Computer Networking a Top Down Approach featuring the internet- James F Kurose.

NOTE: In the semester examination, the examiner will set 8 questions in all, at least one question from each unit, and students will be required to attempt only 5 questions..



#### **ME-213 Workshop Practice**

Marks	Sessional	: 50
	Theory	: 100
Marks L T P	Total	: 150
Marks 3 1 -	Duration of Exam	: 3 hr

Unit-1 Basic workshop tools (Layout, Marking & Cutting Tools, Wrenches, Grinder,
 Riveting Tools & hand tools for bench vice).Simple machine tools( Lathe, Shaper & Drilling M/Cs). Precision Measuring instruments (Vernier calipers, Micrometer), Screw gauge, dial gauge, Thickness or feeler gauge, Radius or fillet gauge, Screw pitch gauge.)

- Unit-II Identification and coding of aircraft bolts, Nuts, Rivets, Screws, Locking devices of British & American system.
- Unit-III Introduction to Machine Drawing, First & Third angle system of orthographic projections, isometric views, Dimensioning, Fits & Tolerances.
- Unit-IV Screw threads and threaded fasteners- Introduction, Thread terms & Nomenclature, various forms of threads used in British, American and ISO metric system.
- Unit-V Introduction & use of simple cutting tools like drills, taps, reamers etc.

Unit-VI Introduction, classification & use of Gears (spur, helical, bevel, worm, Rack & pinion), Lubrication, causes of failure of Gears & solution.Bearings- Classification of bearings, cage & shield, bearing material, specifications, air frame & engine bearings, lubrication, fatigue & premature bearing failure.

Unit-VII Aircraft Cables – Types of wires & cables, their identification, wire material,

co-axial cables, Terminal strips & connectors. Wire insulation & lacing. Bonding.

#### **Text Books :**

- Aircraft General Engiineering Lalit Gupta Himalayan Book House, NewDelhi-110013.
- Machine Drawing P.S. Gill S.K. Kataria & Sons, New Delhi.

#### **Reference Books :**

• Machine Drawing – Ajeet Singh - Tata McGraw Hill, New Delhi.

Note: 1. In the semester examination the examiner will set 8 questions, at least one question from each unit. Students will be required to attempt 5 questions.



## ME- 209 E STRENGTH OF MATERIAL-I LAB

Maulua		Sessional	:	25
Marks		Exam	:	25
Marks				
L T	Р	Total	:	50
Marks				
	2	Duration of exa	am:	3
Hrs.				

List of Experiments :

- 1. To study the Brinell hardness testing machine & perform the Brinell hardness test.
- 2. To study the Rockwell hardness testing machine & perform the Rockwell hardness test.
- 3. To study the Vickers hardness testing machine & perform the Vickers hardness test.
- 4. To study the Erichsen sheet metal testing machine & perform the Erichsen sheet metal test.
- To study the Impact testing machine and perform the Impact tests (Izod & Charpy).
- 6. To study the Universal testing machine and perform the tensile test.
- 7. To perform compression & bending tests on UTM.
- 8. To perform the sheer test on UTM.
- 9. To study the torsion testing machine and perform the torsion test.
- 10. To draw shear Force, Bending Moment Diagrams for a simply Supported Beam under Point and Distributed Loads.
- 11. To determine Mechanical Advantage and Efficiency of Single and Double Purchase Winch Crab.
- 12. To determine Mechanical Advantage and Efficiency of Worm and Worm Gear of Single, Double and Triple start.
- 13. To determine Mechanical Advantage, Efficiency of Simple and Compound Screw Jack.
- 14. To find Moment of Inertia of a Fly Wheel. Note:
- 1. At least ten experiments are to be performed in the semester.
- 2. At least eight experiments should be performed from the above list. Remaining two experiments may either be performed from the above list or designed & set by the concerned institute as per the scope of the syllabus.

## **CSE-217**:Computer Programming & Network -Lab

LTP - - 2 Class Work: 25 Marks Theory: 25 Marks Total : 50 Marks Duration of Exam: 3

Hrs.

1.

The students are required to do Practical on the following:

- (i) Computer Hardware:
- To identify various parts of the system on the Mother Board.
- To observe and study various cables, connections and parts used in computer communication.
- 3. To study various cards used in a system viz. display card, LAN card etc.
- 4. To study laser printer assembly and elementary fault detection.
- 5. To assemble a PC.
- 6. Simple trouble shooting exercises related to various components of computer like monitor, drives, memory and printers etc
- 7. Loading of Computer Software

#### (ii) Computer Software:

- 1. Practice of MS-Excel for drawing tables, graphs, bar-chart etc. To prepare the list of marks obtained by students in different subjects and show with the help of chart/graph the average, min and max marks in each subject.
- 2. Practice of using MS-Access for data storage and databases and use this database in the programs. Create a database of books in the library on a mini scale with respect to Computers and manipulate the database using different forms and reports.
- 3. Using\_MS Power Point prepare a presentation explaining the facilities/infrastructure available in your college/institute.

#### (ii) Computer Programming in C++:

Simple Programs using C++ language such as

- 1. Using C++ write program for (i) addition of matrices, (ii) multiplication of matrices, (iii) norm of matrices.
- 2. Sort an array of numbers/ names using different sorting methods.
- 3. searching a given number in an array using sequential or binary search or pick different numbers in an array which satisfy given conditions
- 4. Prepare result of an examination and print the marks-sheets develop program for inventory system.

#### Note:

1. At least ten experiments are to be performed in the semester. 2.At least eight experiments should be performed from the above list. Remaining two experiments may either be performed from the above list or designed & set by the concerned institute as per the scope of the syllabus.

L T marks	Р	Class Work:	25
	6	Examination:	25
marks		Total:	50
marks		Duration:	3 Hrs.

#### List of Experiments/jobs

- 1. Draw/sketch the isometric view from the given orthographic diagram.
- 2. Draw/sketch the orthographic projections from the given isometric view.
- To cut the plate into two pieces with the help of chisel and hammer.
  a) To study different types of tools and learn their use.
  - b) To mark, cut & prepare a square piece of steel plate 20 cm X 20 cm X 5 mm thick and make a male-female assembly using hacksaw and files.

5. To measure the dimension of the given machined components with the help of vernier caliper.

- 6. To measure the dimension of the given machined components with the help of micrometer.
- 7. To check the roundness and run-out of the clutch hub/bearing with the help of a dial gauge using magnetic V-block.
- 8. Understanding the uses of feeler and fillet gauges with the help of given machined components.
- 9. To check the parallelism of the surface using a dial indicator.
- 10. To measure the major diameter, minor diameter of the given bolts with the help of a screw pitch gauge.
- 11. To prepare a rivetted joint of aluminum sheets using pneumatic riveting machine.
- 12. To prepare sheet metal joints using hems and reams.
- 13. To join two plates with the help of the screws.
- 14. To grind the welded joint for removing the burr from the machined component using bench grinder.
- 15. Tapping of M12 X 1.5 hole in a thick plate (10 mm).
- 16. Drill and reaming in thick plate to a dimension of  $12.5 \pm 0.03\varphi$
- 17. Study of different types of gears and gear terminology.
- 18. Study and uses of ball, roller and taper bearings for understanding bearing specification and their selection.

Note: At least 14 experiments have to be performed out of which at least 10 should be from the above list.

#### ME-214 E FLUID MECHANICS LAB

	Sessional	: 25
Marks	D (* 1/57*	25
Marks	Practical/Viva	: 25
L T P	Total	: 50
Marks		
2	Duration of Exam.	: 3 Hrs

#### List of Experiments:

- 1. To determine the coefficient of impact for vanes.
- 2. To determine coefficient of discharge of an orifice meter.
- 3. To determine the coefficient of discharge of Notch ( V and Rectangular types ).
- 4. To determine the friction factor for the pipes.
- 5. To determine the coefficient of discharge of venturimeter.
- 6. To determine the coefficient of discharge, contraction & velocity of an orifice.
- 7. To verify the Bernoullis Theorem.
- 8. To find critical Reynolds number for a pipe flow.
- 9. To determine the meta-centric height of a floating body.
- 10. To determine the minor losses due to sudden enlargement, sudden contraction and bends.
- 11. To show the velocity and pressure variation with radius in a forced vertex flow.

#### Note:

- 1. At least ten experiments are to be performed in the semester.
- 2. At least eight experiments should be performed from the above list. Remaining two experiments may either be performed from the above list or designed & set by the concerned institute as per the scope of the syllabus.

## AE-201: INTRODUCTION TO AEROSPACE ENGINEERING-LAB

L T P Marks	Class Work:	25
2	Exam :	25
Marks	Total:	50
Marks	Duration of Exam:	3 Hrs.

#### **List of Experiments:**

Any eight of the following experiments:

- 1. Wind tunnel as a tool, their classification, uses and applications.
- 2. Experiments on Reynold's apparatus.
- 3. Use of Pitot static tube.
- 4. Measurement of pressure gradient along a wind tunnel.
- 5. Smoke visualization over cylinder / airfoils.
- 6. Nomenclture of aircraft components
- 7. Aerospace propulsion systems
- 8. To plot lift vs. angle of attack for the given airfoil.
- 9. Basic characteristics of lighter than air vehicle.
- 10. Basic characteristics of ISRO mission 'Chandrayaan'.

#### **Reference Books:**

- 1. Low speed wind tunnel testing, Allen Pope, John Willey &sons
- 2. Low speed wind tunnel testing, W.E. Rae & Allen Pope, John Willey &sons

#### Note:

At least eight experiments are to be performed in the semester.
 At least six experiments should be performed from the above list. Remaining two experiments may either be performed from the above list or designed & set by the concerned institute as per the scope of the syllabus.

# SEMESTER IV

#### **AE-202 MECHANICS**

L T P	Sessional	:50
Marks 3 1 -	Theory	:100
Marks	Total mark	s :150
Marks	Duration of	f exam: 3
Hrs		

- **Unit-I** Equilibrium: Introduction, free body diagram, control volumes, general equations of equilibrium, two point equivalent loading, static indeterminacy, simple truss, method of joints, method of sections, co-planer cable-loading a function of x, coplanar cables- loading the weight of the cable itself. Problems.
- **Unit-II** Kinematics of Particles and Rigid Bodies: Velocity and acceleration in path and cylindrical coordinates, motion of a particle relative to a pair of translating axes, translation and rotation of rigid bodies, Chasles theorem, moving references, velocity and acceleration for different references, inertia and Coriolis forces. Problems (vector method).
- **Unit-III** Particle Dynamics, Energy Methods & Momentum Methods: Newton's law for rectangular coordinates & cylindrical coordinates, rectifier translation, central force motion, Newton's law for path variables, work energy equations, work energy equations for a systems of particles, linear and angular momentum equations for a systems of particles. Problems (vector method).
- Unit IV Planetary motion with reference to satellites kinematics and dynamics.
- **Unit-V** Variational Mechanics: Hamiton principle, Lagrange equations, principle of virtual work, methods of minimum potential energy, stability.

#### **Text Book:**

- 1. Engineering Mechanics Statics & Dynamics by I.H. Shames, PHI, New Delhi.
- 2. Engineering Mechanics Timoschenko.
- **Reference Books :**
- 1. Statics & Dynamics by J.L. Meriam, JohnWiley & Sons (P) Ltd. New York.
- 2. Statics & Dynamics by Beer & Johnson, MGH, New Delhi.

**NOTE :** In the semester examination, the examiner will set 8 questions in all, at least one question from each unit, and students will be required to attempt only 5 questions.

L T P 3 1 -

Class Work	:	50 Marks
Exam.	:	100 Marks
Total	:	150 Marks
Duration of exam	ı. :	3 Hours

#### UNIT 1

#### Air and airflow

Standard atmosphere, airspeed, air resistance or drag, streamlines and form drag, skin friction and boundary layer, wind tunnels.

#### UNIT 2

#### **Subsonic Flow**

Aerofoil, airflow and pressure over aerofoil, Lift and Drag, Chord line and angle of attack, aerofoil characteristics, aspect ratio, Induced drag,  $C_p$ ,  $C_l$ ,  $C_d$ ,  $C_m$ .

#### UNIT 3

Thin Aerofoil theory; Finite wings, induced drag, swept wings. Qualitative effects on low aspect ratio wings. Mach No, critical Mach no.

#### UNIT 4

#### **Aircraft Performance**

Steady Level flights, altitude effects, absolute ceiling, steady climbing flight, take-off and landing, relation between air speed and angle of attack, effect of weight. Flying for maximum range & endurance – propeller propulsion, jet propulsion.

#### UNIT 5

#### **Aircraft Stability and Control**

Longitudinal stability & longitudinal dihedral, lateral stability – dihedral angle, side slip. High wing and low center of gravity, sweepback, fin area and lateral stability. Directional stability. Control of an aircraft- Longitudinal control, Roll control and directional control: control surfaces, control tabs and mass balance.

#### UNIT 6

#### **High Lift and Drag Devices**

Slots and flaps, Vortex Generators,, Boundary layer fences.

#### Text Books

- 1 A.C. Kermode, "Mechanics of Flight", Pearson Education Ltd.
- 2 S.K.Ojha, "Flight Performance of Aircraft", AIAA Series, 1995
- 3 J.D.Anderson, "Introduction to Flight", McGraw Hill, 1989

#### **Reference Books**

1. Houghton E.L. and Brock A.E., "Aerodynamics for Engineering Students", Edwards Arnolds, UK

2. Anderson John D Jr, "Fundamentals of Aerodynamics", McGraw Hill

**NOTE:** In the semester examination, the examiner will set 8 questions in all, at least one question from each unit, and students will be required to attempt only 5 questions.

## AE 206 AIRCRAFT STRUCTURES-I

LTP	Class Work	:	50
Marks 3 1 -	Exam.	:	100
Marks			150
Marks			
Hours	Duration of exam	ι. :	3

#### UNIT 1

Aircraft Structures Introduction, Various Types of Structures used in Aircraft Construction.

#### UNIT 2

#### **Analysis of 2D Problems**

Analysis of 2-D problems in rectangular and polar co-ordinates employing "Theory of Elasticity: Plane Stress and Plane Strain Condition".

#### UNIT 3

#### **Statically Indeterminate Structures**

Truss analysis with single and double redundancy, frames and rings. Torsion and bending of multicell box beams.

#### **UNIT 4**

#### Torsion

Torsion of non-circular solid bars, warping, axially constrained stresses. Torsional deflection of noncircular shell, analysis of thick walled tubes.

#### UNIT 5

#### **Joints in Structures**

Riveted and Bolted Joints. Analysis and Design.

#### UNIT 6

#### Structural components

Function of various components eg aileron, flaps, rudder, landing gear etc. Design Criteria, Safe-Life, Fail Safe and Damage Tolerance Approach. Fatigue damage.

#### Text Books

1. S.Timoshanko and J.N., "Theory of Elasticity".

- 2. Lalit Gupta and O.P. Sharma, "Aircraft Structures", Himalayan Books **References:**
- 1. David J.Perry, "Aircraft Structures", McGraw Hill Book Co. 1949.
- 2. T.H.G.Megson, "Aircraft Structures for Engineering Students", Edward Arnold and Co., 2<sup>nd</sup> Ed,

3. Joe Christy, "Aircraft construction, Repair and Inspection"

**NOTE:** In the semester examination, the examiner will set 8 questions in all, at least one question from each unit, and students will be required to attempt only 5 questions.



#### AE-208 AIRCRAFT MATERIALS AND MANUFACTURING PROCESSES

L	Т	Р	Class Work:	50
3	1	-	Exam:	100
			Total:	150
			Duration of Exam:	3 Hrs.

#### UNIT1

#### Introduction

Properties of flight vehicle materials, Importance of strength/weight ratio of materials for Aerospace

Vehicles: Structures, Importance of temperature variations, factors affecting choice of material for

different parts of airplane.

## UNIT 2

#### Metallurgy

Alloying Theory, Binary diagrams, iron-carbon diagram, Aluminum-copper diagram, structure- property

correlation, General Characteristics of Metallic Materials- Stress- strain curve, fatigue, creep, corrosion

and prevention, Surface hardening of metals, weld ability, formability & machineability.

#### UNIT 3

#### **Aircraft Steels**

Classification of alloy steels, Effect of alloying elements, Carbon steels v/s Alloys steels, corrosion resistant steels, Heat treatment, Corrosion prevention methods, Selection and application of steel alloys to aircraft manufacture

#### UNIT 4

#### **Light Metal Alloys**

Aluminum alloys, Heat treatment, High strength and high corrosion resistant alloys, Magnesium alloys and their properties, Heat treatment. Application to Aerospace Vehicle of these alloys.

#### UNIT 5

#### **High Strength and Heat Resistant Alloys**

Classification of heat resistant materials and iron, Nickel and cobalt base alloys, Refractory materials: Ceramics, Titanium and its alloys, properties of Inconel, Monal and K-Monal, Nimonic and super alloys: Application to Aerospace vehicles.

#### UNIT 6

Transparent Materials, plastic, Rubber, Synthetic Rubber wood, Fabrics.

#### UNIT 7

#### **COMPOSITE MATERIALS:** Types, curing processes.

UNIT 8 Aircraft Manufacturing Processes Profiling, Hydro forming, mar forming bending rolls, Spar milling, Spark erosion and Powdered metal parts, integral machining, Contour etching, High energy rate forming, Manufacturing of honeycomb structures, General methods of construction of aircraft and aero engine parts.

#### Text Books:

1. G.F.Titterton, "Aircraft Materials and Processes", Himalayan Books, New Delhi

#### References

- 1. Chapman WAJ, "Workshop Technology", Vol. I, II, III.
- 3. G.B.Ashmead, "Aircraft Production Methods".
- 4. Lalit Gupta, "Advanced Composite Matertials", Himalayan Books, New Delhi, 1998

**Note:** Eight questions are to be set two questions from unit-1, 2 & 4 and one from unit-3 & 5. Students have two attempt five questions.



#### EE-230 AIRCRAFT ELECTRICAL SYSTEMS & INSTRUMENTS

L	Т	Р

3 1 -

Class Work	:	50 Marks
Exam.	:	100 Marks
Total	:	150 Marks
Duration of exan	1. :	3 Hours

#### UNIT 1

#### AC and DC Power Supply

Batteries Lead Acid and Nickel Cadmium, Battery charging (From "" External Power" / " On Board") DC/AC Generator Construction, Constant Frequency Generators, Paralleling Load sharing, Synchronization, Power conversion, Rectifier Units, Rotary converters, Static Inverters.

#### UNIT 2

#### **Power distribution**

Busbar System, Split Busbar, Combination of parallel operation, Wires and Cables (Types, routing and special Purpose Cables ), Earning and Grounding, Cable Termination, Electrical Bonding, Standardizing of Distribution.

#### UNIT 3

#### **Circuit Controlling and Circuit Protection Devices**

Various Types of Switches (Toggle switch, Push-in solenoid Switch, micro switch, Mercury switch, Thermal switch, Proximity switch) and Relays.

Fuses, current limiters, circuit breakers, over voltage protection and under voltage protection systems.

#### UNIT 4

#### **Measuring Instruments**

Ammeters and voltmeters, Moving coil Instruments, shunts, Instrument transformers, measurement of d.c.loads, frequency meters, Power Meters,

## Unit 5

#### **Indicator System**

Oscilloscope, Electronic Display system, Central warning system,

#### UNIT 6

#### **Power Utilisation Systems**

Lighting System: anti-collision lighting, landing lights and taxi lights, cockpit lights. Engine Starting Systems: Turbine Engine starting, turbo starter system, starter generator system, Ignition systems, Auxiliary starting devices, Impulse coupling, booster coils, ignition switches. Turbine engine ignition system, Fire detection and extinguishing system.

#### Text Book:

1. EHJ pallet, "Aircraft Electrical Systems"' Himalayan Books

NOTE: In the semester examination, the examiner will set 8 questions in all, at least one question from each unit, and students will be required to attempt only 5 questions.

#### MATH-212 : COMPUTATIONAL NUMERICAL METHODS

LTP	Class Work : 50 Marks	3
3 1 -	Exam. : 100 Mark	S
	Total : 150 Mark	S
	Duration of exam. : 3 Hours	

#### Unit-1

#### **Errors in Numerical Calculations & Roots of Non-linear equations:**

Introduction to numerical calculations, Numbers and their accuracy, Absolute, relative and percentage

errors and their analysis, General error formula.

Bisection and Secant methods for locating root of an equation; initial approximations and convergence criteria, Newton-Raphson methods for simple and multiple roots.

#### Unit-2

#### **Interpolation and Curve Fitting**

Introduction to interpolation, Newton forward and backward interpolation methods; Taylor series approximation of functions; Lagrange interpolation method, Chebyshev Polynomials. Interpolation by quadratic and cubic spline functions. Curve fitting, Least squares method for curve fitting.

#### Unit-3

#### **Solution of Linear Systems**

Cramer rule for solution of system of liear equations; Gaussian elimination and Gauss Jorden methods with pivoting, Matrix inversion, UV factorization of matrix method, Iterative methods for linear systems; partition of matrices method.

#### Unit<sub>4</sub>

#### **Numerical Differentiation and Integration**

Approximating the derivative of a function; Numerical differentiation formulas for first and second order derivatives, Introduction to numerical Quadrature, Newton-Cotes formula, Gaussion Quadrature formula. Approximating the derivative of a Cotes

#### Unit – 5

#### **Solution of Ordinary Differential Equations**

Introduction to ordinary differential equations an their solutions; Initial value problems, Euler's methods, second and fourth order Runge-Kutta methods, Taylor series method, Predictor-Corrector methods, Systems of differential equations with constant coefficients.

#### **Review of basic FEM concepts**

FEM Discretization and the Direct Stiffness Method: Formulation of Finite Elements: Mathematical interpretation of finite elements, Computer Implementation of the Finite element Method: Pre processing: model definition, Element level calculation, Equation assembler, Equation solver

## Unit-7

#### **Dynamic analysis using FEM**

- Consistent mass and lumped mass, mass lumping technique.
- Time integration methods: explicit, implicit, explicit-implicit methods
- Stability, convergence and consistency.
- Hyperbolic systems: structural dynamics and wave propagation.

#### **Text Books**

1. Numerical Methods: Balaguruswamy; EWP.

2. Numerical methods in Scientific & Engineering Computation: M.K. Jain, S.R.K. Iyenger, R.K. Jain; New Age publication.

#### **Reference Books:**

- 1. Numerical Algorithms: E.V. Kriahnamurthy.
- 2. Numerical Methods in Science & Enginering< BS Rajashekaran: Wheeler
- 3. Introductory Methods to Numerical Analysis; SS Sastry; PHI.
- 4. Applied Numerical Analysis; F.Gerald Curtis, Weatley, O.Patrick, Wesley
- 5. Finite Element Analysis, Krishnamurthy, C.S., Tata McGraw Hill

Lab: Students are required to do Practical on different methods discussed in the Course using MAT-LAB

or C++ Language.

**NOTE:** In the semester examination, the examiner will set 8 questions in all, at least one question from each unit, and students will be required to attempt only 5 questions.

#### HUM-214 : Principles & Practices of Economics & Management

			Class Work : 50 Marks
L	Т	Р	Theory : 100 Marks
3	1	-	Total : 150 Marks
			Duration of Exam • 3 Hrs

**COURSE OBJECTIVE**: The purpose of this course is to:

- 1. Acquaint the student in the basic economic and management concepts and their operational significance and
- 2. Stimulate him to think systematically and objectively about contemporary economic and management problems.

## UNIT-1

Definition of Economics – various definitions, Nature of Economic problem, production possibility curve Economic laws and their nature. Relation between Science, Engineering, Technology and Economics.

## UNIT-2

Concepts of utility, Law of Diminishing Marginal Utility, Law of equi-marginal utility – its practical application and importance. Meaning of Demand, schedule, Law of Demand, shape of demand curve, Elasticity of Demand, factors effecting elasticity of demand, practical importance & applications of the concept of elasticity of demand, Supply and Law of Suuply, Role of demand & supply in price determination and effect of changes in demand and supply on prices.

## UNIT-3

Meaning of production and factors of production; Law of variable proportions, Returns to scale, Internal and External economics, various concept of cost – short & long term

## UNIT-4

Nature and characteristics of Indian economy (brief and elementary introduction), Privatization – meaning, merits and demerits. Globalization of Indian economy – merits and demerits.

## UNIT-5

Meaning of management, Definitions of Management, Characteristics of management, Management Vs. Administration, Management-Art, Science and Profession, Importance of Management, Development of Management thoughts.

Principles of Management, The Management Functions, Inter-relationship of Managerial functions, Introduction to marketing management – Definition, concept, objectives, functions of marketing

# **Books Recommended:**

# **Text Books**:

- 1. Principles of Economics: P.N.Chopra (Kalyani Publishers)
- 2. Modern Economics Theory K.K. Dewett (S.Chand)
- 3. Principles & Practices of Management- R.S. Gupta, B.D.Sharma,
  - N.S.Bhalla. (Kalayani Publishers)
- 4. Orgnisation and Management R.D.Aggarwal (Tata McGraw Hill)

# **Reference Books**

- 1. A Text Book of Economic Theory Stonier and Haque (Longman's Landon)
- 2. Micro Economic Theory M.L.Jhingan (S.Chand)
- 3. Micro Economic Theoru H.L.Ahuja (S.Chand)
- 4. Modern Micro Economics : S.K>Mishra (Pragati Publications)
- 5. Economic Theory A.B.N. Kulkarni & A.B. Kalkundrikar (R.Chand & Co.)
- 6. Indian Economy : Rudar Dutt & K..M.Sundhram

**NOTE:** Eight questions are to be set at least one question from each unit and the students will have to attempt five questions in all.

# EE-232 AIRCRAFT ELECTRICAL SYSTEM & INSTRUMENTS LAB

LTP	CLASS WORK	Κ:	25
Marks 0 0 2	EXAM	:	25
Marks	TOTAL	dist	50
Marks	DURATION OF EXAM		3 HRS

# LIST OF EXPERIMENTS:

- 1. Charging and Discharging of batteries.
- 2. Load test on dc generator.
- 3. Synchronization of two generators.
- 4. Study of rectifier.
- 5. Measurement of power using ammeter, voltmeter method
- 6. Measurement of power using wattmeter.
- 7. Study of cables and relays.
- 8. Measurement of power using instrument transformer
- 9. Study of oscilloscope
- 10. Study of starters

NOTE : 1. At least ten experiments have to be performed in the semester.

2. At least seven experiments should be performed from above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the syllabus of EE-230.

# AE-218 : AERODYNAMICS- LAB

L T P Marks	Class Work:	25
2 Marks	Exam :	25
	Total:	50
Marks	Duration of Exam:	3 Hrs.

# List of Experiments:

1. Use of Anemometer for measuring velocity.

2. Measurement of velocity profile in favourable and adverse pressure gradient.

3. Pressure distribution over a 2D cylinder and to find lift and drag.

- 4. Pressure distribution over an airfoil and to find lift and drag.
- 5. Experiments on potential flow Analogy (Hele-Shaw flow).
- 6. To study shocks using a water table.
- 7. To find the displacement thickness for the given aerofoil at low Reynolds number.
- 8. To plot Cp vs angle of attack for a pitching aerofoil.

Reference Books:

1. Low speed wind tunnel testing, Allen Pope, John Willey &sons

2. Low speed wind tunnel testing, W.E. Rae & Allen Pope, John Willey &sons

Note:

1. At least eight experiments are to be performed in the semester.

2. At least six experiments should be performed from the above list. Remaining two experiments may either be performed from the above list or designed & set by the concerned institute as per the scope of the syllabus.

L T P - - 2 Class Work: 25 Marks Theory: 25 Marks Total: 50 Marks Duration of Exam: 3 Hrs.

List of Experiments:

Programming related to 'Computational Numerical Methods' as available in MATLAB software.

At least ten experiments/exercises to be conducted – out of which at least six should be from MATLAB.

The student will be evaluated based on his/her awareness of the current affairs (political, environmental, social, economical etc) and his interest in the area of his study. Participation in extra-cuuricular activities eg sports, dramatics, debates, NSS, membership of societies etc and his/her general conduct during the course will contribute to the evaluation.



# **SEMESTER V**

## AE-301: AERODYNAMICS II

L T P 3 1 0 Sessional: 50 Marks Theory : 100 Marks Total : 150 Marks Duration of Exam: 3 Hrs

### Unit-I CONFORMAL TRANSFORMATION

Complex potential function, Blasius theorem, principles of conformal transformation, Kutta - Juokowaski transformation of a circle into flat plate, airfoils & ellipses.

### Unit-II INCOMPRESSIBLE FLOW OVER AIRFOILS

Glauert's thin airfoil theory, symmetrical airfoil, cambered airfoil, flapped airfoil, determination of mean camber line shapes for uniform & linear distribution of circulation. Description of flow about multi-element airfoils.

# Unit-III INCOMPRESSIBLE FLOW OVER FINITE WINGS

Downwash & induced drag, Biot-Savart's law and Helmholtz's theorem, Prandtl's classical lifting line theory, fundamental equations. Elliptic and general lift distribution over finite unswept wings, effect of aspect ratio, Drag polar ,Correlation of Cl distribution over other aspect ratios, Lifting Surface theory, Formation Flying, Ground effect.

### Unit-IV COMPUTATIONAL AERODYNAMICS OF AIRFOILS AND WINGS

Computation of flow field due to distribution of source doublet and line and horse shoe vortices, vortex lattic method, wing as a planar surface covered with HSVs.

### Unit-V DELTA WING AERODYNAMICS

Polhamus theory, leading edge suction analogy, calculations of lift coefficient, flow field, aspect ratio effect, leading edge extension, HAA aerodynamics

### Unit-VI COMPRESSIBLE SUBSONIC FLOWS OVER AIRFOILS

The derivation of velocity potential equation. Linearization , Prandtl-Glauert compressibility correction. Karman – Tsien correction, Critical Mach number, Whitcomb's area rule, Super critical airfoil.

### BOOKS:

- 1. Fundamentals of Aerodynamics : John D.Anderson,2nd Ed. McGrawHill,1991
- 2. Aerodynamics for Engineers : Bertin and Smith, Prentice Hall, 1989

#### **REFERENCE**:

1 Aerodynamics for engineering students ; Houghten EL & Brock AE



### AE-303: FLIGHT MECHANICS

L T P 3 1 0

Sessional: 50 Marks Theory : 100 Marks Total : 150 Marks Duration of Exam: 3 Hrs

### Unit-1 Stick Fixed Static Longitudinal Stability

Introduction to stability of airplane, stick fixed longitudinal stability, effect of power, Neutral point, Centre of gravity limits. In flight measurement of stick fixed neutral point.

### Unit-II Control Surfaces And Aerodynamic Balancing

Control surface hinge moments, floating and restoring tendencies, different types of tabs used on airplanes. Frise Aileron, Spoler Controls.

### Unit-III Stick Free Static Longitudinal Stability

Effect of free elevator on airplane stability, Elevator Control force, stick force gradients, Neutral point, Controls free center of gravity limit. In flight measurement of stick free neutral point.

### Unit-IV Maneuvering Flight

Effect of acceleration on airplane balancing, Elevator angle per g, and stick force per g, Maneuver margins.

### *Unit-V* Directional Stability And Controls

Assymetric flight, Weather cock stability, contribution of different parts of Airplane, Rudder Fixed and Rudder free static directional stability, rudder lock.

### Unit-VI Lateral Stability And Control

Dihedral Effect. Contribution of different. Parts of airplane controls in Roll, Aileron control power, cross coupling of lateral and directional effects.

### Unit-VII Dynamic Stability

Introduction to dynamics, spring-mass system. Equations of motion without derivation, stability derivatives

- (a) Longitudinal Dynamic Stability: Approximate analysis of short period and phugoid modes, stick-fixed and stick-free.
- (b) Lateral and Directional Dynamic Stability: approximate analysis of roll subsidence spiral mode and dutch roll.

### BOOKS:

- 1. Airplane Performance Stability and Control Perkins And Hage, John Wiley, 1949
- 2. Dynamics of flight : Bernard Etkin, John Wiley 1989

#### REFERENCE:

1 Aircraft stability and control for pilots and engineers : Dickinson

Note: In the semester examination, the examiner will set Eight questions, atleast one question from each unit. The students will be required to attempt only 5 questions

# MAHARSHI DAYANAND UNIVERSITY ROHTAK

### AE-305: AEROELASTICITY

L T P 3 1 0 Sessional: 50 Marks Theory : 100 Marks Total : 150 Marks Duration of Exam: 3 Hrs

### Unit-I Introduction

Definition and historical background, Static and dynamic aeroelastic phenomenon, integretion of aerodynamic, elastic and inertia forces, influence of aeroelstic phenomenon on air craft design, comparison of critical speeds.

Unit-II Divergence Of Lifting Surface

The phenomenon of divergence, divergence of 2-D wing section, divergence of an idealized cantilever wing, solution based on semi-rigid assumptions, solution to generalized co-ordinates Method of successive approximation, use of Numerical Methods.

Unit-III Steady State Aero-Elasticity Problems In General

Loss and reversal of aileron Control: 2D case, aileron reversal general case. Lift distribution on a rigid and elastic wing. Effect on Static Longitudinal stability of airplane.

Unit-IV Introduction To Flutter And Buffeting

The phenomenon of flutter, flutter of a cantilever wing. Approximate determination of critical speed by Galerkin's Method, buffeting and stall flutter--an introduction

Unit-V Non Aeronautical Problems

Some typical example in civil engineering, Flow around an oscillating circular cylinder applications to H-shaped sections, Prevention of aero-elastic instabilities.

BOOKS:

1. An introduction to the Theory Of Aeroelasticity : Y.C. Fung, Dover Publications 1st Ed.1967

### **REFERENCE**:

1. Aeroelasticity : R.L Bisplinghoff Holt Ashley R.L Halfman Addison –Wesley Publishing Co. Reading Mass ,1st Ed,1965

AE-307: WIND TUNNEL TECHNIQUES

L T P 3 1 0 Sessional: 50 Marks Theory : 100 Marks Total : 150 Marks Duration of Exam: 3 Hrs

Unit-I WIND TUNNEL AS A TOOL

Test section, diffuser, fan section, fan design, return passage, cooling ,The breather- vibration, test section flow quality, diffuser design , wind tunnel construction , energy ratio, final form.

Unit-11 INSTRUMENTATION AND CALIBRATION OF TEST SECTION

Measurement of pressure, velocity, turbulence , flow angularity, hot wire anemometry, laser velocimeter, data acquisition, flow visualization techniques, wind tunnel calibration.

Unit-III MODEL FORCES, MOMENT AND PRESSURE MEASUREMENT

Wind tunnel balances- Internal & External balances, design of wind tunnel balances, Wake survey method.

Unit-IV WIND TUNNEL CORRECTION

Method of Images, boundary corrections, buoyancy corrections, wake blockage, solid blockage-(2D & 3D corrections).

Unit-V NON AERONAUTICAL USES OF THE WIND TUNNEL

Applications in wind engineering, Surface vehicle testing, testing of buildings for wind forces, pollution, other applications at low Reynolds numbers.

BOOKS:

1. Low speed wind tunnel testing, : W.E.Rae and A.Pope, John Wiley 1985.

**REFERENCE**:

1. Measurement of Airflow Pankhrust and Ower, Pergamon Press

### AE-309: AIRCRAFT PROPULSION

L T P 3 1 0 Sessional: 50 Marks Theory : 100 Marks Total : 150 Marks Duration of Exam: 3 Hrs

#### Unit-I

Basics, simple flows: nozzle flow, nozzle design, nozzle operating characteristics for isentropic flow, nozzle flow and shock waves. Nozzle characteristics for some operational engines. Rayleigh flow and Fanno flow. Effect of frictional duct length in subsonic flow and supersonic flow, numerical problems in 1D flow.

### Unit-II INLETS, NOZZLES AND COMBUSTION CHAMBERS

Subsonic inlets: pressure recovery, inlet sizing drag flow distortion. Supersonic inlets: Total and sonic state points, A/A\* normal shock based internal compression inlets,. Combustion systems, burners, ignition, flame stability. After burners: System design, flame stability, pressure losses etc.

### Unit-III AIRCRAFT GAS TURBINE ENGINES

Air-standard Brayton cycle, actual gas turbine engine cycle, compressor and turbine efficiencies, compressor work and turbine work, centrifugal and axial type of compressor, their comparative action, relative merits in operations, combustion chambers: various arrangements, simplex and duplex burners. line design. Flow path dimensions, no. of blades per stage. Radial variation, design process, performance.

### Unit-IV AXIAL FLOW COMPRESSOR

Euler's Turbo machinery equations. Axial flow compressor analysis, cascade action, flow field. Euler's equation, velocity diagrams, flow annulus area stage parameters. Degree of reaction, cascade airfoil nomenclature and loss coefficient, diffusion factor, stage loading and flow coefficient, stage pressure ratio, Blade Mach No., repeating stage, repeating row, mean

### Unit-V AXIAL FLOW TURBINE

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

### Unit-VI PROPELLERS

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

### BOOKS:

- 1. Gas Turbine Theory Saravanamuttoo, H I H , RC
- 2. Aircraft Gas Turbine Engine Technology Treager, IRWIN E

### **REFERENCE**:

1. Jet Aircraft power systems: Casamassa JV & Bent

AE-311: Communication and Navigation

L T P 3 1 0 Sessional: 50 Marks Theory : 100 Marks Total : 150 Marks Duration of Exam: 3 Hrs

### Unit – I: Introduction to Radar:

Principle of Radar; Block diagram of pulse Radar system, Radar frequencies, Applications of Radar, Classification of Radar, Radar range equation in simple form, Factors affecting the radar performance, Minimum detectable signal.

### Unit – II: Electronic Aids to Navigation:

Principle, operation and characteristics of: Radio Direction finder, ADF system, VOR and DVOR, LORAN, OMEGA Navigation system, DME & TACAN, Instrument Landing System (ILS) & Microwave Landing system (MLS), Doppler Navigational System, Radio Altimeter System, Satellite Navigational System – NAVSAT, GPS, DGPS.

Unit – III: Guidance:

Basic Guidance system, Types of Guidance systems, Gyros, Gyroscopes as motion sensors, various types of gyros. Rate gyros monitors. Accelerometers –Introduction; theory accelerometers or sensor for INS and FCS. Inertial Navigation system (INS), Strap down navigation system.

### Unit – IV: Display Systems:

Operation and working of - Cathode Ray Tubes (CRT), LCD, Active Matrix LCD, Head Down Display (HDD), Head up display (HUD), Helmet Mounted Display (HMD), Integrated stand by Instrument system (ISIS), Plan Positions Indicator (PPI), Comparison of earlier flight deck (Electromechanical type instruments) to modern flight deck (glass flight deck)

#### Unit – V: Sensors:

Air data sensing, Role of Air data computer, Magnetic sensing – Magnetic Heading Reference System, Radar Sensing – Radar Altimeter, Doppler Radar, Weather radar.

Unit – VI: Communication:

HF,V/UHF , Satellite communication, Air traffic control transponder, traffic collision and avoidance system, Identification of friend or foe

Text Books:

1 Malvino, A.P. and Leach, D.P.," Digital Principles and Application ", Tata McGraw Hill, 1990

Reference Books:

- 1. Introduction to radar; M I Skolnik; MGH
- 2. Middleton, D.H., Ed., " Avionics systems ", Longman Scientific and Technical, Longman Group UK Ltd., England, 1989
- 3. Spitzer, C.R., Digital Avionics systems ", Prentice-Hall, Englewood Cliffs, N.J., U.S.A., 1987
  - Fundamental of Radar, Sonar and Navigation Engg.; K.K. Sharma; S.K. Kataria & sons Malvino, A.P. and Leach, D.P.," Digital Principles and Application ", Tata McGraw Hill, 1990
- 5. Gaonkar, R.s., "Microprocessors Architecture Programming and Applications " Wiley and Sons Ltd, New Delhi, 1990

### AE-313: AIRCRAFT STRUCTURES LAB

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Sessional	:	25 Marks
Practical	:	25 Marks
Total	:	50 Marks
Duration of Exa	m	: 3 Hrs

### List of experiments

- 1 study the construction of fuselage and identify the primary load carrying members
- 2 Study the construction of wings, ailerons, flaps, slits, slats and spoilers.
- 3 Study the construction of empennage, stabilizers, rudders adjusting tabs etc with detail
- 4 of honeycomb structure.

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- 5 Study the construction of landing gears and wheel turning mechanism
- 6 Study of aileron control linkages including artificial feel mechanism, booster and mannual controls and their adjustments
- 7 Study the measurement techniques with strain gauges
- 8 Study checks on airframe for life extension
- 9 Dye penetrant testing for surface crack detection
- 10 Measurement of deflection of truss using DTI
- 11 Measurement of deflection of simply supported beam
- 12 Determination of compressive strength of thin plates

# NOTE

- 1 At least eight experiments are to be performed in the semester
- 2 At least six experiments are to be performed from above list. Remaining two experiments may either be performed from above list or designed and set by concerned institute as per the scope of the syllabus



### AE-315: PROPULSION LAB

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Sessional: 25 MarksPractical: 25 MarksTotal: 50 MarksDuration of Exam: 3 Hrs

### List of Experiments :

- 1. Study the constructional details of axial flow compressor
- 2. Study the constructional details of centrifugal compressor
- 3. Study of accessory gear box and its construction
- 4. Study the constructional details of main fuel pump
- 5. Study the constructional details of combustion chamber
- 6. Study the constructional details of after burning system
- 7. Study the constructional details of piston engines
- 8. Study the functioning of complete jet engine
- 9. Study the constructional details of propellers

### NOTE

- 1 At least eight experiments are to be performed in the semester
- 2 At least six experiments are to be performed from above list. Remaining two experiments may either be performed from above list or designed and set by concerned institute as per the scope of the syllabus
- 3 Students will be taken to HAL/ Air Force Station to witness Aero engine run on test bed .

### AE-317: COMMUNICATION AND NAVIGATION LAB

L T P 0 0 3 Sessional : 25 Marks Practical : 25 Marks Total : 50 Marks Duration of Exam : 3

9 10

Hours

# List of experiments

- 1. Carry out the functional check of radio altimeter
- 2. Carry out functional check of gyros for their rigidity & precision & study of various type of gyros and their errors.
- 3. Comparison of electromechnical instruments and digital instruments.
- 4. Working of DME and measurement of distance.
- 5. Setting up of V/UHF communication.
- 6. Carry out functional check of control by Fly by wire.
- 7. Obtain co-ordinates with GPS.

# NOTE

1. At least eight experiments are to be performed in the semester.

2. At least six experiments are to be performed from above list. Remaining two experiments may either be performed from above list or designed and set by concerned institute as per the scope of the syllabus.

# SEMESTER VI

### AE-302: INTRODUCTION TO WIND ENERGY

L T P 3 1 0 Sessional: 50 Marks Theory : 100 Marks Total : 150 Marks Duration of Exam: 3 Hrs

### Unit-I INTRODUCTION

History of wind power technology, wind resources, economic viability, experience in Europe and America, The Indian experience, factors in favor of wind energy, environmental effects.

### Unit-II CLASSIFICATION OF WIND MACHINES

Types of wind energy collectors: horizontal axis rotors; Head on, Fixed pitch and variable pitch blade rotors, cross wind. Vertical axis rotors; Savonius type and its variants, Darrieus type .lift based devices and drag devices.

### Unit-III SOME CASE STUDIES

Description of various types of wind energy conversion systems (WECS) in use through their design features from 1kW range onwards. Considerations of complexities getting in to the design and operation with increase in size and power output.

### Unit-IV APPLICATION:

Stand alone system; water pumping, direct heating and electric generation applications. Wind energy farms; Grid connected mode , hybrid mode.

### Unit-V SITING

Wind histories, wind characteristics, power in wind stream, recording wind streams, wind rose, choice of site.

### Unit-VI PERFORMANCE OF WIND MACHINES

Power extraction from the wind stream, Ideal power coefficient, Typical performance curves for various types, maximum power coefficients, speed-torque curves, power density of a wind stream, ducted system, vortex generator.

### Unit-VII SYSTEM DESIGN

Objectives, power requirements, wind availability, type and size of WECS required, cost of energy delivered, WECS viability, system characteristics, system requirements, system evaluation, design optimization, wind system design synthesis.

### BOOK:

Wind Machines : Frank R Eldridge, Van Nostrand Reinhold 1980.

#### REFERENCE:

Wind power principles, Calvert, NG, Charles Griffin & Co.

Note: In the semester examination, the examiner will set Eight questions, atleast one question from each unit. The students will be required to attempt only 5 questions

# MAHARSHI DAYANAND UNIVERSITY ROHTAK

AE-304: COMPRESSIBLE AERODYNAMICS

L T P 3 1 0 Sessional: 50 Marks Theory : 100 Marks Total : 150 Marks Duration of Exam: 3 Hrs

Unit – I Shock Waves :

Introductory remarks, point source in a compressible flow, Mach waves and shock waves.

- 1. Normal Shock waves: equation of motion for a normal shock,normal shock relations for a perfect gas,stagnation conditions,RH relations,propagating shock waves,weak shock, reflected shock wave,centered expansion waves,shock tube. Numerical examples
- 2. Oblique Sock waves: Introduction, oblique shock relations, M-θ-β relations, shock polar, supersonic flow over wedge, weak oblique shock, supersonic compression, detached shock. Numerical examples.

### Unit-II Expansion waves:

Supersonic expansion by turning, Prandtl-Meyer flow, Numerical problems. Simple and non simple regions, reflection and intersection of shocks and expansion waves, Mach reflections, Method of characteristics, numerical examples

#### Unit-III Lift and drag in supersonic flows:

Shock –Expansion theory, flow field in supersonic,flowfield in supersonic flows, numerical problems,thin airfoil theory,analytical determination of lift and drag coefficients on flat plate, biconvex,and diamond shaped sections in supersonic flows,numerical problems, supersonic leading and trailing edges.

#### Unit-IV Potential equation for compressible flows:

Introduction, Crocco's theorem, derivation of basic potential equation foe compressible flows, linearization of governing equation, boundary conditions, small perturbation theory, application to wavy wall, bodies of revolution.

#### *Unit-V* Airfoils in compressible flow:

Introduction, linearized compressible flow, airfoils in subsonic flow, Prandtl-Glauert transformation, critical Mach number, supercritical flows, airfoils in transonic flow, governing equations, shock wave boundary layer inter action, stability and control problems.

#### *Unit-VI* Measurements in Compressible flows:

Rayleigh's supersonic Pitot formula, Equipment used in supersonic flows, supersonic wind tunnels, heat transfer tunnels, shoch tunnels, Aero-ballistic ranges, terminal ballistic range, rocket sled facility, special instrumentation for these types of tunnels.

BOOK:

1. Aerodynamics and thermodynamics of compressible fluid flow: Shapiro A.H., Vols I& II

**REFERENCES**:

- Elements of Gas Dynamics : Lieppmann and Rosheko ,John Wiley 1957
- Modern compressible Flow with historical perspective: John D. Anderson
- Experimental Methods in Hypersonic flows: J. Lucasiewisz.



AE-306: AIRCRAFT SYSTEMS

L T P 3 1 0 Sessional: 50 Marks Theory : 100 Marks Total : 150 Marks Duration of Exam: 3 Hrs

Unit-1. Air conditioning and Cabin pressurization

- Air Supply Sources including engine bleed, APU and ground Cart
- Air-conditioning System component layout, functioning of individual components & routine checks on the system
- Distribution System
- Flow temperature and humidity control
- Unit- 2. Fire protection system Fire and smoke detection and warning system, Fire Extinguishers system, Portable fire extinguisher type of Fire detectors, standard operating procedures for fire on ground.
- Unit-3. Fuel System System layout, fuel tanks, supply system, dumping, venting and draining Indications and warning, functioning of various components, checks during routine servicing. Common problems in the system components
- Unit- 4. Hydraulic power system layout, hydraulic reservoirs and accumulators, pressure Generation, pressure control, indication and warning system functioning of hydraulic pump. Checks on hydraulic oil, layout of hydraulic lab.
- Unit-5. Ice protection system Ice formation classification and detection, anti icing system, deicing system, working of system in general. Effect of ice formation on functioning on various system.
- Unit-6. Oxygen system system layout, supply regulation, sources, storage charging and distribution. Indications and warning Engine oxygen system, procedures for carrying out oxygen leak check, precaution while working on oxygen system.

### BOOKS

Airframe and Power plant mechanics – Airframe hand book Civil Aircraft Injection Procedure

### REFERENCES

Aircraft repair manual – Lary Rethmaier Light Aircraft Inspection – J E Heywrod



# **ME – 310 E MEASUREMENTS AND INSTRUMENTATION**

Р	Sessional	: 50 Marks	
	Theory	: 100 Marks	
	Total marks	: 150 Marks	
	Duration of	Duration of Exam: 3 Hrs.	

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**Unit I** Instruments and Their Representation : Introduction, Typical Applications of Instrument Systems, Functional Elements of a Measurement System, Classification of Instruments, Standards and Calibration.

**Unit II** Static and Dynamic characteristics of Instruments : Introduction, Accuracy, Precision, Resolution, Threshold, Sensitivity, Linearity, Hysteresis, Dead Band, Backlash, Drift, Formulation of Differential Equations for Dynamic Performance- Zero Order, First Order and Second order systems, Response of First and Second Order Systems to Step, Ramp, Impulse and Harmonic Functions.

- Unit III Transducer Elements : Introduction, Analog and Digital Transducers, Electromechanical; Potentiometric, Inductive Self Generating and Non-Self Generating Types, Electromagnetic, Electrodynamic, Eddy Current, Magnetostrictive, Variable Inductance, Linearly Variable Differential Transformer, Variable Capacitance, Piezo-Electric Transducer and Associated Circuits, Unbonded and Bonded Resistance Strain Gages. Strain Gage Bridge circuits, Single Double and Four Active Arm Bridge Arrangements, Temperature Compensation, Balancing and Calibration, Ionisation Transducers, Mechano Electronic Transducers, Opto-Electrical Transducers, Photo Conductive Transducers, Photo Volatic Transducers, Digital Transducers, Frequency Domain Transducer, Vibrating String Transducer, Binary codes, Digital Encoders.
- Unit IV Intermediate, Indicating and Recording Elements : Introduction Amplifiers, Mechanical, Hydraulic, Pneumatic, Optical, Electrical Amplifying elements, Compensators, Differentiating and Integrating Elements, Filters, Classification of Filters, A-D and D-A Converters, Digital Voltmeters (DVMs), Cathode Ray Oscillo scopes (CROs), Galvanometric Recorders, Magnetic Tape recorders, Data Acquisition Systems, Data Display and Storage.
- Unit V Motion, Force and Torque Measurement : Introduction, Relative motion Measuring Devices, Electromechanical, Optical, Photo Electric, Moire-Fringe, Pneumatic, Absolute Motion Devices, Seismic Devices, Spring Mass & Force Balance Type, Calibration, Hydraulic Load Cell, Pneumatic Load Cell, Elastic Force Devices, Separation of Force Components,

Electro Mechanical Methods, Strain Gage, Torque Transducer, Toque Meter.

- Unit VI Pressure and Flow Measurement : Pressure & Flow Measurement, Introduction : Moderate Pressure Measurement, Monometers, Elastic Transducer, Dynamic Effects of Connecting Tubing, High Pressure Transducer, Low Pressure Measurement, Calibration and Testing, Quantity Meters, Positive Displacement Meters, Flow Rate Meters, Variable Head Meters, Variable Area Meters, Rotameters, Pitot-Static Tube Meter, Drag Force Flow Meter, Turbine Flow Meter, Electronic Flow Meter, Electro Magnetic Flow meter. Hot-Wire Anemometer.
- Unit VII Temperature Measurement : Introduction, Measurement of Temperature, Non Electrical Methods – Solid Rod Thermometer, Bimetallic Thermometer, Liquid-in-Glass thermometer, Pressure Thermometer, Electrical Methods – Electrical Resistance Thermometers, Semiconductor Resistance Sensors (Thermistors), Thermo–Electric Sensors, Thermocouple Materials, Radiation Methods (Pyrometry), Total Radiation Pyrometer, Selective Radiation Pyrometer.
- **Unit VIII** Basic Statistical Concepts : Types of Measured Quantities (Discrete and Continuous), Central Tendency of Data, Mode, Median, Arithmetic Mean, Best Estimate of true Value of Data, Measures of Dispersion, Range, Mean Deviation, Variance, Standard Deviation, Normal Distribution, Central Limit Theorem, Significance Test, Method of Least Squares, Graphical Representation and Curve Fitting of Data.

Text Books :

- 1. Measurement systems Application and Design. Ernest O. Doebelin, Tata McGraw Hill Edition (Fourth Edition) 2002.
- 2. Measurement and Instrumentation in Engineering, Francis S. Tse and Ivan E. Morse, Marcel Dekker.

Reference Books :

- 1. Principles of Measurement and Instrumentation Alan S. Morris Prentice Hall of India.
- 2. Mechanical Measurements : T.G. Beckwith, W.L. Buck and R.D. Marangoni Addison Wesley.
- 3. Instrumentation, Measurement and Analysis B.C. Nakra and K.K. Chaudhary, TMH.
- 4. Mechanical Measurements by D. S. Kumar, Kataria & Sons.

AE-308: BOUNDRY LAYER THEORY

L T P 3 1 0 Sessional: 50 Marks Theory : 100 Marks Total : 150 Marks Duration of Exam: 3 Hrs

### Unit-I BASICS

Basic laws of fluid flow- Continuity, momentum and energy equations as applied to system and control volume –Concept of flow fields- Viscous fluid flow with historical out lines of viscous flow, Boundary conditions for viscous flow problems, Development of boundary layer- Prandtl's hypothesis, Estimation of boundary layer thickness- Displacement thickness, momentum and energy thickness for two-dimensional flows. Viscosity and thermal conductivity, thermodynamic properties.

### Unit-II DERIVATION OF THE NAVIER-STOKES EQUATIONS

General stress system in a deformable body, the rate at which the fluid element is strained in a flow, Relation between stress and rate of deformation, Stoke's hypothesis, bulk viscosity and thermodynamic properties, The Navier – Stokes Equation (N-S) –General properties of Navier – Stokes Equation.

### Unit-III SOLUTIONS OF THE NAVIER-STOKES EQUATIONS

Two dimensional flow through a straight channel. Hagen- Poiseulle flow, Suddenly acceleratedplane wall, Stagnation in plane flow(Hiemenz problem), Flow near a rotating disk, Very slowmotion,Parallelflowpastasphere.

## Unit-IV LAMINAR BOUNDARY LAYER

Analysis of flow past a flat plate and a cylinder, Integral relation of Karman, Integral analysis of energy equation, Laminar boundary layer equations, Flow separation. Similarity solutions for steady two dimensional flows; Blasius solution for flat- plate flow, Boundary layer temperature profiles for constant wall temperature, Falkner-Skan Wedge flows, Free shear flows- plane laminar jet, plane laminar wake. Integral equation of Boundary layer, Karman-Pohlhausen method.Digital computer solutions. Thermal boundary layer calculations- One parameter (Uo) and two parameters (UO and  $\Delta T$ ) integral methods. Stability of laminar flows.

### Unit-V TURBULENT BOUNDARY LAYER:

Two dimensional turbulent boundary layer equations, Integral relations, Eddy-Viscosity theories, Velocity profiles; The law of the wall, The law of the wake. Turbulent flow in pipes and channels.-Turbulent boundary layer on a flat pate, Boundary layers with pressure gradient. Unit -- VI COMPRESSIBLE BOUNDARY LAYER FLOWS

Introduction to the compressible boundary layer on a flat plate, shock wave boundary layer interaction.

]BOOKS:

- 1. Viscous Fluid Flow 3rd Ed. Frank M White McGraw Hill 2006
- Boundary Layer theory 6th Ed. H. Schlichting McGraw Hill 1968

REFERENCES

1 Aerodynamics for Engineers 4th Ed. John Bertin Pearson 2004

### ME -306E HEAT TRANSFER

L T P 3 1 -	Sessional : 50 M Theory : 100 M Total : 150 M Duration of Exam :3 Hrs.	/larks Iarks
UNIT I	Basics and Laws : Definition of Heat Transfer, Reversible and irre processes, Modes of heat flow, Combined heat system and law of energy conservation.	
UNIT II	Steady State Heat Conduction : Introduction, I-D heat con	nduction

- UNIT II Steady State Heat Conduction : Introduction, I-D heat conduction through a plane wall, long hollow cylinder, hollow sphere, Conduction equation in Cartesian, polar and spherical co-ordinate systems, Numericals.
- **UNIT III** Steady State Conduction with Heat Generation : Introduction, 1 D heat conduction with heat sources, Extended surfaces (fins), Fin effectiveness 2-D heat conduction, Numericals.
- UNIT IV Transient Heat Conduction : Systems with negligible internal resistance, Transient heat conduction in plane walls, cylinders, spheres with convective boundary conditions, Chart solution, Relaxation Method, Numericals.
- **UNIT V** Convection: Forced convection-Thermal and hydro-dynamic boundary layers, Equation of continuity, Momentum and energy equations, Some results for flow over a flat plate and flow through tube, Fluid friction and heat transfer (Colburn analogy), Free convection from a vertical flat plate, Empirical relations for free convection from vertical and horizontal o\planes & cylinders, Numericals.
- **UNIT VI** Thermal Radiation: The Stephen-Boltzmann law, The black body radiation, Shape factors and their relationships, Heat exchange between non black bodies, Electrical network for radiative exchange in an enclosure of two or three gray bodies, Radiation shields, Numericals.
- **UNIT VII** Heat Exchangers: Classification, Performance variables, Analysis of a parallel/counter flow heat exchanger, Heat exchanger effectiveness, Numericals.

**UNIT VIII** Heat Transfer with Change of Phase: Laminar film condensation on a vertical plate, Drop-wise condensation, Boiling regimes, Free convective, Nucleate and film boiling, Numericals.

# **Text Books :**

- 1. Heat Transfer J.P. Holman, John Wiley & Sons, New York.
- 2. Fundamentals of Heat & Mass Transfer–Incropera, F.P. & Dewill, D.P –John Willey New York.

Reference Books :

- 1. Conduction of Heat in Solids Carslow, H.S. and J.C. Jaeger Oxford Univ. Press.
- 2. Conduction Heat Transfer Arpasi, V.S. Addison Wesley.
- 3. Compact Heat Exchangers W.M. Keys & A.L. Landon, Mc. Graw Hill.
- 4. Thermal Radiation Heat Transfer Siegel, R. and J.R. Howell, Mc. Graw Hill.
- 5. Heat Transmission W.M., Mc.Adams, Mc Graw Hill.
- **NOTE : 1.** In the semester examination, the examiner will set Eight questions, at least one question from each unit. The students will be required to attempt only 5 questions.

2. The paper setter will be required to mention in the note of question paper that the use of Steam tables, Charts, Graphical plots is permitted.

# **ME-308 E AUTOMATIC CONTROLS**

L T P 3 1 -	Sessional Marks Theory Marks Total Marks Duration of Exam	: 50 : 100 : 150 : 3 brs
	Duration of Exam	: 3 hrs.

- Unit I Introduction And Applications: Types of control systems ; Typical Block Diagram : Performance Analysis; Applications Machine Tool Control, Boiler Control, Engine Governing, Aerospace Control, Active Vibration Control; Representation of Processes & Control Elements Mathematical Modeling. Block Diagram Representation, Representation of Systems or Processes, Comparison Elements; Representation of Feedback Control systems Block Diagram & Transfer Function Representation, Representation, Representation of a Temperature, Control System, Signal Flow Graphs, Problems.
- **Unit II** Types of Controllers : Introduction : Types of Control Action; Hydraulic Controllers; Electronic Controllers; Pneumatic Controllers; Problems.
- Unit III Transient And Steady State Response: Time Domain Representation; Laplace Transform Representation; System with Proportional Control; Proportional – cum – Derivative control; Proportional – cum – Integral Control; Error Constants; Problems.
- **Unit IV** Frequency Response Analysis: Introduction; Closed and Open Loop Transfer Function; Polar Plots; Rectangular Plots; Nichols Plots: Equivalent Unity Feed Back Systems; Problems.
- **Unit V** Stability Of Control Systems : Introduction; Characteristic Equation; Routh's Criterion; Nyquists Criterion, Gain & Phase Margins: Problems.
- **Unit VI** Root Locus Method : Introduction; Root Ioci of a Second Order System; General Case; Rules for Drawing Forms of Root Ioci; Relation between Root Locus Locations and Transient Response; Parametric Variation; Problems.
- **Unit VII** Digital Control System : Introduction; Representation of Sampled Signal; Hold Device; Pulse Transfer Function; Block Diagrams; Transient Response; Routh's Stability Criterion; Root Locus Method; Nyquists Criterion; Problems.
- Unit VIII State Space Analysis Of Control Systems: Introduction; Generalized State Equation; Techniques for Deriving System State – Space Equations; Transfer Function from State Equations; Solution of State Vector Differential Equations; Discrete Systems; Problems.

### **Text Books :**

- 1. Theory & Applications of Automatic Controls by B.C. Nakra, Published by New Age International Pvt. Ltd. Publishers, New Delhi.
- 2. Modern Control Engg. by Ugata, Prentice Hall of India, New Delhi.

Reference Books :

- 1. Automatic Control Systems by Kuo' Published by Prentice Hall of India, New Delhi.
- 2. Control System Engineering, I. J. Nagrath and M. Gopal, New Age, New Delhi.



# ME-312 E INDUSTRIAL ENGINEERING

			Sessional	: 50 Marks	
L	Т		Theory	: 100 Marks	
3	1	-	Total	: 150 Marks	
			Duration of Examina	ation of Examination: 3 Hrs	

### UNIT - I

Definition of Industrial Engineering: Objectives, Method study, Principle of motion economy, Techniques of method study - Various charts, THERBLIGS, Work measurement - various methods, time study PMTS, determining time, Work sampling, Numericals.

### UNIT - II

Productivity & Workforce Management :Productivity - Definition, Various methods of measurement, Factors effecting productivity, Strategies for improving productivity, Various methods of Job evaluation & merit rating, Various incentive payment schemes, Behavioural aspects, Financial incentives.

### UNIT - III

Manufacturing Cost Analysis: Fixed & variable costs, Direct, indirect & overhead costs, & Job costing, Recovery of overheads, Standard costing, Cost control, Cost variance Analysis - Labour, material, overhead in volume, rate & efficiency, Break even Analysis, Marginal costing & contribution, Numericals.

### UNIT - IV

Materials Management : Strategic importance of materials in manufacturing industries, Relevant costs, Inventory control models - Economic order quantity (EOQ), Economic batch quantity (EBQ) with & without shortage, Purchase discounts, Sensitivity analysis, Inventory control systems - P,Q,Ss Systems, Service level, Stock out risk, determination of order point & safety stock, Selective inventory control - ABC, FSN, SDE, VED and three dimensional, Numericals.

### UNIT - V

Quality Management: Definition of quality, Various approaches, Concept of quality assurance systems, Costs of quality, Statistical quality Control (SQC), Variables & Attributes, X, R, P & C - charts, Acceptance sampling, OC - curve, Concept of AOQL, Sampling plan - Single, Double & sequential, Introduction to TQM & ISO - 9000.

# UNIT - VI

Production Planning & Control (PPC) : Introduction to Forecasting - Simple & Weighted moving average methods, Objectives & variables of PPC, Aggregate planning - Basic Concept, its relations with other decision areas, Decision options - Basic & mixed strategies, Master production schedule (MPS), Scheduling Operations Various methods for line & intermittent production systems, Gantt chart, Sequencing - Johnson algorithm for n-Jobs-2 machines, n- Jobs-3 machines, 2 Jobs n-machines, n-Jobs m-machines Various means of measuring effectiveness of PPC, Introduction to JIT, Numericals.

### UNIT - VII

Management Information Systems (MIS) : What is MIS ? Importance of MIS, Organizational & information system structure, Role of MIS in decision making, Data flow diagram, Introduction to systems analysis & design, Organizing information systems.

### UNIT – VIII

Product Design and Development: Various Approaches, Product life cycle, Role 3S's – Standardization, Simplification, Specialization, Introduction to value engineering and analysis, Role of Ergonomics in Product Design.



# ME- 318 E MEASUREMENTS & INSTRUMENTATION LAB.

	Sessional	: 25 Marks
L T P	Practical	: 25 Marks
2	Total	: 50 Marks
	Duration of E	kam: 3 Hrs.

# List of Experiments :

- 1. To Study various Temperature Measuring Instruments and to Estimate their Response times.
  - (a) Mercury in glass thermometer
  - (b) Thermocouple
  - (c) Electrical resistance thermometer
  - (d) Bio-metallic strip
- 2. To study the working of Bourdon Pressure Gauge and to check the calibration of the gauge in a dead-weight pressure gauge calibration set up.
- 3. To study a Linear Variable Differential Transformer (LVDT) and use it in a simple experimental set up to measure a small displacement.
- 4. To study the characteristics of a pneumatic displacement gauge.
- 5. To measure load (tensile/compressive) using load cell on a tutor.
- 6. To measure torque of a rotating shaft using torsion meter/strain gauge torque transducer.
- 7. To measure the speed of a motor shaft with the help of non-contact type pickups (magnetic or photoelectric).
- 8. To measure the stress & strain using strain gauges mounted on simply supported beam/cantilever beam.
- 9. To measure static/dynamic pressure of fluid in pipe/tube using pressure transducer/pressure cell.
- 10. To test experimental data for Normal Distribution using Chi Square test.
- 11. To learn the methodology of pictorial representation of experimental data and subsequent calculations for obtaining various measures of true value and the precision of measurement using Data acquisition system/ calculator.
- 12. Vibration measurement by Dual Trace Digital storage Oscilloscope.
- 13. To find out transmission losses by a given transmission line by applying capacitive /inductive load.
- 14. Process Simulator.

# Note:

- 1. At least ten experiments are to be performed in the Semester.
- 2. At least seven experiments should be performed from the above list. Remaining three experiments may either be performed from the above list or designed & set by the concerned institution as per the scope of the Syllabus.



#### AIRCRAFT SYSTEM LAB

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Sessional : 25 Marks Practical : 25 Marks Total : 50 Marks Duration of Exam : 3 Hrs

#### List of experiments

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- Carry out the functional check of cooling turbine and study the air-conditioning 1 system including cooling turbine, distribution and temperature control system
- Study of refuelling procedure and precautions during refuelling 2
- Carry out jacking up operation of the aircraft 3
- Study of hydraulic system internal leak check procedure and precautions 4
- Study of oxygen system layout and storage 5
- 6 Carry out de fuelling and study the fuel sequencing and its indications
- 7 Study of various types of fire in aircraft and use of fire extinguisher
- Study of ground running procedure and precautions during ground run 8

#### NOTE

- At least eight experiments are to be performed in the semester 1
- 2 At least six experiments are to be performed from above list. Remaining two experiments may either be performed from above list or designed and set by concerned institute as per the scope of the syllabus

## SEMESTER VII

#### AE-401: HELI COPTER DYNAMI CS

L T P 3 1 0 Sessional: 50 Marks Theory : 100 Marks Total : 150 Marks Duration of Exam: 3 Hrs

#### 1. ELEMENTARY BLADE MOTION

Historical development of helicopter and overview, Basic concepts, Introduction to hovering and forward flight theory, Rotor blade motion – flapping, feathering and lagging motion, Composite structures.

#### 2. AERODYNAMICS OF THE ROTOR IN MOTION

The actuator-disc theory, Working states of rotor, Optimum rotor, Efficiency of rotor, Ground effect on lifting rotor, The effect of finite number of blades, Induced velocity and induced power in forward flight – Mangler and Squire method, flight and wind tunnel test, The vortex wake, Aerofoil characteristics in forward flight.

#### 3. HELICOPTER TRIM AND PERFORMANCE IN MOTION

Blade forces and motion in forward flight, Force, torque and flapping coefficient, Helicopter trim analysis, Performance in forward flight.

#### 4. DYNAMIC STABILITY AND CONTROL

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

#### 5. HELICOPTER VIBRATIONS

Exciting forces, Fuselage response, Vibration absorbers, Measurement of vibration in flight.

#### BOOKS:

- 1. Helicopter Dynamics : Bramwell, A.R.S.
- 2. Principles of Helicopter Engineering : Jacob Shapiro

References:-

1. Aerodynamics of Helicopter, Gessow, A, and Myers GC

#### AE-403: AI RPLANE DESI GN

L T P 3 1 0 Sessional: 50 Marks Theory : 100 Marks Total : 150 Marks Duration of Exam: 3 Hrs

#### 1. Introduction

Aircraft design, requirements and specifications, airworthiness requirements. Weight: It's importance. Aerodynamic and structural design considerations. Classifications of airplane, Concept of configuration, features of special purpose airplanes. Unmanned aerial vehicles and their features.

#### 2. Air Loads In Flight

Classical methods of estimating symmetrical maneuvering loads on a wing in flight, basic flight loading conditions, Load factor, V-n diagram, gust loads, estimation of gust loads, structural effects. use of panel methods to estimate air load distribution on a wing.

3. Airplane Weight Estimation

Estimation of airplane weight based on airplane type / mission and material used. trends in wing loading, iterative approach

4. Wing Design Considerations

Factors influencing selection of airfoil and plan form. Span wise air loads variation with span and planform, stalling, take-off and landing considerations. BM and SF. Design principles for the structure of all metal, stressed skin wing (Civil & Military airplane).estimation of wing drag, effect of flaps.

5. Structural Layout And Integration

Structural layout of straight, tapered swept (fwd and aft) wings. fuselage, empennage, Engine locations, Cockpit and passenger cabin layout, layout of flight and engine controls.wing-fuselage jointing methods, all metal airplane considerations, use of composite materials. Preparation of 3-views .CG location.

#### 6. Landing Gears

Requirement of landing gears, different arrangements ,mechanism for retraction into fuselage and wing. absorption of landing loads, calculations of loads.

7. Airframe Power plant integration

Estimation of Horizontal and vertical tail volume ratios, number of engines, location for inlets and considerations their of. Revised CG location.

#### BOOKS:

- 1. Airplane Design- A Conceptual Approach : Daniel P Raymer.
- 2. Design of Airplane : D.Stinton

#### Reference:

1. Fundamentals of Aircraft Design: L.M.Nikolai



#### AE-407: AUTOMATIC FLIGHT CONTROL

L T P 3 1 0 Sessional: 50 Marks Theory : 100 Marks Total : 150 Marks Duration of Exam: 3 Hrs

#### 1. Introduction

Open Loop and Closed Loop (Feed Back) control systems. Types of feedback control systems. Laplace's transform.

#### 2. Feed Back Control System

Transfer function of linear systems. Impulse response of linear systems, Block diagrams of feed back control systems, Multivariable systems, Block diagram algebra.

#### 3. Analysis Of Feedback Control Systems

Typical test input signals, Time domain performance characteristics of feedback control systems. Effects of derivative and integral control. Steady State response of feedback control systemsteady State error, Frequency response.

#### 4. System Stability

Routh-Hurwitz Criterion, the Root Locus Method.

5. Longitudinal Auto-Pilots

Longitudinal Auto Pilots: Brief description through Block diagrams and Root Locus of Displacement Auto Pilot, Pitch Orientational Control System. Acceleration control system. Fly-By-Wire control system, Instrument Landing System.

#### 6. Lateral AutoPilot

Introduction, Damping of the Dutch Roll, Methods of Obtaining coordination, Yaw orientational control system

#### BOOKS:

1. Automatic Control of aircraft and Missiles : John H.Blackelock, John Wiley & Sons

#### Reference:

1. Airplane Performance Stability and Control: C.D.Perkins And .E.Hage,John Wiley & Sons

#### AE-409: AEROMODELLING LAB-I

т	Р	Sessional	: 25 Marks
0	3	Practical	: 25 Marks
		Total Duration of Exam	:50 Marks :3 Hours

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

#### List of experiments

- 1. Comparative studies of different types of airplanes and their specifications and performance details.
- 2. Preliminary weight estimations, selection of main parameters, Power plant selection, Aerofoil selection, Wing, tail and control surfaces.
- 3. Preparation of lay outs of balance diagram and three view drawings.
- 4. Drag estimation, Detailed performance, Calculations and Stability Estimates. V-n diagram.

#### NOTE

L 0

- 1. Validation of data may be done on wind Tunnel.
- 2. Suitable Software may be used to develop the design data.

#### AE-411: AIRCRAFT MAINTENANCE LAB

L T	P	Sessional	: 25
Marks			
0 0	3	Practical	: 25
Marks			
195		Total	: 50
Marks			
2 10		Duration of Exam	: 3
Hours			

#### List of experiments

- 1. Study of standard operating procedures of safely in aircraft maintenance.
- 2. Ground running precautions and carry out checks on gas turbine and air intakes prior and after the ground run with the fibroscope
- 3. Carry out Engine oil system replenishment.
- 4. Carry out Hydraulic oil system replenishment / checks by CM-20 and patch kit for contamination .
- 5. Air / oxygen charging procedure and precautions during charging.
- 6. Study of Mooring, Lashing and picketing procedures.
- 7. Crack detection with NDT checks Magnetic, eddy current and vibro acoustic techniques.
- 8. Inhibition / deinhibition of Aero engines.

#### NOTE

1. At least eight experiments are to be performed in the semester.

2. At least six experiments are to be performed from above list. Remaining two experiments may either be performed from above list or designed and set by concerned institute as per the scope of the syllabus.

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#### ME- 405 E OPERATIONS RESEARCH

L	Т	Р	Sessional	: 50 Marks
3	1	-	Theory	: 100 Marks
			Total	: 150 Marks
			Duration of Exam	: 3 Hrs.

- **Unit I** Introduction: Definition, role of operations research in decision-making, applications in industry. Concept on O.R. model building –Types & methods.
- **Unit II** Linear Programming (LP): Programming definition, formulation, solution- graphical, simplex Gauss-Jordan reduction process in simplex methods, BIG-M methods computational, problems.

**Unit III** Deterministic Model: Transportation model-balanced & unbalanced, north west rule, Vogel's Method, least cost or matrix minimal, Stepperg stone method, MODI methods, degeneracy, assignment, traveling salesman, problems.

- **Unit IV** Advanced Topic Of LP: Duality, PRIMAL-DUAL relations-its solution, shadow price, economic interpretation, dual-simplex, post-optimality & sensitivity analysis, problems.
- **Unit V** Waiting Line Models: Introduction, queue parameters, M/M/1 queue, performance of queuing systems, applications in industries, problems.

Unit VI Project Line Models: Network diagram, event, activity, defects in

network, PERT & CPM, float in network, variance and probability of completion

time, project cost- direct, indirect, total, optimal project cost by crashing of network,

resources leveling in project, problems.

Unit VII Simulation: Introduction, design of simulation, models & experiments,

model validation, process generation, time flow mechanism, Monte Carlo methods-

its applications in industries, problems.

**Unit VIII** Decision Theory: Decision process, SIMON model types of decision making environment- certainty, risk, uncertainty, decision making with utilities, problems.

**Text Books:** 

- 1. Operation Research TAHA, PHI, New Delhi.
- 2. Principle of Operations Research Ackoff, Churchaman, arnoff, Oxford IBH, Delhi.

Reference Books :

- 1. Operation Research- Gupta & Sharma, National Publishers, New Delhi.
- 2. Quantitative Techniques- Vohra, TMH, New Delhi
- 3. Principles of operation Research (with Applications to Managerial Decisions) by H.M.Wagher, Prentice Hall of India, New Delhi.
- 4. Operation Research Sharma, Gupta, Wiley Eastern, New Delhi.
- 5. Operation Research Philips, Revindran, Solgeberg, Wiley ISE.

Note: Paper setter will set eight questions, at least one from each unit. Students are required to answer five questions.

L	Т	Р	Sessional : 50 Marks
3	1	-	Theory : 100 Marks
			Total : 150 Marks
			Duration of Exam: 3 Hrs.

- **Unit I** Fundamentals : Importance of Study of Vibrations, Classifications of Vibrations, Free and Forced, Undamped and Damped, Linear and Nonlinear, Deterministic and Random, Harmonic Motion, Vector and Complex Number Representations, Definitions and Terminology, Periodic Functions, Harmonic Analysis, Fourier Series Expansion.
- **Unit II** Free and Damped Vibrations : Single Degree of Freedom system, D'Alemberts Principal, Energy Methods, Rayleighs Method, Application of these Methods, Damped Free Vibrations, Logarithmic Decrement, Under Damping, Critical and Over Damping, Coulomb Damping.
- Unit III Harmonically Excited Vibrations : Forced Damped Harmonic Vibration of Single Degree of Freedom Systems, Rotating Unbalance, Rotor Unbalance, Critical Speeds and Whirling of Rotating Shafts, Support Motion, Vibration Isolation, Energy Dissipated by Damping, Equivalent, Viscous Camping, Structural Damping Sharpness of Resonance, Vibration Measuring Instruments.
  - Unit IV Transient Vibrations : Impulse Excitation, Arbitrary Excitation, Response

to Step Excitions, Base Excitation Solution by Laplace Transforms, Response

Spectrum, Runge-Kutta Method.

- **Unit V** Two Degrees of Freedom Systems : Introduction to Multi-Degree of Freedom Systems, Normal Mode Vibrations, Coordinate Coupling, Principal Coordinates, Free Vibrations in Terms of Initial Conditions, Forced Harmonic Vibrations, Vibration Absorber, Centrifugal Vibration Absorber, Vibration Damper.
- **Unit VI** Multi degrees of Freedom Systems and Numerical Methods Introduction, Influence Coefficients, Stiffness Matrix, Flexibility Matrix, Natural Frequencies and Normal Modes, Orthogonality of Normal Modes, Dunkerley's Equation, Method of Matrix Iteration, The Holzer Type Problem, Geared and Branched Systems, Beams.

Unit VII Normal Mode Vibration of Continuous System: Vibrating String,

Longitudinal Vibrations of Rod, Torsional Vibrations of Rod, Lateral Vibrations of

Beam.

#### **Text Books :**

- 1. Theory of Vibrations with Applications W.T. Thomson, Prentice Hall of India.
- 2. Mechanical Vibration : G.K. Grover and S.P. Nigam, Nem Chand and Sons

#### **Reference Books :**

- 1. Theory and Practice of Mechanical Vibrations J.S. Rao and K. Gupta, Wiley Eastern Ltd.
- 2. Mechanical Vibrations S.S. Rao, Addison Wesely Publishing Company



#### ME- 451 E FINITE ELEMENT METHODS

L T 3 1	Theory	: 50 Marks : 100 Marks : 150 Marks : 3 Hrs.

**Unit I** Fundamental Concepts : Introduction; Historical Background, Stresses and Equilibrium, Boundary Conditions, Strain-displacement, Relations, Stress- strain Relations, Temperature Effects, Potential Energy and Equilibrium; The Rayleigh-Ritz Method, Galerkin's method. Saint Venant's Principle, Matrix Algebra, Gaussian Elimination.

- **Unit II** One-Dimensional Problems: Introduction; Finite Element Modeling, Coordinates and a Shape Functions, The Potential Energy Approach; The Galerkin Approach, Assembly of the Global Stiffness Matrix and Load Vector. Properties of Stiffness Matrix, The Finite Element Equations; Treatment of Boundary Conditions, Quadratic Shape Functions; Temperature effects.
- Unit III Two-Dimensional Problems using Constant Strain Triangles: Introduction, Finite Element Modeling, Constant Strain Triangle, Problem Modeling and Boundary conditions; Axis Symmetric Solids subjected to Axis Symmetric Loading:-Introduction, Axis Symmetric Formulation, Finite Element Modeling; Triangular Element, Problem Modeling and Boundary conditions.
- **Unit IV** Two Dimensional Isoparametric Elements and Numerical Integration: Introduction, The Four- Node quadrilateral, Numerical Integration Stress Calculations, High – Order Element; Nine-Node quadrilateral, Eight-Node Quadrilateral, Six-Node triangle, Comment on Midside Node; Problems.

Unit V Beams & Frames: Introduction, Finite Element formulation, Load Vector,

Boundary considerations, Shear Force and Bending Moment, Beams on Elastic

supports, Plane Frames, Simple Numerical.

Unit VI Three-Dimensional Problems in Stress Analysis: Introduction, Finite

Element Formulation, Stress Calculations, Mesh Preparation, Hexahedral Elements

and Higher- order Elements, Problem Modeling.

Unit VII Scalar Field Problems : Introduction, Steady-state Heat Transfer,: Introduction One-Dimensional Heat Conduction, Heat transfer in thin Fins, Two-dimensional steady-state Heat conduction, Potential Flow, Seepage, Fluid flow in Ducts.
 Unit VIII Dynamic Considerations: Introduction, Formulation, Element Mass Matrices:

Evaluation of Eigen values and Eigenvectors, Interfacing with previous Finite Element

Programs and a program for determining critical speeds of Shafts.

**Text Books** :

- 1. Introduction to Finite Elements in Engineering Analysis by Tirupathi R. Chandruipatala and Ashok R. Belagundu. Prentice Hall
- 2. The Finite Element Method in Engineering by S.S.Rao, Peragamon Press, Oxford.

#### **Reference Books:**

- 1. Finite Element Procedures, by Klaus Jurgen Bathi, Prentice Hall.
- 2. Concepts and Applications of Finite Element Analysis, by Cook, Malkus and Plesha, John Wiley.
- 3. The Finite Element Method by Zienkiewicz published by Mc Graw Hill.

4. An Introduction to Finite Element Method by J.N. Reddy published by Mc Graw Hill.

# SEMESTER VIII

#### AE-402: SPACE DYNAMICS

L T P 3 1 0 Sessional : 50 Marks Theory : 100 Marks Total : 150 Marks Duration of Exam: 3 Hrs

#### 1. Introduction

Initial works in Germany for space travel. russian and American campaigns, man in space, profile of flight from earth to a destination in space and back. The space shuttle.

#### 2. Particle Dynamics

Introduction, Newton's laws, velocity and acceleration, coordinates and rotation, the spherical pendulum, energy for one particle, angular momentum, energy for systems of particles, angular momentum , the N-body problem.

3. The Two–Body problem

Introduction, the two body problem, energy and angular momentum, orbit equation, Kepler's laws, orbit determination and satellite tracking.

4. The earth satellite operations

The Hohmann transfer, inclination-change maneuver, launc to rendezvous, decay life time, earth oblateness effect, low thrust orbit transfer.

#### 5. Rigid Body Dynamics

Introduction, choice of origin, angular momentum and energy, principal-body-axis frame, particle axis theorem, Euler's equations, Orientational angle, the simple Top.

#### 6. Satellite attitude Dynamics

Torque –Free-axisymmetric Rigid body, The general torque free rigid body, semi-rigid space craft, attitude control: Spinning and Non spinning space craft. The Yo-Yo mechanism, gravity gradient satellite, The dual spin space craft.

#### 7. Re-entry dynamics

Introduction, ballistic re-entry, skip re-entry, double dip re-entry, Aero braking, lifting re-entry.

#### 8. The Space Environment

Introduction, The atmosphere, Light and space craft temperature, charged particle motion,

magnetic mirrors, The van-atten Belts, radiation effects, Meteors, Meteorites and impact. Our local neighborhood

#### BOOKS:

1. Space Flight Dynamics : William E. Wiesel , Mcgraw Hill

#### Reference:

1. Materials for missiles and Space Craft, Parker ER



#### **AE-406: COMPUTATIONAL AERODYNAMICS**

L T P 3 1 0 Sessional: 50 Marks Theory : 100 Marks Total : 150 Marks Duration of Exam: 3 Hrs

#### 1. INTRODUCTION

Numerical experiments in aerodynamics v/s wind tunnel testing, merits and advantages, limitations, reliability and accuracy of the results, comparisons in safety, risks, cost and time factors.initial break throughs, usage of packages for plottings and graphics. Current status

#### 2. THE NAVIER-STOKES EQUATIONS

Stress and strain in a viscous fluid, strain versus rotation, isotropy, the rate of strain tensor, the two coefficients of viscosity, the N-S equations

#### 3. THE BOUNDARY LAYER

The laminar boundary layer, velocity, displacement and momentum thickness, Karman's momentum integral equation, velocity profile fitting, Thwaits method, for laminar boundary layer, Velocity profile fitting, Head's method, separation of BL, The development of circulation about a sharp-tailed airfoil, Computation of boundary layer growth along an airfoil.

#### 4. FD SOLUTION OF BL EQUATIONS:

Statement of the problem, similar solutions of the laminar incompressible boundary layer, FD method or Falkner –Skan equation, iterative solution of nonlinear equations, FD methods based on second order differential equation, based on a system of first order equations. Transformation of laminar boundary layer equations for arbitrary pressure gradients. turbulent BL, separated flows.

#### 5. COMPRESSIBLE POTENTIAL FLOW PAST AIRFOILS:

Shock waves and sound waves, equations of compressible steady potential flow, P-G equation, subsonic flow past thin airfoil, supersonic flow past thin airfoils and transonic flow past thin airfoils; aerodynamics in the transonic range, solution of TSP equation: sub critical flow, conservation v/s non conservation difference schemes. Super critical flow and upwind differencing, the relaxation iteration, the Poisson iteration.

#### BOOKS:

1. Computational Aerodynamics : Jack Moran, john Wiley, 1984

#### **REFERENCES:**

1. Computational Fluid Flow and Heat Transfer : Anderson, Tannehill and Pletcher McGraw Hill, 1984.



#### AE- 404: Rockets and Missiles

L T P 3 1 0 Sessional: 50 Marks Theory : 100 Marks Total : 150 Marks Duration of Exam: 3 Hrs

1. Ignition system in Rockets - Types of igniters - Igniter design considerations - Design consideration of liquid rocket combustion chamber, injector propellant feed lines, valves, Propellant tanks outlet and helium Pressurized and turbine feed systems - Propellant slosh and propellant hammer - Elimination of geysering effect in missiles.

2. Combustion system of solid rockets.

Airframe components of rockets and missiles - Forces acting on a missile while passing through atmosphere -

Classification of missiles - Method of describing aerodynamic forces and moments -Lateral aerodynamic moment - Lateral Damping moment and longitudinal moment of a rocket -Lift and drag forces – Drag

3. Estimation - body upwash and downwash in missiles - rocket dispersion - Numerical problems.

One dimensional and two dimensional rocket motions in free space and homogeneous gravitational fields -

Description of vertical, inclined and gravity turn trajectories - Determination of range and altitude Simple

4. Approximations to burnout velocity:-

Rocket vector control - Methods - Thrust termination - SITVC - Multistage of rockets - Vehicle optimization - Stage separation dynamics - Separation techniques.

5. Selection of materials - Special requirements of materials to perform under adverse conditions.

6. Solid Rocket Motors: General description, interior ballistics component design techniques.

7. Liquid Rocket Engines: General description, engine cycles, power balance calculation, component design fundamentals.

7. Electric Propulsion: Classification of electric propulsion systems.

8. Trajectory Analysis : The rocket equation , vertical trajectories, multistage rockets, generalized 2D trajectory.

#### **BOOKS:**

*1. Sutton, G.P., et al., " Rocket Propulsion Elements " John Wiley & Sons Inc., NewYork, 1993.* 2. Mathur, M., and Sharma, R.P., " Gas Turbines and Jet and Rocket Propulsion ", Standard Publishers, New Delhi, 1998.

#### **Reference:**

1. Cornelisse, J.W., " Rocket Propulsion and Space Dynamics ", J.W., Freeman & Co., Ltd., London, 1982.

2. Parket, E.R., " Materials for Missiles and Spacecraft ", McGraw Hill Book Co., Inc., 1982



#### ME- 402 E COMPUTER AIDED DESIGN

			Sessional	: 50 Marks
L	Т	Р	Theory	: 100 Marks
3	1	-	Total	: 150 Marks
			Duration of Exam	: 3 Hrs.

- **UNIT I** Introduction: Introduction to CAD/CAM, Historical developments, Industrial look at CAD/CAM, Introduction to CIM; Basics of geometric and solid modeling, explicit, implicit, intrinsic and parametric equations, coordinate systems.
- UNIT II **Transformations:** Introduction, transformation of points and line, 2-D rotation, reflection, scaling and combined transformation, homogeneous coordinates, 3-D scaling, shearing, rotation, reflection and translation, combined transformations, orthographic and perspective projections, reconstruction of 3-D objects.
- UNIT III **Curves**: Algebraic and geometric forms, tangents and normal, blending functions reparametrization, straight lines, conics, cubic splines, Bezier curves and B-spline curves.
- UNIT IV **Surfaces**: Algebraic and geometric forms, tangents and normal, blending functions, reparametrization, sixteen point form, four curve form, plane surface, ruled surface, surface of revolution, tabulated cylinder, bi-cubic surface, bezier surface, B-spline surface.
- UNIT V **Solids:** Solid models and representation scheme, boundary representation, constructive solid geometry, sweep representation, cell decomposition, spatial occupancy enumeration.
- UNIT VI Automation and Numerical Control: Introduction, fixed, programmable and flexible automation, types of NC systems, MCU and other components, NC manual part programming, coordinate systems, G & M codes, Part program for simple parts, computer assisted part programming.
- UNIT VII **Group Technology:** Part families, part classification and coding, production flow analysis, Machine cell design, Advantages of GT
- UNIT VIII **Flexible Manufacturing Systems & Computer aided process planning**: Introduction, FMS components, types of FMS, FMS layouts, planning for FMS, advantages and applications Coventional process planning, types of CAPP, Steps in variant process planning, planning for CAPP.

Text Books:

- 1. CAD/ CAM by Groover and Zimmer, Prantice Hall.
- 2. CAD/ CAM Theory and Practice by Zeid, McGraw Hill
- 3. Numerical Control and Computer Aided Manufacturing by Kundra, Rao & Tiwari, TMH.

#### **Reference Books :**

#### 1 CAD/CAM ( Principles, Practice & Manufacturing Management ) by Chirs Mc Mohan & Jimmie Browne, Published by Addison- Wesley.



## ME- 444- E ERGONOMICS AND WORK PLACE DESIGN

L	Т	Р	Sessional	:	50 Marks
4	-	-	Theory	:	100 Marks
			Total	:	150 Marks
			Duration of Exan	n:	3 Hrs.

- **Unit I** Basic Principles of Ergonomics, Anthropometry, Posture and Health; Anthropometry Practical; Displays, Controls and HMI; Tools and Equipment Design; Workplace Design and Assessment; Task Analysis; Questionnaire and Interview Design; Product Design and Evaluation; Designing for manufacture and maintenance; Health and Safety Legislation and Ergonomics.
- Unit II Application of Ergonomics Principles, Cognitive Ergonomics, Human Information Processing; Memory; Reading; Perception; Navigation; Problem Solving; Decision Making, Human-Computer Interaction, Input/Output Technology, Usability; Evaluation; Health problems.
- **Unit III** Future Systems, Job Design, Scientific Management, Enrichment, Enlargement, Rotation, Cells, Shift work, Management Style and Job Design, Change Management. New Technology, Unemployment, Deskilling, Introducing new technology. Questionaire design and assessment. Task analysis techniques. Measurement of human error and risk. Use of simulation and prototypes. Product Evaluation. Experimental Design.
- **Unit IV** Case Studies: A set of case studies will be used to demonstrate how ergnomics has lead to changes in work activity, safety and product design. Case studies will include advanced computer applicatons, workplace assessment and re-design, accident analysis and industrial inspection, and in manufacturing. Students will be required to apply the principles to a real life ergonomic design as applied to a product, service or computer application.

Text Books:

- 1. Work Design: Industrial Ergonomics Knoz, Stephan A., Johnson, Steven, Holcomb Hathaway, Scottsdale, AZ.
- 2. Human factors in engineering and design Sanders, M.S. & McCormick, E.J., 6<sup>th</sup> ed., McGraw-Hill, New York.

Reference Books:

- 1. Ergonomics: Man in his working environment- Murrell, K.F.H, Champan & Hall, London.
- 2. Man Machine Engineering Chapanis A: Wordsworth Publishing Co.
- 3. The Practice and Management of Industrial Ergonomics Alexander, D.C., Prentice-Hall, Englewood Cliffs, NJ.

- 4. Textbook of Work Physiology Astrand, P.O. & Rhodahl, K.– McGraw-Hill, New York.
- 5. Human Factors in Lighting Boyce, P.R. Macmillan, New York.
- 6. The Ergonomics of Workspaces and Machines : A design manual Clark, T.S. & Corlett, E.N. Taylor & Francis, London.
- 7. Ergonomics at work. Oborne, D Wiley, London.
- 8. Bodyspace–Anthropometry, Ergonomics and Design. Pheasant, S. Taylor & Francis,.

Note: In the semester examination, the examiner will set eight questions all, taking at least two question from each unit. The students have to attempt 5 questions.



	IVIE-	446 E N	DERN MANUFACTURING PROCES	SE	5
L	Т	Р	Sessional	:	50 Marks
4	-	-	Theory	:	100 Marks
			Total	:	150 Marks
			Duration of Exa	ım:	3 Hrs.

- Unit I Mechanical Processes: Ultrasonic Machining- Elements of process, cutting tool system design, effect of parameters, economic considerations, applications, limitations of the process, advantages and disadvantages. Abrasive Jet Machining- Variables in AJM, metal removal rate in AJM. Water Jet Machining- Jet cutting equipments, process details, advantages and applications.
- **Unit II** Electrochemical and Chemical Metal Removal Processes: Electrochemical Machining- Elements of ECM process, tool work gap, chemistry of the process, metal removal rate, accuracy, surface finish and other work material characteristics, economics, advantages, applications, limitations. Electrochemical Grinding Material removal, surface finish, accuracy, advantages, applications.
- **Unit III** Thermal Metal Removal Processes: Electric Discharge Machining (EDM) or spark erosion machining processes, mechanism of metal removal, spark erosion generators, electrode feed control, dielectric fluids, flushing, electrodes for spark erosion, selection of electrode material, tool electrode design, surface finish, machining accuracy, machine tool selection, applications. Wire cut EDM. Laser beam machining (LBM)- Apparatus, material removal, cutting speed and accuracy of cut, metallurgical effects, advantages and limitations.
- **Unit IV** Plasma Arc Machining (PAM): Plasma, non thermal generation of plasma, mechanism of metal removal, PAM parameters, equipments for D.C. plasma torch unit, safety precautions, economics, other applications of plasma jets. Electron Beam Machining (EBM) Generation and control of electron beam, theory of electron beam machining, process capabilities and limitations.

#### **Text Books :**

- 1. Modern Machining Processes P.C.Pandey, H.S.Shan, Tata McGraw Hill
- 2. Machining Science- Ghosh and Malik, Affiliated East-West Press

#### **Reference Books :**

- 1. Non Traditional Manufacturing Processes- Benedict G.F, Marcel Dekker
- 2. Advanced Methods of Machining- Mc Geongh J.A, Chapman and Hall

Note: In the semester examination, the examiner will set eight questions in all, taking at

least 2 questions from each unit. The students will be required to attempt only five



#### AE-408: AEROMODELLING LAB-II

L	Т.	Ρ
0	0	3

Sessional: 25 MarksPractical: 25 MarksTotal: 50 MarksDuration of Exam: 3 Hours

The design data developed in VII Semester, is to be validated by fabrication of an aircraft/ Helicopter/ flight vehicles. Suitable Experiments may be done in wind tunnel after fabrication.