



ANNA UNIVERSITY
Chennai-25.
Syllabus for

B.E.(Full Time) Aeronautical Engineering

AE034 Space Mechanics **3 0 0 100**

1 . BASIC CONCEPTS **4**

The solar system - Reference frames and coordinate systems - The celestial sphere - The ecliptic - Motion of vernal equinox - Sidereal time - Solar time - Standard time - The earth's atmosphere.

2 . THE GENERAL N-BODY PROBLEM **10**

The Many body problem - Lagrange - Jacobi identity - The circular restricted three body problem - Libration points - Relative Motion in the N-body problem - The two - body problem - Satellite orbits - Relations between position and time - Orbital elements.

3 . SATELLITE INJECTION AND SATELLITE ORBIT PERTURBATIONS **12**

General aspects of satellite injections - Satellite orbit transfer - Various cases - Orbit deviations due to injection errors - Special and general perturbations - Cowell's Method - Encke's method - Method of variations of orbital elements - General perturbations approach.

4 . INTERPLANETARY TRAJECTORIES **6**

Two dimensional interplanetary trajectories - Fast interplanetary trajectories - Three dimensional interplanetary trajectories - Launch of interplanetary spacecraft - Trajectory about the target planet.

5 . BALLISTIC MISSILE TRAJECTORIES **9**

The boost phase - The ballistic phase - Trajectory geometry - Optimal flights - Time of flight - Re-entry phase - The position of the impact point - Influence coefficients.

6 . MATERIALS FOR SPACECRAFT **4**

Space environment - Peculiarities -Effect of space environment on the selection of materials of spacecraft.

Total No of periods: 45

References:

1. *Sutton, G.P., " Rocket Propulsion Elements " , John Wiley, 1993.*
2. *Van de Kamp, P., " Elements of Astromechanics " , Pitman, 1979.*
3. *Cornelisse, J.W., " Rocket propulsion and space dynamics " , W.H. Freeman & Co., 1984.*
4. *Parker, E.R., " Materials for Missiles and Spacecraft " , McGraw Hill Book Co., Inc., 1982.*

- 1 . ELEMENTS OF HELICOPTER AERODYNAMICS 5**
Configurations based on torque reaction-Jet rotors and compound helicopters- Methods of control - Collective and cyclic pitch changes - Lead - Lag and flapping hinges.
- 2 . IDEAL ROTOR THEORY 15**
Hovering performance - Momentum and simple blade element theories - Figure of merit - Profile and induced power estimation - Constant chord and ideal twist rotors.
- 3 . POWER ESTIMATES 10**
Induced, profile and parasite power requirements in forward flight-Performance curves with effects of altitude- Preliminary ideas on helicopter stability
- 4 . LIFT, PROPULSION AND CONTROL OF V/STOL AIRCRAFT 8**
Various configuration - Propeller, rotor, ducted fan and jet lift - Tilt wing and vectored thrust - Performance of VTOL and STOL aircraft in hover, transition and forward motion.
- 5 . GROUND EFFECT MACHINES 7**
Types - Hover height, lift augmentation and power calculations for plenum chamber and peripheral jet machine - Drag of hovercraft on land and water. Applications of hovercraft.

Total No of periods: 45

References:

1. Gessow, A., and Myers, G.C., " *Aerodynamics of Helicopter* ", MacMillan & Co., N.Y. 1987.
2. McCormick, B.W., " *Aerodynamics of V/STOL Flight* ", Academic Press, 1987.
3. Johnson, W., " *Helicopter Theory* ", Princeton university Press, 1980.
4. McCormick, B.W., " *Aerodynamics, Aeronautics & Flight Mechanics* " John Wiley, 1995.
5. Gupta, L., " *Helicopter Engineering* ", Himalayan Books, 1996.

1 . ATMOSPHERE	5
Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height.	
2 . WIND ENERGY COLLECTORS	8
Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory.	
3 . VEHICLE AERODYNAMICS	7
Power requirement and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of trains and Hovercraft.	
4 . BUILDING AERODYNAMICS	10
Pressure distribution on low rise buildings, Wind forces on buildings, Environmental winds in city blocks, Special problems of tall buildings, building codes, building ventilation and architectural aerodynamics.	
5 . FLOW INDUCED VIBRATIONS	8
Effect of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter.	
6 . FLOW MACHINERY	7
Special features of industrial and stationary gas turbines as compared to aircraft gas turibines.	

Total No of periods: 45

References:

1. Scorer, R.S., " *Environmental aerodynamics* ", Ellis Harwood Ltd., England, 1978.
2. Sovran, M., " *Aerodynamic Drag Mechanisms of Bluff Bodies and Road Vehicles* ", Plenum Press, N.Y., 1978.
3. Sachs. P., " *Wind Forces in Engineering* ", Pergamon Press, 1988.
4. Blevins, R.D., " *Flow Induced Vibrations* ", Van Nostrand, 1990.
5. Calvert, N.G., " *Wind Power Principles*", Charles Griffin & Co., London, 1979

1 . BASICS 7

Basic laws of fluid flow - Continuity, momentum and energy equations as applied to system and control volume
- Concept of flow fields - Viscous fluid flow - Boundary conditions - Hotwire and Laser - Doppler anemometry.

2 . INTRODUCTION TO BOUNDARY LAYER 8

Development of boundary layer - Estimation of boundary layer thickness-Displacement thickness, momentum and energy thickness for two-dimensional flows.

3 . LAMINAR BOUNDARY LAYER 15

Analysis of flow past of flat plate and a cylinder - Integral relation of Karman - Integral analysis of energy equation - Laminar boundary layer equations - flow separation - Blasius solution for flat-plate flow - Boundary layer temperature profiles for constant plate temperature - Falkner Skan Wedge flows - Integral equation of Boundary layer - Pohlhausen method - Thermal boundary layer calculations - One parameter and two parameter integral methods.

4 . TURBULENT BOUNDARY LAYER 15

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 plate - 'Boundary layers with pressure gradient.

Total No of periods: 45

References:

1. White, F.M., " *Viscous Fluid Flow* ", McGraw Hill Book Co., Inc., New York, 1985
2. Reynolds, A.J., " *Turbulent Flows in Engineering* ", John Wiley & Sons, 1980.
3. Panton, R.L., " *Incompressible Flow* ", John Wiley and Sons, 1984.
4. Anderson, J.D., " *Fundamentals of Aerodynamics* ", McGraw Hill Book Co., Inc., New York, 1985.
5. Schlichting, H., " *Boundary Layer Theory* ", McGraw Hill New York, 1979.

1 . BASIC CONCEPTS 12

Basic fluid dynamics equations, Equations in general Orthogonal coordinate system, A body fitted coordinate system, Stability analysis of linear system. Finding solution of a simple gas dynamic problem, Local similar solutions of boundary layer equations. Numerical integration and shooting technique.

2 . TRANSONIC RELAXATION TECHNIQUES & PANEL METHODS 15

Small perturbation flows, Transonic small perturbation (TSP) equations, Central and backward difference schemes, Conservation equations and shock-point operator, Line relaxation techniques. Acceleration of convergence rate, Jameson's difference scheme, Stretching of coordinates, Shock fitting techniques, Flow in body fitted coordinate system. Elements of two and three dimensional panels, Panel singularities. Application of panel method to incompressible, compressible, subsonic and supersonic flows.

3 . TIME DEPENDENT METHODS 10

Stability of solution, Explicit methods, Time split method, approximate factorization scheme, Unsteady transonic flow around airfoils, Some time dependent solutions of gas dynamic problems.

4 . CONTROL VOLUME METHOD 8

Basic concepts - Staggered grid application - SIMPLE & SIMPLER algorithms - Application of the methods to practical flow problems.

Total No of periods: 45

References:

1. Bose, T.K., " *Computation Fluid Dynamics* ", Wiley Eastern Ltd., 1988.
2. Chow, C.Y., " *Introduction to Computational Fluid Dynamics* ", John Wiley, 1979.
3. Hirsch, A.A., " *Introduction to Computational Fluid Dynamics* ", McGraw Hill, 1989.
4. Fletcher, " *Computational Fluid Dynamics* ", Vol.I & II, Springer Verlag, 1993.
5. Patankar,S.V., " *Numerical heat transfer and fluid flow* ", Hemispher Publishing Corporation, 1992

1 . FUNDAMENTALS	2
Different modes of heat transfer and general principles.	
2 . HEAT CONDUCTION	8
Steady and unsteady state heat conduction in solids - Effect of variation of thermal conductivity on heat transfer in solids - Heat transfer problems in infinite and semi infinite solids - Extended surfaces - Application of numerical techniques.	
3 . CONVECTIVE HEAT TRANSFER	20
Introduction - Free convection in atmosphere free convection on a vertical flat plate - Empirical relation in free convection - Forced convection - Laminar and turbulent convective heat transfer analysis in flows between parallel plates, over a flat plate and in a circular pipe. Empirical relations application of numerical techniques in problem solving.	
4 . RADIATIVE HEAT TRANSFER	6
Introduction to physical mechanism - Radiation properties - Radiation shape factors - Heat exchange between non-black bodies - Radiation shields.	
5 . HEAT TRANSFER PROBLEMS IN AEROSPACE ENGINEERING	9
Heat transfer problems in gas turbine combustion chambers - Rocket thrust chambers - Aerodynamic heating - Ablative heat transfer.	

Total No of periods: 45

References:

1. Lienhard, J.H., " A Heat Transfer Text Book ", Prentice Hall Inc., 1981.
2. Holman, J.P., " Heat Transfer ", McGraw Hill Book Co., Inc., New York, 6th Edn., 1991.
3. Sachdeva, S.C., " Fundamentals of Engineering Heat and Mass Transfer " , Wiley Eastern Ltd., New Delhi, 1981.
4. Sutton, G.P., " Rocket Propulsion Elements ", John Wiley and Sons, 5th Edn.1986.
5. Mathur, M.and Sharma, R.P., " Gas Turbine and Jet and Rocket Propulsion " , Standard Publishers, New Delhi 1988.

1 . FUNDAMENTAL CONCEPTS IN COMBUSTION CHEMICAL KINETICS AND FLAMES 14

Thermo - chemical equations - Heat of reaction first order, second order and third order reactions - premixed flames - Diffusion flames - Measurement of burning velocity - Various methods - Effect of various parameters on burning velocity - Flame stability - Detonation - Deflagration - Rankine - Hugoniot curve - Radiation by flames.

2 . COMBUSTION IN GAS TURBINE ENGINES 10

Combustion in gas turbine combustion chambers - Re-circulation - Combustion efficiency - Factors affecting combustion efficiency - Fuels used for gas turbine combustion chambers - Combustion stability - Flame holder types - Numerical problems.

3 . COMBUSTION IN ROCKETS 12

Solid propellant combustion - Double base and composite propellant combustion - Various combustion models - Combustion in liquid rocket engines - Single fuel droplet combustion model - Combustion in hybrid rockets.

4 . SUPERSONIC COMBUSTION 9

Introduction - Supersonic combustion controlled by mixing, diffusion and heat convection - Analysis of reaction and mixing processes - Supersonic burning with detonation shocks.

Total No of periods: 45

References:

1. Sharma, S.P., and Chandra Mohan, *Fuels and Combustion*, Tata McGraw Hill Publishing Co., Ltd., New Delhi 1987.
2. Loh, W.H.T., *Jet Rocket, Nuclear, Ion and Electric Propulsion Theory and Design*, Springer Verlag, New York 1982
3. Beer, J.M. and Chigier, N.A. *Combustion Aerodynamics*, Applied Science Publishers Ltd., London, 1981.
4. Chowdhury, R., *Applied Engineering Thermodynamics*, Khanna Publishers, New Delhi, 1986
5. Sutton, G.P., et al *Rocket Propulsion Elements*, John Wiley and Sons, Inc., New York, 1993.
6. Mathur, M., and Sharma, R.P., *Gas turbines and Jet and Rocket Propulsion*, Standard Publishers, New Delhi, 1988.

1 . LIQUID FUELS 8

Properties and tests for petroleum products - Motor gasoline - Aviation gasoline - Aviation turbine fuels - Requirements of aviation turbine fuels of Kerosene type and high flash point type - Requirements for fuel oils

2 . SOLID PROPELLANTS 8

Single base propellants - Double base propellants - composite propellants - CMDB propellants - Metallized composite Propellants - Brief introduction to combustion theory of composite and double base propellants

3 . LIQUID PROPELLANTS 10

Various liquid propellants and their properties - Monopropellant and bipropellant systems - Concept of ullage - Ignition studies of liquid propellants - Propellant loading tolerances - Inventory-Volume versus mass loading - Loading measurement and control - Outage control

4 . CRYOGENIC PROPELLANTS 10

Introduction to cryogenic propellants - Liquid Hydrogen, liquid Oxygen, Liquid nitrogen and liquid helium - Theory behind the production of low temperature - Expansion Engine - Cascade process - Joule Thompson Effect - Magnetic effect - Ortho and para H₂ - Helium⁴ and Helium³ - Ideal cycles and Efficiency of cryo systems - Storing of cryogenic propellants - Cryogenic loading problems

5 . PROPELLANT TESTING 9

Laboratory testing - Arc Image Furnace - Ignitability studies - Differential Thermal Analysis - Thermo-gravimetric analysis - Particle size measurement Micro-merograph - Strand burner tests Impulse Bomb - Performance estimation

Total No of periods: 45

References:

1. Sutton, G.P., *rocket Propulsion Elements*, John Wiley, 1993.
2. Sharma, S.P. and Mohan, C., *Fuels and Combustion*, Tata McGraw Hill Publishing Co., Ltd., 1984
3. Mathur, M., and Sharma, R.P., *Gas Turbines and Jet and Rocket Propulsion*, Standard Publishers, New Delhi, 1988
4. Cornelisse, J.W., *Rocket propulsion and space dynamics*, W.H. Freeman & Co., Ltd., London, 1980.
5. Parner S.F., *Propellant Chemistry*, Reinhold Publishing Corp., New York 1985

1 . INTRODUCTION	2
Historical Background - Introduction to Cryogenic propellants - Liquid hydrogen, Liquid helium, liquid nitrogen and Liquid oxygen and their properties	
2 . PRODUCTION OF LOW TEMPERATURE	10
Theory behind the production of low temperature - Expansion engine heat exchangers - Cascade process Joule Thompson Effect - Magnetic effect - Ortho and Para H ₂ - Helium ₄ and Helium ₃	
3 . EFFICIENCY OF CRYOGENIC SYSTEMS	6
Types of losses and efficiency of cycles - specific amount of cooling - The fraction liquified - Cooling coefficient of performance - Thermodynamic efficiency - The energy balance Method	
4 . CYCLES OF CRYOGENIC PLANTS	12
Classification of cryogenic cycles - The structure of cycles - Throttle expansion cycles - Expander cycles - Thermodynamic analysis - Numerical problems	
5 . CRYOGENIC IN AEROSPACE APPLICATIONS	15
Cryogenic liquids in missile launching and space simulation - Storage of cryogenic liquids - Effect of Cryogenic liquids on properties of Aerospace materials - Cryogenic loading problems - Zero gravity problems associated with cryogenic propellants - Phenomenon of tank collapse - Elimination of Geysering effect in missiles	
Total No of periods:	45

References:

- 1. Haseldom, G., Cryogenic Fundamentals, Academic Press, 1971*
- 2. Barron, R. F., Cryogenic Systems, Oxford University, 1985*
- 3. Parner S. F., Propellant Chemistry, Reinhold Publishing Corp., New York 1985*

1 . INTRODUCTION	7
State of the art in airplane design, Classification of airplanes based on purpose and configuration, Factors affecting configuration, Merits of different airplane layouts	
2 . SHAPING THE AIRPLANE	8
Principal features, Aerodynamic consideration, Lift, Drag and Interference effects, Weights and Strength considerations, Peculiarities in layout, Designing for manufacturability, Maintenance, Operational costs, Interactive design	
3 . PRELIMINARY DESIGN PROCEDURE	6
Data collection and 3-View drawings, their purpose, weight estimation, choice of wing loading and thrust loading.	
4 . POWER PLANT SELECTION	6
choices available, Comparative merits, Location of power plants, Functions dictating the locations.	
5 . DESIGN OF MAJOR AIRPLANE COMPONENTS	18
a) Wing design: Airworthiness requirements, V-n diagram, loads, Elements of wing design, Structural features.	
b) Fuselage design: Loads on fuselage, Elements of fuselage design, Determination of tail surface areas, Structural features.	
c) Landing gear design: Loads on Landing gear, Preliminary landing gear design	
d) Elements of computer Aided Design:	

Total No of periods: 45

References:

1. *Torenbeek, E., " Synthesis of Subsonic Airplane Design " , Delft University Press, U.K. 1986*
2. *Kuechemann, D., " Aerodynamic Design of Aircraft " , Pergamon Press, 1978*
3. *Raymer, D.P., " Aircraft Conceptual Design " , AIAA Series, 1989*

1 . PROBABILITY THEORY	10
Random Variables - Probability distribution and density functions - Expected values, mean, Variance - Conditional probability - Characteristic and log characteristic functions - Chebyshev inequality - Functions of random variables.	
2 . RANDOM PROCESSES	20
Concept of stationarity and ergodicity - Evolutionary nonstationary process - Auto and cross correlation and covariance Functions - Mean square limit, differentiability and integrability - Spectral decomposition, power spectral and cross spectral density Functions - Wiener - Khintchine relations - Properties of Gaussian, Poisson and Markov processes - Fokker - Planck Equation - Broad band and narrow band random processes - White noise.	
3 . RANDOM VIBRATION	15
Response of linear single and multi-degree of freedom systems to stationary excitation-Response of continuous systems - Normal mode method. Level crossing, peak and envelope statistics - First excursion and fatigue failures - Application to aero engineering systems.	
	Total No of periods: 45

References:

1. Elishakoff, I., " Probabilistic Methods in the Theory of Structures ", John Wiley, NewYork, 1983.
2. Newland, D.E., " An Introduction to Random Vibrations and Spectral Analysis " , Longman Inc., New York, Second Edition, 1984.
3. Nigam, N.C., " Introduction to Random Vibrations ", MIT Press, Cambridge, Massachusettes, 1983.
4. Nigam, N.C. and Narayanan, S., " Applications of Random Vibrations ", Narosa Publications, 1995.

1 . FATIGUE OF STRUCTURES 7

S.N. Curves - Endurance limit - Effect of mean stress, Goodman, Gerber and Sodeberg relations and diagrams - Notches and stress concentrations -Neuber's stress concentration factors - Plastic stress concentration factors - Notched S.N. curves.

2 . STATISTICAL ASPECTS OF FATIGUE BEHAVIOUR 10

Low cycle and high cycle fatigue - Coffin - Manson's relation - Transition life - Cyclic strain hardening and softening - Analysis of load histories - Cycle counting techniques - Cumulative damage - Miner's theory - Other theories.

3 . PHYSICAL ASPECTS OF FATIGUE 10

Phase in fatigue life - Crack initiation - Crack growth - Final fracture -Dislocations - Fatigue fracture surfaces.

4 . FRACTURE MECHANICS 10

Strength of cracked bodies - Potential energy and surface energy - Griffith's theory - Irwin - Orwin extension of Griffith's theory to ductile materials - Stress analysis of cracked bodies - Effect of thickness on fracture toughness - Stress intensity factors for typical geometries.

5 . FATIGUE DESIGN AND TESTIONG 8

Safe Life and Fail safe design philosophies Importance of Fracture Mechanics in aerospace structure - Application to composite materials and structures.

Total No of periods: 45

References:

1. Barrois, W., and Ripley, E.L., " *Fatigue of Aircraft Structures* ", Pergamon Press, Oxford, 1983.
2. Sih, C.G., " *Mechanics of Fracture* ", Vol.1 sijthoff and Noordhoff International Publishing Co., Netherlands, 1989.
3. Knott, J.F., " *Fundamentals of Fracture Mechanics* ", Butterworth & Co., (Publishers) Ltd., London, 1983.

1 . AEROELASTIC PHENOMENA	8
Stability versus response problems - The aero-elastic triangle of forces Aeroelasticity in Aircraft Design - Prevention of Aeroelastic instabilities.	
2 . DIVERGENCE OF A LIFTING SURFACE	10
Simple two dimensional idealizations - Strip theory - Fredholm integral equation of the second kind - Exact solutions for simple rectangular wings -Semirigid assumption and approximate solutions - Generalized coordinates -Successive approximations - Numerical approximations using matrix equations.	
3 . STEADY STATE AEROELASTIC PROBLEMS	10
Loss and reversal of aileron control - Critical aileron reversal speed - Aileron efficiency - Semirigid theory and successive approximations - Lift distribution -Rigid and elastic wings.	
4 . FLUTTER PHENOMENON	12
Non-dimensional parameters - Stiffness criteria Dynamic mass balancing -Model experiments - Dimensional similarity - Flutter analysis - Two dimensional thin airfoils in steady incompressible flow - Quasisteady aerodynamic derivatives - Galerkin method for critical speed - Stability of distributed motion - Torsion flexure flutter - Solution of the flutter determinant - Methods of determining the critical flutter speeds - Flutter prevention and control.	
5 . EXAMPLES OF AEROELASTIC PROBLEMS IN CIVIL AND MECHANICAL ENGINEERING	5
Galloping of transmission lines and flow induced vibrations of tall slender structures and suspension bridges.	

Total No of periods: 45

REFERENCES:

1. Bisplinghoff, R.L., Ashley, H., and Halfmann, R.L., "Aeroelasticity", Addison Wesley Publishing Co., Inc., II ed, 1987.
2. Broadbent, E.G., "Elementary Theory of Aeroelasticity" BunHill Publications Ltd., 1986.
3. Fung, Y.C., "An Introduction to the Theory of Aeroelasticity", John Wiley & Sons Inc., New York 1985.
4. Scanlan, R.H. and Rosenbaum, R., "Introduction to the Study of Aircraft Vibration and Flutter", MacMillan Co., N.Y., 1991.

1 . CLASSICAL PLATE THEORY	3
Classical plate theory - Assumptions - Differential equation - Boundary conditions.	
2 . RECTANGULAR PLATES	12
Navier's method of solution for simply supported rectangular plates - Levy's method of solution for rectangular plates under different boundary conditons.	
3 . CIRCULAR PLATES	6
Governing equation solution for axi-symmetric loading - Annular plates - Plates of other shapes.	
4 . ENGEN VALUE ANALYSIS	8
Stability and free vibration analysis of rectangular plates.	
5 . APPROXIMATE METHODS	8
Rayleigh - Ritz - Galerkin - Finite difference method - Application to rectangular plates for static, free vibration and stability analysis.	
6 . SHELLS	8
Basic concepts of shell type of structures - Membrane and bending theories for circular cylindrical shells.	

Total No of periods: 45

References:

1. *Timoshenko, S.P. Winowsky.S., and Kreger, Theory of Plates and Shells, McGraw Hill Book Co., 1989.*
2. *Flugge, W., Stresses in Shells, Springer - Verlag, 1980.*
3. *Timoshenko, S.P. and Gere, J.M., Theory of Elastic Stability, McGraw Hill Book Co., 1986.*

AE048 Approximate Methods in Structural Mechanics

3 0 0 100

1 . INTRODUCTION

3

Exact method versus approximate method - Need for approximate methods.

2 . ENERGY METHODS

8

Review of basic energy principles - Application to statically determinate and indeterminate structures. Free vibration and stability analysis - Beams and Columns - Variational Principle.

3 . METHOD OF WEIGHTED RESIDUALS

8

Application of Galerkin, Collection, least square methods to analysis of beams.

4 . FINITE DIFFERENCE METHOD

8

Application to statics, dynamics and stability analysis of beams and plates.

5 . FINITE ELEMENT METHOD

12

Application of truss, bar, beam and two dimensional elements.

6 . SOLUTION TECHNIQUES

6

Approximate methods used in the solution procedure in equilibrium and eigen value problems - Numerical integration.

Total No of periods: 45

References:

1. Szilard, R., *Theory and Analysis of Plates - Classical and Numerical Methods*, Prentice Hall , 1984.
2. Chajes, A., *Principles of Structural Stability Theory*, Prentice Hall, Inc.,1987.
3. Tauchert, T.R. *energy Principles in Structural Mechanics*, McGraw Hill, International Student edition, 1989.
4. Bathe, K.J. and Wilson, E.L., *Numerical Methods in Finite Element Method*, Prentice Hall (India) Ltd.,1985.

1 . COMPUTER GRAPHICS 15

Fundamentals of interactive computer graphics - Modelling Techniques for two and three - dimensional geometrics using standard software packages.

2 . CASE STUDY 20

Finite element analysis and design of typical structural components using one, two and three dimensional elements.

3 . GRAPHICAL USER INTERFACE 10

Element of graphical user interface. Exercise on preparation of pull down menus, dialogue boxes scroll bar and push buttons for applications programs.

Total No of periods: 45*References:*

1. Donald and Hearn Pauline Baker, " Computer Graphics ", Prentice Hall, New York, 1986.
2. Harrington, S., " Computer Graphics ", McGraw Hill, 1980.
3. Segarind, L.J., " Applied Finite Element Analysis ", John Wiley and Sons, New York, 2nd edition, 1984.
4. Bathe, K.J., and Wilson, E.L., " Numerical Methods in Finite Elements Analysis ", Prentice Hall Ltd.,1983.

1 . INTRODUCTION TO AVIONICS	4
Need for avionics in civil and military aircraft and space systems - Integrated avionics and weapon systems - Typical avionics subsystems, design, technologies.	
2 . PRINCIPLES OF DIGITAL SYSTEMS	10
Digital computers - Microprocessors - Memories	
3 . DIGITAL AVIONICS ARCHITECTURE	6
Avionics system architecture - Databases - MIL - STD - 1553B - ARINC - 420 - ARINC - 629.	
4 . FLIGHT DECKS AND COCKPITS	5
Control and display technologies: CRT, LED, LCD, EL and plasma panel - Touch screen - Direct voice input (DVI) - Civil and Military Cockpits: MFDS, HUD, MFK, HOTAS.	
5 . INTRODUCTION TO AVIONICS SYSTEMS	20
Communication systems - Navigation systems - Flight control systems - Radar-Electronic Warfare - Utility systems Reliability and maintainability - Certification.	

Total No of periods: 45

References:

1. Middleton , D.H., Ed., " Avionics systems ", Longman Scientific and Technical, Longman Group UK Ltd., England,1989.
2. Spitzer, C.R., " Digital Avionics systems ", Prentice-Hall, Englewood Cliffs, N.J., U.S.A., 1987.
3. Malvino, A.P. and Leach, D.P., " Digital Principles and Application ", Tata McGraw Hill, 1990.
4. Gaonkar, R.s., " Microprocessors Architecture - Programming and Applications " , Wiley and Sons Ltd, New Delhi, 1990.

1 . UNIT -I 5

(A) OPERATION, INSPECTION, MAINTENANCE AND TROUBLE SHOOTING OF PISTON ENGINES:

Types of piston engines - Principles of operation - Function of components - Materials used - Details of starting the engines - Details of carburetion and injection systems for small and large engines - Ignition system components - spark plug detail - Engine operating conditions at various altitudes - Maintenance and inspection check to be carried out.

Inspection and maintenance and trouble shooting - Inspection of all engine components - Daily and routine checks - Overhaul procedures - Compression testing of cylinders - Special inspection schedules - Engine fuel, control and exhaust systems - Engine mount and super charger - Checks and inspection procedures.

2 . UNIT -II 2

Classification - General Inspection procedures - Checks on constant speed propellers - Pitch setting - Installation and maintenance checks.

3 . UNIT-III 6

Symptoms of failure - Fault diagnostics - Case studies of different engine systems - Rectification during testing equipments for overhaul: Tools and equipments requirements for various checks and alignment during overhauling - Tools for inspection - Tools for safety and for visual inspection - Methods and instruments for non destructive testing techniques - Equipment for replacement of part and their repair. Engine testing: Engine testing procedures and schedule preparation - Online maintenance.

4 . UNIT - IV 12

(B) OPERATION, INSPECTION, MAINTENANCE AND TROUBLE SHOOTING OF JET ENGINES:

i) 12 Types of jet engines - Principles of operation - Functions of components - Materials used - Details of starting and operating procedures - Gas turbine engine inspection & checks - Use of instruments for online maintenance - Special inspection procedures : Foreign Object Damage - Blade damage - etc.

ii) Gas turbine engine maintenance: Minor and Major maintenance. Maintenance procedures of gas turbine - Trouble shooting and rectification procedures - Component maintenance procedures - Systems maintenance procedures.

iii) Engine Testing and Storage : Gas turbine testing procedures - test schedule preparation - Storage of Engines - Preservation and de-preservation procedures.

5 . UNIT - V 5

i) Engine Overhaul : Overhaul procedures - Inspections and cleaning of components - Repairs schedules for overhaul - Balancing of Gas turbine components.

ii) Trouble Shooting : Procedures for trouble shooting - Condition monitoring of the engine on ground and at altitude - engine health monitoring and corrective methods.

6 . PRACTICALS 30

Total No of periods: 60

References:

- 1. Kroes & Wild, " Aircraft Power plants ", 7th Edition - McGraw Hill, New York, 1994.*
- 2. Turbomeca, " Gas Turbine Engines ", The English Book Store ", New Delhi, 1993.*
- 3. United Technologies Pratt & Whitney, " The Aircraft Gas turbine Engine and its Operation ", The English Book Store, New Delhi.*

1 . BASIC CONCEPTS 9

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

2 . AIR TRAFFIC SERVICES 9

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

3 . FLIGHT INFORMATION ALERTING SERVICES, COORDINATION, EMERGENCY PROCEDURES AND RULES OF THE AIR: 10

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

4 . AERODROME DATA, PHYSICAL CHARACTERISTICS AND OBSTACLE RESTRICTION: 9

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

5 . VISUAL AIDS FOR NAVIGATION, VISUAL AIDS FOR DENOTING OBSTACLES EMERGENCY AND OTHER SERVICES: 8

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

Total No of periods: 45

References:

1. *" Aircraft Manual (India) Volume I ", latest Edition - The English Book Store, 17-1 Connaught Circus, New Delhi.*
2. *" PANS - RAC - ICAO DAC 4444 ", Latest Edition, The English Book Store, 17-1, Connaught Circus, New Delhi.*
3. *" AIP (India) Vol. I & II ", The English Book Store, 17-1, Connaught Circus, New Delhi.*

AE054 Helicopter Maintenance

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1 . HELICOPTER FUNDAMENTAL: 5

Basic directions - Ground handling, bearing - Gears.

2 . MIAN ROTOR SYSTEM: 10

Head maintenance - blade alignment - Static main rotor balance - Vibration - Tracking - Span wise dynamic balance - Blade sweeping - Electronic balancing - Dampener maintenance - Counter weight adjustment - Auto rotation adjustments.

MAST & FLIGHT CONTROL ROTOR:

Mast - Stabiliser, dampeners - Swash plate flight control systems collective - Cyclic - Pushpull tubes - Torque tubes - Bell cranks - Mixer box - Gradient unit control boosts - Maintenance & Inspection control rigging.

3 . MAIN ROTOR TRANSMISSIONS: 12

Engine transmission coupling - Drive shaft - Maintenance clutch - Free wheeling units - Spary clutch - Roller unit - Torque meter - Rotor brake - Maintenance of these components - Vibrations - Mouting systems - Transmissions.

4 . POWER PLANTS: 12

Fixed wing power plant modifications - Installation - Different type of power plant miantenance.
TAIL ROTORS: Tail rotor system - Servicing tail rotor track - System rigging.

5 . AIRFRAMES & RELATED SYSTEMS: 6

Fuselage miantenance - Airframe Systems - Special purpose equipment.

Total No of periods: 45

References:

1. " *Civil Aircraft Inspection Procedures* ", Part I and II, CAA, English Book House, New Delhi, 1986.
2. " *Larry Reithmier, Aircraft Repair Manual* ", Palamar Books Marquette, 1992.
3. Jeppesen, " *Helicopter Maintenance* ", Jeppesons ans Sons Inc.

1 . INTRODUCTION	6
Historical review, Simple pneumatic, hydraulic and thermal systems, Series and parallel system, Analogies, mechanical and electrical components, Development of flight control systems.	
2 . OPEN AND CLOSED LOOP SYSTEMS	6
Feedback control systems Block diagram representation of control systems, Reduction of block diagrams, Output to input ratios.	
3 . CHARACTERISTIC EQUATION AND FUNCTIONS	8
Laplace transformation, Response of systems to different inputs viz., Step impulse, pulse, parabolic and sinusoidal inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit.	
4 . CONCEPT OF STABILITY	15
Necessary and sufficient conditions, Routh-Hurwitz criteria of stability, Root locus and Bode techniques, Concept and construction, frequency response.	
5 . SAMPLED DATA SYSTEMS	10
Z-Transforms Introduction to digital control system, Digital Controllers and Digital PID Controllers.	

Total No of periods: 45

References:

1. *Azzo, J.J.D. and Houpis, C.H., " Feed back control system analysis and synthesis ", McGraw-Hill International, 3rd Edition, 1998.*
2. *Kuo, B.C., "Automatic Control Systems ", Prentice-Hall of India Pvt. Ltd., NewDelhi, 1998.*
3. *Houpis, C.H. and Lamont, G.B., " Digital Control Systems ", McGraw Hill Book Co., New York, U.S.A., 1995.*
4. *OGATO, " Modern Control Engineering ", Prentice-Hall of India Pvt. Ltd., NewDelhi, 1998.*
5. *Naresh K. Sinha, " Control Systems ", New Age International Publishers, New Delhi, 1998.*

1 . SEMICONDUCTOR DEVICES:	9
PN Junction diodes - Zenor diodes - Tunnel diodes - Thermistors - Transistors - FET and MOSFET - Silicon controlled rectifiers and triacs - Their applications - half wave and full wave rectifiers - Filters - Ripple factor - Zenor regulators and IC voltage regulators - Principles and types of transistor amplifiers - RC coupled, transformer coupled, direct coupled - Multistage, FET and Power amplifiers.	
2 . LINEAR AND DIGITAL ICs:	9
IC technology - Elements of fabrication of linear and digital IC's - D/A and A/D converters - Converters - Comparison between analog and digital systems - Number representation - Binary, Octal and Hexadecimal number systems - logic families and logic gates - Flip-flops - Multi vibrators using IC's - Half and full adders - Registers - Counters - Multiplexers - Demultiplexers - Decoders - Encoders.	
3 . MICROPROCESSORS:	9
Block diagram of microprocessors - Architecture of intel 8085 - Importance of data, Address and control buses - Instruction formats - Addressing modes and types of Intel 8085 - Instruction set for 8085 - Development of simple language assembly programs - Architecture and functioning of processors like Z80, M6800 and Intel family of 80 x 86 processors.	
4 . MICROPROCESSOR APPLICATIONS:	9
5 . MEMORY DEVICES:	9
RAM, ROM, EPROM - Magnetic bubble memory - Floppy and hard disc - Interfacing of memory chips - CRT terminals - Printers, Keyboards and their interfacing - Parallel and series communication - Synchronous and asynchronous data transfer - DMA data transfer.	
	Total No of periods: 45

References:

1. *Malvino A.P. Leach, D.P., " Digital Principles & Applications ", Tata McGraw-Hill, 1990.*
2. *Goankar R.S., " Microprocessors Architecture. Programming and Applications ", Wiley Eastern, 1992.*
3. *Ajit Pal., " Microprocessors ", Tata McGraw-Hill, Revised Edition.*
4. *Douglas., Hall, Microprocessors and Interfacing ", Tata McGraw-Hill, Revised Edition.*
5. *Mathur A.P., Introduction to Microprocessors, Tata McGraw-Hill, Revised Edition.*

AE332 Wind Tunnel Techniques

3 0 0 100

1 . PRINCIPLES OF MODEL TESTING 6

Buckingham Theorem - Non dimensional numbers - Scale effect Types of similarites.

2 . WIND TUNNELS 8

Classification - special problems of testing in subsonic, transonic, supersonic and hypersonic speed regions -
Layouts - sizing and design parameters.

3 . CALIBRATION OF WIND TUNNELS 11

Test section speed - Horizontal buoyancy - Flow angularities - Turbulence measurements - Associated
instrumentation - Calibration of supersonic tunnels.

4 . WIND TUNNEL MEASUREMENTS 12

Pressure, and velocity measurements - Force measurements - Three component and six component balances -
Internal balances.

5 . FLOW VISUALIZATION 8

Smoke and Tuft grid techniques - Dye injection special techniques - Optical methods of flow visualization.

.

Total No of periods: 45

References:

- 1. Pope, A., and Goin, L., " High Speed wind Tunnel Testing ", John Wiley, 1985.*
- 2. Rae, W.H. and Pope, A., " Low Speed wind Tunnel Testing ", John Wiley Publication , 1984.*

1 . ASSUMPTIONS IN ELASTICITY 4

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

2 . BASIC EQUATIONS OF ELASTICITY 15

Strain-displacement relations, Stress-strain relations, Lamé's constant-cubical dilatation, Compressibility of material, bulk modulus, Shear modulus, Compatibility equations for stresses and strains, Principal stresses and principal strains, Mohr's circle, Saint Venant's principle, Theories of failure.

3 . PLANE STRESS AND PLANE STRAIN PROBLEMS 8

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

4 . POLAR COORDINATES 10

Equations of equilibrium, Strain displacement relations, Stress-strain relations, Axi-Symmetric problems, Kirch, Michell's and Boussinesque problems.

5 . TORSION 8

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

Total No of periods: 45

References:

1. Timoshenko, S., and Goodier, T.N. " *Theory of Elasticity* ", McGraw-Hill Ltd., Tokyo, 1990.
2. Enrico Volterra & J.H.Caines, " *Advanced Strength of Materials* ", Printice Hall, New Jersey, 1991.
3. Wang, C.T., " *Applied Elasticity* ", Mc Graw-Hill Co., New York, 1993.
4. Sokolnikoff, I.S., " *Mathematical Theory of Elasticity* ", McGraw-Hill New York, 1978.

- 1 . ONE DIMENSIONAL COMPRESSIBLE FLOW 7**
 Energy, momentum, continuity and state equations, Velocity of sound, Adiabatic steady state flow equations, Flow through converging, diverging passages, Performance under various back pressures.
- 2 . NORMAL SHOCKS IN TUBES 8**
 Prandi equation and Rankine - Hugoniot relation, Normal shock equations, Pitot static tube, corrections for subsonic and supersonic flows, Oblique shocks and corresponding equations, Hodograph and pressure Turning angle, shock polars, Flow past wedges and concave corners, strong, weak and etached shocks.
- 3 . PRANDTL -MEYER EXPANSION 8**
 Flow past convex corners, Expansion hodograph, Reflection and interaction of shocks and expansion, waves, Families of shocks, Method of characteristics, Two dimensional supersonic nozzle contours.
- 4 . DIFFERENTIAL EQUATIONS OF MOTION FOR STEADY COMPRESSIBLE FLOWS 8**
 Small perturbation potential theory, Solutions for supersonic flows. Mach waves and Mach angles, Prandti-Glauert affine transformation relations for subsonic flows, Linearised two dimensional supersonic flow theory, Lift, drag pitching moment and centre of pressure of supersonic profiles.
- 5 . COMPRESSIBILITY EFFECTS 6**
 Aerofoils in high speed flows, Lower and upper critical Mach numbers, Lift and draft divergence, shock induced separation, Characteristics of swept wings, Effects of thickness, camber and aspect ratio of wings, Transonic area rule, Tip effects.
- 6 . HIGH SPEED WIND TUNNELS 8**
 Blow down, indraft and induction tunnel layouts and their design features, Transonic, supersonic and hypersonic tunnels and their peculiarities, Helium and gun tunnels, Shock tubes, Optical methods of flow visualization.

Total No of periods: 45

References:

1. Shapiro, A.H., " *Dynamics and Thermodynamics of Compressible Fluid Flow* ", Ronald Press, 1982.
2. Zucrow, M.J., and Anderson, J.D., " *Elements of gas dynamics* " McGraw-Hill Book Co., New York, 1989.
3. Rathakrishnan, E., " *Gas Dynamics* ", Prentice Hall of India, 1995.
4. Hodge B.K. & Koenig, K, " *Compressible fluid Dynamics with Computer applications* ", Prentice Hall, 1995.

AE337 Propulsion Laboratory

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1. Study of free convective heat transfer over a flat plate.
2. Study of Goblin and P11F2 engines.
3. Ignition studies of solid and liquid propellants.
4. Operation of a ramjet engine.
5. Study of free jet.
6. Study of wall jet.
7. Study of Hybrid propulsion system.
8. Preparation of HTNR fuel grain for hybrid rocket.
9. Study of forced convective heat transfer from a plate.
10. Burning rate measurement of solid propellants in strand burner.

Total No of periods: 60

AE343 Composite Materials and Structures

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1 . INTRODUCTION 4

Advantages and applications of composite materials - Reinforcements and matrices.

2 . STRESS STRAIN RELATION: 6

Isotropic, orthotropic and anisotropic materials Transformation of material properties for arbitrary fibre orientation.

3 . METHODS OF ANALYSIS 9

Micromechanics - Macromechanics - Netting analysis

4 . LAMINATED PLATES 15

Governing differential equation for a general laminate - Angle ply and cross ply laminates, Failure criteria for composites.

5 . SANDWICH CONSTRUCTIONS 6

Basic design concepts of sandwich construction - Materials used for sandwich construction - Failure modes of sandwich panels.

6 . FABRICATION PROCESSES 5

Open and closed mould processes. Filament winding and on-line production method. Manufacture of fibers and properties.

Total No of periods: 45

REFERENCES :

1. *Calcote, L.R., " The Analysis of Laminated Composite Structures ", Von-Nostrand Reinhold Company, New York, 1998.*
2. *Jones, R.M., " Mechanics of Composite Materials ", McGraw Hill Kogakusha Ltd., Tokyo, 1985.*
3. *Agarwal, B.D., and Broutman, L.J., " Analysis and Performance of Fibre Composites ", John wiley and sons Inc., New York, 1980.*
4. *Lubin, G., " Handbook on Advanced Plastics and Fibre Glass ", Von Nonstrand Reinhold Co., New York 1989.*

1 . INTRODUCTION 8

Simple harmonic motion, definition of terminologies, Review of Newton's, Laws, D'Alembert's principle, Energy methods.

2 . SINGLE DEGREE OF FREEDOM SYSTEMS 8

Free vibrations free damped vibrations, forced excitations with and without damping, support excitation, vibration measuring instruments.

3 . MULTI-DEGREE OF FREEDOM SYSTEMS 23

Two degrees of freedom systems, Static and dynamic couplings, vibration absorber, Principal coordinates, Principal modes, orthogonality conditions. Hamilton's Principle, Lagrangean equation and applications. Vibrations of elastic bodies, String or stretched cord, Longitudinal vibration, Lateral vibration, Torsional vibration. Approximate methods for calculating natural frequencies.

4 . ELEMENTS OF AEROELASTICITY 6

Aeroelastic problems - Collar's triangle of courses - Wing divergence - Aileron control reversal-Flutter.

Total No of periods: 45

REFERENCES :

1. Timoshenko,S., " *Vibration Problems in Engineering* ", John Wiley & Sons Inc., 1987.
2. Meirovitch, L., " *Elements of Vibration Analysis* ", McGraw-Hill Inc., 1986.
3. F.S.Tse, I.F. Morse and R.T.Hinkle, " *Mechanical Vibrations* ", Prentice Hall of India, 1984.
4. Fung, Y.C., " *An Introduction to the Theory of Aeroelasticity* ", John Wiley & Sons Inc., New York, 1985.
5. Rao.J.S. and Gupta K., " *Theory and practice of Mechanical Vibrations* " Wiley Eastern Ltd., New Delhi., 1999.

AE347 Industrial Lectures / Seminar / Comprehension

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The objective of 'Comprehension' is to provide opportunity for the student to apply the knowledge acquired during the academic programme to real-life problems which he/she may have to face in future as an engineer. Three period per week shall be allotted in the time table for this activity and this time shall be utilised by the students to receive guidance from the members of faculty on solving real-life problems, practice solving these problems and on group discussions, seminar presentations, library reading as assigned by the faculty member in-charge.

For internal assessment, there will be 3 or 4 written tests covering all the courses studied in previous semesters. The written tests may be of objective type of questions, short answer questions, etc.

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Total No of periods: 60

1 . C.A.R SERIES 'A' - PROCEDURE FOR CIVIL AIR WORTHINESS REQUIREMENTS AND RESPONSIBILITY OPERATORS VIS-A-VIS AIR WORTHINESS DIRECTORATE: 8

Responsibilities of operators / owners; Procedure of CAR issue, amendments etc., Objectives and targets of airworthiness directorate; Airworthiness regulations and safety oversight of engineering activities of operators.

C.A.R. SERIES 'B' - ISSUE APPROVAL OF COCKPIT CHECK LIST, MEL, CDL:
Deficiency list (MEL & CDL); Preparation and use of cockpit check list and emergency list.

2 . C.A.R. SERIES 'C' - DEFECT RECORDING, MONITORING, INVESTIGATION AND REPORTING 7

Defect recording, reporting, investigation, rectification and analysis; Flight report; Reporting and rectification of defects observed on aircraft; Analytical study of in-flight readings & recordings; Maintenance control by reliability Method.

C.A.R. SERIES 'D' - AND AIRCRAFT MAINTENANCE PROGRAMMES:

Reliability Programme (Engines); Aircraft maintenance programme & their approval; On condition maintenance of reciprocating engines; TBO - Revision programme; Maintenance of fuel and oil uplift and consumption records - Light aircraft engines; Fixing routine maintenance periods and component TBOs - Initial & revisions.

3 . C.A.R. SERIES 'E' - APPROVAL OF ORGANISATIONS: 10

Approval of organisations in categories A, B, C, D, E, F, & G; Requirements of infrastructure at stations other than parent base.

C.A.R. SERIES 'F' - AIR WORTHINESS AND CONTINUED AIR WORTHINESS:

Procedure relating to registration of aircraft; Procedure for issue / revalidation of Type Certificate of aircraft and its engines / propeller; Issue / revalidation of Certificate of Airworthiness; Requirements for renewal of Certificate of Airworthiness.

4 . C.A.R. SERIES 'L' - AIRCRAFT MAINTENANCE ENGINEER - LICENSING: 8

Issue of AME Licence, its classification and experience requirements, Complete Series 'L'.

C.A.R. SERIES 'M' MANDATORY MODIFICATIONS AND INSPECTIONS:

Mandatory Modifications / Inspections.

5 . C.A.R. SERIES 'T' - FLIGHT TESTING OF AIRCRAFT: 12

Flight testing of (Series) aircraft for issue of C of A; Flight testing of aircraft for which C of A had been previously issued.

C.A.R. SERIES 'X' - MISCELLANEOUS REQUIREMENTS:

Registration Markings of aircraft; Weight and balance control of an aircraft; Provision of first aid kits & Physician's kit in an aircraft; Use furnishing materials in an aircraft; Concessions; Aircraft log books; Document to be carried on board on Indian registered aircraft; Procedure for issue of taxi permit; Procedure for issue of type approval of aircraft components and equipment including instruments.

Total No of periods: 45

References:

1. *" Aircraft Manual (India) ", Volume - Latest Edition, The English Book Store, 17-1, Connaught Circus, New Delhi.*
2. *" Civil Aviation Requiements with latest Amendment (Section 2 Airworthiness) ", Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi.*
3. *" Aeronautical Information Circulars (relating to Airworthiness) ", from DGCA.*
4. *" Adivsory Circulars ", form DGCA.*

1 . AIRCRAFT GROUND HANDLING AND SUPPORT EQUIPMENT: 10

Mooring, jacking, levelling and towing operations - Preparation - Equipment and precautions - Engine starting procedures - Piston engine, turboprops and turbojets - Engine fire extinguishing - Ground power units.

2 . GROUND SERVICING VARIOUS SUB SYSTEMS: 8

Air conditioning and pressurisation - Oxygen and oil systems - Ground units and their maintenance.

3 . MAINTENANCE OF SAFETY: 5

Shop safety - Environmental cleanliness - Precautions.

4 . INSPECTION: 10

Process - Purpose - Types - Inspection intervals - Techniques - Checklist - Special inspection - Publications, bulletins, various manuals - FAR Air worthiness directives - Type certificate Data Sheets - ATA specifications.

5 . AIRCRAFT HARDWARE, MATERIALS, SYSTEMS PROCESSES: 12

Hand tools - Precision instruments - Special tools and equipments in an airplane maintenance shop - Identification terminology - Specification and correct use of various aircraft hardware (i.e. nuts, bolts, rivets, screws, etc.) - American and British systems of specifications - Threads, gears, bearings, etc. - Drills, tapes & reamers - identification of all types of fluid line fittings. Materials, metallic and non-metallic.

PLUMBING CONNECTORS:

Cables - Swaging procedures, tests, Advantages of swaging over splicing.

Total No of periods: 45

References:

1. *KROES WATKINS DELP., " Aircraft Maintenance and Repair ", McGraw Hill, New York 1993.*
2. *A & P MECHANICS, " Aircraft hand Book - F.A.A. Himalayan Book House ", New Delhi, 1996.*
3. *A & P MECHANICS, " General hand Book - F.A.A. Himalayan Book House ", New Delhi, 1996.*
4. *ATA SPECIFICATIONS - F.A.A. Himalayan Book House ", New Delhi, 1996.*

1 . UNIT - I 7

Description of flow past a wing - Streamline pattern, formation of tip vortices - Down wash - Induced angle of attack and induced drag - Momentum theory of wing for lift and induced drag - Schrenk's method of estimation of wing characteristics from airfoil data.

2 . UNIT - II 10

Representation of lifting effect of wing by vortex lines - Lifting line theory - Formulation of governing integro - Differential equation - Method of solution by Fourier series - Effect of Individual terms of the series (first 3 terms) - Effect of taper twist and sweep back - Influence of flaps on wing lift distribution.

3 . UNIT - III 8

Extended lifting theory - Vortex lattice method for wings - Low aspect ratio wings - Jones theory - Winglets and strakes - Flow past slender bodies of revolution - Lift, drag and moment characteristics of complete airplane.

4 . UNIT - IV 10

Shock expansion method for flow over airfoils - small perturbation equation for compressible flow - Prandtl, Glauret and Geothert's rules - Ackert's supersonic airfoil theory - Three dimensional thin wings in supersonic flows - Perturbation potential - Non-lifting wings - Lifting wings of simple plan form - Conical flows - Numerical integration procedures - Drag at supersonic speeds - Supersonic area rule.

5 . UNIT - V 10

Principles of model testing - Types of subsonic wind tunnels - Balances and measurements - Interference effects - transonic, Supersonic and hypersonic wind tunnels and characteristic features, their operation and performance - Shock tubes and shock tunnels - Free flight testing - Measurements of pressure, velocity and Mach number - Flow visualisation methods of subsonic and supersonic flows.

Total No of periods: 45

References:

1. CLANCY J., " *Aerodynamics* ", Pitman, 1986.
2. HOUGHTON and CARUTHER, " *Aerodynamics for engineering students* ", Edward Arnold Publishers, London, 1989.
3. ANDERSON J.D., " *Fundamental of Aerodynamics* ", McGraw Hill Book Co., New York, 1985.
4. ALLEN POPE, " *Low Speed Wind Tunnel Testing* ", Vol. I - John Wiley & Sons Inc., New York, 1966.
5. ALLEN POPE, " *High Speed Wind Tunnel Testing* ", Vol. II - John Wiley & Sons Inc., New York, 1966.
6. McCORNICK. W., " *Aerodynamics, Aeronautics and Flight Mechanics* ", John Wiley, New York, 1979.

1 . AIRCRAFT WOOD GLUING PRACTICES: 60

Splicing, repairing cracks in wooden structural members, repairs to curved plywood skins, Patch work - Finishing.

2 . WELDING PRACTICES:

TIG, MIG, PLASMA ARC, SHIELD CARBON ARC & OXY ACETYLENE GAS WELDINGS, Making specimens welding and testing - Welded patch repairs, tube splicing.

3 . RIVETING PRACTICES:

Rivert material identification - Rivet spacing - Edge distances - Riveting specimen pieces and testing for strength - Patch repair work. Imperfection in riveting - Splicing sheets - Rivet replacement - Repair of crack member.

4 . SHEET METAL WORK:

Hand forming of a typical rib.

5 . CONTROL CABLE INSPECTION AND REPAIR:

Practice - Safetying turn buckles. - Repair of Composites & Sandwich Panels.

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Total No of periods: 60

1 . WELDING IN AIRCRAFT STRUCTURAL COMPONENTS: 9

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

SHEET METAL REPAIR AND MAINTENANCE:

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

2 . PLASTICS AND COMPOSITES IN AIRCRAFT: 8

PLASTICS IN AIRCRAFT : Review of types of plastics used in airplanes - Maintenance and repair of plastic components - Repair of cracks, holes etc., various repairs schemes - Scopes.

ADVANCED COMPOSITES IN AIRCRAFT : Inspection - Repair of composite components - Special precautions - Autoclaves.

3 . AIRCRAFT JACKING, ASSEMBLY AND RIGGING: 8

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

4 . REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM: 12

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

5 . SAFETY PRACTICES: 8

Hazardous materials storage and handling, Aircraft furnishing practices - Equipments.

Trouble shooting.

Theory and practices.

Total No of periods: 45

References:

- 1. Larry Reithmeir, " Aircraft Repair Manual ", Palamar Books, Marquette, 1992.*
- 2. Brimm D.J. Bogges H.E., " Aircraft Maintenance ", Pitman Publishing corp., New York, 1940.*
- 3. Kroes, Watkins, Delp, " Aircraft Maintenance and Repair ", McGraw Hill, New York, 1992.*

1 . RECIPROCATING ENGINES: 6

Ignition and starting - Fuels and their characteristics for IC engines, contamination of fuels and prevention - Instruments for reciprocating engines.

2 . GAS TURBINE ENGINES: 12

Fuels - Characteristics - Fuel Systems - Lubricant and Lubricant systems - Ignition and starting systems - Electronic Engine controls - Full Authority Digital Engine Control (FADEC) - engine Indicating, warning and control systems - Instruments for gas turbine engine - Fire warning systems - Aircraft Instruments systems.

3 . FLIGHT INSTRUMENTS: 10

Location, visibility and grouping of Instrument, Panels, Basic Instrument elements and Mechanism, Instrument Panels - Displays - Layouts - Grouping details of:

- i) Pitot instrument & systems.
 - ii) Primary flight instruments.
 - iii) Heading indicating instruments.
 - iv) Remote indicating systems.
 - v) Synchronous data transmission systems.
 - vi) Flight director & Flight data recording systems.
 - vii) ECAM/EICAS/EFIS - Their concepts, detailed description maintenance and practices.
- ECAM - Electronic Central Aircraft Monitor.
EICAS - Engine Indicator Crew Alert Systems.
EFIS - Electronic Flight Instruments Systems.

4 . COMMUNICATION AND NAVIGATIONS SYSTEMS: 6

Basic Principles - Equipment - Power Sources - Airborne Navigational Equipment - VHF - ILS - DME - ADF - Radar & Doppler Navigation - Inertial Navigation, VOR, MLS (Microwave Landing System) Cockpit Voice Recorder (CVR), ELT (Emergency Locator Transmitter).

5 . BASIC AIRCRAFT ELECTRICAL SYSTEMS: 11

Source of power - DC and AC generators - Inverters, rectifiers, transformers, batteries - Airplane lighting - Power utilisation in airplanes.

Total No of periods: 45

References:

1. *Bent R.D. Mickinely, " Aircraft Maintenance and Repair ", 2nd Edition - McGraw Hill Inc., New York, 1978.*
2. *Casamassa J.V. & Bent R., " Jet Aircraft Power Systems ", McGraw Hill Book Co., New York, 1975.*
3. *Adams H.W., " Aircraft Hydraulic ", McGraw Hill Book Co. Inc., New York, 1943.*

AE357 Aeroengine Repair and Maintenance Practices

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1. Stripping of a piston engine, visual inspection and reasoning.
2. Disassembly of turbojet engine, inspection & assesmbly.
3. Engine balancing.
4. Propeller pitch setting.
5. Engine starting procedures.
6. Trouble shooting practices.

Total No of periods: 60

1 . ROCKETS SYSTEM 10

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 - Combustion system of solid rockets.

2 . AERODYNAMICS OF ROCKETS AND MISSILES 13

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

3 . ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD 10

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 approximations to burnout velocity.

4 . STAGING AND CONTROL OF ROCKETS AND MISSILES 7

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

5 . MATERIALS FOR ROCKETS AND MISSILES 5

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

Total No of periods: 45

REFERENCES:

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.
3. Cornelisse, J.W., " *Rocket Propulsion and Space Dynamics* ", J.W., Freeman & Co., Ltd., London, 1982.
4. Parket, E.R., " *Materials for Missiles and Spacecraft* ", McGraw Hill Book Co., Inc., 1982.

1 . INTRODUCTION	6
Review of basic analysis - Stiffness and Flexibility matrix for simple cases - Governing equation and convergence criteria of finite element method.	
2 . DISCRETE ELEMENTS	8
Bar, Frame, beam elements - Application to static, dynamic and stability analysis.	
3 . CONTINUUM ELEMENTS	8
Various types of 2-D-elements Applications to plane stress, plane strain and axisymmetric problems. Consistent and lumped formulation.	
4 . ISOPARAMETRIC ELEMENTS	8
Application to two and three dimensional problems. Numerical integration.	
5 . COMPUTER IMPLEMENTATION	8
Computer implementation for assembly of element matrices and solution procedure.	
6 . FIELD PROBLEM	7
Application to other field problems like heat transfer and fluid flow.	

Total No of periods: 45

REFERENCES:

1. *Segarland, L.J., " Applied Finite Element Analysis ", John Wiley and Sons, INC., NewYork, 1991.*
2. *Desai, C.S. and Abel, J.F., " An introduction into Finite Element Method ", affiliated East-West Press Pvt., Ltd., NewDelhi, 1987.*
3. *Krishnamurthy, C.S., " Finite Element Analysis ", Tata McGraw Hill, 1987.*
4. *Bathe, K.J. and Wilson, E.L., " Numerical Methods in Finite Element Analysis " , Prentice Hall of India, 1985.*

AE434 Aerodynamics Lab II

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1. Pressure distribution studies on 3-d bodies
2. Pressure distribution over an aerofoil at different angles of attack.
3. Drag measurements in wind tunnel.
4. Experiments in Blow-down supersonic wind tunnel
5. Calibration of supersonic wind tunnel
6. Supersonic flow studies in miniature wind tunnels
7. Supersonic flow visualisation with Schlieren system.

Total No of periods: 60

1 . INTRODUCTION: 8

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

2 . AIRLINE ECONOMICS: 10

Forecasting - Fleet size, Fleet planning, the aircraft selection process, operating cost, passenger capacity, load factor etc. - Passenger fare and tariffs - Influence of geographical, economic & political factors on routes and route selection.

FLEET PLANNING: The aircraft selection process - Fleet commonality, factors affecting choice of fleet, route selection and Capital acquisition - Valuation & Depreciation - Budgeting, Cost planning - Aircrew evaluation - Route analysis - Aircraft evaluation.

3 . PRINCIPLES OF AIRLINES SCHEDULING: 10

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

4 . AIRCRAFT RELIABILITY: 9

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

5 . TECHNOLOGY IN AIRCRAFT MAINTENANCE: 8

Airlines scheduling (with reference to engineering) - Product support and spares - Maintenance sharing - Equipments and tools for aircraft maintenance - Aircraft weight control - Budgetary control.

On board maintenance systems - Engine monitoring - Turbine engine oil maintenance - Turbine engine vibration monitoring in aircraft - Life usage monitoring - Current capabilities of NDT - Helicopter maintenance - Future of aircraft maintenance.

Total No of periods: 45

References:

1. *Fedric J.H., " Airport Management ", English Book House, New Delhi-I.*
2. *Gene Krope, " Airline Procedures ", English Book House, New Delhi-I.*
3. *Wilson & Bryon, " Air Transportation ", English Book House, New Delhi-I.*
4. *Philip Lockin D, " Economics of Transportation ", English Book House, New Delhi-I.*
5. *" Indian Aircraft manual ", Published by DGGA, English Book House, New Delhi-I.*
6. *Alexander T Wells, " Air Transportation ", Wadsworth Publishing Company, California, 1993.*
7. *C.H. Friend, " Aircraft Maintenance Management ", English Book House, New Delhi-I.*

A. AIRCRAFT SYSTEMS LABORATORY:

1. Aircraft Hydraulic System.
2. Aircraft Pneumatic System.
3. Aircraft Oxygen System.
4. Aircraft Landing Gear System.
5. Aircraft Pressurisation System.
6. Aircraft De-icing and anti-icing System.
7. Aircraft Electrical System.
8. Aircraft Control System.
9. Aircraft Fuel System.

B. AVIONICS LABORATORY:

1. DIGITAL ELECTRONICS : Adder, Subtractor, Comparator, Shift Registers, Timers, DAC, ADC, Encoders & Decoders, Multiplexers and Demultiplexers - LED and Seven Segment displays - Semi conductor Memories.
2. MICROPROCESSORS : Familiarisation of special trainer kit - Assembly language programming exercises - interfacing of switches and LEDs - Interfacing of ADC, DAC.
3. DIGITAL AVIONICS SYSTEMS : Data Buses - MIL Std 1553B message transfer - 1553B RT configuration - 1553B inverse assembler.

Total No of periods: 60

GE037 Intellectual Property Rights (IPR)**3 0 0 100****1 . UNIT I 5**

Introduction - Invention and Creativity - Intellectual Property (IP) - Importance - Protection of IPR - Basic types of property (i. Movable Property ii. Immovable Property and iii. Intellectual Property).

2 . UNIT II 10

IP - Patents - Copyrights and related rights - Trade Marks and rights arising from Trademark registration - Definitions - Industrial Designs and Integrated circuits - Protection of Geographical Indications at national and International levels - Application Procedures.

3 . UNIT III 10

International convention relating to Intellectual Property - Establishment of WIPO - Mission and Activities - History - General Agreement on Trade and Tariff (GATT).

4 . UNIT IV 10

Indian Position Vs WTO and Strategies - Indian IPR legislations - commitments to WTO-Patent Ordinance and the Bill - Draft of a national Intellectual Property Policy - Present against unfair competition.

5 . UNIT V 10

Case Studies on - Patents (Basumati rice, turmeric, Neem, etc.) - Copyright and related rights - Trade Marks - Industrial design and Integrated circuits - Geographic indications - Protection against unfair competition.

Total No of periods: 45

TEXT BOOK

1. Subbaram N.R. " Handbook of Indian Patent Law and Practice ", S. Viswanathan (Printers and Publishers) Pvt. Ltd., 1998.

REFERENCES

- 1. Eli Whitney, United States Patent Number : 72X, Cotton Gin, March 14, 1794.*
- 2. Intellectual Property Today : Volume 8, No. 5, May 2001, [www.iptoday.com].*
- 3. Using the Internet for non-patent prior art searches, Derwent IP Matters, July 2000. [www.ipmatters.net/features/000707_gibbs.html.*

1 . UNIT I 9

Historical Background - Constituent Assembly of India - Philosophical foundations of the Indian Constitution - Preamble - Fundamental Rights - Directive Principles of State Policy - Fundamental Duties - Citizenship - Constitutional Remedies for citizens.

2 . UNIT II 9

Union Government - Structures of the Union Government and Functions - President - Vice President - Prime Minister - Cabinet - Parliament - Supreme Court of India - Judicial Review.

3 . UNIT III 9

State Government - Structure and Functions - Governor - Chief Minister - Cabinet - State Legislature - Judicial System in States - High Courts and other Subordinate Courts

4 . UNIT IV 9

Indian Federal System - Center - State Relations - President's Rule - Constitutional Amendments - Constitutional Functionaries - Assessment of working of the Parliamentary System in India.

5 . UNIT V 9

Society : Nature, Meaning and definition; Indian Social Structure; Caste, Religion, Language in India; Constitutional Remedies for citizens - Political Parties and Pressure Groups; Right of Women, Children and Scheduled Castes and Scheduled Tribes and other Weaker Sections.

Total No of periods: 45

TEXT BOOKS

1. *Durga Das Basu, " Introduction to the Constitution of India ", Prentice Hall of India, New Delhi.*
2. *R.C.Agarwal, " (1997) Indian Political System ", S.Chand and Company, New Delhi.*
3. *Maciver and Page, " Society: An Introduction Analysis ", Mac Milan India Ltd., New Delhi.*
4. *K.L.Sharma, " (1997) Social Stratification in India: Issues and Themes ", Jawaharlal Nehru University, New Delhi.*

REFERENCES

1. *Sharma, Brij Kishore, " Introduction to the Constitution of India:, Prentice Hall of India, New Delhi.*
2. *U.R.Gahai, " (1998) Indian Political System ", New Academic Publishing House, Jalaendhar.*
3. *R.N. Sharma, " Indian Social Problems ", Media Promoters and Publishers Pvt. Ltd.*
4. *Yogendra Singh, " (1997) Social Stratification and Charge in India ", Manohar, New Delhi.*

1 . INTRODUCTION 5

Special and comparative features of German with English, Hindi and Tamil - German Alphabets, pronunciation.

2 . THEMA 10

Name, Land Wohnort - Studium, Beruf - Familie, Geschwister, Alter - Tagesablauf , termine - Einladung - Stellensuche, Berufswahl - Einkauf.

3 . GRAMMATIK 10

Personalpronomen, Verb, Wortstellung, Ort - Possessivpronomen, Verb - 'Sein' - Verb - 'Haben', Unbestimmter Artikel, Negation - 'Nicht' - 'Kein' - Zeit, Bestimmter Artikel, Starke Verben - Trennbare Verben, Imperativ - Modal Verben - Akkusativ.

4 . UEBUNGEN 10

Partner uerbungen - Sachriftliche Uebungen - Aussprache Uebungen - Kontrollue bungen - Text generation.

5 . DIALOGUE 5

Oral - Written.

6 . GLOSSARY 5

Technical Words.

7 . TUTORIAL 15

Total No of periods: 60

Text Book:

1. LERNZIEL DEUTSCH (Deutsch als Fremdsprache) - Grundstufe 1 from Max Hueber varlag.

Text Book:

1. LERNZIEL DEUTSCH (Deutsch als Fremdsprache) - Grundstufe 1 from MAX Hueber Verlag.

1 . 9

Introduction to Japanese Alphabets - Hiragana, Katakana and Kanji - group 1,2,3 & 4 Syllabus - Writing Practice - Pronunciation - word Order - Greetings - Receiving a visitor and exchange of pleasantries - Kanji Practice.

2 . 9

Basic structure of sentences - classification of verbs - Polite form of verbs - irregular verbs - Particle-E - Time expressions - question sentences - Japanese numerals - Kanji practice.

3 . 9

Classification of particles - Ga, Ka, Wa, O, E, Ni etc - aural comprehension - reading comprehension - noun -1 Wa, noun -2 desu - Demonstrative pronouns - kore, sore , are and dore - kono, sono, ano and dono - kochira - sochira - achira and dochira - particle - No, kara, ni and de - question - itsu - conversational grammar - soo desu ka - Na, I adjectives perfect and imperfect - question words - Doo and ikaga - particle - To, ne and yo - Kanji practice.

4 . 9

Desu as a substitute for a verb - demonstrative pronouns sono and sore - Group 1 particles - de, O, Made and Ka - conjunction - soshite - Question words - dare, nani, doko, itsu, dore, dochira,doyatte, ikutsu, ikura - Words for degrees - gurai or kurai - Phrase - Saa - anoo - numerals - counters and numbers - humble form of desu and arimasu - Kanji practice.

5 . 9

Verbs ending in-te or de - classification of Te forms and Masu forms - verb modifiers - koo,soo, aa and doo - Set phrase - Onegaishimasu - Sumimasen - Adverbs - Mazu,sore kara and saigo ni - formation of the Te form of I adjective and desu - kanji practice.

Total No of periods: 45

Text Books:

1. *OOTSUBO et al - " A Course in Modern Japanese ", Vol.1, 1983, The University of Nagoya Press, Japan.*
2. *SHIYO SUZUKI and IKUO KAWASE - Nihongo Shoho text book with audio tapes, 1981.*
3. *YAN - SAN Serial - Video tapes, Japan.*

1 .	9
<p>Demonstrative Pronouns: Are - Interjection: Ee - Quoted Sentences - omoimsu - Non polite form of verbs - Group 1 ending in -ert or iru, group 2 verbs ending in - u - Non polite forms of - I - adjectives -non polite form of desu,deshoo,daroo - Suffic - Sugiru - expression of reason - tame (ni) - Counters: - Hon and - Do - Kanji practice.</p>	
2 .	9
<p>Negative - Te - form of verbs -I adjectives - Permission and prohibition - te mo desuka and - te wa ikemasen ka - Na - adjectives - suki and kirai - Verbs:Itadaku - Conjunction - Nagara - Phrase - No koto na n desu ga - usage of chotto - kanji practice.</p>	
3 .	9
<p>Noun modifiers - Quoting modifier - Suffix - Kata - sa and me - Particles - Made ni and dake - te form of verb and iru/imasu - noun - Uchi - Eba form of verbs - Kanji practice.</p>	
4 .	9
<p>Potential sentences - group 1 verbs - group 2 verbs irregular verbs - Nouns - Tsumori and Hazu - Adverbs: Moo and Made - Form of address: moshomoshi - Expression - Ee - verbs: Naru and suru - Particles - De and ka - kanji practice.</p>	
5 .	9
<p>Comparative sentences - no hoo ga and yori - Negative comparative sentences - Negative request - Adverbs of extent - Konna ni, sonna ni and anna ni - Te form of transitive verb and - arul - Passive sentence - neutral passive sentence - technical vocabulary related to Engineering and Technology - Preparation of technical reports.</p>	
6 . TUTORIALS	15

Total No of periods: 60

Text Books:

1. *OOTSUBO ET AL - " A Course in Modern Japanese ", Vol.II, The University of Nagoya Press, Japan, 1983.*
2. *SHIYO SUZUKI and IKUO KAWASE - Nihongo Shoho text book with audio tapes, The Japan Foundation, Tokyo, Japan, 1981.*
3. *YAN - SAN Serial - Video tapes, Japan.*

1 .	9
Alphabets - Pronunciation - Masculine and Feminine Genders only - Numbers - Indefinite and definite articles - plurals - Verbs to be and to have.	
2 .	9
Present tense - Affirmative, interrogative and negative sentences - Adjectives - Adverbs - Prepositions - Possessive Pronoun - Personnel Pronoun - Indirect Object.	
3 .	9
Group I verbs - Conjugations - Present, Past compound, Simple past and future tenses - Singular & Plural - Masculine and Feminine - adjectives and adverbs.	
4 .	9
Group II Verbs - Conjugations- Present, Past compound, simple past and future tenses - Singular and Plural - Masculine and Feminine - adjectives and adverbs.	
5 .	9
Pronomial verbs - Present, Past compound, Simple past and future tenses - Singular and Plural - Masculine and Feminine - adjectives - adverbs - Dialogue - Glossary.	
6 . TUTORIAL	15

Total No of periods: 60

Text Books:

1. MAUGER. G - *Course de Langue et de - Civilization Francaises*, HACHETTE -PARIS, 1986.
2. DOMINIQUE BERGER and REGINE MIRIEUX, *Cadences, Method de Francais Didier*, Paris, 1994.

References:

1. DENIS GIRARD, *French to English, English to French Dictionary*, Cassell - Mac Millan, 1981.

HS040 Technical French II**3 1 0 100**

1 .	9
Group III Verbs - Conjugations - Adjectives - Adverbs - sentences - present - past compound - Simple past - future.	
2 .	9
Comparative, superlative sentences - recent past - immediate future - grammatical analysis.	
3 .	9
Translation from English to French - Translation from French to English - Texts from Physics and Chemistry.	
4 .	9
Translation from English to French - Translation from French to English - Texts from Basic Engineering.	
5 .	9
Report writing and translation from English to French - Translation from French to English - Letter Writing - Dialogue - Glossary.	
6 . TUTORIALS	15

Total No of periods: 60

Text Books:

1. MAUGER, G - *Cours de Langue et de - Civilization Francaises*, HACHETTE - PARIS, 1986.
2. DOMINIQUE BERGER and REGINE MIRIEUX, *Cadences Methods de Francais*, Didier, Paris, 1994.

References:

1. CENTRE D'ETUDES FRANCAISES, " *Functional French for Scientists and Technologists* ", Jawaharlal Nehru University, New Delhi, 1986.
2. J.O.KETTRIDGE " *Dictionary of Technical terms and phrases Vol 1 & 2* ", The Gresham Press, Surrey, Great Britain, 1980.

1 . LISTENING 7

Listening comprehension-listening for specific information-note-taking-use of charts and diagrams.

2 . SPEAKING 7

Defining-describing objects-describing uses/functions-comparing-offering suggestions-analysing problems and providing solutions-expressing opinions (agreement/disagreement) predicting-expressing possibility/certainty-framing questions-providing answers-pronunciation practice (word stress).

3 . READING 12

Skimming-scanning-detailed reading-predicting content-interpreting charts and tables-identifying stylistic features in texts - evaluating texts-understanding discourse coherence-guessing meaning from the context- note - making / transferring information.

4 . WRITING 12

Sentence definition-static description-comparison and contrast-classification of information-recommendations-highlighting problems and providing solutions-formal and informal letter writing-using flow-charts/diagrams-paragraph writing-editing.

5 . FOCUS ON LANGUAGE 7

Word formation with prefixes and suffixes-discourse markers and their functions-degrees of comparison-expressions relating to recommendations and comparisons-active and passive voice-antonyms-tense forms-gerunds-conditional sentences-modal verbs of probability and improbability-acronyms and abbreviations - compound nouns and adjectives-spelling-punctuation.

6 . PRACTICE IN LANGUAGE LAB 15

Pronunciation practice - word stress - sentence stress - Listening comprehension - discussion - interpretation of visuals.

Total No of periods: 60

Text Books:

1. "*English for Engineers and Technologists* ", Volume I. Authors : *Humanities and Social Science Department, Anna University, Published by Orient Longman Ltd., 1990.*

References:

1. *Narayanaswami, V.R.Strengthen Your Writing, Orient Longman Ltd., Chennai 1996 (Revised Edition)*
2. *Pickett and Laster, Technical English, Writing, Reading and Speaking, New York Harper and Row Publications.*
3. *Swan, Michael, Basic English Usage, Oxford University Press, 1984.*

1 . LISTENING 7

Listening comprehension - listening for specific information - note-taking and using non-verbal devices.

2 . SPEAKING 7

Describing processes-stating purpose-offering opinions, suggestions and recommendations-summarizing-reporting-free discussion of chosen topics-pronunciation practice (word stress, consonant clusters-homonyms)

3 . READING 12

Skimming-scanning-note -making-understanding the organisation of texts discourse cohesion-predicting and evaluating content-evaluating style-inferring meaning-study reading-interpreting tables, flow-charts.

4 . WRITING 12

Extended definition-process description-cause and effect analysis-stating choice and justifying it -safety instructions-check list-letter of application-data sheet/resume.

5 . FOCUS ON LANGUAGE 7

Word formation-synonyms-prepositions-adverbs-passive voice-sequence words/discourse markers-connective adverbs-numerical expressions-expansion of abbreviations-rules for writing SI units-language of instructions, check-lists, causes and effects, purpose and means-indefinite adjectives of number and quantity-spelling and punctuation.

6 . PRACTICE IN LANGUAGE LABORATORY

Pronunciation practice - listening comprehension - discussion - interpreting and reporting from visual inputs.

7 . TUTORIAL 15**Total No of periods: 60**

Text Books:

1. *" English for Engineers and Technologists ", Volume II, AUTHORS :Humanities and Social Science Department, Anna University, Published by Orient Longman Ltd.,1990.*

References:

1. *Swales, John.M. and Christine B Feak, "Academic Writing for graduates students", The University of Michigan Press, USA, 1994.*
2. *Goddard, Ken - " Informative Writing - Your Practical Guide to Effective Communication ", Cassell Publication U.K. 1998.*
3. *Cutts, Martin " The Plain English guide-How to write clearly and Communicate Better ", Oxford University Press, New Delhi, 1995.*

1 . UNIT I 22

ORAL COMMUNICATION - Practical use of language in simulated real - life situations through role playing - social skills - interaction with employers, peers and subordinates - Group dynamics - Listening techniques - Phonological aspects of language use - pronunciation, stress and intonation.

Introducing oneself and others, narrating events - Making telephonic conversation - Making requests, Asking questions, Making recommendations using modal verbs, Expressing causal relations with suitable discourse markers, Giving instructions using imperatives, Expressing purposes and functions, obligation and preferences, Accepting offers and Counselling, Interpreting advertisements, Describing processes using sequential expressions. (Lecture:8, Practicals 14)

2 . UNIT II 12

Presenting one's ideas at meetings and conferences, Making extempore talks, Public speaking, Body language, Strategic competence, Use of audio - visual aids and multimedia presentations. (Lecture : 6, Practical 6)

3 . UNIT III 8

Technical Writing - the structure of organised writing - paragraph writing, coherence, cohesion (use of Discourse Markers) and punctuation, Use of titles, nonverbal devices - Layout - Revision strategies - Reading techniques.

Letter Writing: - Personal/Informal letters: Letters to family members and friends Business / Formal letters: Letters thanking the recipients, announcing functions, extending invitations, congratulating associates on important occasions, letters of application (Resumes), apology and complaint, letters to the editor. (Lecture:8, Practical : 0)

4 . UNIT IV 8

Report Writing: - persuasive, explanatory, argumentative and informative, Writing agenda, minutes, memos, project proposals and checklists.

(Lecture : 8, Practical 0)

5 . UNIT V 10

Grammar - study of grammatical items in contexts. Nouns, pronouns, adjectives, comparative adjectives, adverbs, gerund, prepositions, voice, tenses, 'if clauses, direct and indirect speech (reporting verbs), concord Vocabulary - Synonyms, antonyms, homonyms, homophones, hyponyms, affixes, reference words, phrasal verbs and prepositional phrases. (Lecture:10, Practical : 0)

Total No of periods: 60

Text Books:

1. *Doff, Adrian and Jones, Christopher, Language in Use: Classroom Book (Intermediate level). Cambridge: CUP. 1994 (2 audio cassettes).*
2. *Dr.V.Chellammal, Learning to Communicate - a resource book for Engineers and Technologists. Coimbatore: Kamakhya Publications 2002 (1 audio cassette)*

References:

1. *Sung, Abraham. 330 more Model Letters for all occasions Malaysia-Minerva Publications. 2002.*
2. *Bentley, T.J. Report Writing in Business: The Effective Communication of Information. New Delhi: Viva Books Pvt.Ltd., 2001*
3. *Vivanilam, J.V. More Effective Communication: A Manual for Professionals. New Delhi: Response Books. 2000*
4. *Michael, V.P.Communication and Research for Management. Mumbai: Himalaya Publishing House 2001.*
5. *Nauheim, Ferd. How to Write Business Letters. New Delhi; Crest Publishing House 2000.*
6. *Mohan, Krishna, Meera Banerji. Developing Communication Skills. New Delhi: Macmillan 1991.*
7. *Denny, Richard. Communicate to Win. New Delhi: Kogan Page 2002.*