Engineering and Technology
Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Third Semester) Aeronautical Engineering
Applied Mathematics – III (BEAE-301T)
(Total Credits: 05)

Teaching Scheme **Examination Scheme**
Lectures: 4 Hours/ Week **Theory**
Tutorial: 1 Hours / Week **T (U): 80 Marks** **T (I): 20 Marks**
Duration of University Exam: 03 Hours

UNIT - I: Laplace Transform **12 Hours**

Definition, Properties, Laplace Transform of Derivatives and Integrals, Evaluation of integrals by Laplace Transform, Inverse Laplace Transform and its Properties, Convolution theorem(Statement only), Laplace Transform of Periodic Functions(Statement only), Unit Step Function and Unit Impulse Function, Applications of Laplace Transform to solve Ordinary Differential Equations, Simultaneous Differential Equations, Integral Equations & Integro-Differential Equations.

UNIT – II: Fourier Transform **04 Hours**

Definition and Properties (excluding FFT), Fourier Integral Theorem, Relation with Laplace Transform, Applications of Fourier Transform to Solve Integral Equation.

UNIT- III: Functions Of Complex Variable **12 Hours**

Analytic function, Cauchy- Riemann conditions, Harmonic Functions, Milne-Thomson Method,
,
Singularities, Cauchy Integral Theorem & Integral Formula (Statement only), Taylor's & Laurent's theorem (Statement only), Residue Theorem (Statement only), Evaluation of Real Definite Integrals by Contour Integration (around unit circle & semi- circle), Conformal mapping, Mapping by Linear and Inverse Transformation.

UNIT - IV: Partial Differential Equations. **10 Hours**

Partial Differential Equations of First Order First Degree i.e. Lagrange's Form, Linear Homogeneous

Partial Differential Equations of Higher Order with Constant Coefficients. Method of Separation of Variables, Applications to One- dimensional Heat Flow Equations. Two-dimensional Heat Flow Equations (only steady state). Applications of Laplace Transform to Solve Partial Differential Equations.

UNIT –V: Matrices: **12 Hours**

Linear and Orthogonal Transformations, Linear Dependence of Vectors, Characteristics Equation, Eigen Values and Eigen Vectors, Statement and Verification of Cayley- Hamilton Theorem [without proof], Reduction to Diagonal Form, Reduction of Quadratic Form to Canonical Form by Orthogonal

Transformation, Sylvester's Theorem [without proof], Solution of Second Order Linear Differential

Equations with Constant Coefficients by Matrix method. Largest Eigen Value and Eigen Vector by Iteration Method.

UNIT – VI: Numerical Methods: **10 Hours**

Error Analysis, Solution of Algebraic and Transcendental Equation by False Position Method, Newton –Raphson Method, Newton- Raphson Method for Multiple Roots, Solution of

System of Simultaneous Linear Equations: Gauss Elimination Method, Gauss- Seidel Method, Crout's Method, Solution of Ordinary Differential equations by Taylor's Series method, Runge-Kutta 4th

Order Method, Euler's Modified Method. Milne ' s Predictor- Corrector Method.

Total No of Periods- 60 hours

Text Books

1. Higher Engineering Mathematics by B.S. Grewal, 40th Edition, Khanna Publication
2. Advanced Engineering Mathematics by Erwin Kreysizig, 8th Edition, Wiley India
3. Applied Mathematics for Engineers & Physicist by L.R. Pipes and Harville,

Reference Books

1. A Text Book of applied Mathematics, Volume I & II , by P.N. Wartikar & J.N. Wartikar, Poona Vidyarthi Griha Prakashan
2. Introductory methods of Numerical Analysis, by S.S. Sastry, PHI
3. Mathematics for Engineers by Chandrika Prasad
4. A text book of Engineering Mathematics by N. P. Bali & M. Goyal, Laxmi Publication

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Third Semester) Aeronautical Engineering

Aero- Thermodynamics (BEAE-302T)

(Total Credits: 04)

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hours/ Week	**Theory**

Tutorial: 1 Hours / Week **T (U): 80 Marks** **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit – I: Introduction to Thermodynamics **7 hours**

Basic concepts of Thermodynamics, Closed & Open Systems, Forms of energy, Properties of system, State & Equilibrium, Processes & Cycles, Temperature & Zeroth Law of Thermodynamics. Introduction to First Law of Thermodynamics (Law of Conservation of Energy), Heat & Work, Mechanical forms of work, Non-Mechanical forms work (Electrical, Magnetic etc.) The Ideal Gas equation of state, Difference between Gas & Vapor, Compressibility factor, Internal energy & specific heats of gases, Universal Gas Constant.

Unit - II: First Law of Thermodynamics **8 hours**

Closed Systems (Control mass system), Work done, Change in internal energy, Heat transferred during various thermodynamic processes, P-V diagrams. Open systems (Control volume systems), Thermodynamic analysis of control volumes, Conservation of energy principle, Flow work & enthalpy.

Unit – III: Second Law of Thermodynamics **10 hours**

Introduction (Law of degradation of energy), Thermal energy reservoirs, Kelvin-Plank & Clausius statements, Heat engines, Refrigerator & Heat pump, Perpetual motion machines, Reversible & Irreversible processes, Carnot cycle, Thermodynamic temperature scale.

Entropy: - The Clausius inequality, Entropy, Principle of increase of entropy, Change in entropy for Closed & Steady flow open systems.

Second law analysis of engineering systems: - Availability, Reversible work, Irreversibility, Temperature-entropy diagram.

Unit – IV: Properties of Steam **7 hours**

Critical state, Sensible heat, Latent heat, Super heat, Wet steam, Dryness fraction, Internal energy of steam, External work done during evaporation, T-S diagram, Mollier chart, Work & Heat transfer during various thermodynamics processes with steam as working fluid. Determination of dryness fraction using various calorimeters.

Unit – V: Air Standard Cycles **7 hours**

Otto cycle, Diesel cycle, Stirling & Ericsson cycle, Brayton cycle, Vapour cycles :- Simple & Modified Rankine cycle with reheat & regeneration.

Unit - VI: Application **6 hours**

Applications to i) Nozzles & Diffusers ii) Turbine & Compressors iii) Throttle Valves. (Simple systems like charging & discharging of tanks)

Total No of Periods- 45 hours

Text Book:

1. Thermodynamics An engineering approach by Yunus Cengal, M.A.Boles
2. Thermodynamics by C. P. Arora, Tata Mc-Graw Hill Publication
3. Fundamentals of classical by Gorden J. V. Wylen, Sonntag
4. Engineering Thermodynamics by P. K. Nag, Tata Mc-Graw Hill Publication
5. Fundamentals of engineering Thermodynamics by R. K. Rajput

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Third Semester) Aeronautical Engineering

Aero- Thermodynamics (BEAE-302P)

(Total Credits: 01)

Teaching Scheme	**Examination Scheme**
Practical: 2 Hours/ Week	**Practical**
	T (U): 25 Marks **T (I): 25 Marks**

List of Experiments in Aero- Thermodynamics:

1. Study of steam turbines.
2. Study of internal combustion engines.
3. Study of various types of compressors.
4. Performance and evaluation of Rotary air Compressor.
5. Performance and evaluation of Reciprocating air Compressor.
6. Visit to thermal power plant .(Case study to be prepared by students)

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Third Semester) Aeronautical Engineering

Fluid Mechanics and Machinery (BEAE-303T)

(Total Credits: 04)

Teaching Scheme
Lectures: 3 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit – I: Introduction to Fluid Mechanics **7 hours**

Properties of fluids, Newton`s law of viscosity and its applications, Pascal`s law, Basic equation of fluid statics, Fluid pressure & its measurement (Manometers & Bourdon`s

pressure gauge), Pressure variations in compressible & incompressible fluids.

Unit – II: Kinematics of Fluid Flow **8 hours**

Types of flow, Stream line, Path line, Streak line, Stream tube, Continuity equation, One & Two dimensional flow, Velocity & Acceleration at a point, Potential lines, Flow net, Stream function, Velocity potential, Circulation, Vortex motion.

Dynamics of Fluid Flow: One dimensional method for flow analysis, Euler`s equation of motion, Derivation of Bernoulli`s equation for incompressible flow & its applications.

Unit – III: Viscous Flow **7 hours**

Introduction to laminar and turbulent flow, Reynolds number and its significance, Mach number and its significance, Boundary layer concept, Wall shear and boundary layer thickness, Displacement thickness and Momentum thickness, Separation, Drag and Lift on immersed bodies. Flow of viscous fluids through parallel plates, Pipes, Kinetic energy correction factor.

Unit – VI: Principles & Classification of Hydraulic Machines **8 hours**

Impulse Turbines :- Principle, Constructional features, Installation of Pelton turbine, Velocity diagram & analysis, Working proportions, Design parameters, Performance characteristics, Governing & selection criteria.

Unit - V: Reaction or Pressure turbine **7 hours**

Principles of operation, Degree of reaction, Comparison over pelton turbine, Development of reaction turbines, Classification, Draft tubes, Cavitation in turbines. Francis turbine, Propeller turbine, Kaplan turbine: Types, Constructional features, Installations, Velocity diagram & analysis. Working proportions, Design parameters, Performance characteristics, Governing, Selection of hydraulic turbines

Unit - VI : Hydraulic Pumps **8 hours**

Classification & Applications

Introduction to Centrifugal, axial & mixed flow Pumps, Self priming
pumps. Introduction to Reciprocating Piston / Plunger Pumps.

Rotary Displacement Pumps: - Introduction to gear pumps, Sliding vane pumps, Screw pumps.

Total No of periods: 45

Text Books:

1. Fluid Mechanics by Frank M. White
2. Fluid Mechanics & Fluid Power Engineering by D.S.Kumar
3. Fluid Mechanics for Engineers by P.N. Chartterjee
4. Fluid Mechanics by J.F.Douglas, J.M. Gasiorek
5. Fluid Mechanics & hydraulic Machines by R.K.Bansal
6. Mechanics of Fluids by B.S.Massey
7. Fluid Mechanics by A.K.Jain
8. Fluid Mechanics with engineering applications by Daugherty & Franizini

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Third Semester) Aeronautical Engineering
Fluid Mechanics and Machinery (BEAE-303P)
(Total Credits: 01)

Teaching Scheme **Examination Scheme**

Practical: 2 Hours/ Week **Practical**

T (U): 25 Marks **T (I): 25 Marks**

List of Experiments in Fluid Mechanics and Machinery:

1. To verify Bernoulli's Theorem
2. To determine the critical velocity of flow by Reynolds's apparatus.
3. Performance characteristics of Pelton Turbine
4. Performance characteristics of Francis Turbine
5. Performance characteristics of Kaplan Turbine
6. To study the Centrifugal Pump
7. To study the Axial Flow Pump
8. To study the Reciprocating Pump

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Third Semester) Aeronautical Engineering
Computer Programming (BEAE-304T)
(Total Credits: 04)

Teaching Scheme
Lectures: 3 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit - I: Introduction **8 hours**

Introduction to programming, programming languages, algorithms, flowcharts. C: Data types, Identifiers, Storage class, Constant, Operators, expression, Statements, console I/O statements, Selection statements: if-else, switch,Iteration Statements: for, while, do-while, Jump statements:return, go to, break, continue, comments.

Unit - II: Functions **8 hours**

Function, Call by value, Call by reference, calling functions with arrays, arguments to main (), return statements, recursion, function prototypes, inline keyword, preprocessor directives. Pointers: pointer variables, pointer operator, pointer expression, array of pointers, multiple indirection, pointers to functions, dynamic allocation functions.

Unit - III: Arrays **7 hours**

Arrays: single dimensional arrays, two dimensional arrays, multidimensional arrays, variable length arrays. Strings, array of strings.

Unit - IV: Structures **8 hours**

Structures: array of structures, passing structure to function, structure pointers, structure within structures. Unions, bit-fields, enumerations, sizeof, type def.

Unit - V: File I/O **7 hours**

File I/O: Streams and files, file system basics, fread, fwrite, fseek, random access I/O, fprintf(), fscanf(), standard streams.

Unit – VI: Advanced Concept in C **7 hours**

Advanced Concepts in C: Different types of pointers, ROM-BIOS functions, Elementary TSRs

Total No of Periods- 45 hours

Text Books:

1. The Complete Reference C (4th Edition) : Herbert Schildt [TMH]
2. C How to Program, 4th Edition by H. M. Deitel & P. J. Deitel, Pearson Education.
3. Writing TSRs through C : Yashwant Kanetkar (BPB)

Reference Books:

1. The C Programming Language : Dennis Ritchie & Brain Kernighan [Pearson]

2. Programming with C : K.R.Venugopal & S.R.Prasad [TMH]
3. Let Us C : Yashwant Kanetkar [BPB]

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Third Semester) Aeronautical Engineering

Computer Programming (BEAE-304P)

(Total Credits: 01)

Teaching Scheme	**Examination Scheme**	
Practical: 2 Hours/ Week	**Practical**	
	T (U): 25 Marks	**T (I): 25 Marks**

List of Experiments in Fluid Computer Programming:

1. Write a programme to perform swapping of two variables without using third variable.
2. Write a programme to calculate the sum of all digit of a five digit number.
3. Write a programme to check whether the year is a leap year or not.
4. Write a programme to print Armstrong number from 1to 500.
5. A menu programme for finding the factorial of a number, prime number & odd number or even number.
6. Write a programme to check whether the entered string of number is paleindrome or not.
7. Write a programme to find the biggest number of three numbers.
8. Write a programme to calculate or demonstrate call by value & call by reference

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Third Semester) Aeronautical Engineering

Elements of Aeronautics (BEAE-305T)

(Total Credits: 04)

Teaching Scheme
Lectures: 4 Hours/ Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Duration of University Exam: 03 Hours

Unit - I: Introduction **5 hours**

To introduce the basic concepts of aerospace engineering early airplanes, biplanes and monoplanes

Unit - II: Development **5 hours**

Developments in aerodynamics, materials, structures and propulsion over the years

Unit -III: Aircraft Configurations **8 hours**

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

Unit -IV: Introduction to Principles of Flight **9 hours**

Physical properties and structure of the atmosphere, Temperature, pressure and altitude relationships, Evolution of lift, drag and moment. Aerofoil's, Mach number,Maneuvers.

Unit - V: Introduction to Airplane Structures and Materials **9 hours**

General types of construction, Monocoque, semi-monocoque construction, Typical wing and fuselage structure. Metallic and non-metallic materials, Use of aluminium alloy, titanium, stainless steel and composite materials.

Unit -VI: Power Plants Used In Airplanes **9 hours**

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

Total No of periods: 45

Text Books:

1. Anderson, J.D., "Introduction to Flight", McGraw-Hill, 1995.

Reference Book:

1. Kermode, A.C., "Flight without Formulae", McGraw-Hill, 1997.

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Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Fourth Semester) Aeronautical Engineering

Mechanics of Machine (BEAE-401T)

(Total Credits: 04)

Teaching Scheme
Lectures: 3 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit - I **8 hours**

Basic concept of mechanism , link , kinematic pairs , kinematic chain , mechanism , machine , simple & compound chain , Degree of freedom , estimation of degree of freedom of mechanism by Grubbler`s criterion and other methods. Harding`s notation , classification of four bar chain (class -I & class - II), inversion of four- bar- chain , Kutchbach theory of multiple drives , energy paths. Various types of mechanism such as Geneva wheel , Pawal and ratchet mechanism , Exact straight line mechanism , Approx. straight line mechanism , steering mechanism, Transport mechanism.

Unit - II **7 hours**

Quantitative kinematic analysis of mechanism :- Displacement , Velocity , and Acceleration analysis of planner mechanism by graphical method as well as analytical method (complex number method / matrix method) , Coriolis component of acceleration , Instantaneous center method , Kennedy`s theorem.

Unit - III **7 hours**

Concepts of cam mechanism , comparison of cam mechanism with linkages. Types of cams and followers and applications. Synthesis of cam for different types of follower motion like constant velocity , parabolic , SHM , cycloidal etc. Cam dynamics and jump-off phenomenon.

Unit – IV **8 hours**

Static & Dynamic force analysis :- Free body diagram, condition of equilibrium. Analysis of all links of given linkages, cam, gear mechanism and their combinations without friction. Dynamic force analysis of planar linkages such as four bar chain & reciprocating mechanism by graphical method, virtual work method & analytical (complex number) method.

Unit - V **8 hours**

Rigid body motion in space. Euler`s equation of motion, Gyroscope, angular velocity, angular acceleration, simple precession & gyroscopic couple. Gyroscopic effect on airplane. Ship, vehicles. Speed governors, centrifugal & inertia type, Watt, Portal, Proell, Hartnell governors, Operating characteristics of governors.

Unit – VI **7 hours**

Static & Dynamic balancing in rotating machines. Balancing machines & field balancing by vector diagram. Balancing in reciprocating mechanism. Effect of partial balancing in

locomotives, secondary balancing. Balancing of inline engine, V – engine, and radial engine.

Total No of periods: 45

TEXT BOOKS:

1. Theory of mechanisms & machines by Shigley J. E.
2. Theory of mechanisms & machines by Ghosh & Mallik
3. Mechanism & Machine Theory by J. S. Rao & Dukki Patti
4. Theory of Machine by Ratan

REFERENCE BOOKS:-

1. Theory of Machines by Thoman Beven CBS publication
2. Theory of Machines by Sandor & Erdman.
3. Mechanical Vibrations by Grover

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Fourth Semester) Aeronautical Engineering
Manufacturing Process- I (BEAE-402T)
(Total Credits: 04)

Teaching Scheme
Lectures: 4 Hours/ Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Duration of University Exam: 03 Hours

Unit- I **8 hours**

Casting Process: - Introduction. Pattern making: - Types, materials used, Type of Pattern, allowances, colour codes. Core making: - Types of core, Core materials & its properties.
Moulding: - Types of sand moulds, moulding sand composition, moulding sand properties, moulding machines

Unit- II **9 hours**
Gating design: - Type of gating systems, pouring time, riser design (Analytical treatment)
Melting furnaces: - Types, Electric furnace, Induction furnace, Cupola - construction & operation. Cleaning, inspection & casting defects.
Special casting processes such as investment casting, centrifugal casting, shell moulding, Slush casting, Die casting

Unit - III **7 hours**
Mechanics of forming processes: - Rolling - rolling pressure & roll separation force, driving force & torque, power loss in bearing. Forging - forging forces & stresses, equipment (Hammer / Press) capacity required. Extrusion & Wire Drawing

Unit- IV **8 hours**
Joining Processes:- Introduction to Welding, Soldering, Brazing Processes. Types of Welding, Arc Welding & Gas Welding Processes, Joints, Electrodes, Weldability of Metals, Defects & Inspection of Welding, Welding equipments of Fixtures. Soldering, Brazing Processes

Unit - V **6 hours**
Powder Metallurgy:- Powder manufacturing & conditioning, Fabrication methods, Production of Sintered Structural Components. Self lubricating bearing, Cemented Carbides, Ceramics, Sintered Carbide cutting tools
Composite Materials: - Classification, Different types of composite materials and its applications

Unit- VI **7 hours**
Processing of Plastics:- Thermoplastic, Thermosetting plastics, General properties & applications of Thermosetting & Thermoplastics. Extrusion, Injection Moulding, Compression Moulding, Transfer Moulding, Blow Moulding, Calendering, Wire Drawing, Embossing.

Total No of periods: 45

TEXT BOOKS:

1. Manufacturing Science by Ghosh & Mallik, Affiliate East –West Press – Pvt Ltd.
2. Manufacturing Engineering & technology 4th Edn by S. Kalpakjian & SR Schmid, Addison Wesley Longman Pvt.Ltd.
3. Production Technology 8th Edn by R.K.Jain, Khanna Publication , New Delhi

REFERENCE BOOKS:-

1. Work Shop Technology, Vol. I - III by WAJ Chapman.
2. Manufacturing Processes by M. Begman
3. Processes & Materials of Manufacture by R. Lindberg.
4. Work Shop Technology (Volume - I & II) by Bawa
5. Work Shop Technology (Volume - I & II) by B. S. Raghuvanshi

Aircraft Materials (BEAE-403T)
(Total Credits: 04)

Teaching Scheme
Lectures: 4 Hours/ Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Duration of University Exam: 03 Hours

Unit – I: Introduction to aerospace materials: **10 hours**

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: Introduction to composite materials **8 hours**

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 **7 hours**

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

Unit – IV: Creep **5 hours**

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, Monk man-Grant relationship.

Unit – V: Fracture **8 hours**

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 –VI: Super alloys and Other Materials **6 hours**

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, Intermetallics, high temperature ceramics.

Total No of periods: 45

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 Behavior 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.

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Fourth Semester) Aeronautical Engineering

Aircraft Structure- I (BEAE-404T)

(Total Credits: 04)

Teaching Scheme
Lectures: 3 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit – I: Concept of simple stresses & strains **8 hours**

Concept of simple stresses & strains :- Introduction, stress, strain, types of stresses, stresses & strains with uni-axial loading, stress-strain diagram for brittle & ductile material, elastic limit, Hooks law, Poisson`s ratio, bulk modulus, relation between Young`s modulus & Shear modulus.

Torsion of circular shafts :- Derivation of torsion equation with the assumptions made in it. Torsion, shear stress induced in the shaft, when it is subjected to torque. Strength & rigidity criterion for design of shaft. Torque transmitted by solid & hollow circular shaft.

Thin cylinders and spherical shells subjected to internal pressure

Unit – II: Shear force & bending moment 11 hour

Shear force & bending moment: - Types of beams (cantilever beam, simply supported beam, overhung beam etc.) Types of loads (Concentrated & UDL), Shear force & bending moment diagrams for different types of beams subjected to different types of loads, Sign. Conventions for bending moment & shear force, shear force & bending moment diagrams for beams subjected to couple, Relation between load, shear force & bending moment.

Stresses in beams:- Pure bending, theory of simple bending with assumptions & expressions for bending stress, derivation of bending equation, bending stresses in symmetrical sections, section modulus for various shapes of beam sections.

Deflection of beams :- Derivation of differential equation of elastic curve with the assumptions made in it. Deflection & slope of cantilever, simply supported, overhung beams subjected to concentrated load, UDL, Relation between slope, deflection & radius of curvature. Macaulay`s method, area moment method to determining deflection of beams.

Shear stresses in beams :- Concept, derivation of shear stress distribution formula, shear stress
distribution diagram for common symmetrical sections, maximum & average shear stress.

Unit – III: Strain energy & impact loading 8 hour

Strain energy & impact loading :- Definition of strain energy stored in a body when it is subjected to gradually applied load, suddenly applied loads & impact loads. Strain energy under uniaxial tension and compression, bending and torsion. Castingliano`s theorem.

Statically indeterminate beams and frames, Clapeyron's three moment equation method, Moment distribution method.

Unit- IV: Columns 6 hour

Buckling of columns with various end conditions, column curves, Columns with initial curvature, with eccentric loading, South well plot, short column formulae like Rankine's Johnsons, etc. Energy method. Beam Column.

Unit- V: Principal stresses & strains 6 hour

Principal stresses & strains :- Definition of principal planes & principal stresses, analytical method of determining stresses on oblique section when member is subjected to direct stresses in one plane in mutually perpendicular two planes, when member is subjected to shear stress &direct stresses in two mutually perpendicular planes, Mohr`s circle for representation of stresses. Derivation of maximum & minimum principle stresses & maximum shear stresses when the member is subjected to different types of stresses simultaneously (i.e. combined stress)

Unit- VI **6 hour**

Derivation of maximum, minimum principle stresses & maximum shear stress induced in shaft when it is subjected to bending moment, torque & axial load. Theories of failure, modes of failure, compound stresses, eccentric axial loading, variable stresses in machine parts, stress concentration & stress raisers, notch sensitivity, stress concentration factor, methods for reducing stress concentration factor, Factor of safety

Total No of periods: 45

TEXT BOOKS:

1. Strength of Material by S. Ramamurtham
2. Strength of Material by R. K. Rajput
3. Strength of Material by F. L. Singer
4. Mechanics of Material by Beer & Johnson
5. Timoshenko, S., "Strength of Materials", Vols, I and II, Princeton D.Von Nostrand Co., 1988.
6. Donaldson, B.K., "Analysis of Aircraft Structures - An Introduction", McGraw Hill, 1993.

REFERENCE BOOKS:

1. Strength of materials by Timoshenks
2. Machine Design by Black & Adam
3. Machine Design by J. E. Shigley

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Fourth Semester) Aeronautical Engineering

Aircraft Structure- I (BEAE-404P)

(Total Credits: 01)

Teaching Scheme
Practical: 2 Hours/ Week

Examination Scheme
Practical
T (U): 25 Marks **T (I): 25 Marks**

List of Experiments in Aircraft Structure- I (Minimum any Ten Experiments)

1. Study of strain measuring instruments mechanical, electrical types.
2. Tension test on metals.
3. Hardness test on metals.
4. Torsion test on metals.
5. Impact test metals.
6. Transverse test on beams including deflections.
7. Notch Bar Test for toughness of metals.
8. Measurement of static strains using electrical resistance gauges.

9. Verification of S.T. in beams.
10. Deflection of springs.
11. Aircraft structure material: Absorption Test, Dimension Test, Crushing strength

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Fourth Semester) Aeronautical Engineering

Aerodynamics- I (BEAE-405T)

(Total Credits: 04)

Teaching Scheme	**Examination Scheme**
Lectures: 3 Hours/ Week	**Theory**
Tutorial: 1 Hours / Week	**T (U): 80 Marks T (I): 20 Marks**
	Duration of University Exam: 03 Hours

Unit-I: Introduction **6 Hours**

To understand the behaviour of airflow over bodies with particular emphasis on airfoil sections in the incompressible flow regime.

CHARACTERISTICS PARAMETERS FOR AIRFOIL AND WING AERODYNAMICS

Characterizations of Aerodynamic Forces and Moments, Airfoil Geometry Parameters, Wing Geometry Parameters, Aerodynamic Force and Moment Coefficients, Wings of Finite Spans

Unit-II: Two Dimensional Flows **8 Hours**

Basic flows – Source, Sink, Free and Forced vortex, uniform parallel flow. Their combinations, Pressure and velocity distributions on bodies with and without circulation in ideal and real fluid flows. Kutta Joukowski's theorem.

Unit-III: Incompressible Flows Around Airfoils 11 Hours

General Comments, Circulation and the Generation of Lift, General Thin- Airfoil Theory, Thin, Flat-Plate Airfoil (Symmetric Airfoil),Thin, Cambered Airfoil, High-Lift Airfoil Sections, Multielement Airfoil Sections for Generating High Lift, High-Lift Military Airfoils.

Unit-IV: Dynamics of A Compressible Flow Field 6 Hours

Thermodynamic Concepts, Adiabatic Flow in a Variable Area Stream tube, Isentropic Flow in a Variable area stream tube, Characteristic equations and Prandtl- Meyer Flow, Shock Waves.

Unit-V: Compressible Flow 6 Hours

Stagnation properties, speed of sound wave. Mach number, one dimensional isentropic flow, Stagnation properties, isentropic flow through convergent - divergent nozzles. Normal shock.

Unit VI: Introduction To Boundary Layer Theory 6 Hours

Concepts of laminar and turbulent boundary layer. Momentum integral equation. Approximate methods for solution of boundary later for simple cases.

Total No of periods: 45

TEXT BOOKS

1. Anderson, J.D., "Fundamentals of Aerodynamics", McGraw-Hill Book Co., New York, 1985.

REFERENCES

1. Houghton, E.L., and Carruthers, N.B., "Aerodynamics for Engineering students", Edward Arnold Publishers Ltd., London, 1989.
2. Milne Thomson, L.H., "Theoretical aerodynamics", Macmillan, 1985.
3. Clancey, L.J., "Aerodynamics", Pitman, 1986

Engineering and Technology

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Fourth Semester) Aeronautical Engineering

Aerodynamics- I (BEAE405P)
(Total Credits: 01)

Teaching Scheme
Practical: 2 Hours/ Week

Examination Scheme
Practical
T (U): 25 Marks T (I): 25 Marks

List of Experiments in Aerodynamics- I

Based on above syllabus minimum eight practical's to be performed.

1. To draw the graph for different velocities verses manometer deflection.

2. Analysis of forces (Lift & Drag) over cambered aerofoil symmetrical.
3. Analysis of forces (Lift & Drag) over cambered aerofoil unsymmetrical.
4. Analysis of forces (Lift & Drag) over flat plate.
5. To draw graph of pressure distribution on a symmetrical aerofoil.
6. To draw graph of pressure distribution on a unsymmetrical aerofoil.
7. To draw graph of pressure distribution on flat plate.
8. To draw graph of pressure distribution on a circular cylinder.
9. To visualize the flow patterns over the surface of different model.
10. To study the side force in yawing motion of an aircraft.
11. To study the boundary layer concept over the various models.

Engineering and Technology

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Fourth Semester) Aeronautical Engineering

Aircraft layout and Component drawing
(BEAE-406P) (Total Credits: 02)

Teaching Scheme
Practical: 2 Hours/ Week

Examination Scheme
Practical
T (U): 25 Marks **T (I): 25 Marks**

List of Experiments in Aircraft Layout and Component Drawing:
Study of layout and component parts of different types of aircraft through drawings
Suggested

1. Considerations to be taken while lay outing the cockpit of aircraft.
2. Layout of cockpit of civil aircraft.
3. Layout of cockpit of military aircraft.
4. Considerations to be taken while lay outing the fuselage of aircraft
5. Layout of fuselage of jet transport aircraft.
6. Layout of fuselage of jet commercial aircraft.
7. Layout of fuselage of jet fighter aircraft.
8. Considerations to be taken while designing an aircraft.
9. Three Views drawing of commercial aircraft.
10. Three Views drawing of fighter aircraft.
11. Three Views drawing of jet transport aircraft.
12. Physical models of gliders using balsa.

REFERENCES

1. Janes all the World's Aircraft
2. Drawings available from Aircraft Manufacturers

Engineering and Technology

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Fourth Semester) Aeronautical Engineering

Environmental Studies(BEAE-407T)
(Total Credits: 0)

Teaching Scheme:
Practical: 3 Hours/ Week

Examination Scheme:
Audit Subject
College Assessment :(Grades: O, A, B, C)

Course Objectives and Expected Outcomes:

This course provides an integrated and interdisciplinary approach to the study of environment and solutions to environmental problems. This course will spread awareness among the student s about environmental issues and shall alert them to find solutions for sustainable development.

UNIT – I **4 Hours**

Introduction: Definition, scope and importance; Need for public awareness - Institutions in environment, people in environment.

Natural Resources: Renewable and non-renewable and associated problems; Role of an individual in conservation of natural resources; equitable use of resources for sustainable lifestyles.

UNIT – II **6 Hours Ecosystems:**

Concept of an ecosystem - understanding ecosystems, ecosystem degradation, resource utilization, Structure and functions of an ecosystem- producers, consumers) and decomposers. Energy flow in the ecosystem - water, carbon, oxygen, nitrogen; and energy cycles, integration of cycles in nature. Ecological succession; Food chains, food webs and ecological pyramids; Ecosystem types - characteristic features, structure:, and functions of forest, grassland, desert and aquatic ecosystems

.

UNIT – III **8 Hours**

Biodiversity :

Introduction – Biodiversity at genetic, species and ecosystem levels Bio-geographic classification of India Value of biodiversity - Consumptive use value, productive use .value, social, ethical, moral, aesthetic and optional value of biodiversity. India as a mega-diversity nation; hotspots of biodiversity Threats to bio-diversity - habitat loss, poaching of wildlife, man-wild life conflicts. Common endangered and endemic plant and animal species of India. Insitu and Exsitu conservation of biodiversity

UNIT – IV **8 Hours**

Pollution :

Definition; Causes, effects and control measures of air, water, soil, marine, noise and thermal pollutions and nuclear hazards. Solid waste management - Causes, effects and contro l measures of urban and industrial waste. Role of individual and institutions in prevention of pollution. Disaster management Floods, Earth quacks, Cyclone and land slides.

UNIT – V **8 Hours**

Social Issues and the Environment: Unsustainable to sustainable development; Urban problems, related to energy; Water conservation, rainwater harvesting, watershed management; Problems and concerns of resettlement and rehabilitation of affected people.

Environmental ethics - issues and possible solutions – Resource consumption patterns and need for equitable utilization; Equity disparity in Western and Eastern countries; Urban and rural equity issues; need for gender-equity.

Preserving Resources for future generations. The rights of animals; Ethical basis of environment education and awareness; Conservation ethics and traditional value systems of India.

Climate change, global warming, acid-, rain, Ozone layer depletion, nuclear accidents and holocausts. Wasteland Reclamation; Consumerism and Waste products.

Environment legislations - The Environment (protection) Act; The water (Prevention and Control of Pollution) Act; The. Wildlife Protection Act; Forest Conservation Act; Issues involved in enforcement of environmental legislations - environment impact assessment (EIA), Citizens action sand action groups.

Public awareness — Using an environmental calendar of activities, self initiation.

UNIT – VI **6 Hours**

Human Population and the Environment:

Global population growth, variation among nations, population explosion; Family Welfare Programmers.- methods of. sterilization; Urbanization.

Environment and human health - Climate and health, Infectious diseases, water- related diseases, risk due to chemicals in food, Cancer and environment. Human rights — Equity, Nutrition and health rights,

intellectual property rights (1PRS), Community Biodiversity registers (CBRs) Value education - environmental values, valuing nature, valuing cultures, social justice, human

heritage, equitable use of resources, common property resources, ecological degradation. HIY/A1DS; Women and Child Welfare; Information technology in environment and human health.

Total No of periods: 40

GUIDELINES FOR EVALUATION OF ENVIRONMENTAL STUDIES SUBJECT (As per Ordinance No. 2 of 2012):

At the end of the course, the student shall be evaluated for 100 marks with distribution as below: Field note book - 25 Marks

Objective Questions - 50 Marks (50 questions, each of one mark) Essay type question - 25 Marks.

Passing marks - 40 Marks.

OR

In view of the above entire course the students in terms of batches of 20 students each may be assigned a project work encompassing People's Bio-diversity Register (PBR) of any Gram Panchayat as per the format of Bio-diversity Authority of India under the guidance of a teacher. The PBR should be evaluated for 100 marks.

The result shall be declared in grades as follows: Grade O: above 75 Marks;
Grade A: 61–75 Marks;Grade B: 51-60 Marks; Grade C: 40-50 Marks

TEXT BOOKS:

A Text Book of Environmental Studies for Undergraduate Courses, Erach Bharucha, University Press (India) Pvt. Ltd., Hyderabad

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Fifth Semester) Aeronautical Engineering

Heat Transfer (BEAE-501T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit – I **7 Hours**

Introduction: Basic modes of heat transfer, conduction, convection and radiation, Laws of heat transfer and conservation of energy requirement.

Heat Conduction – One dimensional steady state heat conduction: Composite Medium – Critical thickness – Effect of variation of thermal Conductivity – Extended Surfaces – Unsteady state. Lumped System Analysis – Heat Transfer in Semi infinite and infinite solids – Use of Transient – Temperature charts– Biot Number,

Unit – II **7 Hours**

Free Convection:

Free or natural convection, Grashof number, Rayleigh number, Horizontal and vertical plate. Empirical co-relations for cylinders and spheres. Heat transfer with phase change, pool boiling curve & regimes of pool boiling. Film & Drop wise condensation, laminar film condensation on vertical surface, film condensation on horizontal tubes, effect of super heated & non-condensable gasses on condensation heat transfer, Introduction to heat pipe.

Unit – III **7 Hours**

Forced convection:

Physical significance of non-dimensional parameters. Flow of high moderate & low prandtl number, fluid over flat surface. Concept of velocity & thermal boundary layer thickness, local and average heat transfer coefficients. Empirical co-relations for external, internal flow, laminar & turbulent flow through conduits.

Unit – IV **8 Hours**

Radiative Heat Transfer

Radiation, nature of thermal radiation, black body radiation, radiation intensity, laws of radiation– Kirchoffs, Planks, Weins displacement, Stefan Boltzmann & Lamberts Co-sine law. Emissivity, Absorbtivity, Transmissivity, Reflectivity, Radiosity, Emissive power, irradiation. Radiation network, radiation exchange between surfaces, idea of shape factor & reciprocity theorem, radiation between parallel plates, cylinder & spheres. Radiation shields, effect of radiation on temperature measurement.

Unit – V **8 Hours**

HEAT EXCHANGERS

Heat Exchanger :- Classification, Overall heat transfer coefficient, fouling factor, LMTD method of heat exchange analysis for parallel, counter flow & cross flow arrangement. Effectiveness NTU method, heat exchanger analysis by NTU method, design aspects of heat exchangers. Introduction to compact heat exchanger. Introduction to mass transfer.

Unit – VI **8 Hours**

HEAT TRANSFER PROBLEMS IN AEROSPACE ENGINEERING

High-Speed flow Heat Transfer, Heat Transfer problems in gas turbine combustion chambers – Rocket thrust chambers – Aerodynamic heating – Ablative heat transfer.

Total No of periods: 45

TEXT BOOKS:

1. Introduction to heat Transfer Incropera. F.P.and Dewitt.D.P. ,John Wiley and Sons – 2002.
2. Elements of Heat Transfer M. N. Ozisik
3. Heat Transfer -A practical approach Yunus A. Cengel , "Tata Mcgraw Hill publication Second Edition
4. Heat Transfer J. P. Holman McGraw Hill Publication

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Fifth Semester) Aeronautical Engineering

Aircraft Flight Mechanics (BEAE-502T)

(Total Credits: 05)

Teaching Scheme **Examination Scheme**

Lectures: 4 Hours/ Week **Theory**
Tutorial: 1 Hours / Week **T (U): 80 Marks** **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit- I Introduction and background **6 hours**

Dimensional analysis, Buckingham Pi theorem-applications-similarity laws and models International Standard Atmosphere

Unit-II: FORCES AND MOMENTS ON THE AIRPLANE **10 hours**

Forces and moments acting on a flight vehicle - Equation of motion of a rigid flight vehicle - Different types of drag - Drag polars of vehicles from low speed to high speeds - Variation of thrust, power and SFC with velocity and altitudes for air breathing engines and rockets - Power available
and power required curves.

AIRCRAFT PERFORMANCE

Unit-III **8 Hours**

Performance of airplane in level flight - Maximum speed in level flight - Conditions for minimum drag and power required - Range and endurance, - Climbing flight (Maximum rate of climb and steepest angle of climb,) Service and absolute ceiling

Unit –IV **7 Hours**

Gliding flight (minimum rate of sink and shallowest angle of glide) Turning performance (Turning rate turn radius). Bank angle and load factor, take off and landing performance - Limitations of pull up and push over

STATIC LONGITUDINAL STABILITY

Unit-V **7 Hours**

Degree of freedom of rigid bodies in space - Static and dynamic stability - Purpose of controls in airplanes -Inherently stable and marginal stable airplanes – Static, Longitudinal stability - Stick fixed stability - Basic equilibrium equation - Stability criterion

Unit-VI **7 Hours**

Effects of fuselage and nacelle - Influence of CG location - Power effects - Stick fixed neutral point - Stick free stability-Hinge moment coefficient - Stick free neutral points-Symmetric maneuvers - Stick force gradients - Stick _ force per 'g' - Aerodynamic balancing. Determination of neutral points and maneuver points from flight test.

Total No of periods: 45

TEXT BOOK

1. Perkins, C.D., and Hage, R.E., “Airplane Performance stability and Control”, John Wiley & Son:,
   Inc, New York, 1988.

REFERENCES

1. Etkin, B., “Dynamics of Flight Stability and Control”, Edn. 2, John Wiley, New York, 1982
2. Babister, A.W., “Aircraft Dynamic Stability and Re¬sponse”, Pergamon Press, Oxford, 1980.
3. Dommasch, D.O., Shelby, S.S., and Connolly, T.F., “Aeroplane Aero dynamics”, Third Edition,
   Issac Pitman, London, 1981.
4. Nelson, R.C. “Flight Stability and Automatic Control”, McGraw-Hill Book Co., 1998.

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Fifth Semester) Aeronautical Engineering

Aerodynamics- II (BEAE-503T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

UNIT – I **7 Hours**

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.

UNIT – II **8 Hours**

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.

UNIT – III **8 Hours**

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

Unit – IV **8 Hours**

Shock expansion method for flow over airfoils - small perturbation equation for compressible flow - 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 - Numercial integration procedures - Drag at supersonic speeds - Supersonic area rule.

Unit – V **7 Hours**

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

Unit-VI **7 Hours**

Free flight testing - Measurements of pressure, velocity and Mach number - Flow visualisation methods of subsonic and supersonic flows.

Total No of periods: 45

TEXT BOOKS:

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.

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Fifth Semester) Aeronautical Engineering

Aircraft Structure- II (BEAE-504T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Unit – I: Unsymmetrical Bending **8 Hours**
Review of bending of symmetrical sections, Stresses in beams of unsymmetric sections

Unit – II: Shear Flow in Open Sections **8 Hours**
Thin walled beams, Concept of shear flow, shear centre, Elastic axis.
Shear Flow in Closed Sections

Unit – III: **7 Hours**
Membrane Analogy , Bredt - Batho formula, Single and multi-cell structures. Shear flow in single and multicell structures under torsion.

Unit – IV: **7 Hours**

Shear flow in single and multicell under bending with walls effective and ineffective.

Unit – V Buckling of Plates **7Hours**

Rectangular sheets under compression, Local buckling stress of thin walled sections, Crippling stresses by Needham's and Gerard's methods, Thin walled column strength. Sheet stiffener panels. Effective width, Inter rivet and sheet wrinkling failures.

Unit – VI: Stress Analysis of Wing and Fuselage **8 Hours**

Procedure - Shear and bending moment distribution for semi cantilever and other types of wings and fuselage, thin webbed beam. With parallel and non parallel flanges, Shear resistant web beams, Tension field web beams (Wagner's).

Total No of periods: 45

REFERENCES*:*

1. Megson, New edition T.M.G., "Aircraft Structures for Engineering Students", Edward Arnold, 1985.
2. Bruhn. E.H, "Analysis and Design of Flight vehicles Structures", Tri-state off set company, USA, 1965.
3. Peery, D.J., and Azar, J.J, "Aircraft Structures ", 2nd edition, Mcgraw-Hill, N.Y., 1993.
4. Rivello, R.M., "Theory and Analysis of Flight Structures ", McGraw Hill, 1993.

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Fifth Semester) Aeronautical Engineering

Aircraft Structure- II (BEAE-504P)

(Total Credits: 01)

Teaching Scheme	**Examination Scheme**	
Practical: 2 Hours/ Week	**Practical**	
	T (U): 25 Marks	**T (I): 25 Marks**

List of Experiments in Aircraft Structures-II

1. Determination of Unsymmetrical bending using different section using bend test set up.
2. Determination of Shear centre location for open sections
3. Determination of Shear centre location for closed sections
4. Experiment on Constant strength beam
5. Finding out flexibility matrix for cantilever beam
6. Testing of Beam with combined loading
7. Determination of resonance frequency of Beams using free vibrations
8. Determination of resonance frequency of Beams using forced vibrations
9. Column testing and Southwell plot
10. Verification of Maxwell’s Reciprocal theorem & principle of superposition

Engineering and Technology
Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Fifth Semester) Aeronautical Engineering
Propulsion- I (BEAE-505T)
(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit-I: Fundamentals of Gas Turbine Engines **8 Hours**

Illustration of working of gas turbine engine - The thrust equation - Factors affecting thrust - Effect of pressure, velocity and temperature changes of air entering compressor - Methods of thrust augmentation - Characteristics of turboprop, turbofan and turbojet - Performance characteristics.

Unit-II: Subsonic and Supersonic Inlets for Jet Engines **7 Hours**

Internal flow and Stall in Subsonic inlets - Boundary layer separation - Major features of external flow near a subsonic inlet - Relation between minimum area ratio and eternal deceleration ratio. Inlet Diffuser performance - Supersonic inlets - Starting problem in supersonic inlets - Shock swallowing by area variation – External deceleration - Modes of inlet operation.

Unit-III: Combustion Chambers **8 Hours**

Classification of combustion chambers - Important factors affecting combustion chamber design – Combustion process - Combustion chamber performance - effect of operating variables on performance - Flame tube cooling - Flame stabilization - Use of flame holders - Numerical problems.

Unit-IV: Nozzles **7 Hours**

Theory of flow in isentropic nozzles - Convergent nozzles and nozzle choking - Nozzle throat conditions - Nozzle efficiency - Losses in nozzles - Over expanded and under-expanded nozzles - Ejector and variable area nozzles - Interaction of nozzle flow with adjacent surfaces - Thrust reversal.

Unit-V: Compressors & Turbines **8 Hours**

Description Classification, type, performance parameters – efficiency, component characteristics.

Unit – VI: Matching of Gas Turbine Components: **7 Hours**

Inlet, compressor, combustion chamber, turbine, and nozzle. Numerical problems.

Total No of periods: 45

REFERENCES:

1. Hill, P.G & Peterson, GR. “Mechanics of Thermodynamics of Propulsion” Addison – Wesley Longman JNC, 1999.
2. Cohen, H.Rogers, G.F.C. and Saravanamuttoo, H.I.H. " Gas Turbine Theory ", Longman, 1989.
3. Mathur, M.L., and Sharma, R.P.,"Gas Turbine", "Jet and Rocket Propulsion", Standard Publishers and Distributors, Delhi, 1988.
4. Oates, G.C. " Aerothermodynamics of Aircraft Engine Components ", AIAA Education Series, New York, 1985.

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Fifth Semester) Aeronautical Engineering

Non Destructive Inspection (BEAE-506P)
(Total Credits:02)

Teaching Scheme	**Examination Scheme**	
Practical: 2 Hours/ Week	**Practical**	
	T (U): 25 Marks	**T (I): 25 Marks**

Objective:

The training will have a focus on creating awareness of various non destructive techniques such as ultrasonic, radiography, dye penetration etc. for determination of defects / damage in structural component for maintenance.

List of Experiments for Non Destructive Inspection:

1. Simple optical inspection
2. Borescope
3. Ultrasonic flaw detection
4. Ultrasonic thickness measurement
5. Dye Penetration testing
6. Eddy current testing
7. Magnetic particle testing
8. Radiography
9. Weld inspection
10. Metallurgical Microscope

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Fifth Semester) Aeronautical Engineering
CAD/ CAM (BEAE-507P)
(Total Credits: 02)

Teaching Scheme	**Examination Scheme**	
Practical: 2 Hours/ Week	**Practical**	
	T (U): 25 Marks	**T (I): 25 Marks**

List of Experiments in Computer Aided Design
(Any Ten Practicals)

1. Introduction to CAD Software's, tools, Menu Commands and shortcut keys.
2. Program to generate Line, Circle using Bresenham's principle Algorithm and one Numerical on two dimensional transformations and three dimensional transformations.
3. Program for generation of any one synthetic curve surface (Bezeier or B-spline)
4. Scaling, rotation, translation, editing, dimensioning – Typical CAD command
5. Structure.
6. Wire frame modeling – surface modeling
7. Solid Modeling & Advanced modeling
8. Flow Simulation Over A Symmetrical Airfoil Using CFD
9. Flow Simulation Over A Cambered Airfoil Using CFD
10. Flow Simulation Over A Turbine Blade(static analysis)Using CFD
11. Stress Analysis Of A Turbine Blade (Rotation only and no pressure loads)
12. Stress Analysis Of Any Aircraft Component
13. Analysis of Truss & 2- dimensional problem of finite element method using Ansys or any analysis software.
14. Analysis of Beam and Axisymmetric problem of finite element method using Ansys or any analysis software.
15. Analysis of any one Heat conduction problem of finite element method using Ansys or any analysis software.

List of Software's:
CAD: Pro/E, NX-5, Catia, Solid Edge
CAE: Anysys. Cosmos, Hypermesh, Nisa

Turbo C

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Sixth Semester) Aeronautical Engineering

Propulsion- II (BEAE-601T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit-I: Ramjet Propulsion **7 Hours**

Operating principle - Subcritical, critical and supercritical operation - Combustion in ramjet engine– Ramjet performance - Sample ramjet design calculations.

Unit-II: Scramjet and Hypersonic Propulsion **7 Hours**

Introduction to scramjet - Preliminary concepts in supersonic combustion - Integral ram - rocket - Numerical problems, Hypersonic propulsion.

Unit-III FUNDAMENTALS OF ROCKET PROPULSION **7 Hours**

Operating principle - Specific impulse of a rocket - internal ballistics - Rocket nozzle classification – Rocket performance considerations - Numerical problems.

Unit-IV SOLID PROPELLENTS **8 Hours**

Solid propellant rockets - Selection criteria of solid propellants - Important hardware components of solid rockets - Propellant grain design considerations.

Unit-V LIQUID PROPELLANT **8 Hours**

Selection of liquid propellants – Thrust control in liquid rockets - Cooling in liquid rockets - Limitations of hybrid rockets - Relative advantages of liquid rockets over solid rockets - Numerical problems.

Unit-VI ADVANCED PROPULSION TECHNIQUES **8 Hours**

Electric rocket propulsion - Ion propulsion techniques - Nuclear rocket - Types -Solar sail - Preliminary Concepts in nozzle less propulsion.

Total No of periods: 45

REFERENCES:

1. Sutton, G.P & Oscar Bilbraz,., "Rocket Propulsion Elements", John Wiley & Sons Inc., New

York, 7th Edition,2004
2. Gorden, C.V., "Aerothermodynamics of Gas Turbine and Rocket Propulsion ", AIAA Education Series, New York, 1986.
3. Mukunda H. S . " Understanding Aerospace chemical propulsion ",Interline publications ,2004

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Sixth Semester) Aeronautical Engineering

Propulsion- II (BEAE-601P)

(Total Credits: 01)

Teaching Scheme	**Examination Scheme**	
Practical: 2 Hours/ Week	**Practical**	
	T (U): 25 Marks	**T (I): 25 Marks**

List of Experiments in Propulsion- II:

1. Subsonic free /wall jet apparatus
2. Subsonic Free/wall jet with open section wind tunnel
3. Supersonic free jet apparatus
4. Propeller performance test apparatus
5. Aircraft engines models/cut section
6. Cascade Test setup
7. free/forced convective heat transfer test setup
8. Study of magneto and ignition system
9. Study of combustion characteristics

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Sixth Semester) Aeronautical Engineering

Manufacturing Process- II (BEAE-602T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit – I **6 Hours**

Theory of metal cutting : Mechanics of Metal Cutting, Orthogonal and oblique cutting, Stress, Strain & Cutting Forces, Merchant Circle,

Unit – II **7 Hours**

Cutting Force Calculations, Determination of Torque and Power Required for Turning, Drilling and Milling, Influence of tool angle, Cutting Fluids, Cutting speed, Feed and depth of cut on power requirement, Estimation of tool life.

Unit – III **8 Hours**

Study of construction , working , accessories and operations of (1) Lathes (ii) Drilling (iii) Milling Machines (IV) Capstan & Turret Lathe

Unit – IV **8 Hours**

Press Working : Die cutting operation, classification, types of presses, press terminology, introduction to shaping operations, bending, forming & drawing.

Jigs and Fixtures : Introduction, principles of jigs and fixtures design. Materials, principles of location, methods of location. Clamping requirements, types of clamps, jig bushes, drilling jigs, milling fixtures, classification of fixtures.

Manufacturing process of special interest for Aerospace application

Unit – V **8 Hours**

Joints , Rivets , Non-conventional Machining Processes :- Characteristics, Operation, Applications, Limitations and Selection of Process Parameters of the following Processes. Abrasive Jet Machining, Ultrasonic Machining, Water Jet Machining, EDM, ECM.

Unit – VI **8 Hours**

Advanced Welding Methods :- Introduction to TIG, MIG, Spot Welding, Plasma Arc Welding. Electron Beam Welding, Laser Beam Welding.

Total No of periods: 45

TEXT BOOKS:

1. Production Technology - R.K. Jain,8th Edn, Khanna Pub.

2.	Modern Machining Processes	–	Pandey, Shah, Tata McGraw Hill
3.	Production Engineering	–	P. C. Sharma.
4.	Tool Design	–	Donaldson, Tata McGraw Hill

REFERENCE BOOKS :-

1.	Work Shop Technology , Vol. I - III	- WAJ Chapman.
2.	Manufacturing Processes	- M. Begman
3.	Processes & Materials of Manufacture	- R. Lindberg.
4.	Work Shop Technology (Volume - I & II)	- Bawa
5.	Work Shop Technology (Volume - I & II)	- B. S. Raghuvanshi

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Sixth Semester) Aeronautical Engineering
System Modeling and Simulation (BEAE-603T)
(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks T (I): 20 Marks
Duration of University Exam: 03 Hours

Unit – I **7 Hours**

Mathematical Modeling of Physical System and Concept of Transfer Function system Representation through Block Diagram and Signal Flow Graph. Transfer friction through Block

Diagram Simplification and Mason's Gain Formula.

.**Unit – II** **6 Hours**

System Models: Concept of a system, system environment, stochastic activities continuous & discrete system, system modeling, type of models static physical models, dynamic physical models,static & dynamic mathematical models, principles used in modeling.

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Unit – III **7 Hours**

System Studies: Subsystems, a corporate model,types of system study, system analysis design & postulation.

Unit – IV **8 Hours**

Control System Components such as hydraulic actuators, Servomechanism D.C. and liquid level control, Automobile Power Steering Control, Speed Control, Position control of Robotic Manipulator Etc.

Unit –V **9 Hours**

Use of computer based simulation package such as Mat lab simulink. .

Unit – VI **8 Hours**

Typical Navigational systems- - Integrated Avionics system, Avionic sub system

Total No of periods: 45

TEXT BOOKS:

1. System Simulation second Edition by Geoffrey Gordon (PHI Pub.)
2. System Simulation with Digital Computer by Narsingh Deo (PHI Pub.)

REFERENCE BOOKS:

1. "System Simulation" the Art & Science by Shannon R.E.(PHI Pub.)
2. The Application of GPSS to Discrete System Simulation by Gorden. Englewood Cliffs (PHI)

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Sixth Semester) Aeronautical Engineering
Applied Electronics (BEAE-604T)
(Total Credits: 05)

Teaching Scheme	**Examination Scheme**
Lectures: 4 Hours/ Week	**Theory**
Tutorial: 1 Hours / Week	**T (U): 80 Marks T (I): 20 Marks**

Duration of University Exam: 03 Hours

Unit I **6 Hours**

Digital Computers, Memory Classification, Architecture of 8085 Microprocessor, Interfacing of memories/latches/buffers /leds/7-segment display/pushbutton/switches.

Unit II **9 Hours**

Addressing Modes, Instruction Set Classification, Simple Instructions with programs for data transfer, arithmetic, logical , branching and machine control ,Stacks and subroutines , simple and nested calls and return.

Unit III **10 Hours**

Code conversion ,BC D arithmetic and 16 bit data handling instructions and programs, Formats of data transfer, Interrupts (hardware and software). Serial data communication using SID and SOD pins.

Unit IV **8 hours**

Programmable peripheral interface(PPI) 8255, architecture, interfacing and different modes,Interfacing of keyboards/leds/7-segment display/pushbutton/switches using 8255, Interfacing of matrix keyboard, multiplexed 7- segment displays, stepper motors, ADC and DAC.Bus contention and slow memories interfacing

Unit V **6 Hours**

Introduction: Importance and role of avionics, avionic environment, Displays and man-machine interaction: Head up displays, intelligent displays management, Displays technology, control and data entry, instrument placement .

Unit VI **6 Hours**

Onboard communications: Microphones, Digital communications, Transmission lines, Digital data bus systems ARINC 426, MIL STD 1553, Commercial standard digital bus, Fiber optic communication Avionics system integration: Data bus systems, integrated modular avionic

Total No of periods: 45

TEXT BOOKS:

1. Microprocessor architecture programming and applications with 8085: Ramesh Gaonkar

2. Microprocessor architecture and programming: D.V.Hall
3. Microprocessor and programming : Vibhute and Borle
4. Introduction to Avionics : Collins on RPG, , Second Edition, Kluwer Academic Publishers, Chapman & Hall, 2003.
5. Principals of Avionics: Albert Helfrick, 2nd Edition, Avionics Communication Inc.
6. Avionics Systems: Middleton, D.H., Ed., Longman Scientific and Technical, Longman Group UK Ltd., England, 1989.
7. Manual of Avionics: Brain Kendal, The English Book House, 3rd Edition, New Delhi, 1993.

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Sixth Semester) Aeronautical Engineering
Applied Electronics (BEAE-604P)
(Total Credits: 01)

Teaching Scheme
Practical: 2 Hours/ Week

Examination Scheme
Practical
T (U): 25 Marks **T (I): 25 Marks**

List of Experiments for Applied Electronics

Sr.No.	Aim
1.	Introduction of 8085 kit
2.	Write an ALP to add two 16 bit numbers and store the result in memory location
3a.	Write an ALP to transfer 8 bytes of data from one memory location to another when these parts are not overlapping.
3b.	Write an ALP to transfer 8 bytes of data from one memory location to another when these parts are overlapping.
4.	Write an ALP to calculate sum of 8 bytes stored in memory from D000H.
5a.	Write an ALP to count the No. of even as well as odd No. in a given set of Nos.
5b.	Write an ALP to count the No. of Positive as well as Negative No. in a given set of Nos.
6a.	Write an ALP to find the smallest No. from the given set of 10 Nos.
6b.	Write an ALP to find the largest No. from the given set of 10 Nos.
7a.	Write an ALP to sort the given series in Ascending order.
7b.	Write an ALP to sort the given series in Descending order.
8.	Write an ALP to exchange the contents of two memory blocks.
9.	Write an ALP to perform multiplication of two 8 bit numbers using 8085 simulator.
10.	To study the interfacing of traffic controller using 8255.
11.	To study the interfacing of stepper motor with 8085.

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Sixth Semester) Aeronautical Engineering
Aircraft Design (BEAE-605T)
(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Unit I: Introduction **6 Hours**

Airplane design process – conceptual, preliminary & detail design phases, Classification of airplanes based on purpose and configuration, Factors affecting configuration, Merits of different airplane layouts

Unit II: Shaping the Airplane **8 Hours**

Principal features, Aerodynamic consideration, Lift, Drag and Interference effects, Weights and Strength considerations, Peculiarities in layout, Designing for manufacturability, Maintenance, Operational costs, Interactive design

Unit III: Conceptual Design Procedure **10 Hours**

Data collection and 3-View drawings, their purpose, initial sizing - weight estimation, choice of wing loading and thrust loading, rubber engine sizing, fixed engine sizing. Constraint analysis. Power plant selection - Choices available, Comparative merits, Location of power plants, Functions dictating the locations

Unit IV: Design of Major Airplane Components – I **7 Hours**

Wing design: Airworthiness requirements, V-n diagram, loads, Elements of wing design, Structural features.

Unit V: Design of Major Airplane Components – II **7 Hours**

Fuselage design: Loads on fuselage, Elements of fuselage design, Determination of tail surface areas, Structural features.

Unit VI: Design of Major Airplane Components – III **7 Hours**

Landing gear design: Loads or Landing gear, Preliminary landing gear 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, 1989s
4. Bruhn E F, Design and Analysis of Flight Vehicle Structures, Tri-state Offset Press,

Engineering and Technology
Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Sixth Semester) Aeronautical Engineering
Seminar (BEAE-606P)
(Total Credits: 02)

Teaching Scheme	**Examination Scheme**	
Practical: 2 Hours/ Week	**Practical**	
	T (U): 25 Marks	**T (I): 25 Marks**

This will be train the student to search literature on selected topic, understand research papers on the topic, summarize and extract material. Prepare a report on his / her own and make a presentation

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Seventh Semester) Aeronautical Engineering

Aircraft Systems and Instrumentation (BEAE-701T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks T (I): 20 Marks
Duration of University Exam: 03 Hours

Unit I: Airplane Control Systems **8 Hours**

Conventional Systems - Power assisted and fully powered flight controls - Power actuated systems
– Engine control systems - Push pull rod system, flexible push pull rod system
Modern control systems - Digital fly by wire systems - Auto pilot system active control Technology, Communication and Navigation systems Instrument landing systems, VOR - CCV case studies.

Unit II: Aircraft Hydraulic Systems **6 Hours**

Hydraulic systems - Study of typical workable system - components - Hydraulic system controllers - Modes of operation

Unit III: Pneumatic & Hybrid Systems **8 Hours**

Pneumatic systems - Advantages - Working principles ,Typical Air pressure system – Brake system - Typical Pneumatic power system - Components, Landing Gear systems - Classification – Shock absorbers,Retraction mechanism.

Unit IV: Engine Systems **7 Hours**

Fuel systems for Piston and jet engines, - Components of multi engines. lubricating systems for piston and jet engines - Starting and Ignition systems - Typical examples for piston and jet engines.

Unit V: Auxilliary System **8 Hours**

Basic Air cycle systems - Vapour Cycle systems, Boost-Strap air cycle system - Evaporative vapour cycle systems - Evaporative air cycle systems - Oxygen systems - Fire protection systems, Deicing and anti icing systems.

Unit VI: Aircraft Instruments **8 Hours**

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

Total No of periods: 45

TEXT BOOKS

1. McKinley, J.L., and Bent, R.D., “Aircraft Maintenance & Repair”, McGraw-Hill, 1993.
2. “General Hand Books of Airframe and Power plant Mechanics”, U.S. Dept. of

Transportation, Federal Aviation Administation, The English Book Store, New Delhi1995.

REFERENCES

1. Mekinley, J.L. and Bent, R.D., "Aircraft Power Plants", McGraw-Hill, 1993.
2. Pallet, E.H.J., "Aircraft Instruments & Principles", Pitman & Co., 1993.
3. Treager, S., "Gas Turbine Technology", McGraw-Hill, 1997.

Syllabus for B.E. (Seventh Semester) Aeronautical Engineering

Design of Machine Elements (BEAE-702T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks T (I): 20 Marks
Duration of University Exam: 03 Hours

Unit I: Fundamentals of Design **4 Hours**

Design Process – Computer aided design – Optimum design – Mechanical properties of materials – Types of loads – Stresses –Static, varying, thermal, impact and residue – Factor of safety – Stress concentration factors –Preferred numbers.

Unit II: Design of Basic Machine Elements and Joints **10 Hours**

Design of shafts, keys, couplings. Design of riveted and welded joints, Bolted Joints & Applications to Aircraft.

Unit – III: Design of Springs and Bearing **8 Hours**

Design of Helical compression & Tension springs for static & fatigue loading. Design of design of journal bearings for radial and thrust loads, selection of ball & roller bearings for radial and thrust loads

Unit IV: Design of Gears **10 Hours**

Design of gears – Spur and Helical gears – Design of multistage speed reducers.

Unit V: Design of Drives **5 Hours**

Belt Drives - Flat belt drive :- Types of belts & belt material, analysis of belt tension, condition for transmitting maximum power, design of flat belt, flat belt pulley. V Belt drive: - Types of V-belt, analysis of V-belt tension, design of V-belt pulley.

Unit VI: Design Of Engine Parts **8 Hours**

Design of Cylinder – piston – connecting rod – crank shaft

Flywheel - Coefficient of fluctuation of energy and coefficient of fluctuation of speed, energy store in flywheel, stresses in flywheel, design of flywheel.

Total No of periods: 45

Text Books:

1. Mechanical Design of Machine by Maleev Hartman.
2. Machine Design by P. H. Black.
3. Mechanical Engineering Design by J. E. Shigley.
4. Design of Machine Elements by B. D. Shiwalkar.
5. Design of Machine Elements by V.B. Bhandari.
6. Design of Data for Machine Elements by B. D. Shiwalkar.
7. PSG Data Book

Reference Books:

1. Hand Book of Machine Design by Shigley & Mischke.

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Seventh Semester) Aeronautical Engineering

Space Flight Mechanics (BEAE-703T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit-I: Basic Concepts **8 Hours**

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.

Unit-II: The General N-Body Problem **8 Hours**

The Many body problems - 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.

Unit-III: Satellite Injection and Satellite Orbit Perturbations **8 Hours**

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.

Unit-IV: Interplanetary Trajectories **7 hours**

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

Unit-V: Ballistic Missile Trajectories **7 hours**

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

Unit-VI: Materials For Spacecraft **7 hours**

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

Total No of periods: 45

References Books:

1. Sutton, G.P & Oscar Bilbraz,., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 7th Edition,2004.
2. Van de Kamp, P., "Elements of Astromechanic", 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. Wiesel, W.E., “Spaceflight Dynamics”, 2nd Edition, McGraw Hill, 1997
5. Thompson, W.T., “Introduction to Space Dynamics”, Dover, New York, 1986

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Seventh Semester) Aeronautical Engineering

Control Engineering (BEAE-704T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit I **7 Hours**

Review of Mathematical Modeling, Time Domain Response Analysis under transient input, Steady stare error analysis and error constants

Unit II **7 Hours**

Stability of control systems, condition of stability, characteristics equation .Routh Hurwitz criterion-special cases for determining relative stability. Frequency Domain analysis Root - Locus techniques

Unit III **7 Hours**

Bode plot, gain Margin and phase margin, transportation lag, System Identification from Bode plot.

Unit IV **9 Hours**

Polar Plot, Nyquist Plot and Stability criterion, Feed Back, Compensation and Pole -Zero placement. Concept of PI, PD and PID controller

Unit V **7 Hours**

Closed loop performance specifications, gain and phase margin as design specifications, use of root locus, bode plots in design, design rules for lag-lead compensation

Unit VI **8 Hours**

State Variable approach and state equations, Transfer function from state models state transition matrix and solution of state equations controllability and observability test through test model.

Total No of periods: 45

TEXT BOOKS:-

1. Ogata Katsuhika, "Modern Control Engineering", Printice Hall of India, New Delhi, Second Edition, No. of Copies: 40
2. Kuo B.C. and Golnaraghi F. " Automatic control systems",John Wiley and sons,8th edition, 2003
3. Nise Normal, "Control System Engineering", California Benjamin Cumming Publication
   ,Willey, Second Edition, No. of Copies: 12
4. NagrathI.J. & Gopal M., "Control Systems" , Tata McGraw Hill Publication, New Delhi, Revised Edition,2004. No. of Copies: 03
5. Dorf Richard C., "& Bishop Robert H. , "Modern Control Systems", Addision Wesley, New York, Eighth Edition.No. of Copies: 12
6. Gopal M., "Digital Control & State Variable Methods", Tata McGraw Hill Publication, New Delhi, Second Edition,2004. No. of Copies:10

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Seventh Semester) Aeronautical Engineering

Aircraft General Engineering and Maintenance Practices (BEAE-705T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Unit I **8 Hours**

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

Unit II **6 Hours**

Ground servicing various sub systems, Air conditioning and pressurisation - Oxygen and oil systems - Ground units and their maintenance.

Unit III **7 Hours**

Shop safety - Environmental cleanliness - Precautions. Hand tools - Precision instruments – Special tools and equipments in an airplane maintenance shop – Identification terminology

Unit IV **9 Hours**

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

Unit V **9 Hours**

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.

Unit VI **6 Hours**

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 SPECFICATIONS - F.A.A. Himalayan Book House ", New Delhi, 1996.

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Seventh Semester) Aeronautical Engineering

Aircraft Design Project(BEAE-706P)
(Total Credits: 02)

Teaching Scheme	**Examination Scheme**	
Practical: 2 Hours/ Week	**Practical**	
	T (U): 25 Marks	**T (I): 25 Marks**

OBJECTIVE

To enhance the knowledge in continuation of the design project given in project–I. To introduce and develop the basic concept of aircraft design. Each student is assigned with the design of an Airplane for given preliminary specifications. The following are the assignments to be carried out:

Task list for the project

1. Comparative configuration study of similar airplanes
2. Selection of main parameters for the design
3. Preliminary weight estimations
4. Power plant selection, Aerofoil selection, Wing tail and control surfaces
5. Preparation of layouts of balance diagram and three view drawings
6. Estimation of various Drag components.
7. Performance calculations and stability estimates
8. V-n diagram for the design study
9. Load estimation of wings
10. Load estimation of fuselage.
11. Balancing and Maneuvering loads on tail plane, Aileron and Rudder loads.
12. Preliminary structural design of wing/fuselage

13. Preparation of a detailed design report

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Seventh Semester) Aeronautical Engineering

Aircraft System (BEAE-707P)

(Total Credits: 02)

Teaching Scheme	**Examination Scheme**	
Practical: 2 Hours/ Week	**Practical**	
	T (U): 25 Marks	**T (I): 25 Marks**

OBJECTIVE

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

List of Experiment for Aircraft Systems and Instrumentation

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

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Seventh Semester) Aeronautical Engineering
Project Work Phase- I(BEAE708P) (Total Credits: 02)

Teaching Scheme	Examination Scheme
Practical: 2 Hours/ Week	Practical
	T (I): 50 Marks

OBJECTIVE

The objective of the phase – I of the students project work is to prepare themselves to undertake lively project which will found end application to the industry / society.

Preparation for the project work involve

1. Form a team of likeminded students (not more than 8 in numbers) to carry out the project.
2. Make a preliminary survey and data collection or literature review of the project proposed in the next semester.
3. Conduct a thorough literature survey and publish or present a paper of the proposed work in any one of the forthcoming National seminars.
4. Plan for necessary supports, facilities, analytical tools and fixation of faculties / supervisors for the final semester project work.

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Air Transportation (BEAE-801T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit I: Introduction **8 Hours**

Development of air transportation, comparison with other modes of transport - Role of IATA, ICAO

– The general aviation industry airline - Factors affecting general aviation, use of aircraft, airport: airline management and organisation - levels of management, functions of management, Principles of organisation planning the organisation - chart, staff departments & line departments.

Unit II: Airline Economics **7 Hours**

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.

Unit III: Fleet Planning **8 Hours**

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

Unit IV Principles of Airlines Scheduling **7 Hours**

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

Unit IV: Aircraft Reliability **8 Hours**

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

Unit VI: Technology in Aircraft Maintenance **7 Hours**

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. hilip 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.

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Eighth Semester) Aeronautical Engineering
Vibration and Aero- elasticity (BEAE-802T)
(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit I: Basic Notions **6 Hours**

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

Unit II: Single Degree of Freedom Systems **9 Hours**

Free vibrations – Damped vibrations – Forced Vibrations, with and without damping – support excitation – Vibration measuring instruments. Response to periodic and non-periodic excitations –
Duhamel's Integral.

Unit III: Multi Degrees of Freedom Systems **7 Hours**

Two degrees of freedom systems – Static and Dynamic couplings - vibration absorber - Principal co-ordinates, Principal modes and orthogonality condition – Eigen value problems.

Unit IV **6 Hours**

Generalized Co-ordinates - Hamilton's principle- Lagrange's equation and application

Unit V: Continuous Systems **10 Hours**

Vibration of strings - Longitudinal, Lateral and Torsional vibrations of beams - forced response of beams

Unit VI: Elements of Aero elasticity **7 Hours**

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

Total No of periods: 45

TEXT BOOKS:

1. P.Srinivasan, Mechanical Vibration Analysis, Tata Mc Graw Hill, New Delhi
2. J.P.Den Hartog Mechanical Vibration (4^{th} edition Mc Graw Hill, New York 1985.
3. N. L. Meirovitch , Elements of vibration Analysis, Mc Graw Hill New York 1986.

4. W. T. Thomson, Theory of Vibrations with Applications,
5. Broadbent, E.G., " Elementary Theory of Aeroelasticity " BunHill Publications Ltd., 1986.
6. Fung, Y.C., " An Introduction to the Theory of Aeroelasticity ", John Wiley & Sons Inc., New York 1985.
7. Timoshenko, Engineering vibration.

Engineering and Technology

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Theory of Elasticity (BEAE-803T)

(Total Credits: 04)

Teaching Scheme
Lectures: 3 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Unit I: Assumptions in Elasticity **6 Hours**

Definitions, notations and sign conventions for stress and strain in 3D. stress/strain transformation, Mohr's circle, Principal stresses and principal strains.

Unit II: Basic Equations of Elasticity **8 Hours**

Strain-displacement relations, Stress-strain relations, Lame's constant-cubical dilatation, Compressibility of material, bulk modulus, Shear modulus, Equations of equilibrium. Compatibility equations for stresses and strains, Saint Venant's principle, Theories of failure.

Unit III: Plane Stress and Plane Strain Problems **8 Hours**

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

Unit IV: POLAR COORDINATES **7 Hours**

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

Unit V: CURVILINER COORDINATES: **8 Hours**

Displacement, strain & stress field components in curvilinear co-ordinates. Elasticity equations in curvilinear co-ordinates. Stress functions in terms of harmonic & complex functions, displacement from given stress function, stress & displacement in terms of complex potentials, resultant of a stress on a curve, Boundary conditions.

Unit VI: TORSION **8 Hours**

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

Total 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.

Engineering and Technology

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Optimization Techniques (BEAE-803T)

(Total Credits: 04)

Teaching Scheme
Lectures: 3 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Unit I: Introduction **9 Hours**

General characteristics of engineering design problems, design variables objective function, Design constraints, mathematical statement of optimization problems, feasible & optimal design, local and global optimum, principles of optimization, necessary and sufficient conditions for optimal solution.

Unit II: Optimization Techniques – I **9 Hours**

Unconstrained minimization methods, single & multivariable gradient search methods – steepest gradient, conjugate harmonic and Newton's methods, random search techniques.

Unit III: Optimization Techniques – II **9 Hours**

Minimization procedure with equality and inequality constraints, penalty functions, concept of multicriterion Optimization

Unit IV: Optimization Techniques – III **6 Hours**

Linear programming problems, Optimality criterion, Simplex method and its variants

Unit V: Application – I **6 Hours**

Design of simple axial and transversely loaded members, torsionally loaded members, shafts for minimum weight, maximum torque, Design of springs, hydraulic cylinders

Unit VI: Application – II **6 Hours**

Optimum design of single & two degree of freedom system, Vibration absorbers, optimum design of simple machine/structural members under dynamic loads.

Total No of periods: 45

REFERENCES

1. Rao S.S. optimization Theory & Applications, Wiley Eastern Limited,New Delhi , 1978.
2. Fox Richard L. Optimizations methods for Engg. Design, Addision Wesley ,1971 .
3. Haug,E.J.and Arora, J.S. Applied optimal design. Wiley Inter Science Publication ,New York ,1979.

4. Douglas J. Willde, Globally optimal design Jhon Wiley & Sons, New York, 1978
5. Johnson Ray C. optimum design of mechanical elements, John Wiley & Sons 1981.
6. Mischke, Charles R., An introduction to Computer Aided Design, Prentice Hall Inc, 1968.

Engineering and Technology

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Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Reliability Centered Maintenance (BEAE-803T)

(Total Credits: 04)

Teaching Scheme
Lectures: 3 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Unit 1: Introduction to Reliability: **7 Hours**

Definition of reliability, Failure data Analysis, Mean Time to Failure (MTTF), Mean Time between Failure (MTBF), Hazard Rate and Failure density

Unit 2: System Reliability: **7 Hours**

Reliability in series and Reliability in Parallel, combined series - parallel system, Standby redundancy.

Unit 3: History Reliability Centered Maintenance: **8 Hours**

Definition of RCM, Evolution of RCM, RCM Achievements, RCM Methodologies- Systems Analysis
Process

Unit 4: Functional Failure of RCM **7 Hours**

Failure Mode and Effect Analysis (FMEA), Analysis & Categories of failure Modes

Unit 5: RCM Maintainability: **8 Hours**

RCM Maintenance Policies, Proactive Maintenance - Predictive Task, Proactive Maintenance - Preventive Task, Proactive Vs. Predictive and Preventive Maintenance

Unit 6: Application of RCM: **8 Hours**

Application of RCM to Airlines industry, US military, Nuclear Power industry

Total No of periods: 45

REFERENCES:

1. Charles E. Ebling “Reliability and Maintainability Engineering” Tata Mc Graw Hill.
2. John Moubray “ Reliability Centered Maintenance”
3. L.S. Srinath “Reliability Engineering” East West Press

4. Jim August “ Reliability Centered Maintenance”

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Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Aircraft Mechanisms- Analysis and Synthesis (BEAE-803T)

(Total Credits: 04)

Teaching Scheme
Lectures: 3 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks T (I): 20 Marks
Duration of University Exam: 03 Hours

Unit 1: Synthesis of Mechanisms **8 Hours**

Harding's notation, classification of four bar chains, Immersions, Deciding Mobility bonds of immersion, synthesis for rigid body guidance, space synthesis of mechanism, Analytical treatment for synthesis of planer mechanism.

Unit 2: Balancing of linkages **7 Hours**

Force & moment balancing of four bar Mechanisms, Quantitative analysis of effect of unbalance,
Treatment of Berkof & Oven.

Unit 3: Kinematics of 3D Mechanisms **8 Hours**

D-H notation, Application of D-H Notation of RSSR, RSSS, PSC PSR Mechanisms, Forward and
reverse kinematics

Unit 4: Dynamics of 3D Mechanisms **8 Hours**

Derivation of (i) Lagragrian (ii) Largragrian Euler (iii) Recursive Lagrangian formulation for dynamics of 3D Mechanisms (iv) D-Alembart's formulation, Application of these treatments to RSSR, RSSS, RSCPSR linkages.

Unit 5: Motion Analysis of Mechanisms of Aircraft I **7 Hours**

Kinematic Analysis, Dynamics & design of Mechanisms for operating Flaps & Aileron, Rudder, and Elevator

Unit 6: Motion Analysis of Mechanisms of Aircraft :II **7 Hours**

Kinematics Analysis, Dynamics & Design of Mechanisms for Landing Gear, Conveyor for luggage Transport in Cargo

Total No of periods: 45

REFERENCES:

1. Sandor G.N., and Erdman A.G., "Advanced Mechanism Design Analysis and Synthesis", Prentice
Hall, 1984.
2. Shigley, J.E., and Uicker, J.J., "Theory of Machines and Mechanisms", McGraw Hill, 1995.

3. Amitabha Ghosh and Asok Kumar Mallik, “Theory of Mechanism and Machines”, EWLP, Delhi,
1999.
4. Norton R.L., “Design of Machinery”, McGraw Hill, 1999.
5. Kenneth J, Waldron, Gary L. Kinzel, “Kinematics, Dynamics and Design of Machinery”, John
Wiley-sons, 1999.

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Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Finite Element Method (BEAE-804T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Unit-I **6 Hours**

Fundamentals of stress and strain, stress and strain components, stress strain relationship, Elastic constants, plane stress, plane strain, differential equation of equilibrium, compatibility equation,
Boundary conditions, Saint Venant's principle, Airy's stress function.

Unit-II **11 Hours**

Fundamental concepts of FEM - Historical background, Scope of FEM in Engg. Applications, Principle of minimum potential energy, Concept of Virtual work, Raleigh–Ritz method, FEM analysis procedure.

Concept of discritization of body into elements, degrees of freedom, bandwidth, Basic types of 2-D & 3-D elements, displacement models, convergence requirements, shape function.

Unit-III **7 Hours**

Finite element modeling and analysis using Bar and Beam elements – stiffness matrix, assembly, boundary conditions, load vector, temperature effects.

Two dimensional plane trusses – Local & Global coordinate system, element stiffness matrix, assembly, boundary conditions, and load vector, force and stress calculations

Unit-IV **7 Hours**

Two dimensional problem using CST & LST – formulation of CST & LST elements, elemental stiffness matrix, assembly, boundary conditions, load vector, stress calculation,
Temperature effect.

Unit-V **7 Hours**

Introduction to Isoparametric & Higher order elements. Introduction to dynamic analysis, formulation of mass matrix for one-dimensional bar element, free vibration analysis using one dimensional bar element. Torsion of prismatic bars using triangular elements.

Unit-VI **7 Hours**

Extention of the method to other engineering problems – For example: Steady state one dimensional heat conduction problems using 1-D element, Introduction to programming

aspects of
FEM, Pre & Post processing in FEA, Commercial F E Software's.

Total No of periods: 45

Text Books:

1. Introduction to Finite Elements in Engineering– T.R.Chandrupatla & AD Belegundu.
2. Theory of Elasticity – S.P. Timoshenko
3. Concept and applications of Finite element Analysis – P.D. Cook
4. Finite Element Analysis(Throry & Programming) - Krishnamurthy CS - Tata McGraw Hill Publishing Co.

Reference Books:

1. The Finite Element Method–A Basic introduction for engineers–D W.Griffths,D.A Nethercot-
2. Introduction to Finite Element- Reddy J.N. - McGraw Hill
3. Applied Finite Element Analysis - Larry J. Segelind - John Wiley
4. Finite Element Method Vs. Classical Methods - H.S. Govinda Rao- New Age International Pub.
5. The Finite Element Method -Zienkiewiez OC - Tata McGraw Hill Publishing Co.
6. Finite Element Methods: Basic Concepts & Application- Chennakesava R. Alavala
7. PHI Learing PVT. LTD.

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Syllabus for B.E. (Eighth Semester) Aeronautical Engineering
Airframe Maintenance and Repair (BEAE-804T)
(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Unit-I: **Sheet Metal Repair And Maintenance** **8 Hours**

Inspection of damage - Classification - Repair or replacement - Sheet metal inspection - N.D.T. Testing – Riveted repair design, Damage investigation - reverse technology WELDING IN AIRCRAFT STRUCTURAL COMPONENTS:

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

Unit- II: Plastics and Composites in Aircraft **7 Hours**

PLASTICS IN AIRCRAFT: Review of types of plastics used in airplanes - Maintenance and repair of plastic components - Repair of cracks, holes etc., and various repairs schemes - Scopes. ADVANCED COMPOSITES IN AIRCRAFT: Inspection - Repair of composite components – Special precautions - Autoclaves

Unit- III: Aircraft Jacking, Assembly and Rigging **7 Hours**

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

Unit- IV Review Of Hydraulic And Pneumatic System 8 Hours

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.

Unit- V 8 Hours

Installation and maintenance of Instruments - handling - Testing – Inspection, Inspection and maintenance of auxiliary systems - Fire protection systems - Ice protection system - Rain removal system -Position and warning system - Auxiliary Power Units (APUs).

Unit – VI: Safety Practices 7 Hours

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

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

Engineering and Technology

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Aero- Engine Maintenance and Repair (BEAE-804T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

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

Unit – I **10 Hours**

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 troubleshooting - 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.

Unit – II **5 Hours**

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

Unit- III **8 Hours**

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.

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

Unit – IV **10 Hours**

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.

Unit – V **5 Hours**

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

Unit – VI **7 Hours**

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

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.
4. Maintenance Manuals from different engine manufacturers

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Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Flight Dynamics (BEAE-804T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Unit I **4 Hours**

Introduction: Equilibrium, static and dynamic stability, control.

Unit II **10 Hours**

Longitudinal stability and control: Longitudinal equilibrium and static stability, stick fixed neutral point, all moving horizontal tail OR elevator as longitudinal control. Trimmed lift curve slope and advantages of reduced/negative longitudinal static stability. Hinge moments, reversible control, stick force, and trim tab. Stick free static stability, stick-free neutral point.

Unit III **8 Hours**

Lateral -directional stability and control: Directional equilibrium, stability and rudder as control. Lateral stability, dihedral angle, aileron control.

Unit IV **10 Hours**

Dynamical equations: Euler angles. Body angular velocity and Euler angle rates. Body-fixed axis, wind axis, stability axes. Equations of motion of rigid aircraft in body fixed axes. Stability derivatives. Steady flight and perturbed flight leading to linearised equations of motion.

Unit V **8 Hours**

Aircraft motion modes: Decoupling of longitudinal dynamics and lateral-directional dynamics. Short period and phugoid modes of longitudinal dynamics. Dutch roll, spiral and roll subsidence modes of lateral-directional dynamics.

Unit VI **5 Hours**

Effect of winds. Flight simulation.

REFERENCES

1. Stengel, R. F., Flight Dynamics, Princeton University Press, 2004.
2. Roskam, J., Airplane Flight Dynamics and Automatic Flight Controls, DAR Corporation, 1995.

3. Nelson, R. C., Flight Stability and Automatic Control, Mc Graw Hill International, 1990.
4. Etkin, B. and Duffy, L. D., Dynamics of Flight: stability and control, John Wiley, NY 1995.
5. Perkins, C. D. and Hage, R. E., Airplane Performance Stability and Control, Wiley, New York, 1949.

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Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Experimental Stress Analysis (BEAE-805T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks T (I): 20 Marks
Duration of University Exam: 03 Hours

Unit I **6 Hours**

Fundamentals of stress & strain, stress strain relationship, Elastic constant, plane stress and plane strain. Stress Analysis for two dimensional problems in Cartesian co-ordinate system, equations of Equilibrium, compatibility equation

Unit II Measurements & Extensometer **7 Hours**

Principles of measurements, Accuracy, Sensitivity and range of measurements, Mechanical, Optical Acoustical and Electrical extensometers and their uses, Advantages and disadvantages

Unit III: Electrical Resistance Strain Gauges **10 Hours**

Principle of operation and requirements, Types and their uses, Materials for strain gauge, Calibration and temperature compensation, cross sensitivity, Rosette analysis, Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators

Unit IV: Photoelasticity **8 Hours**

Two dimensional photo elasticity, Concept of light – photo elastic effects, stress optic law, Interpretation of fringe pattern, Compensation and separation techniques, Photo elastic materials

Unit V: Brittle Coating and Moire Methods **7 Hours**

Introduction to Moire techniques, brittle coating methods and holography

Unit VI: Non – Destructive Testing **7 Hours**

Fundamentals of NDT, Radiography, ultrasonic, magnetic particle inspection, Fluorescent penetrant technique, Eddy current testing, Acoustic Emission Technique

Total Number of Periods: 45

REFERENCES:

1. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., “Experimental Stress Analysis”, Tata McGraw-Hill, New Delhi, 1984.

2. Dally, J.W., and Riley, W.F., “Experimental Stress Analysis”, McGraw-Hill Inc., New York, 1998.
3. Hetyenyi, M., “Hand book of Experimental Stress Analysis”, John Wiley and Sons Inc., New
York, 1972.

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Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Fatigue and Fracture (BEAE-805T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit I: Fatigue of Materials **8 Hours**

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

Unit II: Statistical Aspects of Fatigue Behavior **8 Hours**

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 – Rainflow counting technique.

Unit III: Physical Aspects of Fatigue **7 Hours**

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

Unit IV: Fracture Mechanics **10 Hours**

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.

Unit V: Fatigue Design and Testing **6 Hours**

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

Unit VI: Case Studies **6 Hours**

Case studies to be discussed regarding fatigue and fracture induced in all components of propulsion system, Aircraft structure, Landing Gear.

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.

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Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Computational Fluid Dynamics (BEAE-805T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Unit- I **7 Hours**

Importance of CFD to various engineering streams. Basic fluid dynamics equations – continuity, momentum and energy, Conservation law form and non-conservation law forms of the Governing Differential Equations, Lagrangian and Eulerian formulations.

Unit- II **7 Hours**

Description and procedure used in Finite Difference, Finite Element and Finite Volume schemes for simple one dimensional conduction problems, Application to unsteady one-dimensional conduction problems.

Unit- III **8 Hours**

Application of Finite Difference method to 1D & 2D steady and unsteady conduction problems. Central and backward difference schemes. Explicit & Implicit schemes, Crank-Nicholson scheme.

Unit- IV **7 Hours**

Solution of linear algebraic equations - Direct solution methods and Iterative schemes. Boundary value and initial value problems and their solution procedure. Runge Kutta methods. Shooting methods.

Unit-V **8 Hours**

Conduction and convection problems. Navier Stokes equations. Application to incompressible flow. Pressure correction scheme, staggered grid, SIMPLE and SIMPLER schemes.

Unit-VI **8 Hours**

Finite Volume method for compressible flow. Schemes like Jameson, MacCormack. Acceleration devices, Grid independent studies, Grid Generation

Total No of periods: 45

PRACTICAL:

Based on above syllabus minimum eight practical to be performed

REFERENCES:

1. Bose, T.K., "Computation Fluid Dynamics" , Wiley Eastern Ltd., 1988.

2. Chow, C.Y., "Introduction to Computational Fluid Dynamic", 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
6. Anderson J.D.,"Computational fluid dynamics", 1995

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Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Project Work Phase- II
(BEAE-806P)
(Total Credits: 05)

Teaching Scheme	Examination Scheme
Practical: 5 Hours/ Week	Practical
	T (U): 75 Marks T (I): 75 Marks

OBJECTIVE

This should be the extension of the partial work already done in Phase-I in earlier semester