UNIVERSITY OF KERALA

B. TECH. DEGREE COURSE

(2013 SCHEME)

SYLLABUS FOR

V SEMESTER

AERONAUTICAL ENGINEERING

SCHEME -2013

V 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				
13.501	Engineering Mathematics IV (BCHMPSU)	4	3	1	-	50	3	100	150
13.502	Gas Dynamics (S)	3	2	1	-	50	3	100	150
13.503	Machine Design (S)	4	3	1	-	50	3	100	150
13.504	Aircraft Structures-II (S)	4	3	1	-	50	3	100	150
13.505	Experimental Stress Analysis (S)	4	3	1	-	50	3	100	150
13.506	Elective I	4	3	1	-	50	3	100	150
13.507	Experimental Stress Analysis Lab (S)	3	-	-	3	50	3	100	150
13.508	Aircraft Structures Lab (S)	3	-	-	3	50	3	100	150
	Total	**29**	**17**	**6**	**6**	**400**		**800**	**1200**

13. 506 Elective I

13.506.1	Composite Materials (S)
13.506.2	Theory of Elasticity (S)
13.506.3	Advanced Fluid Mechanics (S)
13.506.4	Quality Engineering and Management (S)
13.506.5	Environmental Science (S)

13.501 ENGINEERING MATHEMATICS - IV (BCHMPSU)

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

Course Objective:

- *To provide a basic understanding of random variables and probability distributions.*
- *Mathematical programming techniques are introduced as a part of this course. These techniques are concerned with the allotment of available resources so as to minimize cost or maximize profit subject to prescribed restrictions.*

Module – I

Random Variables -Discrete and continuous random variables and their probability distributions-Probability distribution (density) functions - Distribution functions - mean and variance-simple problems-
Binomial distribution, Poisson distribution, Poisson approximation to Binomial, Uniform distribution, Exponential Distribution, Normal distribution - mean and variance of the above distributions(derivations except for normal distribution) - Computing probabilities using the above distributions.

Module – II

Curve fitting - Principle of least squares - Fitting a straight line – Fitting a parabola-Linear correlation and regression - Karl Pearson's coefficient of correlation - Sampling distributions - Standard error –Estimation - Interval estimation of population mean and proportions(small and large samples)- Testing of hypothesis - Hypothesis concerning mean - Equality of means - Hypothesis concerning proportions- Equality of proportions.

Module – III

Linear programming - Formation of LPP - General linear programming problem - Slack and surplus variables - Standard form - Solution of LPP - Basic solution - Basic feasible solution - Degenerate and non-degenerate solutions - Optimal solution - Solution by simplex method - Artificial variables - Big-M method.

Module – IV

Duality in LPP - Properties of primal and dual optimal solutions - solution using duality-Transportation problem and Assignment problem.

References:

1. Veerarajan, T., *Probability, Statistics and Random Processes,* 3/e, Tata McGraw Hill, 2002.

2. Papoulis A. and S. U. Pillai, *Probability, Random Variables and Stochastic Processes*, 3/e, Tata McGraw Hill, 2002.
3. Koneru S. R., *Engineering Mathematics*, 2/e, Universities Press (India) Pvt. Ltd., 2012.
4. Bali N. P. and M. Goyal, *Engineering Mathematics*, 7/e, Laxmi Publications, India, 2012.
5. Kreyszig E., *Advanced Engineering Mathematics*, 9/e, Wiley India, 2013.
6. Swarup, K., P. K. Gupta and Manmohan, *Operations Research*, 6/e, Sulthan Chand and Sons, 1978.
7. Sharma S. D. and H. Sharma, *Operations Research: Theory, Methods and Applications*, 13/e, Kedar Nath and Ram Nath, 1972.

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 familiar with the large scale applications of linear programming techniques which require only a few minutes on the computer. Also they will be familiar with the concepts of probability distributions which are essential in transportation engineering.

13.502 GAS DYNAMICS (S)

Teaching Scheme: 2(L) - 1(T) - 0(P) **Credits**: 3

Course Objectives:

To study the various concepts of compressible flow, wave propagation and flow through constant area.

Module – I

Introductory Concepts to Compressible Flow- Concept of continuum system and control volume approach- conservation of mass, momentum and energy- stagnation state-compressibility

Wave propagation- Acoustic velocity-Mach number-effect of Mach number on compressibility- Pressure coefficient-physical difference between incompressible, subsonic and supersonic flows- Mach cone-sonic boom reference velocities-Impulse function adiabatic energy equation representation of various flow regimes on steady flow adiabatic ellipse.

Module – II

One dimensional steady isentropic flow- Adiabatic and isentropic flow of a perfect gas-basic equations- Area-Velocity relation using 1D approximation nozzle and diffuser-mass flow rate-chocking in isentropic flow-flow coefficients and efficiency of nozzle and diffuser-working tables-charts and tables for isentropic flow.

Flow in a constant area duct with friction (Fanno Flow) – Governing Equations- Fanno line on h-s and P-v diagram- Fanno relation for a perfect gas- Chocking due to friction-Isothermal flow(elementary treatment only)- working tables for Fanno flow.

Module – III

Flow through constant area duct with heat transfer (Rayleigh Flow)- Governing equations-Rayleigh line in h-s and P-v diagram-Rayleigh relation for perfect gas- maximum possible heat addition-location of maximum enthalpy point- thermal chocking-working tables for Rayleigh flow.

Irreversible discontinuity in supersonic flow- one dimensional shock wave- stationary normal shock- governing equations- Prandtl- Meyer relations- Shock strength- Rankine-Hugoniot Relation- Normal Shock on Fanno, Rayleigh curves- working formula- curves and tables-moving normal shock (elementary treatment only) - operation of nozzle under varying pressure ratios- two dimensional shock waves- Oblique shock waves supersonic flow over a compression and expansion corner (basic idea only).

Module – IV

Compressible flow field visualization and measurement- shadowgraph- Schlieren technique- interferometer- subsonic compressible flow field measurement (Pressure, Velocity and Temperature) – compressibility correction factor- hot wire anemometer- supersonic flow measurement- Rayleigh Pitot tube- wedge probe- stagnation temperature probe- temperature recovery factor.

References:

1. Shapiro A. H., *Dynamics and Thermodynamics of Compressible Fluid Flow*, Vol 1., Wiley, 1953.
2. Rathakrishnan E., *Gas Dynamics*, PHI Learning, 2004.
3. Yahya S. M., *Gas Tables for Compressible Flow Calculations*, New Age International, 2006.
4. Yahya S. M., *Fundamentals of Compressible Flow*, New Age International, 2003.
5. Balachandran P., *Fundamentals of Compressible Fluid Dynamics*, PHI Learning, 2006.
6. Balachandran P., *Gas Dynamics for Engineers*, PHI Learning, 2010.
7. Balachandran P., *Gas Tables*, PHI Learning, 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) - 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 understand the basic difference between incompressible and compressible flow and understand the phenomenon of shock waves and its effect on flow.

13.503 MACHINE DESIGN (S)

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

Course Objectives :

To acquaint the students with design procedures, standards and material selection of various components.

Module – I

Introduction to design - steps in design process - design factors - tolerances and fits - principles of standardisation – Materials and their properties- Elastic and plastic behaviour of metals- ductile and brittle behaviour-true stress and true strain- stress strain curves- Selection of materials – stresses in machine parts tension, compression, shear, bending, and torsional stresses, combined stress, stress concentration – stress intensity factor- Fracture toughness-factor of safety, margin of safety-variable stress-endurance limit-fatigue factor- theories of failure –combined steady and variable stress-Gerber, Goodman, Soderberg method- impact load - fatigue loading - consideration of creep and thermal stresses in design.

Module – II

Design of Pins, keys, splines and cotters. Thread standards - stresses in screw threads, Power screw- analysis of power screws. Design of bolted joints - preloading of bolts- shaft couplings, - stresses in couplings -design of couplings. Welded joints - types of welded joints - stresses in butt and fillet welds - torsion and bending in welded joints - welds subjected to fluctuating loads -design of welded machine parts and structural joints.

Module – III

Springs: classification and use of springs- spring materials stresses in helical springs - deflection of helical springs - extension, compression and torsion springs - design of helical springs for static and fatigue loading – critical frequency of helical springs - design of leaf springs. Power shafting - stresses in shafts - design for static loads - reversed bending and steady torsion - design for strength and deflection - design for fatigue loading.

Module – IV

Design of gears- nomenclature – spur, helical, bevel and worm gears – gear materials -tooth loads - design stresses -basic tooth stresses – stress concentration - service factor - velocity factor - bending strength of gear teeth - Lewis equation and Lewis form factor. Working stress in gear teeth- Dynamic load and wear load on gear teeth- Buckingham's equation for dynamic load - surface strength and durability - heat dissipation - design for strength and wear, Design of spur gear, Helical gear, bevel gear and worm gear-AGMA standards.

Design Data Handbooks:

1. Iyengar B. R. N. and K. Lingaiah, *Machine Design Databook,* Vol.I &II, McGraw Hill, 2003.
2. *Machine Design Data Handbook*, P.S.G. College of Technology, Tech., 1966.
3. Mahadevan K. and K. B. Reddy, *Design Data Hand Book for Mechanical Engineers*, C.B.S Publishers,2013.

References:

1. Phelan R. M., *Fundamentals of Mechanical Design,* Tata McGraw Hill, 1975.
2. Vallance A. and V. L. Doughtie, *Design of Machine Members*, McGraw Hill, 1951.
3. Juvinall R.C. and K.M. Marshek, *Fundamentals of Machine Component Design,* Wiley, 1991.
4. Norton R. L., Machine Design: An Integrated Approach, Pearson, 2000.
5. Spotts M.F., T. E. Shoup and L. E. Hornberger, *Design of Machine Elements*, Pearson, 2000.
6. Wentzell T. H., *Machine Design*, Thomson Delmer Learning, 2004.
7. Kulkarni S. G., *Machine Design*, Tata McGraw Hill, 2008.
8. Babu K. G. and K. Sridhar, *Design of Machine Elements*, Tata McGraw Hill, 2010.
9. Shigley J.E. and C. R. Mischke, *Mechanical Engineering Design*, McGraw Hill, 2003.
10. Siegel M. J., V. L. Maleev and J. B. Hartman, *Mechanical Design of Machines*, International Textbook Co., 1965.
11. Sharma P. C. and D. K. Aggarwal, *Machine Design*, S. K. Kataria & Sons, 1997.
12. Khurmi R. S. and J. K. Gupta, *A Textbook of Machine Design*, S. Chand, 2008.

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:

- *be able to analyze and design common machine elements;*
- *be able to communicate machine element designs through the use of assembly, working and detail drawings;*
- *become more conversant with the design process;*
- *become more familiar with the range and function of common machine elements.*

13.504 AIRCRAFT STRUCTURES - II (S)

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

Course Objectives:

- *To study the behaviour of various aircraft structural components under different types of loads.*
- *To provide the students various methods for analysis of aircraft wings and fuselage.*

Module – I

Bending stresses in beams of unsymmetrical sections -Bending of symmetric sections with skew loads - Generalized 'k' method, neutral axis method, principal axis method.

Module – II

Shear flow in open sections. Thin walled beams, Concept of shear flow, shear centre, Elastic axis. With one axis of symmetry, with wall effective and ineffective in bending, unsymmetrical beam sections. Shear flow in closed sections. Bredt -Batho formula, Single and multi -cell structures. Approximate methods. Shear flow in single & multicell structures under torsion. Shear flow in single and multicell under bending with walls effective and ineffective.

Module – III

Buckling of plates. 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.

Module – IV

Stress analysis in wing and fuselage. 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).

References :

1. Blaauwendraad J., *Plates and FEM*, Springer, 2010.
2. Szilard R., *Theories and Applications of Plate Analysis*, John Wiley, 2004.
3. Timoshenko S. and S. W. Krieger, Theories of Plates and Shells, McGraw-Hill, 2003.

4. Leissa A. W., Vibration of Plates, NASA Technical Report, 1969.
5. Peery D.J. and J. J. Azar, Aircraft Structures, 2/e, McGraw Hill, 1993.
6. Megson, T.M.G., *Aircraft Structures for Engineering Students*, Edward Arnold, 1995.
7. Bruhn E. H., *Analysis and Design of Flight Vehicles Structures*, Tri -state off set company, USA, 1985.
8. Rivello, R. M., Theory and Analysis of Flight Structures, McGraw Hill, 1993.
9. Curtis H. D, Fundamentals of Aircraft Structural Analysis, McGraw Hill, 1997.

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 have,

- *Ability to analyse the aircraft wings and fuselage.*
- *Ability to demonstrate the behaviour of major aircraft structural components.*

13.505 EXPERIMENTAL STRESS ANALYSIS (S)

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

Course Objective:

To bring awareness on experimental method of finding the response of the structure to different types of load.

Module – I

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

Module – II

Electrical resistance strain gauges: Principle of operation and requirements of electrical strain gauges. 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.

Module – III

Photoelasticity: Two dimensional photo elasticity, Concept of light – photoelastic effects, stress optic law, Interpretation of fringe pattern, Compensation and separation techniques, Photoelastic materials, Introduction to three dimensional photo elasticity.

Module – IV

Non – destructive testing: Fundamentals of NDT. Radiography, ultrasonic, magnetic particle inspection, Fluorescent penetrant technique, Eddy current testing, Acoustic Emission Technique, Fundamentals of brittle coating methods, Introduction to Moiré techniques, Holography, ultrasonic C- Scan, Thermograph, Fiber – optic Sensors.

References:

1. Dally J. W. and W. F. Riley, Experimental Stress Analysis, McGraw Hill, 1991.
2. Hetyenyi, M., *Hand book of Experimental Stress Analysis*, John Wiley, 1972.
3. Pollock A. A., Acoustic Emission in Acoustics and Vibration Progress, Ed. Stephens R.W.B., Chapman and Hall, 1993.
4. Singh S., Experimental Stress Analysis, McGraw Hill, 1995.
5. Srinath L. S., M. R. Raghava, K. Lingaiah, G. Garagesha, B. Pant and K. Ramachandra, Experimental Stress Analysis, Tata McGraw Hill, New Delhi, 1984.

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 stress and strain measurements in loaded components and of the application of NDT in stress analysis. They will have knowledge of the usage of strain gauges and photo elastic techniques of measurement.

13. 506.1 COMPOSITE MATERIALS (S)

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

Course Objectives:

To provide knowledge on characteristics of composites, manufacturing and testing methods, mechanical behaviour, recent trends and its application.

Pre-requisites: Basic knowledge of material science and mechanics of solids

Module – I

Introduction to composites: Characteristics and classifications of composites – study of fibers, flake and particulate composites. Manufacturing methods: Production of various fibers – matrix materials and surface treatments.

Module – II

Fabrication of composites – fabrication of thermosetting resin matrix composites – fabrication of thermoplastic resin matrix composites – short fiber composites – fabrication of metal matrix and ceramic matrix composites.

Module – III

Testing aspects of composites: Experimental characterisation of composites – uniaxial tension, compression and shear tests – determination of inter-laminar fracture toughness – damage identification through non-destructive evaluation techniques – ultrasonic, acoustic emission and X-radiography.

Module – IV

Mechanical behaviour of UD composites: Longitudinal strength and stiffness – transverse strength and stiffness – failure modes – analysis of laminated composites – stress-strain variation in a laminate. Special laminates: Symmetric laminates, uni-directional, cross-ply and angle-ply laminates, quasi-isotropic laminates. Recent trends in composite materials – carbon-carbon composites, Bucky Paper. Application of composite materials in aerospace, automotive, defence and industry.

References

1. Daniel I. M. and O. Ishai, *Engineering Mechanics of Composite Materials*, Oxford University Press, 2006.
2. Mallick P. K., *Fiber-Reinforced Composites: Materials, Manufacturing and Design*, CRC Press, 2007.

3. Halpin J.C., *Primer on Composite Materials: Analysis*, Technomic Publishing Co., 1984.
4. Agarwal B. D. and L. J. Broutman, *Analysis and Performance of Fiber Composites*, Wiley, 1990.
5. Mallick P. K. and S. Newman, *Composite Materials Technology: Processes and Properties*, Carl Hanser Verlag GmbH &Co, 1990.
6. Gibson R., *Principles of Composite Material Mechanics*, Tata McGraw Hill, 1994.
7. Hyer M., *Stress Analysis of Fiber - Reinforced Composite Materials*, Tata McGraw Hill, 1998.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, 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 this course, the students will be able to:

- *understand the mechanics of composite materials.*
- *analyse the laminated composites for various loading eases.*
- *gain knowledge in manufacture of composites.*

13. 506.2 THEORY OF ELASTICITY (S)

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

Course Objectives:

To understand the theoretical concepts of material behaviour with particular emphasis on their elastic property.

Module – I

Assumptions in elasticity**:** Definitions- notations and sign conventions for stress and strain, Equations of equilibrium. Basic equations of elasticity**,** Strain – displacement relations, Stress – strain relations, Lame's constant – cubical dilation, Compressibility of material, bulk modulus, Shear modulus, Compatibility equations for stresses and strains, Principal stresses and principal strains, Mohr's circle, Saint Venant's principle.

Module – II

Plane stress and plane strain problems, Airy's stress function, Bi-harmonic equations, Polynomial solutions, Simple two-dimensional problems in Cartesian coordinates like bending of cantilever and simply supported beams, etc.

Module – III

Polar coordinates**,** Equations of equilibrium, Strain displacement relations, Stress – strain relations, Axi – symmetric problems, Kirsch, Michell's and Boussinesque problems.

Module – IV

Torsion, 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.

Theory of plates and shells - classical plate theory – assumptions – governing equations – boundary conditions – navier's Method of solution for simply supported rectangular plates – levy's method of solution for rectangular Plates under different boundary conditions.

References

1. Volterra E. and J.H. Caines, *Advanced Strength of Materials*, Prentice Hall, 1991.
2. Wang C. T., *Applied Elasticity*, McGraw Hill, New York, 1993.
3. Sokolnikoff I. S., *Mathematical Theory of Elasticity*, McGraw Hill, 1971.
4. Timoshenko S. and T. N. Goodier, *Theory of Elasticity*, McGraw–Hill, 1990.

5. Bhaskar K. and T. K. Varadan, *Theory of Isotropic/Orthotropic Elasticity*, CRC Press, 2009.

6. Ugural A. C. and Fenster S. K., *Advanced Strength and Applied Elasticity*, 4/e, Prentice Hall, 2003.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, 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 this course the students will be able to use mathematical knowledge to solve problem related to structural elasticity.

13. 506.3 ADVANCED FLUID MECHANICS (S)

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

Course Objectives:

- *To provide the student with some specific knowledge regarding fluid-flow phenomena observed in aeronautical engineering systems, such as potential flow, vortex flow, boundary-layer flow etc.*
- *To enhance the understanding of fluid mechanics, including the equations of motion in differential form and turbulence.*

Module – I

Conservation equation of fluid flow: Conservation of mass, conservation of momentum – stress and strain in fluid flow and their relationship, conservation of energy, work done due to viscous stress.

Module – II

Laminar flow of viscous incompressible fluids: Flow between parallel flat plates, couette flow, plane Poiseuille flow, flow between two co-axial cylinders, flow between two concentric rotating cylinders, unsteady motion of flat plates.

Module – III

Boundary layer theory: Boundary layer equation, Blasius solution, shear stress and boundary layer thickness, boundary layer on a surface with pressure gradient, momentum integral theorem for boundary layer, separation and its prevention by boundary layer suction.

Module – IV

Turbulence: Concept of linearized stability of parallel viscous flow, transition to turbulent flow, Reynolds equation for turbulent flow, Reynolds stresses, Prandtl's mixing length theory, velocity profile, turbulent flow in pipes, and turbulent boundary layer on flat plate.

Inviscid flow: Elementary plane flow solutions, uniform stream, source or sink, vortex. Superposition of plane flow solutions, flow over wedge, circular cylinder and Rankine oval.

References

1. Liepmann H. W. and A. Roshko, *Elements of Gas Dynamics*, Dover Publications, 2002.
2. Yahya S. M., Fundamentals of Compressible Flow, New Age International, 2003.
3. White F.M., *Viscous Fluid Flow*, 3/e, McGraw Hill, 2005.
4. Muralidhar K. and G. Biswas, Advanced Engineering Fluid Mechanics, Alpha Science International, 2005.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, 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 this course the students will have

- *Familiarity with current practice in fluid measurement,*
- *Ability to apply fluid mechanics principles to the analysis of real systems,*
- *Ability to apply fluid mechanics principles to the design of real systems,*
- *Well developed problem solving and analytical skills.*

13. 506.4 QUALITY ENGINEERING & MANAGEMENT (S)

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

Course Objectives:

- *To understand the Total Quality Management concept and principles and the various tools available to achieve Total Quality Management.*
- *To understand the statistical approach for quality control.*
- *To create an awareness about the ISO and QS certification process and its need for the industries.*

Module – I

Quality and quality control: Concept of Quality and Quality Control, total quality control, Quality System economics, System approach for quality management, Quality Policy, Product and Process reliability, Process capability, Quality cost optimization.

Quality planning: Quality Planning, Quality information feed-back, Taguchi's philosophy of Robust product and process design, Machine and process capability analysis and charts, Control Charts X, R, P and C, special process control charts; acceptance sampling, plans and tables for attributes and variables.

Module – II

Quality improvement techniques: Quality improvement techniques, variance concepts, fishbone diagrams, pareto charts, just-in-time philosophy; quality assurance systems, ISO 9000, philosophy, documentation, implementation and certification process, Management's commitment to quality, team work approach, training and motivation quality circles.

Module – III

Quality management: Organization structure and design, quality function, decentralization, designing and fitting, organization for different type products and company, economics of quality value and contribution, quality cost, optimizing quality cost, seduction program.

Human Factor in quality**:** Attitude of top management, cooperation of groups, operators attitude, responsibility, causes of apparatus error and corrective methods.

Module – IV

Defects diagnosis and prevention defect study, identification and analysis of defects, correcting measure, factors affecting reliability, MTTF, calculation of reliability, building reliability in the product, evaluation of reliability, interpretation of test results, reliability control, maintainability, zero defects, quality circle.

References

1. Feigenbaum A. V., Total Quality Control, 4/e, ASQ Quality Press, 2008.
2. Mitra A., Fundamentals of Quality Control and Improvement, 2/e, Cenagage Learning, 2005.
3. Juran J. M., Quality Control Handbook, 4/e, McGraw Hill, 1988.
4. Lal H., Total Quality Management, Eastern Limited, 1990.
5. Bounds G., Beyond Total Quality Management, McGraw Hill, 1994.
6. Menon H. G, TQM in New Product manufacturing, McGraw Hill, 1992.
7. Juran J. M. and F. M. Gryna, Quality Planning & Analysis, McGraw Hill, 1993.
8. Grant E. L., Statistical Quality Control, McGraw Hill, 1964.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, 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 will have a knowledge of and ability to apply sound engineering practice to management of Industrial Relations issues, the role of staff associations and user groups in design, certification and operation of engineering works as well as employment contracts and agreements.*
- *Students will have a knowledge of and ability to apply the occupational health and safety act and awareness of liability and systems assurance as applied to workplace safety in both the practice of delivery and the in the product safety.*
- *Students will have knowledge of and ability to apply a professional approach to ethical issues related to the Engineering Profession and the social responsibility of engineers.*

13. 506.5 ENVIRONMENTAL SCIENCE (S)

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

Course Objectives:

- *To create an awareness on the various environmental pollution aspects and issues.*
- *To give a comprehensive insight into natural resources, ecosystem and biodiversity.*
- *To educate the ways and means to protect the environment from various types of pollution.*
- *To impart some fundamental knowledge on human welfare measures..*

Module – I

Introduction to environmental studies and natural resources: Definition, scope and importance – need for public awareness – forest resources: use and over-exploitation, deforestation, case studies. Timber extraction, mining, dams and their ground water, floods, drought, conflicts over water, dams-benefits and problems.

Mineral resources: use effects on forests and tribal people – water resources: use and over-utilization of surface and exploitation, environmental effects of extracting and using mineral resources, case studies.

Food resources: world food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – energy resources: growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. Case studies.

Land resources: land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – equitable use of resources for sustainable lifestyles.

Field study *of local area to document environmental assets – river/ forest/ grassland/ hill/ mountain.*

Module – II

Ecosystems and biodiversity: Concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

Introduction to biodiversity – definition: genetic, species and ecosystem diversity – biogeographical classification of india – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

***Field study** of common plants, insects, birds. Field study of simple ecosystems – pond, river, hill slopes, etc*

Module – III

Environmental pollution : Definition – causes, effects and control measures of: (a) air pollution (b) water pollution (c) soil pollution (d) marine pollution (e) noise pollution (f) thermal pollution (g) nuclear hazards – solid waste management: causes, effects and control measures of urban and industrial wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides.

***Field study** of local polluted site – urban / rural / industrial / agricultural.*

Module – IV

Social issues and the environment: From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies.

Environmental ethics: issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment protection act – air (prevention and control of pollution) act – water (prevention and control of pollution) act – wildlife protection act – forest conservation act – issues involved in enforcement of environmental legislation – public awareness.

References

1. Bharucha E., *The Biodiversity of India*, Mapin Publishing, 2002.
2. Trivedi R. K., *Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards*, Vol. I and II, Enviro media, 1998.
3. Cunningham W. P., T. H. Cooper, E. Gorham and M. T. Hepworth, *Environmental Encyclopedia*, Jaico Publishing House, 2001.
4. Wager K. D., *Environmental Management*, W.B. Saunders Co., 1998.
5. Masters G. M., *Introduction to Environmental Engineering and Science*, Pearson Education, 2004.

6. Miller T.G., *Environmental Science*, Wadsworth Publishing Co., 1997.
7. Townsend C., J. Harper and M. Begon, *Essentials of Ecology*, Blackwell Science, 1995.
8. Trivedi R. K. and P. K. Goel, *Introduction to Air Pollution*, BS Publications, 2005.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, 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 this course the students will be able to understand the importance of protecting environment for future developments and also the need for preserving natural resources for future generations.

13.507 EXPERIMENTAL STRESS ANALYSIS LAB (S)

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

Course Objective:

To bring awareness on experimental method of finding the response of the structure to different types of load.

List of Experiments:

1. Calibration of photoelastic material using tensile specimen and disc under diametrical compression. Determination of fringe stress co efficient at different loads.
2. Measurement of isochromatic and isoclinic fringe orders and determination of magnitude and directions of principal stresses at different location in a circular disc under diametrical compression or beam under bending.
3. Measurement of stress in a tensile specimen with hole using photoelasticity. Computation of stress at different loads. Estimation of stress concentration factor.
4. Stress freezing of simple specimens.
5. Strain gauge bonding and circuits.
6. Strain measurement in simple specimens like tensile specimen, cantilever beam using strain gauges.
7. Use of 2/3 element strain gauge rosettes for determination of principal stresses.
8. Measurement of deflectors in cantilever, simply supported beams using LVDT or dial gauges. Calculation of modulus of elasticity from deflections.
9. Thin walled tubes under torsion- measurement of shear stress and twist.
10. Detection of cracks to other defects using ultrasonic methods

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 experimental techniques used for stress analysis and structural modeliing.

13.508 AIRCRAFT STRUCTURES LAB (S)

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

Course Objective:

To experimentally study the unsymmetrical bending of beams, find the location of shear centre, obtain the stresses in circular discs and beams using photo elastic techniques, calibration of photo -elastic materials and study on vibration of beams.

List of Experiments:

1. Unsymmetrical bending of beams
2. Shear centre location for open sections
3. Shear centre location for closed sections
4. Constant strength beam
5. Flexibility matrix for cantilever beam
6. Beam with combined loading
7. Calibration of Photo-elastic materials
8. Stresses in circular discs and beams using photo elastic techniques
9. Vibrations of beams

1. Wagner beam -Tension field beam.

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 experimental techniques to study the structural elements of aircrafts.