MATS UNIVERSITY

Raipur (C.G.)

Syllabus Scheme

(4th Semester)

For

Bachelor of Engineering

In

AERONAUTICAL

MATS School of Engineering & Technology

ARANG, RAIPUR (C.G.)

MATS UNIVERSITY

ARANG, RAIPUR

Subject Code for School of Engineering & Tech.

4th Semester (AERONAUTICAL)

S.No.	Subject Code	Subject Name
1	BE450	Numerical Methods
2	BE451	Mechanics Of Machines
3	BE452	Aerodynamics-I
4	BE453	Aircraft Materials
5	BE454	Aircraft Structures-I
6	BE455	Aircraft Systems & Instrumentation
7	BE456	Aircraft Structures-I Lab
8	BE457	Aerodynamics Lab
9	BE458	Mechanics Of Machines Lab
10	BE459	Design & Drafting Lab

MATS UNIVERSITY

ARANG, RAIPUR

Scheme of Teaching & Examination

B.E. IV SEMESTER AERONAUTICAL ENGINEERING

S.N.	code	Subject	Periods per week			Scheme of marks		Total Marks
			L	T	P	ESE	IM	
1.	BE450	Numerical Methods	4	1	-	70	30	100
2.	BE451	Mechanics Of Machines	4	1	-	70	30	100
3.	BE452	Aerodynamics-I	4	1	-	70	30	100
4.	BE453	Aircraft Materials	4	1	-	70	30	100
5.	BE454	Aircraft Structures-I	4	1	-	70	30	100
6.	BE455	Aircraft Systems & Instrumentation	4	1	-	70	30	100
7.	BE456	Aircraft Structures-I Lab	-		3	20	30	50
8.	BE457	Aerodynamics Lab	-		3	20	30	50
9.	BE458	Mechanics Of Machines Lab	-		3	20	30	50
10.	BE459	Design & Drafting Lab	-		3	20	30	50
		Total	24	6	12	500	300	800

L – Lecture, T – Tutorial, ESE – End Semester Examination,

P – Practical, IM – Internal Marks (Include Class Test & Teacher's Assessments)

MATS UNIVERSITY, RAIPUR

Semester	:	4th BE Course
Branch	:	Aeronautical
Subject	:	Numerical Methods
Total Theory Periods	:	40
Total Tutorial Periods	:	15
Code	:	BE 450

UNIT-I SOLUTION OF EQUATIONS & EIGENVALUEPROBLEMS

Solution of algebraic and transcendental equations - Fixed point iteration method –Newton-Raphson method- Solution of linear system of equations - Gauss Eliminationmethod – Pivoting - Gauss-Jordan methods – Iterative methods of Gauss-Jacobi andGauss-Seidel - Matrix Inversion by Gauss-Jordan method - Eigenvalues of a matrixby Power method and by Jacobi's method.

UNIT-II INTERPOLATION AND APPROXIMATION

Interpolation with unequal intervals - Lagrange interpolation – Newton's divided difference interpolation – Cubic Splines - Interpolation with equal intervals - Newton'sforward and backward difference formulae.

UNIT-III NUMERICAL DIFFERENTATION AND INTEGRATION

Approximation of derivatives using interpolation polynomials - Numerical integrationusing Trapezoidal, Simpson's 1/3 and Simpson's 3/8 rules – Romberg's method -Two point and three point Gaussian quadrature formulae – Evaluation of doubleintegrals by Trapezoidal and Simpson's rules.

UNIT-IV INITIAL VALUE PROBLEMS FOR ORDINARY DIFFERENTIAL EQUATIONS

Single step-methods - Taylor's series method - Euler's method - Modified Euler'smethod - Fourth order Runge-Kutta method for solving first and second order equations - Multi-step methods - Milne's and Adams-Bashforth predictor-corrector methods for solving first order equations.

UNIT-V BOUNDARY VALUE PROBLEMS IN ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS

Finite difference methods for solving two-point linear boundary value problems. Finite difference techniques for the solution of two dimensional Laplace's and Poisson'sequations on rectangular domain – One dimensional heat-flow equation by explicitand implicit (Crank Nicholson) methods - One dimensional wave equation by explicitmethod.

TEXT BOOKS

1. Grewal, B.S. and Grewal,J.S., " Numerical methods in Engineering and Science",6th Edition, Khanna Publishers, New Delhi, 2004.
2. Sankara Rao, K. "Numerical methods for Scientists and Engineers', 3rd EditionPrentice Hall of India Private Ltd., New Delhi, 2007.

REFERENCES

1. Chapra, S. C and Canale, R. P. "Numerical Methods for Engineers", 5th Edition, Tata Mc Graw-Hill, New Delhi, 2007.
2. Gerald, C. F. and Wheatley, P. O., "Applied Numerical Analysis", 6th Edition, Pearson Education Asia, New Delhi, 2006.
3. Brian Bradie, "A friendly introduction to Numerical analysis", Pearson EducationAsia, New Delhi, 2007.

MATS UNIVERSITY, RAIPUR

Semester	:	4th BE Course
Branch	:	Aeronautical
Subject	:	Mechanics of Machines
Total Theory Periods	:	40
Total Tutorial Periods	:	15
Code	:	BE 451

UNIT I MECHANISMS

Definition – Machine and Structure – Kinematic link, pair and chain – classification ofKinematic pairs – Constraint & motion – Degrees of freedom slider crank – Singleand double – Crank rocker mechanisms – Inversions – applications, Kinematicanalysis and synthesis of simple mechanisms – Determination of velocity and acceleration of simple mechanisms.

UNIT II FRICTION

Types of friction – friction in screw and nut – pivot and collar – thrust bearings – collarbearing – plate and disc clutches – belt (flat & vee) and rope drives – creep in belts –Jockey pulley – open and crossed belt drives – Ratio of tensions – Effect ofcentrifugal and initial tensions – Effect of centrifugal and initial tension – condition for maximum power transmission.

UNIT III GEARING AND CAMS

Gear profile and geometry – nomenclature of spur & helical gears – laws of gearing – interference – requirement of minimum number of teeth in gears – gear trains –simple and compound gear trains – determination of speed and torque in epicyclic gear trains – cams different types of followers – cam design for different follower motions.

UNIT IV BALANCING

Static and dynamic balancing – single and several masses in different planes –primary and secondary balancing of reciprocating masses – balancing single and multi-cylinder Engines – Governors and Gyroscopic effects.

UNIT V VIBRATION

Free, forced and damped vibrations of single degree of freedom systems – force transmitted to supports – vibration Isolation – vibration absorption – Torsional vibration of shafts – single and multirotor systems – geared shafts – critical speed of shafts.

TEXT BOOKS

1. Bansal Dr. R.K. “Theory of Machines” Laxmi Publications (P) Ltd., New Delhi, 2001.
2 .Rattan S.S.”Theory of machines” Tata McGraw Hill publishing Co., New Delhi, 2002.

REFERENCES:

1. Rao J. S. and Dukkipati R.V. “Mechanism and Machine Theory” Second Edition, Wiley Eastern Limited, 1992.
2. Malhotra D.R. and Gupta H.C “The Theory of machines” Satya Prakasam, Tech. India Publications, 1989.
3. Gosh A and Mallick A.K. “Theory of Machines and Mechanisms” affiliated eastwest press, 1989.
4. Shingley J.E. and Vicker J.J. Theory of Machines and Mechanisms” McGraw Hill, 1986.
5. Burton Paul “Kinematics and Dynamics of Machinery”, Prentice Hall, 1979.

MATS UNIVERSITY, RAIPUR

Semester	:	4th BE Course
Branch	:	Aeronautical
Subject	:	Aerodynamics-I
Total Theory Periods	:	40
Total Tutorial Periods	:	15
Code	:	BE 452

UNIT I REVIEW OF BASIC FLUID MECHANICS

System and Control volume approach, substantial, local and convective derivative, Continuity, momentum and energy equations, inviscid flow, Euler equation, incompressible Bernoulli's Equation. Circulation and Vorticity, Green's Lemma and Stoke's Theorem, Barotropic Flow, Kelvin's theorem, Streamline, Stream Function, Irrotational flow, Potential Function, Equi pontential Lines, Elementary Flows and their combinations.

UNIT II TWO DIMENSIONAL INVISCID INCOMPRESSIBLE FLOW

Ideal Flow over a circular cylinder, D'Alembert's Paradox, Magnus effect, Kutta Joukowski's Theorem, Starting Vortex, Kutta condition, Real flow over smooth and rough cylinder.

UNIT III AIRFOIL THEORY

Cauchy-Riemann relations, Complex Potential, Methodology of Conformal Transformation, Kutta-Joukowski transformation and its applications, Karman Trefftz Profiles, Thin Airfoil theory and its applications.

UNIT IV SUBSONIC WING THEORY

Vortex Filament, Biot and Savart Law, Bound Vortex and trailing Vortex, Horse ShoeVortex, Lifting Line Theory and its limitations.

UNIT V INTRODUCTION TO LAMINAR AND TURBULENT FLOW

Boundary layer and boundary layer thickness, displacement thickness, momentumthickness, Energy thickness, Shape parameter, Boundary layer equations for asteady, two dimensional incompressible flow, Boundary Layer growth over a Flatplate, Critical Reynolds Number, Clasius solution, Basics of Turbulent flow, Prandtl's mixing length hypothesis, Free shear layers.

TEXT BOOKS

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

REFERENCES

1. Milne Thomson, L.H., Theoretical Aerodynamics, Macmillan, 1985.
2. John J Bertin., Aerodynamics for Engineers, Pearson Education Inc, 2002.
3. Clancey, L J., Aerodynamics, Pitman, 1986.

MATS UNIVERSITY, RAIPUR

Semester	:	4th BE Course
Branch	:	Aeronautical
Subject	:	Aircraft Materials
Total Theory Periods	:	40
Total Tutorial Periods	:	15
Code	:	BE 453

UNIT – I INTRODUCTION

Introduction to Aerospace materials: Classification, composition, properties, heat treatment & application of plain carbon steels, alloy steels. Stainless steels. Classification, composition, properties, heat treatment & application of aluminium and its alloys. Titanium alloys, Special alloys for high temperature.

UNIT – II COMPOSITE MATERIALS

Introduction to composite materials: Definition – Classification of Composite materials based on structure – based on matrix. Advantages of composites – application of composites – functional requirements of reinforcement and matrix. FIBERS: Preparation, properties and applications of glass fibers, carbon fibers, Kevlar fibers and metal fibers – properties and applications of whiskers, particle reinforcements.

UNIT – III MANUFACTURING OF ADVANCED COMPOSITES

Polymer matrix composites: Preparation of Moulding compounds and prepregs – hand lay up method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot iso static pressing.

UNIT – IV CREEP AND FRACTURE

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

DESIGN FOR CREEP RESISTANCE

Design of transient creep time, hardening, strain hardening, expressions of rupture life of creep, ductile and brittle materials, Monkman-Grant relationship. Various types of fracture, brittle to ductile from low temperature to high temperature, cleavage fracture, ductile fracture due to micro void coalescence-diffusion controlled void growth; fracture maps for different alloys and oxides. Fatigue of aircraft materials.

OXIDATION AND HOT CORROSION

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

UNIT –V SUPERALLOYS AND OTHER MATERIALS

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

TEXT BOOKS AND REFERENCE BOOKS:

1. Material Science and Technology – Vol 13 – Composites by Cahn – VCH, West Germany Composite Materials – K.K. Chawla.
2. Calcote, L R. "The Analysis of laminated Composite Structures", Von – Noastrand Reinhold Company, New York 1998.
3. Jones, R.M., "Mechanics of Composite Materials", McGraw-Hill, Kogakusha Ltd., Tokyo, 1985.
4. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites", John Wiley and sons. Inc., New York, 1995.
5. Lubin, G., "Handbook on Advanced Plastics and Fibre Glass", Von Nostrand Reinhold Co., New York, 1989.
6. Raj. R., "Flow and Fracture at Elevated Temperatures", American Society for Metals, USA, 1985.
7. Hertzberg R. W., "Deformation and Fracture Mechanics of Engineering materials", 4th Edition, John Wiley, USA, 1996.
8. Courtney T.H, "Mechanical Behaviour of Materials", McGraw-Hill, USA, 1990.
9. Boyle J.T, Spencer J, "Stress Analysis for Creep", Butterworths, UK, 1983.
10. Bressers. J., "Creep and Fatigue in High Temperature Alloys", Applied Science, 1981.
11. McLean D., "Directionally Solidified Materials for High Temperature Service", The Metals Society, USA, 1985.

MATS UNIVERSITY, RAIPUR

Semester	:	4th BE Course
Branch	:	Aeronautical
Subject	:	Aircraft Structures-I
Total Theory Periods	:	40
Total Tutorial Periods	:	15
Code	:	BE 454

UNIT I STATICALLY DETERMINATE STRUCTURES

Statically determinate frames – plane truss analysis – method of joints – method of sections – 3-D trusses – the landing gear tripod – beams of two materials.

UNIT II STATICALLY INDETERMINATE STRUCTURES

Propped cantilevers – fixed-fixed beams– Clapeyron's 3 moment equation –moment distribution method.

UNIT III ENERGY METHODS

Strain energy evaluation in structural members – energy theorems – dummy load & unit load methods – Maxwell's reciprocal theorem – energy methods applied tostatically determinate and indeterminate beams, frames, rings & trusses.

UNIT IV COLUMNS

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

UNIT V FAILURE THEORIES

Ductile and brittle materials – maximum principal stress theory - maximum principalstrain theory - maximum shear stress theory - distortion energy theory – octahedralshear stress theory.

TEXT BOOKS

1. Timoshenko and Gere, `Mechanics of Materials', Tata McGraw Hill, 1993.
2. Bruhn E F, 'Analysis and Design of Flight Vehicle Structures', Tri-State Off-set Company, USA, 1985

REFERENCES

1. Donaldson, B.K., 'Analysis of Aircraft Structures - An Introduction', McGraw Hill, 1993.
2. Megson T M G, `Aircraft Structures for engineering students' Edward ArnoldPublishers.
3. Peery, D.J., and Azar, J.J., Aircraft Structures, 2nd edition, McGraw – Hill, N.Y., 1999.

MATS UNIVERSITY, RAIPUR

Semester	:	4th BE Course
Branch	:	Aeronautical
Subject	:	Aircraft Systems and Instrumentation
Total Theory Periods	:	40
Total Tutorial Periods	:	15
Code	:	BE 455

UNIT I AIRCRAFT SYSTEMS

Hydraulic systems – Study of typical workable systems – components – Hydraulicsystems controllers – Modes of operation – Pneumatic systems – Working principles– Typical Pneumatic Power system – Brake system – Components, Landing GearSystems – Classification – Shock absorbers – Retractive mechanism.

UNIT II AIRPLANE CONTROL SYSTEMS

Conventional Systems – Power assisted and fully powered flight controls – Power actuated systems – Engine control systems – Push pull rod system – operatingprinciples – Modern control systems – Digital fly by wire systems – Auto pilot system, Active Control Technology.

UNIT III ENGINE SYSTEMS

Fuel systems – Piston and Jet Engines – Components - Multi-engine fuel systems, lubricating systems - Piston and jet engines – Starting and Ignition systems – Pistonand Jet engines.

UNIT IV AIRCONDITIONING AND PRESSURIZING SYSTEM

Basic Air Cycle systems – Vapour Cycle Systems, Boot-strap air cycle system –Evaporative vapour cycle systems – Evaporation air cycle systems –Oxygensystems – Fire protection systems, De-icing and anti-icing system.

UNIT V AIRCRAFT INSTRUMENTS

Flight Instruments and Navigation Instruments – Accelerometers, Air speed Indicators – Mach Meters – Altimeters - Gyroscopic Instruments– Principles and operation – Study of various types of engine instruments – Tachometers –Temperature gauges – Pressure gauge – Operation and principles.

TEXT BOOKS

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

REFERENCES

1. Teager, S. Gas Turbine technology, McGraw Hill 1997.
2. Mckinley, J.L. and Bent R.D. Aircraft Maintenance & Repair, McGraw Hill, 1993.
3. Handbooks of Airframe and Powerplant Mechanics, US Dept. of Transportation, Federal, Aviation Administration, The English Book Store, New Delhi, 1995.

MATS UNIVERSITY, RAIPUR

Semester : 4th BE Course
Branch : Aeronautical
Subject : Aircraft Structures-I Lab
Code : BE 456

LIST OF EXPERIMENTS

1. Determination of Young's modulus of steel using mechanical extensometers.
2. Determination of Young's modulus of aluminum using electrical extensometers.
3. Determination of fracture strength and fracture pattern of ductile and brittle materials.
4. Determination of forces in statically indeterminate force system.
5. Deflection of beams with various end conditions.
6. Verification of Maxwell's Reciprocal theorem & principle of superposition.
7. Column – Testing.
8. South – well's plot.
9. Testing of Riveted Joints.
10. Determination of membrane stresses in a thin cylinder under internal pressure.

LIST OF EQUIPMENTS

(For a batch of 30 students)

S. No.	Details of Equipments	Qty Req.	Expt. No.
1	Universal Testing Machine	1	1,2,3, 9
2	Mechanical Extensometer	1	1
3	Electrical strain gauge	10	2, 4, 10
4	Hinged bar suspended by two wires of different materials	1	4
5	Strain indicator	1	2, 4, 10
6	Dial Gauges	12	5, 6
7	Beam Test set up with various end conditions	2	5, 6
8	Column Test Apparatus	1	7, 8
9	Thin walled pressure vessel	1	10

MATS UNIVERSITY, RAIPUR

Semester : 4th BE Course
Branch : Aeronautical
Subject : Aerodynamics Lab
Code : BE 457

LIST OF EXPERIMENTS

1. Generation of lift and tip vortices.
2. Flow visualization in water flow channel
3. Flow visualization in smoke tunnel
4. Plot of RPM Vs test section velocity in a subsonic wind tunnel.
5. Pressure distribution over circular cylinder.
6. Pressure distribution over airfoil and estimation of CL and CD.
7. Force measurement using wind tunnel balance.
8. Mach number distribution in nozzle of supersonic wind tunnel.
9. Use of Schlieren system to visualize shock.
10. Use of Shadow graph system to visualize shock.

LIST OF EQUIPMENTS

(For a batch of 30 students)

S. No.	Details of Equipments	Qty Req.	Expt. No.
1	Blower, Balance, and small aspect ratio model	1	1
2	Water flow channel & models	1 set	2
3	Subsonic wind tunnel	1	3, 4,5,6,7
4	Smoke apparatus and rake	1	3
5	Manometer, Pitot-Static tube	1	4,5,6
6	Circular cylinder and Aerofoil pressure distribution models	1	5,6
7	Wind tunnel strain gauge balance	1	7
8	Supersonic wind tunnel, Mercury manometer	1	8,9,10
9	Schlieren system and Shadow graph system	1	9,10
10	Sharp nosed and Blunt nosed models	1	9,10

MATS UNIVERSITY, RAIPUR

Semester : 4th BE Course
Branch : Aeronautical
Subject : Mechanics of Machines Lab
Code : BE 458

LIST OF EXPERIMENTS

1. To observe the lift-off speed of a Porter Governor.
2. To observe the effect of varying sleeve weight or spring force on the operation of a Porter Governor.
3. To observe the lift-off speed of a Proell Governor.
4. To observe the effect of varying sleeve weight or spring force on the operation of a Proell Governor.
5. To observe the lift-off speed of a Hartnell Governor.
6. To observe the effect of varying sleeve weight or spring force on the operation of a Hartnell Governor.
7. To investigate the behavior of Flat Clutch plates and to compare the results using two different methods (uniform pressure and uniform wear) of calculations.
8. To investigate the behavior of a Worm wheel gear set.
9. To measure the coefficient of static and kinetic friction between wooden blocks.
10. To study the tension in the tight and in slack side of a square thread and a vee thread.
11. To determine the coefficient of friction for a square belt and vee belt and compare the results which is in contact with a cast iron pulley.
12. To investigate different types of epicyclic gear configurations and check ratios with theoretical values.
13. To investigate the masses which required to balance the rod in the rotating and reciprocating positions.

LIST OF EQUIPMENTS

(For a batch of 30 students)

S. No.	Details of Equipments	Qty Req.	Expt. No.
1	Varying Sleeve Weight	2 each	2, 4, 6
2	Porter Governor Setup	1	1, 2
3	Proell Governor Setup	1	3, 4
4	Hartnell Governor Setup	1	5, 6
5	Flat Clutch Plates	2	7
6	Worm Wheel Gear Setup	1	8
7	Wooden Blocks	2	9
8	Static and Kinetic Friction Test Setup	1	9
9	Square Thread and Vee Thread Test Setup	1	10
10	Cast Iron Pulley	1	11
11	Square Belt and Vee Belt Friction Test Setup	1	11
12	Epicyclic Gear Arrangements	1	12
13	Rod Balancing Test Setup	1	13

MATS UNIVERSITY, RAIPUR

Semester	:	4th BE Course
Branch	:	Aeronautical
Subject	:	Design and Drafting Lab
Code	:	BE 459

LIST OF EXPERIMENTS

1. Design and Drafting of riveted joints.
2. Design and Drafting of welded joints.
3. Design and Drafting Control Components Cam.
4. Design and Drafting Control Components Bell Crank.
5. Design and Drafting Control Components Gear.
6. Design and Drafting Control Components Push-pull rod.
7. Three view diagram of a typical aircraft.
8. Layout of typical wing structure.
9. Layout of typical fuselage structure.
10. Layout of Control System.

LIST OF EQUIPMENTS

(For a batch of 30 students)

S. No.	Details of Equipments	Qty Req.	Expt. No.
1	Drawing Boards, Drafting Machines	30	1 to 10