

**Rajasthan Technical University, Kota**



# **B.Tech.**

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## **(Aeronautical Engineering)**

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# **Scheme & Syllabus**

**Effective from Session 2011-12**

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SEMESTER III Subject Code	Title	Hrs. / Week			IA	Exam	Total
		L	T	P			
3AN1	Mechanics of solids	3	1	Theory Subjects	20	80	100
3AN2	Material science & Engineering	3			20	80	100
3AN3	Engineering Thermodynamics	3	1		20	80	100
3AN4	Manufacturing Processes	3			20	80	100
3AN5	Object Oriented Programming in C++	3			20	80	100
3AN6	Advanced Engg. Mathematics	3			20	80	100
3AN7	Strength of Material Lab.	Practical laboratory courses		2	45	30	75
3AN8	Material science Lab.			2	45	30	75
3AN9	Production Practice Lab.			3	60	40	100
3AN10	Computer Programming Lab.			3	60	40	100
3AN11					0	0	0
3ANDC	Discipline & Extra cirricular Activity	50					
	Total	18	2	10			1000

SEMESTER IV Subject Code	Title	Hrs. / Week			IA	Exam	Total	
		L	T	P				
4AN1	Introduction to Aeronautics	3		Theory Subjects	20	80	100	
4AN2	Instrumentation And Control Engg.	3	1		20	80	100	
4AN3	Fluid Mechanics	3			20	80	100	
4AN4	Theory of Machines	3	1		20	80	100	
4AN5	Aircraft materials	3			20	80	100	
4AN6	Machine Design	3	1		20	80	100	
4AN7	Machine Design Sessional	Practical laboratory courses			3	60	40	100
4AN8	Instrumentation Lab.				2	45	30	75
4AN9	Fluid Mechanics Lab.				2	45	30	75
4AN10	Introduction to Aeronautics lab.				3	60	40	100
4AN11							0	0
4ANDC	Discipline & Extra cirricular Activity	50						
	Total	18	3	10			1000	

Note:

3AN2 Material science & Engineering  
 3AN3 Engineering Thermodynamics  
 3AN4 Manufacturing Processes  
 3AN5 Object Oriented Programming in C++  
 3AN6 Advanced Engg. Mathematics  
 4AN3 Fluid Mechanics

Common with 3ME2  
 Common with 3ME3  
 Common with 3ME4  
 Common with 3ME5  
 Common with 3ME6  
 Common with 4ME3

SEMESTER V Subject Code	Title	Hrs. / Week			IA	Exam	Total
		L	T	P			
5AN1	Vibration Engg.	3	1	Theory Subjects	20	80	100
5AN2	Heat Transfer	3	1		20	80	100
5AN3	Aircraft System	3			20	80	100
5AN4	Aircraft structure I	3	1		20	80	100
5AN5	Propulsion	3			20	80	100
5AN6.1	Reliability and Maintenance Engg.	3			20	80	100
5AN6.2	Fatigue and Fracture						
5AN6.3	Total Quality Management						
5AN7	Thermal Engineering Lab.	Practical laboratory courses		3	60	40	100
5AN8	Aircraft Structure Lab.			2	45	30	75
5AN9	Aircraft System lab.			3	60	40	100
5AN10	Propulsion Lab.			2	45	30	75
5AN11					0	0	
5ANDC	Discipline & Extra cirricular Activity	50					
	Total	18	1	10			1000

SEMESTER VI Subject Code	Title	Hrs. / Week			IA	Exam	Total
		L	T	P			
6AN1	Digital Techniques	3		Theory Subjects	20	80	100
6AN2	Mechanics of Composite Material	3			20	80	100
6AN3	Aerodynamics I	3	1		20	80	100
6AN4	Aircraft Structure II	3	1		20	80	100
6AN5	Aircraft Design	3			20	80	100
6AN6.1	Maintenance of Power Plant System	3			20	80	100
6AN6.2	CFD						
6AN6.3	Helicopter Theory						
6AN7	Aircraft Design Lab.	Practical laboratory courses		3	60	40	100
6AN8	Aerodynamics Lab.			3	60	40	100
6AN9	Airframe Lab.			3	60	40	100
6AN10	Soft Skill Development Lab.			2	30	20	50
6AN11					0	0	
6ANDC	Discipline & Extra cirricular Activity	50					
	Total	18	2	11			1000

SEMESTER VII Subject Code	Title	Hrs. / Week				IA	Exam	Total
		L	T	P				
7AN1	Aircraft Communication and Navigation	3		Theory Subjects		20	80	100
7AN2	FEM	3	0			20	80	100
7AN3	Aerodynamics II	3	1			20	80	100
7AN4	Civil aviation and Regulation	3				20	80	100
7AN5	Aircraft Instrument	3				20	80	100
7AN6.1	Maintenance of Airframe System	3				20	80	100
7AN6.2	Theory of Plate and Shells							
7AN6.3	Rocket and Missile Design							
7AN7	Finite Element Lab.	Practical laboratory courses		3	60	40	100	
7AN8	Aircraft Communication Systems Lab.			2	30	20	50	
7AN9	Aircraft Instruments Lab.			2	30	20	50	
7AN10					0	0	0	
7AN11	Practical Training & Industrial visit			2	60	40	100	
7AN12	Project Part-I			2	30	20	50	
7ANDC	Discipline & Extra cirricular Activity	50						
	Total	18	1	11				1000

SEMESTER VIII Subject Code	Title	Hrs. / Week			IA	Exam	Total
		L	T	P			
8AN1	Avionics	3	1	Theory Subjects	20	80	100
8AN2	Aircraft Performance	3	1		20	80	100
8AN3	Aircraft Stability and Control	3	1		20	80	100
8AN4.1	Aircraft Electrical Systems	3	1		20	80	100
8AN4.2	Aeroelasticity						
8AN4.3	Space Dynamics						
8AN5	Avionics Lab.	Practical laboratory courses		2	30	20	50
8AN6	Aircraft Electrical Lab.			3	60	40	100
8AN7	CAD Lab.			3			100
8AN8					0	0	0
8AN9	Project Part-II			2	120	80	200
8AN10	Seminar			2	60	40	100
8ANDC	Discipline & Extra cirricular Activity	50					
	Total	12	4	12			1000

## **3AN1 MECHANICS OF SOLIDS**

### **UNIT 1**

Simple Stress and Strain: Tension, compression, shearing stress and strain, Linear elasticity, Poisson's ratio, Hooke's law for linear elastic isotropic material, Equations of static equilibrium, Concept of free body diagram, Composite bars, Thermal stresses, Stresses on inclined planes, Generalised Hooke's law for 2D and 3D cases, Strain Energy in axial loads, Stress-strain curves: Behavior of common materials in simple tension and compression test, Concept of factor of safety and permissible stress, Introduction to plasticity, viscoelasticity, anisotropy and orthotropy.

### **UNIT 2**

Principal Stress and Strain: Combined loading, Plane stress and Plane strain, Stress and strain Transformation, Principal stress and maximum shear stress, and their planes, Concept of equivalent bending and equivalent twisting moments, Mohr's circle of stress and strain. Theories of Elastic Failures: The necessity for a theory, Different theories and their applications.

### **UNIT 3**

Members Subjected to Flexural Loads: Theory of simple bending, bending moment and shear force diagrams for different types of static loading and support conditions on beams, Moving loads, Relation between load, shear force and bending moment.

### **UNIT 4**

Bending and Shear Stresses in Beam: Bending formula, Section modulus, Distribution of bending stresses. Transverse shear stress and its distribution in circular, hollow circular, rectangular, Box, I, wide flange, T sections etc. Strain energy in bending, Combined axial and lateral loads. Thin-walled Pressure Vessels: Stresses in cylindrical and spherical vessels.

### **UNIT 5**

Torsion: Torsional shear stress in solid, hollow and stepped circular shafts, angular deflection and power transmission capacity, Strain energy in torsion, Stresses in members subjected to combined axial, bending and torsional loads.

Columns and struts: Equilibrium, buckling and stability, Short, long and intermediate columns, Euler's formula for crippling load for columns, different end conditions, equivalent length, Eccentric loading Rankine formula and other empirical relations.

### **Suggested Readings**

1. Mechanics of Materials, James M. Gere, Cengage Learning (Brooks\Cole).
2. Mechanics of Material, Pytel and Kiusalaas, Thomson (Brooks\Cole).
3. An Introduction to the Mechanics of Solids, Crandall, Dahl and Lardner, Tata McGraw Hill.
4. Mechanics of Materials, Beer, Johnston, Dewolf and Mazurek, Tata McGraw Hill.
5. Strength of Materials, Ryder G.H., Macmillan India.
6. Strength of Materials, Sadhu Singh, Khanna Publishers.
7. Mechanics of Material, Punmia, Jain and Jain, Laxmi Publications.

## **3AN2 MATERIAL SCIENCE AND ENGINEERING (Common with 3ME2)**

### **UNIT 1**

Atomic structure of Metals: Crystal structure, crystal lattice of (i) Body centred cubic (ii) Face centred cubic (iii) Closed packed hexagonal, crystallographic Notation of atomic planes and Directions (Miller Indices), polymorphism and allotropy, Crystal imperfection.

### **UNIT 2**

3 Theories of plastic deformation. Phenomenon of slip, twinning and dislocation. Identification of crystallographic possible slip planes and direction in FCC, BCC, HCP. Recovery and recrystallization, preferred orientation causes and effects on the property of metals.

### **UNIT 3**

Classification of engineering materials. Solidification of metals and of some typical alloys: Mechanism of crystallisation (i) nuclear formation (ii) crystal growth. General principles of phase transformation in alloys, phase rule and equilibrium diagrams, Equilibrium diagram of binary system having complete mutual solubility in liquid state and limited solubility in solid state, Binary isomorphous alloy system, Hume-Rothery rule, Binary system with limited solid solubility of terminal phase and in which solubility decreases with temperature and also alloy with a peritectic transformation. Equilibrium diagram of a system whose components are subject to allotropic change. Iron carbon Equilibrium diagram, phase transformation in the iron carbon diagram (i) Formation of Austenite (ii) Transformation of Austenite into pearlite (iii) Martensite transformation in steel, TTT curves.

### **UNIT 4**

Engineering properties and their measurements. Principles and applications of annealing, normalising, hardening, tempering. Recovery and recrystallization. Hardenability -its measures, variables, effecting Hardenability, methods, for determination of Hardenability. Over-heated and Burnt steel, its causes and remedies. Temper brittleness -its causes and remedies. Basic principles involved in heat treatment of plain carbon steel, alloy steels, cast iron and Non-ferrous metals and their alloys. Chemical Heat treatment of steels: Physical principles involved in chemical heat treatment procedure for carburizing, Nitriding, Cyaniding, carbo-nitriding of steel.

### **UNIT 5**

Effects produced by Alloying element on the structures and properties of steel Distribution of alloying elements (Si, Mn, Ni, Cr, Mo, Co, W, Ti, Al) in steel, structural classes of steel. Classification of steels, BIS Standards. Fibre reinforced plastic composites: Various fibres and matrix materials, basic composite manufacturing methods, applications of composite materials.

## **3AN3 ENGINEERING THERMODYNAMICS (Common with 3ME3)**

### **UNIT 1**

Basic Concepts of Thermodynamics : Thermodynamics system, control volume, Properties, state, processes and cycle, equality of temperature, Zeroth Law of thermodynamics, temperature scale, laws of perfect gas, Pure substances, vapour-Liquid -solid-phase equilibrium in a pure substances,

thermodynamic surfaces

## **UNIT 2**

Work and heat, Law of conservation of mass and energy, First law of thermodynamics, steady state Processes, Second law of thermodynamics, Heat engine, Carnot cycle, thermodynamic temperature scale, entropy, change of entropy for different processes, equivalence of Kelvin plank and clausius statements, clausius inequality.

## **UNIT 3**

Available and unavailable energy, availability of a non flow and steady flow system, Helmbeltz and Gibb's functions, Thermodynamic Relations: Important mathematical relations, Maxwell relations, Tds Relations, Joule-Thomson coefficient, Clayperon relation.

## **UNIT 4**

Air - standard power cycle, Brayton cycle, Otto cycle, diesel cycle, Dual cycle, Stirling cycle, Ericsson cycle and Atkinson cycle, Mean effective pressure and efficiencies, Four stroke petrol and diesel engine, Two stroke Petrol and diesel engine.

## **UNIT 5**

Properties of steam, phase change process, use of steam table & molier chart. Rankine cycle, Reheat cycle, Regenerative cycle, cogeneration vapour compression refrigeration cycle.

## **3AN4 MANUFACUTRING PROCESSES (Common with 3ME4)**

### **UNIT 1**

Importance of manufacturing, economic and technological definition of manufacturing, survey of manufacturing processes.

Foundry Technology: Patterns practices: Types of patterns, allowances and material used for patterns, moulding materials, moulding sands, Moulding sands; properties and sand testing; grain fineness; moisture content, clay content and permeability test, core materials and core making,coreprint; core boxes, chaplets, gating system design. Moulding practices: Green, dry and loam sand moulding, pit and floor moulding; shell moulding; permanent moulding; carbon dioxide moulding.

Casting practices: Fundamental of metal casting, sand casting, Shell-Mould casting, mold casting (plaster and ceramic), investment casting, vacuum casting, Permanent mould casting, slush casting, pressure casting, die casting, centrifugal casting, continuous casting, squeeze casting, casting alloys, casting defects, design of casting, gating system design, and riser design. Melting furnaces-rotary, pit electric, tilting and cupola.

### **UNIT 2**

Metal Joining Processes: Principle of welding, soldering, brazing and adhesive bonding. Survey of welding and allied processes. Arc welding: power sources and consumables. Gas welding and cutting: Processes and equipments. Resistance welding: principle and equipments. Spot, projection and seam welding process. Atomic hydrogen, ultrasonic, plasma and laser beamwelding, electron beam welding, and special welding processes e.g. TIG, MIG, friction and explosive welding, welding of C.I. and Al, welding defects. Electrodes and Electrode Coatings.

### **UNIT 3**

Forming and Shaping Processes: Metal working, elastic and plastic deformation, concept of strain hardening, hot and cold working, rolling, principle and operations, roll pass sequence, forging, forging operations, extrusion, wire and tube drawing processes. Forging: Method of forging, forging hammers and presses, principle of forging tool design, cold working processes-Shearing, drawing, squeezing, blanking, piercing, deep drawing, coining and embossing, metal working defects, cold heading, riveting, thread rolling bending and forming operation.

### **UNIT 4**

Powder Metallurgy: Powder manufacturing, mechanical pulverization, sintering, Electrolytic Process, chemical reduction, atomization, properties of metal powders, compacting of powders sintering, advantages and applications of P/M. Rapid Prototyping Operations: Introduction, subtractive processes, additive processes, Virtual Prototyping and applications.

### **UNIT 5**

Plastic Technology: Introduction, Classification of Plastics, Ingredients of Moulding compounds, General Properties of Plastics, Plastic part manufacturing processes such as compression moulding, transfer moulding, injection moulding, extrusion moulding, blow moulding, calendaring, thermoforming, slush moulding, laminating.

## **3AN5 OBJECT ORIENTED PROGRAMMING IN C++ (Common with 3ME5)**

### **UNIT 1**

Introduction to Object Oriented Programming: Basic concepts: Class, Object, Method, Message passing, Inheritance, Encapsulation, Abstraction, Polymorphism.

### **UNIT 2**

Basics of C++ Environment: Variables; Operators; Functions; user defined, passing by reference, passing an array to the function, inline function, scope, overloading; Pointers: objects and lvalue, arrays and pointers, the new and delete operators, dynamic arrays, arrays of pointers and pointers to arrays, pointers to pointers and functions; Strings: String I/O, character functions in ctype.h, string functions in string.h.

### **UNIT3**

Object oriented concepts using C++: Classes: Member functions, Friend functions, Constructors, Access functions, Private member functions, class destructor, static data and function members; Overloading: inline functions, this operator, overloading various types of operators, conversion operators; the StringClass; Composition and Inheritance: Hierarchy and types of inheritance, protected class members, private versus protected access, virtual functions and polymorphism, virtual destructors, abstract base classes.

### **UNIT 4**

Templates and Iterators: function and class templates, container classes, subclass templates, iterator classes; Libraries: standard C++ library, contents of a standard C headers, string streams, file processing: Files and streams classes, text files, binary files, classification of files, the

standard template library.

### **UNIT 5**

Data Structures Using C++: Linked lists - Singly linked list, Doubly linked lists, Circular lists, Stacks and Queues priority Queues, Stacks, Queues.

## **3AN6 ADVANCED ENGINEERING MATHEMATICS (Common with 3ME6)**

### **UNIT 1**

Fourier Series and method of separation of variables (Boundary value problems) Expansion of simple functions in Fourier series, half range series, change of interval, Harmonic analysis. Application to the solution of wave equation and diffusion equation in one dimension and Laplace's equation in two dimensions by method of separation of variable.

### **UNIT 2**

Laplace Transform : Laplace Transform with its simple properties . Inverse Laplace transform convolution Theorem ( withoutproof) solution of ordinary differential equation with constant coefficient .

### **UNIT 3**

Special functions : Bessel's function of first kind, simple recurrence relations, orthogonal property. Legendre's function of first kind simple recurrence relations, orthogonal property, Rodrigue's formula.

### **UNIT 4**

Numerical Analysis : Finite differences , Difference operators, forward, Backward, central & average operators. Newton's forward and backward interpolation formula, Stirling's central difference formula Lagrange's interpolation formula for unequal interval. Solution of non linear equations in one variable by Newton Raphson's and Regulafalsi's method .

### **UNIT 5**

Numerical Analysis : Numerical solution of simultaneous algebric equation by Gauss elimination and Gauss seidel method. Numerical differentiation , Numerical integration trapezoidal rule, Simpson's one third and three eight rule. Numerical solution of ordinary differential equation of first order: Picards method, Euler's, and modified Euler's method, Milne's methods and RungeKutta fourth order method.

## **3AN7 STRENGTH OF MATERIALS LAB**

1. Izod Impact testing.
2. Rockwell Hardness Testing.
3. Spring Testing
4. Column Testing for buckling

5. Torsion Testing
6. Tensile Testing
7. Compression Testing
8. Shear Testing
9. Brinell Hardness Testing
10. Bending Test on UTM.
11. Study of Fatigue Testing Machine.

### **3AN8 MATERIAL SCIENCE LAB**

1. Study of Engineering Materials and crystals structures. Study of models BCC, FCC, HCP and stacking sequence, tetrahedral and octahedral voids.
2. To calculate the effective number of atoms, co-ordination number, packing factors, c/a ratio for HCP structure.
3. Study of brittle and ductile fracture.
4. To prepare metallic samples for metallographic examination and to study the principle and construction of the Metallurgical Microscope.
5. Study of the following Micro structures: Hypo, Hyper and Eutectoid Steel, Grey, White, Nodular and Malleable Cast Iron.
6. Annealing of Steel -Effect of annealing temperatures and time on hardness.
7. Study of Microstructure and hardness of steel at different rates of cooling. Microstructure examination of white cast iron.
8. Hardening of steel, effect of quenching medium on hardness.
9. Effect of Carbon percentage on the hardness of Steel.
10. Study of various crystal structures and dislocations through models.
11. Study of Iron-Carbon Equilibrium Diagram and sketch the various structures present at room temperature.

### **3AN9 PRODUCTION PRACTICE Lab**

1. Study of lathe machine, lathe tools, cutting speed, feed and depth of cut.
2. To perform step turning, knurling and chamfering on lathe machine as per drawing.
3. Taper turning by tailstock offset method as per drawing.
4. To cut metric thread as per drawing.
5. To perform square threading, drilling and taper turning by compound rest as per drawing.
6. To study shaper machine, its mechanism and calculate quick return ratio.
7. To prepare mould of a given pattern requiring core and to cast it in aluminum.
8. Moisture test and clay content test.

9. Strength Test (compressive, Tensile, Shear Transverse etc. in green and dry conditions)
10. Hardness Test (Mould and Core).
11. Permeability Test.
12. A.F.S. Sieve analysis Test.

### **3AN10 COMPUTER PROGRAMMING LAB**

List of programs in C:

1. Program for revising control statements, arrays and functions.
2. Program using string handling and various functions described in string.h, ctype.h.
3. Program using structures and sorting algorithm (Insertion, Selection, Quick, Heap sort) and functions described in math.h.
4. Program using file handling and related functions defined in stdio.h, io.h.
5. Program using pointers, array and pointers, pointers to structures, dynamic memory allocation.
6. List of Programs in C++
7. Program using basic I/O and control statements.
8. Program using class, objects, objects as function parameters.
9. Program using functions and passing reference to a function, inline functions. Program using Inheritance and virtual base class.
10. Program using pointers, arrays, dynamic arrays. Program using functions defined in ctype.h and string.h.
11. Program using constructors, destructors. Program using function and operator over Loading.
12. List of program in C++ implementing Data Structures
13. Creating and managing (add, delete, print, insert) nodes of a Linked list.
14. Creating and managing (create, pop, push etc.) stacks and queues.
15. Note: Students should submit and present a minor project at the end of the lab.

### **4AN 1 INTRODUCTION TO AERONAUTICS**

#### **UNIT1**

Introduction: Mankind's desire to fly, various efforts in Pre-Wright Brothers era-brief historical sketch, Wright flyer, Earlier types of flying machines, Development of aeronautics in America and Europe. Progress in Aircraft design, aerospace applications. Current Status: Different types of heavier than air vehicles, along with prominent features. Airplane, Helicopter, Hovercraft, V/STOL machines, modern developments

#### **UNIT2**

Airplane Aerodynamics: Nomenclature used in Aerodynamics, different parts of airplane. Wing as lifting surface, Types of wing plan forms, Aerodynamic features like Aerofoil pressure distribution, Aerodynamic forces and moments, Lift and Drag. Drag polar, L/D ratio, high lift devices, Airplane performance like Thrust/Power available, climb and glide, maximum range and endurance, take off and landings. Illustrations through sketches/plots.

#### **UNIT3**

**Airplane Stability and Control:** Airplane axis system, forces and moments about longitudinal, lateral and vertical axes, equilibrium of forces developed on wing and horizontal tail, centre of gravity, its importance in stability and control. Control surfaces elevator sailer on sand rudder.

#### **UNIT4**

**Airplane Propulsion:** Requirement of power: various means of producing power. Brief description of thermodynamics of engines. Piston engines, Jet engines. Engine airframe combinations of various types, their performance. Detailed functioning of components of a Piston-Propengine. Use of propellers as means of producing forward thrust. Functioning of Jet engine, turbo-prop, turbo-fan, turbo-shaft, Prop-fan, Possible locations of power plant on air- plane, Rocket Propulsion, Classification of rockets like liquid and solid propellant rockets.

#### **UNIT5**

**Airplane Structure, Materials and Production:** Structural arrangement of earlier airplane, developments leading to all metal aircraft. Strength to weight ratio-choice of aircraft materials for different parts. Detailed description of wing, tail and fuselage joints. Stress-Strain diagrams, Plane and Space, Trusses, loads on airplane components, V-n diagram. Mechanical properties of materials. Materials for different components, use of composites. Aircraft production methods and equipment.

#### **Suggested Readings**

1. R S Shevell, Fundamentals of Flight, Prentice Hall
2. John Anderson Jr., Introduction to Flight, McGraw Hill.
3. Introduction to Aeronautics, By School of Aeronautics.
4. E W Somerset Maugham, Jet Engine Manual, BIP Publications
5. Fundamentals of Flight; By Dr.O.P.Sharma and Lalit Gupta.

### **4AN2 INSTRUMENTATION AND CONTROL ENGINEERING**

#### **UNIT 1**

**Electronic & Electrical Measuring Instruments:** Accuracy & precision, Repeatability, Limits of errors, Systematic & random errors, standard deviation, Gaussian error analysis, Combination of errors. Theory and working principle of galvanometer, Analog Voltmeter, ammeter and Multimeters, Digital Voltmeter, Component Measuring Instruments, Q meter, Vector Impedance meter, Measurement of RF Power ,frequency & Voltage. Introduction to shielding, grounding and interference.

#### **UNIT 2**

**OSCILLOSCOPES, SIGNAL GENERATION and TRANSDUCERS:** CRT Construction, Basic CRO circuits, CRO Probes, Oscilloscope Techniques of Measurement of frequency, Phase Angle and Time Delay, Multibeam, multi trace, storage & sampling Oscilloscopes. Curve tracers. Sine wave generators, Frequency synthesized signal generators, Sweep frequency generators. Signal Analysis - Measurement Technique, Wave Analyzers, Frequency - selective wave analyser, Heterodyne wave analyser, Harmonic distortion analyzer, Spectrum analyzer., Construction, Working Principles, Application of following Transducers- RTD, Thermocouples,

Thermistors, LVDT, RVDT, Strain Gauges, Bourdon Tubes, Bellows. Diaphragms, Seismic Accelerometers, Tachogenerators, Load Cell, Piezoelectric Transducers, Ultrasonic Flow Meters.

### **UNIT 3**

**CONTROL SYSTEMS ANALYSIS AND COMPONENTS:** open loop and close loop control systems. Block diagram algebra and transfer function. Differential equations, Determination of transfer function by block diagram reduction technique & signal flow graph method. Mason gain formula and calculation of transfer function. Basic component of electrical control system, Armature and field control methods for Speed control.

### **UNIT 4**

**TIME DOMAIN ANALYSIS OF FIRST ORDER & SECOND ORDER SYSTEMS:** Transient and steady state response analysis. Steady state error & error constants. Dynamic error and dynamic error coefficient, Performance Indices. Effects of pole and zero addition on transient and steady state response.

### **UNIT 5**

Absolute stability and relative stability. Routh's and Hurwitz criterion of stability. Root locus method of analysis. Polar plots,

## **4AN3 FLUID MECHANICS**

### **UNIT-1**

Basic Definitions and Fluid Properties; Definition of Fluid, Incompressible and compressible fluids, Fluid as a continuum, Mass, Density, specific weight, relative density, specific volume, Bulk modulus, velocity of sound Ideal fluid Viscosity. Newtonian and Non Newtonian fluid, Kinematic viscosity, Effect of temperature and pressure on viscosity, surface tension capillarity, vapour pressure and cavitation.

Fluid Statics: General differential equation, Hydrostatics Manometry, Fluid forces on submerged surfaces. Curved surfaces, Aerostatics, Isothermal atmosphere, polytropic atmosphere. The international standard atmosphere, static stability. The international standard atmosphere submerged bodies. Floating bodies.

### **UNIT-2**

Kinematics and conservation of Mass: Flow classifications. Fluid velocity and acceleration, streamlines and the streamfunction. Path line and streaklines. Deformation of a fluid element, vorticity and circulation. Irrotational and Rotational flow. Flownet, Laplace equation. Conservation of mass and the continuity equation for three dimensions.

Fluid Momentum: The Momentum theorem Applications of the momentum theorem Equation of motion, Euler's equation of motion Integration of Euler's equation of motion. Bernoulli's equation. Applications of Bernoulli's Pitot tube, Equation of motion for Viscous fluid, Navier Stoke's equation.

### **UNIT-3**

Orifice discharging free, Jet, venacontracts, co-efficient of contraction, velocity and discharge,

coefficient of resistance. Orifices and mouthpieces Nozzles and weires.

Flow Through Pipes: Reynold's experiment Darcy's Weisback equation. Loss of head due to sudden enlargements, contraction, entrance, exit obstruction, bend, pipe fittings. Total and Hydraulic grandient lines, Flow through pipeline. Pipes in series, parallel Transmission of power through pipes.

#### **UNIT-4**

Laminar Flow: Simple solution of Navier Stokes equations. Hagen–Poiseuille flow. Plans Poiseuille flow and coutteflow.

Turbulent Flow; Variation of friction factor with Reynold's number. The Prandt Mixing length hypothesis applied to pipeflow, velocity distribution in smooth pipes, soughpipes. The Universal pipe friction laws, Colebrook.White formula.

Dimensional Analysis: Buckingham variables, Model Similitude, Force ratio, Reynolds, Froude's Mach, Weber and Euler numbers and their applications. Undistorted model distorted model scale effect.

#### **UNIT-5**

The Boundary Layer: Description of the boundary layer. Boundary Layer thickness boundary layer separation and control. The Prandtl boundary layer equation. Solution for laminar boundary layer. The momentum equation for the boundary layer. The flat plate in uniform free stream with no pressures gradients. Approximate momentum analysis laminar boundary Aerofoils Theory. Flow round a body; Drag skin friction drag, pressure drag, combined skinfriction & pressure drag(Profile drag)wave drag, lift induced drag. Flow past sphere & Cylinder.

### **4AN4 THEORY OF MACHINES**

#### **UNIT -1**

Kinematics: Elements, pairs, mechanisms, four bar chain and its inversions, velocity and acceleration, Klein's construction, coriolis component, instantaneous center method, synthesis of mechanisms, pantograph, scott-Russel, Tchbeicheff straight line, indicator diagram mechanisms.

#### **UNIT -2**

Friction: Laws of static, dynamic and rolling friction, dry and viscous friction, inclined plane and screw jack, pivots and clutches. Brakes: Band, block and band & block brakes, braking action.

Dynamometers: Absorption and transmission type dynamometers, prony, rope and hydraulic dynamometers.

#### **UNIT -3**

Gears: Laws of gearing, gears terminology; tooth form; interference, undercutting and minimum number of teeth on pinion in contact with gear. Spur, helical, bevel gear, rack and pinion.

#### **UNIT-4**

Gear trains: Simple, compound, reverted and epicyclic gear trains, analytical and tabular methods for velocity ratio. Gear boxes- sliding and constant mesh.

Gyroscope: Principle of gyroscopic couple, effect of gyroscopic couple and centrifugal force on airplanes taking a turn.

## **UNIT-5**

Balancing: Balancing of rotating masses, balancing of reciprocating masses, balancing of inline engines and V-engines.

## **4AN5 AIRCRAFT MATERIALS**

### **UNIT1**

Broad classification of aircraft materials. Ferrous materials, nonferrous materials and alloys, ceramic materials and fibre reinforced composite materials, polymers, metal matrix particulate.

### **UNIT2**

#### **MATERIALS IN AIRCRAFT CONSTRUCTION-I**

Aluminum and its alloys: Types and identification. Properties–Castings–Heat treatment processes–Surface treatments. Magnesium and its alloys: Cast and Wrought alloys–Aircraft application, features specification, fabrication problems, Special treatments. Titanium and its alloys: Applications, machining, forming, welding and heat treatment.

### **UNIT3**

#### **MATERIALS IN AIRCRAFT CONSTRUCTION- II**

Steels: Plain and low carbon steels, various low alloy steels, aircraft steel specifications corrosion and heat resistant steels, structural applications. Maraging Steels: Properties and Applications Copper Alloys–Monel, KMonel Super Alloys: Use–Nickel base–Cobalt base–Iron base–Forging and Casting of Super alloys–Welding, Heat treatment.

### **UNIT4**

#### **ADHESIVE AND SEALANTS FOR AIRCRAFT**

Advantages of Bonded structure in airframes–Crack arresting–Weight saving–Technology of adhesive Bonding Structural adhesive materials–Test for bonding structure. Typical bonded joints & non destructive tests for bonded joint. Bonded Sandwich structures–Materials–Methods of construction of honeycombs

### **UNIT5**

Corrosion, its detection and prevention. Protective finishes. Testing: Destructive and non-destructive testing techniques. Crack detection, inspection of parts by hot oil and chalk, dye-penetrant, fluorescent and magnetic particles, X-ray, ultrasonic, eddy current and acoustic emission methods.

### **Suggested Readings**

1. S K Hajra Chowdhary, Materials, Science and Engineering Processes, Media Promoters
2. George E.F. Titterton, Aircraft Materials, English Book Stores, Delhi
3. M L Begman, Manufacturing Processes, Asia Publishing House, Bombay.
4. Aircraft General Engineering by Lalith Gupta, Himalaya Book House, New Delhi.
5. King and Butler, Principles of Engineering Inspection, Clever Humes Press.
6. C G K Nair, Aircraft Materials, Interline
7. Balram Gupta, Aerospace Materials, S Chand

## **4AN6 MACHINE DESIGN**

### **UNIT -1**

Design for strength: Allowable stresses, detailed discussion on factor of safety (factor of ignorance). Introduction of various design considerations like strength, stiffness, weight, cost, space etc. Design of machine elements subjected to direct stress, Pin, cotter and keyed joints. Design of screw fastening. Pre loading of bolts; effect of initial tension & applied loads.

### **UNIT -2**

Design of members in Bending: Beams and levers. Design of members in torsion: Shafts and shaft couplings.

### **UNIT -3**

Design of shafts under combined stresses, Calculation of transverse & torsional deflections. Brackets and screw fasteners subjected to eccentric loading.

### **UNIT -4**

Fatigue Considerations in Design: Variable load, loading pattern, Endurance stresses, influence of size, surface finish, notch sensitivity & stress concentration. Goodman line, Soderberg criteria, Design of machine members subjected to combined, steady and alternating stresses. Design for finite life. Design of Shafts under Variable Stresses.

### **UNIT- 5**

Design of journal bearing; method of lubrication, hydrodynamic, hydrostatic, boundary etc. Minimum film thickness and thermal equilibrium. Selection of anti-friction bearings for different loads and load cycles. Mounting of the bearings. Method of lubrication, selection of oil seals.

## **4AN7 MACHINE DESIGN SESSIONAL**

Problems on

1. Knuckle & Cotter joints
2. Torque: Keyed joints & shaft couplings
3. Design of screw fastening
4. Bending: Beams, Levers etc.
5. Combined stresses: Shafts, brackets, eccentric loading.
6. Fatigue loading
7. Preloaded bolts and bolts subjected to variable stresses
8. Sliding contact bearing design
9. Anti-friction bearing selection

## **4AN8 INSTRUMENTATION LAB**

1. Study of various electronic components, their Identification ,symbols & Testing: study of Resistances, Capacitors, Inductors, Diodes, Transistors, SCRs, ICs, Photo diode, Photo transistor ,LED, LDR, CRO demonstration kit and Potentiometers.
- 2 Plot V-I characteristics & measure open circuit voltage & short circuit current of a solar panel.

3. Measure unknown inductance capacitance resistance using following bridges  
(a) Anderson Bridge (b) Maxwell Bridge.
4. Measurement of the distance with the help of ultrasonic transmitter & receiver.
5. Measurement of displacement with the help of LVDT.
6. Draw the characteristics of the following temperature transducers:  
(a) RTD (Pt-100) (b) Thermistors (c) Thermocouple
7. Draw the characteristics between temperature & voltage of a K type thermocouple.
8. Measurement of strain/ force with the help of strain gauge load cell.

#### **4AN9 FLUID MECHANICS LAB.**

1. Determine Meta-centric height of a given body.
2. Determine  $C_d$ ,  $C_v$  &  $C_c$  for given orifice.
3. Determine flow rate of water by V-notch.
4. Determine velocity of water by pitot tube.
5. Verify Bernoulli's theorem.
6. Determine flow rate of air by Venturimeter
7. Determine flow rate of air by orificemeter
8. Determine head loss of given length of pipe.
9. Determine flow rate of air by nozzlemeter.
10. Study of Pelton, Kaplan Turbine models.

#### **4AN10 INTRODUCTION TO AERONAUTICS LAB.**

1. Smoke visualization over cylinder and airfoil section to show boundary layer separation.
2. To acquaint with aircraft fuselage constructional details and types.
3. Study of fuselage structure i.e. longerons, bulkheadstringers etc.
4. To acquaint with aircraft wing constructional details and types.
5. To acquaint with aircraft primary control surfaces along with their locations on aircraft.
6. To acquaint with aircraft secondary flight control surfaces along with their locations on aircraft
7. Study of Piston engine and its components like cylinder block, piston, camshaft, crank- shaft, piston rod, valves etc.
8. Study of Jet Engine and its components like inlet, compressors, combustion chambers, turbine exhaust cone etc.
9. To acquaint with different types of Jet Engine e.g. turbojet, turboprop, turboshaft etc.