UNIVERSITY OF KERALA

B. TECH. DEGREE COURSE

(2013 SCHEME)

SYLLABUS FOR

IV SEMESTER

AERONAUTICAL ENGINEERING

SCHEME -2013

IV SEMESTER
AERONAUTICAL ENGINEERING (S)

Course No	Name of subject	Credits	Weekly load, hours			C A Marks	Exam Duration Hrs	U E Max Marks	Total Marks
			L	T	D/P				
13.401	Engineering Mathematics -III (BCHMNPSU)	4	3	1	-	50	3	100	150
13.402	Aerocraft Structures-I (S)	4	3	1	-	50	3	100	150
13.403	Fundamentals of Aerodynamics (S)	4	3	1	-	50	3	100	150
13.404	Aero Acoustics (S)	4	3	1	-	50	3	100	150
13.405	Theory of Machines (S)	4	3	1	-	50	3	100	150
13.406	Turbo Machinery (S)	3	-	-	3	50	3	100	150
13.407	Modelling and Simulation Lab (S)	3	-	-	3	50	3	100	150
13.408	Production Engg Lab (S)	3	-	-	3	50	3	100	150
	Total	**29**	**15**	**5**	**9**	**400**		**800**	**1200**

13.401 ENGINEERING MATHEMATICS – III (BCHMNPSU)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objective:

- *To introduce the basic notion in complex analysis such as Analytic Functions, Harmonic functions and their applications in fluid mechanics and differentiations and integration of complex functions, transformations and their applications in engineering fields.*
- *Numerical techniques for solving differential equations are also introduced as a part of this course.*

Module – I

Complex Differentiation: Limits, continuity and differentiation of complex functions. Analytic functions – Cauchy Riemann equations in Cartesian form (proof of necessary part only).Properties of analytic functions – harmonic functions. Milne Thomson method.

Conformal mapping: Conformality and properties of the transformations $w = \frac{1}{z}$, $w = z^2$, $w = z + \frac{1}{z}$, $w = \sin z$, $w = e^z$ - Bilinear transformations.

Module – II

Complex Integration: Line integral – Cauchy's integral theorem – Cauchy's integral formula – Taylor's and Laurent's series – zeros and singularities – residues and residue theorem.

Evaluation of real definite integrals – $\int_0^{2\pi} f(sinx, cosx)dx$, $\int_{-\infty}^{\infty} f(x)dx$ (with no poles on the real axis). (Proof of theorems not required).

Module – III

Numerical techniques-Solutions of algebraic and transcendental equations-Bisection method – Regula-falsi method – Newton - Raphson method. Solution of system of equations- Gauss elimination, Gauss - Siedel iteration. Interpolation – Newton's Forward and backward formulae - Lagrange's interpolation formula.

Module – IV

Numerical integration-Trapezoidal Rule- Simpson's one third rule.

Numerical solution of ODE –Taylor's series method - Euler's method - Modified Euler's method – Runge-Kutta method of order Four.

Numerical Solution of two-dimensional partial differential equation (Laplace equation)-using finite difference method (five point formula)

References:

1. Bali N. P. and M. Goyal, *Engineering Mathematics*, 7/e, Laxmi Publications, India, 2012.
2. Kreyszig E., *Advanced Engineering Mathematics*, 9/e, Wiley India, 2013.
3. Grewal B. S., *Higher Engineering Mathematics*, 13/e, Khanna Publications, 2012.
4. Koneru S. R., *Engineering Mathematics*, 2/e, Universities Press (India) Pvt. Ltd., 2012.
5. Sastry S. S., *Introductory Methods of Numerical Analysis*, 5/e, PHI Learning, 2012.
6. Babu Ram, *Numerical Methods*, 1/e, Pearson Education, 2010.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Five Short answer questions of 4 marks each. All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

After successful completion of this course, the students will be able to use numerical methods to solve problems related to engineering fields. This course helps students to master the basic concepts of complex analysis which they can use later in their career.

13.402 AIRCRAFT STRUCTURES – I (S)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

To study different types of beams and columns subjected to various types of loading and support conditions with particular emphasis on aircraft structural components.

Module – I

Classification of structures: Static equilibrium, Determinate Structures and Indeterminate Structures, static stability concept

Determinate and indeterminate structures: Analysis of plane truss, Method of joints, 3 D Truss, - Plane frames, Composite beam - Clapeyron's Three Moment Equation - Moment Distribution Method for indeterminate beams.

Module – II

Energy methods: Work and energy principles, Strain Energy and complementary strain energy, potential and complementary potential theorems, Maxwell's Reciprocal theorem, dummy load & unit load methods, applications of energy principles for analysis of statically determinate and indeterminate structures.

Module – III

Beams : Beams bending and extension, stress resultants, modulus weighted section properties, bending shear stresses- solid and open section.

Shells: Idealization of stiffened shells, shear center, shear flow in thin walled multicell box beams, effect of taper.

Module – IV

Failure theory: Maximum principal Stress theory – Maximum principal Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum Strain energy theory – Application to aircraft Structural problems.

References:

1. Timoshenko S., *Strength of Materials*, Vol. I and II, Princeton D. Von Nostrand Co, 1990.

2. Donaldson B.K., *Analysis of Aircraft Structures – An Introduction*, McGraw-Hill, 1993.
3. Megson T.H.G, *Aircraft Structure for Engineering Students*, Butterworth-Heinemann, 5/e, 2010.
4. Peery D. J., *Aircraft Structures*, McGraw-Hill, 2/e, 1982.
5. Curtis H. D., *Fundamentals of Aircraft Structural Analysis*, McGraw Hill, 1996.
6. Rivello R. M., *Theory and Analysis of Flight Structures,* McGraw Hill, 1969.
7. Bruhn E. F., *Analysis and Design of Flight Vehicle Structures*, Tri-State Off-set Co., USA, 1985.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

Students successfully completing this course will be able:

- *To perform linear static analysis of determinate and indeterminate aircraft structural components*
- *To design the structural component using different theories of failure*

13.403 FUNDAMENTALS OF AERODYNAMICS (S)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives :

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

Module – I

Review of basic fluid mechanics, Continuity, momentum and energy equations. Viscous flow: Newton's law of viscosity, Boundary Layer, Navier-Stokes equation, displacement, Momentum thickness, Flow over a flat plate, Blasius solution. Two dimensional 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.

Module – II

Conformal transformation Joukowski Transformation and its application to fluid flow problems, Kutta condition, Blasius theorem. Airfoil and Wing Theory. Joukowski, Karman - Trefftz, Profiles -Thin aerofoil theory and its applications. Vortex line, Horse shoe vortex, Biot and Savart law, Lifting line theory and its limitations.

Module – III

Normal, oblique shocks and expansion waves: Prandtl equation and Rankine Hugonoit relation, Normal shock equations, Pitot static tube, corrections for subsonic and supersonic flows, Oblique shocks and corresponding equations, Hodograph and pressure turning angle, shock polars, flow past wedges and concave corners, strong, weak and detached shocks. Rayleigh and Fanno Flow. Flow past convex corners.

Module – IV

Differential equations of motion for steady compressible flow: Small perturbation potential theory, solutions for supersonic flows, Mach waves and Mach angles, Prandtl Glauert affine transformation relations for subsonic flows, Linearised two dimensional supersonic flow theory, Lift, drag pitching moment and centre of pressure of supersonic profiles.

Airfoil in high speed flows: Lower and upper critical Mach numbers, Lift and drag divergence, shock induced separation, Characteristics of swept wings, Effects of thickness, camber and aspect ratio of wings, Transonic area rule, Tip effects.

References:

1. Houghton E. L. and N. B. Carruthers, , *Aerodynamics for Engineering students*, Edward Arnold Publishers Ltd., London, 1989.
2. Milne Thomson L. H., *Theoretical Aerodynamics*, Macmillan, 1985.
3. Clancy L. J., *Aerodynamics*, Pitman, 1986.
4. Anderson J. D., *Fundamentals of Aerodynamics*, McGraw-Hill Book Co., New York, 1985.
5. Rathakrishnan E., *Gas Dynamics*, Prentice Hall of India, 2003.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

Students successfully completing this course are expected to have:

- *An ability to apply airfoil theory to predict air foil performance*
- *Knowledge of incompressible flow*
- *An exposure to Boundary layer theory*
- *Understanding on fluid flow characteristics over wings, airfoils and airplanes*
- *Knowledge gained in shock phenomenon and fluid waves.*

13.404 AERO ACOUSTICS (S)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

To expose the students to the acoustic principle, transmission, measurement, various types of noise control and various methods of acoustic insulation.

Module – I

Introduction – Basic acoustic principles-acoustic terminology and definitions - Plane waves - harmonic solution - velocity of sound in inviscid fluids - relationship between wave length, particle velocities, acceleration – Energy density – acoustic intensity – reference standards and measurement.

Module – II

Transmission of sound through one, two and three media. Transmission through pipes - branched and un-branched resonators - Transmission loss reflection at plane surface-standing waves and standing wave apparatus, spherical waves – radiation – simple source – hemispherical source-radiating piston-pressure intensity distribution-Beam width and directivity index-sound absorbing materials.

Module – III

Noise measurement: Decibel scale - relationship between pressure, intensity and power - sound level meter, noise analyzer and graphic level recorder-measurement in anechoic and reverberation chambers, machinery noise control.

Environmental noise control: Human reaction to sound-definitions of speech interference level, perceived noise level, phon and sone etc, hearing loss-principles of noise control-control at source, during transmission and at receiver-protection of receiver.

Module – IV

Acoustic insulation-acoustic materials-acoustic filter and mufflers – plenum chamber-noise criteria and standards - noise and number index guide lines for designing quieter equipments – machinery noise such as pumps, rotating machines, reciprocating machines etc. Methods of control of noise using baffles, coverings, perforations etc. Transmission through structures – control vibration by damping and other methods. Principles of noise control in an auditorium-requirements of a good auditorium.

References :

1. Petrusowicz and Longmore, *Noise and Vibration Control for Industrialists*, Elsevier, 1974.
2. Thumann A and R. K. Miller, *Secrets of Noise Control*, Fairmont Press, 1976.
3. J. D. Irwin and E. R. Graf, *Industrial Noise and Vibration Control*, Prentice-Hall, Englewood Cliffs, New Jersey, 1979.
4. Ford R.D., *Introduction to Acoustics*, Elsevier, New York, 1970.
5. Reynolds D. D., *Engineering Principles of Acoustics*, Allyn and Bacon Inc., Boston, 1981.
6. Kinsler L. E. , A. R. Frey, A. B. Coppens and J. V. Sanders, *Fundamentals of Acoustics*, 3/e, John Wiley and Sons, New York, 1982.
7. Beranek, L. L. and István L. Vér, *Noise and Vibration Control Engineering: Principles and Applications*, Wiley-Inter Science, 1992.
8. Harris C.M., *Handbook of Noise Control*, McGraw Hill, 1979.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

- *Students would be able to understand the generation and propagation of sound in fluids, and sound generated by turbulent flows.*
- *Students will know how scaling laws may be derived and to interpret the results.*
- *Students will have an exposure to the state-of-the-art research in aero acoustics and will be able to apply aero acoustics theory to new problems.*

13.405 THEORY OF MACHINES (S)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objective:

To expose the students the different mechanisms, their method of working, forces involved and consequent vibration during working of machines.

Module – I

Mechanisms: Machine Structure – Kinematic link, pair and chain – Grueblers criteria – Constrained motion – Degrees of freedom - Slider crank and crank rocker mechanisms – Inversions – Applications – Kinematic analysis of simple mechanisms – Determination of velocity and acceleration.

Friction: Friction in screw and nut – Pivot and collar – Thrust bearing – Plate and disc clutches – Belt (flat and V) and rope drives. Ratio of tensions – Effect of centrifugal and initial tension – Condition for maximum power transmission – Open and crossed belt drive - brakes – Tractive resistance.

Module – II

Gearing and cams: Gear profile and geometry – Nomenclature of spur and helical gears – Gear trains: Simple, compound gear trains and epicylic gear trains - Determination of speed and torque - Cams – Types of cams – Design of profiles – Knife edged, flat faced and roller ended followers with and without offsets for various types of follower motions.

Module – III

Balancing: Static and dynamic balancing – Single and several masses in different planes – Balancing of reciprocating masses- primary balancing and concepts of secondary balancing – Single and multi cylinder engines (Inline) – Balancing of radial V engine – direct and reverse crank method.

Module – IV

Vibration: Free, forced and damped vibrations of single degree of freedom systems - natural Frequency– Damped Vibration- Force transmitted to supports – Vibration isolation – Vibration absorption – Torsional vibration of shaft – Single and multi rotor systems – Geared shafts – Critical speed of shaft.

References:

1. Rao J. S. and R. V. Dukkipati, *Mechanism and Machine Theory*, Wiley Eastern, 1992.

2. Malhotra D. R. and H.C. Gupta, *Theory of Machines*, Satya Prakasam Tech. India Publications, 1989.
3. Gosh A. and A. K. Mallick, *Theory of Machines and Mechanisms*, Affiliated East West Press, 1989.
4. Shigley J. E. and J. J. Uicker, *Theory of Machines and Mechanisms*, McGraw-Hill, 1980.
5. Burton Paul, *Kinematics and Dynamic of Planer Machinery*, Prentice Hall, 1979.
6. Rattan S. S., *Theory of Machines*, Tata McGraw–Hill Publishing Co, New Delhi, 2004.
7. Ballaney P. L., *Theory of Machines*, Khanna Publishers, New Delhi, 2002.
8. Ramamurthi V., *Mechanisms of Machine*, Narosa Publishing House, 2002.
9. Norton R. L., *Design of Machinery*, McGraw-Hill, 2004.
10. Ambekar A. G., *Mechanism and Machine Theory*, Prentice Hall of India, New Delhi, 2007.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

After this programme students are expected to have a thorough understanding of different mechanisms and theories which will help in optimising design of machines and its components, and also to solve practical problems in the area of machines and mechanisms.

13.406 TURBO MACHINERY (S)

Teaching Scheme: 3(L) - 0(T) - 0(P) **Credits**: 3

Course Objectives :

To expose the students the different types of machineries like turbines, compressors, their operation, purpose of cascading, various stages, losses, efficiencies, performance studies.

Module – I

Definition and Classification of Turbo-machines, Principles of operation, Specific work-representations on enthalpy entropy diagram. Fundamental equation of energy transfer, flow mechanism through the impeller, vane congruent flow, velocity triangles, ideal and actual flows, slip and its estimation, losses and efficiencies, degree of reaction, shape number and specific speed.

Module – II

Two dimensional cascades: cascade nomenclature, lift and drag, circulation and lift, losses and efficiency, compressor and turbine cascade performance, cascade test results, cascade correlations, fluid deviation, off –design performance, optimum space-chord ratio of turbine blades.

Module – III

Axial flow compressors: Two dimensional analysis Velocity diagram, Thermodynamics, Stage losses and efficiency, reaction ratio stage loading, stage pressure rise, stability of compressors. Centrifugal compressors: Theoretical analysis of centrifugal compressor, inlet casing, impeller, diffuser, inlet velocity limitations, optimum design of compressor inlet, pre-whirl, slip factor, pressure ratio, choking in a compressor stage, Mach number at exit.

Module – IV

Axial flow turbines: Two dimensional theory Velocity diagram, Thermodynamics, stage losses and efficiency, Soderberg's correlation, stage reaction, diffusion within blade rows, efficiencies and characteristics.

Radial Flow Turbines. Types of inlet flow radial turbines (IFR), thermodynamics of 90 IFR turbine. Efficiency, Mach number relations, loss coefficient, off-design operating conditions, losses, pressure ratio limits.

References :

1. Saravanamuttoo H. I. H., G. F. C. Rogers and H. Cohen, *Gas Turbine Theory*, 5/e, Prentice Hall, 2001.

2. Hill P. G.and C. R. Peterson, *Mechanics and Thermodynamics of Propulsion*, Addison Wesley, 1992.
3. Wislicenus G. F., *Fluid Mechanics of Turbomachinery*, 2/e, Dover, 1965
4. Csandy G. T., *Theory of Turbomachines,* McGraw Hill, 1964.
5. Yahya S. M*., Turbines, Compressors and Fans,* McGraw Hill, 2005.
6. Kadambi V. and M. Prasad, *An Introduction to Energy Conversion: Turbomachinery (Volume* III*)*, Wiley Eastern, 1977.
7. Dixon S. L., *Fluid Mechanics and Thermodynamics of Turbomachinery*, Elsevier, 1998.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

At the end of the course, the students will have an overview of

- *Different types of fluid machinery used for energy transformation, such as pumps, fans, compressors, as well as wind- , hydraulic, steam- and gas-turbines.*
- *Applications for transfer the power, as well as energy use in refrigeration and the built environment.*

13.407 MODELLING AND SIMULATION LAB (S)

Teaching Scheme: 0(L) - 0(T) - 3(P) **Credits**: 3

Course Objective:

To introduce the design and drafting of aero components and to give practical training using modelling and simulation.

List of Experiments:

1) Design and drafting of riveted joints
2) Design and drafting of welded joints.
3) Layout of typical wing structure.
4) Stress analysis of a rectangular plate with a hole.
5) Static analysis on cantilever beam
6) Static analysis of forces in a simply supported beam
7) Static analysis- Plane truss
8) 2-D static stress analysis
9) 3-D static stress analysis
10) Three view diagram of a typical aircraft
11) Analysis of a model airplane wing
12) Simulation of flow through a Converging-diverging nozzle.
13) Structural analysis of a tapered wing
14) Stress and modal analysis of a cylinder under pressure
15) Stress distribution in indeterminate structure

References :

1. Ogata K., *System Dynamics*, 4/e., Pearson Education LPE, 2004.
2. Doebelin E. O., *System Dynamics: Modeling, Analysis, Simulation, Design,* Marcel Dekker, New York, 1998.
3. User Manuals for the Setups and AME Sim Engg. System Modelling & Simulation Software Tool.

Internal Continuous Assessment *(Maximum Marks-50)*

40% - Test
40% - Class work and Record
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

Questions based on the list of experiments prescribed.

80% - Procedure, conducting experiment, results, tabulation and inference

20% - Viva voce

Candidate shall submit the certified fair record for endorsement by the external examiner.

Course Outcome:

*Students will get an insight into the use of different simulation and analysis software (viz. PRO/E, CATIA, ANSYS, MSC / Nastran**)** to simulate flow behaviour and perform Structural analysis.*

13.408 PRODUCTION ENGINEERING LAB (S)

Teaching Scheme: 0(L) - 0(T) - 3(P) **Credits**: 3

Course Objective:

- *To acquaint the basics of lathe and accessories, shaping and slottng machine, planning machines*
- *To learn the different tools used for various operations of machines.*
- *To impart training on plane turning, groove cutting, form turning, taper turning, facing and thread cutting.*

List of Experiments:

1. General study of Lathe and Accessories, Tools used for different operations.
2. Exercises involving plane turning, Groove cutting, form turning, taper turning, facing and thread cutting.
3. Study of shaping and slotting machines, and planning machines, exercises involving production of flat surfaces, grooves and key ways.

Note: Students should complete at least 8 models using the above operations

Internal Continuous Assessment *(Maximum Marks-50)*

40% - Test
40% - Class work and Record
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

Questions based on the list of experiments prescribed.

80% - Procedure, conducting experiment, results, tabulation and inference

20% - Viva voce

Candidate shall submit the certified fair record for endorsement by the external examiner.

Course Outcome:

At the end of the course, the students will be familiar with the various operations using lathe, shaping, slotting and planning machines.