SCHEME OF EXAMINATION

B.TECH. 2nd Year Aeronautical Engineering -4th Semester

Course No.	Course Title	Teaching Schedule				Examination schedule			Total Marks	Duration of Exam
		L	T	P/D	Total	Theory	Sessional	Practical		
HUM -201 E / MATH-201 E	Basic of Economics & Management/ Mathematics-III	3	1	-	4	100	50	-	150	3
ARE-202E	Aircraft Structures-I	3	1	-	4	100	50	-	150	3
ARE-204E	Aerodynamics-I	3	1	-	4	100	50	-	150	3
ME-206E	Strength of Materials-II	3	1	-	4	100	50	-	150	3
ME-208E	Fluid Mechanics	3	1	-	4	100	50	-	150	3
ARE-208E	Flight Dynamics	3	1	-	4	100	50	-	150	3
ARE-210E	Aerodynamics - Lab	-	-	2	2	-	25	25	50	3
ARE-212E	Aircraft Structures Lab	-	-	2	2	-	25	25	50	3
ME-214 E	Fluid Mechanics Lab	-	-	3	3	-	25	25	50	3
ARE-214 E	Aeromodelling Lab	-	-	3	3	-	25	25	50	3
	TOTAL	18	6	10	34	600	400	100	1100	-

B. Tech. (Fourth Semester) Aeronautical Engineering

Basics of Economics and Management

HUM -201 E

L	T			
		Sessional	:	50 Marks
3	1	Theory	:	100 Marks
		Total	:	150 Marks
		Duration of Exam.	:	3 Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT-I

Meaning of Industrial Economics, production function, its types, least cost combination, law of variable proportions, law of returns: increasing, constant & diminishing.

Fixed & variable costs in short run & long run, opportunity costs, relation between AC & MC,U-shaped short run AC curve.

Price & output determination under monopoly in short run & long run, price discrimination, price determination under discrimination Monopoly, comparison between Monopoly & perfect competition.

UNIT-II

Meaning of management, characteristics of management, management Vs administration, management-Art, Science& Profession, Fayol's principles of management, Human relations approach, functions of management

UNIT – III

Planning & organizing: planning, steps in planning, planning premises, difference between planning policy & strategy, authority & responsibility, centralization & decentralization.

UNIT – IV

Staffing, Directing & Controlling-Manpower planning, recruitment & selection, styles of leadership, communication process and barriers, control process and steps in controlling.

TEXT BOOKS:

1. "Modern Economic Theory" Dewett, K.K., S. Chand & Co.
2. "Economic Analysis" K.P. Sundharam & E.N. Sundharam (Sultan Chand & Sons).
3. "Micro Economic Theory" M.L. Jhingan (Konark Publishers Pvt. Ltd.).
4. "Principles of Economics" M.L. Seth (Lakshmi Narain Aggarwal Educational Publishers – Agra).
5. "An Introduction to Sociology", D.R. Sachdeva & Vidya Bhusan.
6. "Society – An Introductory Analysis", R.M. Maclver Charles H. Page.
7. "Principles and Practices of Management : R.S. Gupta; B.D. Sharma; N.S. Bhalla; Kalyani.

REFERENCE BOOKS

1. "Organization and Management: R.D. Aggarwal, Tata McGraw Hill.
2. Business Organization and Management: M.C. Shukla

B. Tech. (Fourth Semester) Aeronautical Engineering

Mathematics-III

MATH 201 E

L	T	P
3	1	-

Sessional	: 50 Marks
Theory	: 100 Marks
Total	: 150 Marks
Duration of Exam.	: 3 Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT – I

Fourier series: Euler's Formulae, Conditions for Fourier expansions, Fourier expansion of functions having points of discontinuity, change of interval, Odd & even functions, Half-range series. Fourier Transforms: Fourier integrals, Fourier transforms, Fourier cosine and sine transforms. Properties of Fourier transforms, Convolution theorem, Perseval's identity, Relation between Fourier and Laplace transforms, Fourier transforms of the derivatives of a function, Application to boundary value problems.

UNIT-II

Functions of a Complex Variables: Functions of a complex variable, Exponential function, Trigonometric, Hyperbolic and Logarithmic functions, limit and continuity of a function, Differentiability and analyticity. Cauchy-Riemann equations, Necessary and sufficient conditions for a function to be analytic, Polar form of the Cauchy-Riemann equations, Harmonic functions, Application to flow problems, Conformal transformation, Standard transformations (Translation, Magnification & rotation,inversion & reflection, Bilinear).

UNIT-III

Probability Distributions : Probability, Baye's theorem, Discrete & Continuous probability distributions, Moment generating function, Probability generating function, Properties and applications of Binomial, Poisson and normal distributions.

UNIT-IV

Linear Programming : Linear programming problems formulation, Solution of Linear Programming Problem using Graphical method, Simplex Method, Dual-Simplex Method.

Text Book:

Higher Engg. Mathematics: B.S. Grewal
Advanced Engg. Mathematics: E. Kreyzig

References:

1. Complex variables and Applications: R.V. Churchil; Mc. Graw Hill
2. Engg. Mathematics Vol. II: S.S. Sastry; Prentice Hall of India.
3. Operation Research: H.A. Taha

Aircraft Structures-1

ARE-202E

L	T	P
3	1	-

Sessional	:	50 Marks
Theory	:	100 Marks
Total	:	150 Marks
Duration of Exam.	:	3 Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT-I

Aircraft Structures

Introduction, Various Types of Structures used in Aircraft Construction.

Analysis of 2D Problems

Analysis of 2-D problems in rectangular and polar co-ordinates employing "Theory of Elasticity:Plane Stress and Plane Strain Condition".

UNIT -II

Statically Indeterminate Structures

Truss analysis with single and double redundancy, frames and rings.Torsion and bending of multicell box beams.

UNIT-III

Torsion

Torsion of non-circular solid bars, warping, axially constrained stresses. Torsional deflection of noncircular shell, analysis of thick walled tubes.

Joints in Structures

Riveted and Bolted Joints. Analysis and Design.

UNIT -IV

Structural components

Function of various components eg aileron, flaps, rudder, landing gear etc. Design Criteria, Safe-Life, Fail Safe and Damage Tolerance Approach. Fatigue damage.

Text Books

1. T.H.G.Megson, "Aircraft Structures for Engineering Students", Edward Arnold and Co., 2nd Ed, 1990.
2. David J.Perry, "Aircraft Structures", McGraw Hill Book Co. 1949

References:

1. S.Timoshanko and J.N., "Theory of Elasticity".
2. Lalit Gupta and O.P. Sharma, "Aircraft Structures", Himalayan Books
3. Joe Christy, "Aircraft construction, Repair and Inspection"

B. Tech. (Fourth Semester) Aeronautical Engineering

Aerodynamics-I

ARE-204E

L	T	P
3	1	-

Sessional	:	50 Marks
Theory	:	100 Marks
Total	:	150 Marks
Duration of Exam.	:	3 Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT-I

REVIEW OF BASIC FLUID MECHANICS

Continuity, momentum and energy equations.

TWO DIMENSIONAL FLOWS

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-II

CONFORMAL TRANSFORMATION

Joukowski transformation and its application to fluid flow problems, Kutta condition, Blasius theorem.

UNIT –III

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.

UNIT -IV

. **VISCOUS FLOW**

Newton's law of viscosity, Boundary Layer, Navier-Stokes equation, displacement, Momentum thickness, Flow over a flat plate, Blasins solution.

Text Books:

1. Houghton E.L. and Brock A.E., "Aerodynamics for Engineering Students", Edwards Arnolds,UK
2. Anderson John D Jr, "Fundamentals of Aerodynamics", McGraw Hill

References

1 A.C. Kermode, " Mechanics of Flight", Pearson Education Ltd.
2 S.K.Ojha, "Flight Performance of Aircraft", AIAA Series, 1995
3 J.D.Anderson, "Introduction to Flight", McGraw Hill, 1989

B. Tech. (Fourth Semester) Aeronautical Engineering

Strength of Materials -II

ME- 206 E

L	T	P
3	1	-

Sessional : 50Marks
Theory : 100 Marks
Total : 150 Marks
Duration of Exam: 3Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

Unit I

Strain Energy & Impact Loading: Definitions, expressions for strain energy stored in a body when load is applied (i) gradually, (ii) suddenly and (iii) with impact, strain energy of beams in bending, beam deflections, strain energy of shafts in twisting, energy methods in determining spring deflection, Castigliano's & Maxwell's theorems, Numerical. Theories of Elastic Failure: Various theories of elastic failures with derivations and graphical representations, applications to problems of 2- dimensional stress system with (i) Combined direct loading and bending, and (ii) combined torsional and direct loading, Numericals.

Unit II

Unsymmetrical Bending: Properties of beam cross section, product of inertia, ellipse of inertia, slope of the neutral axis, stresses & deflections, shear center and the flexural axis Numericals. Thin Walled Vessels : Hoop & Longitudinal stresses & strains in cylindrical & spherical vessels & their derivations under internal pressure, wire would cylinders, Numericals.

UNIT III

Thick Cylinders & Spheres : Derivation of Lame's equations, radial & hoop stresses and strains in thick, and compound cylinders and spherical shells subjected to internal fluid pressure only, wire wound cylinders, hub shrunk on solid shaft, Numericals. Rotating Rims & Discs: Stresses in uniform rotating rings & discs, rotating discs of uniform strength, stresses in (I) rotating rims, neglecting the effect of spokes, (ii) rotating cylinders, hollow cylinders & solids cylinders. Numericals.

UNIT IV

Bending of Curved Bars : Stresses in bars of initial large radius of curvature, bars of initial small radius of curvature, stresses in crane hooks, rings of circular & trapezoidal sections, deflection of curved bars & rings, deflection of rings by Castigliano's theorem stresses in simple chain link, deflection of simple chain links, Problems. Springs: Stresses in open coiled helical spring subjected to axial loads and twisting couples, leaf springs, flat spiral springs, concentric springs, Numericals.

Text Books:

1. Strength of Materials – G.H.Ryder, Third Edition in SI Units 1969 Macmillan, India. 2. Mechanics of Materials – (Metric Edition) : Ferdinand P. Beer and E. Russel Johnston, Jr. Second Edition, McGraw Hill.

References :.

1. Book of Solid Mechanics – Kazmi, Tata Mc Graw Hill
2. Strength of Materials – D.S. Bedi - S. Chand & Co. Ltd.
3. Advanced Mechanics of Solids and Structures – N. Krishan Raju and D.R.Gururaje- Narosa Publishing House.
4. Strength of Materials – Andrew Pytel and Fredinand L. Singer Fourth Edition, Int. Student Ed. Addison – Wesley Longman.

B. Tech. (Fourth Semester) Aeronautical Engineering

Fluid Mechanics

ME- 208 E

L	T	P
3	1	-

Sessional	: 50 Marks
Theory	: 100 Marks
Total	: 150 Marks
Duration of Exam	: 3 Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

Unit I

Fluid Properties and Fluid Statics: Concept of fluid and flow, ideal and real fluids, continuum concept, properties of fluids, Newtonian and non-Newtonian fluids. Pascal's law, hydrostatic equation, hydrostatic forces on plane and curved surfaces, stability of floating and submerged bodies, relative equilibrium. Problems. Fluid Kinematics: Eulerian and Lagrangian description of fluid flow; stream, streak and path lines; types of flows, flow rate and continuity equation, differential equation of continuity in cylindrical and polar coordinates, rotation, vorticity and circulation, stream and potential functions, flow net. Problems.

Unit II

Fluid Dynamics: Concept of system and control volume, Euler's equation, Bernoulli's equation, venturimeter, orifices, orificemeter, mouthpieces, kinetic and momentum correction factors, Impulse momentum relationship and its applications. Problems.Potential Flow: Uniform and vortex flow, flow past a Rankin half body, source, sink, source-sink pair and doublet, flow past a cylinder with and without circulation. Problems.

UNIT III

Viscous Flow: Flow regimes and Reynold's number, Relationship between shear stress and pressure gradient, uni-directional flow between stationary and moving parallel plates, movement of piston in a dashpot, power absorbed in bearings. Problems. Flow Through Pipes: Major and minor losses in pipes, Hagen-Poiseuilli law, hydraulic gradient and total energy lines, series and parallel connection of pipes, branched pipes; equivalent pipe, power transmission through pipes. Problems.

UNIT IV

Boundary Layer Flow: Boundary layer concept, displacement, momentum and energy thickness, von-karman momentum integral equation, laminar and turbulent boundary layer flows, drag on a flat plate, boundary layer separation and control. Streamlined and bluff bodies, lift and drag on a cylinder and an airfoil, Problems. Turbulent Flow: Shear stress in turbulent flow, Prandtl mixing length hypothesis, hydraulically smooth and rough pipes, velocity distribution in pipes, friction coefficients for smooth and rough pipes. Problems.

Text Books:

1. Fluid Mechanics – Streeter V L and Wylie E B, Mc Graw Hill
2. Mechanics of Fluids – I H Shames, Mc Graw Hill

References :

1. Introduction to Fluid Mechanics and Fluid Machines – S.K. Som and G. Biswas, TMH
2. Fluid Mechanics and Fluid Power Engineering – D.S. Kumar, S.K. Kataria and Sons
3. Fluid Mechanics and Machinery – S.K. Agarwal, TMH, New Delhi

B. Tech. (Fourth Semester) Aeronautical Engineering

Flight Dynamics

ARE –208 E

L	T	P
3	1	-

Sessional	: 50 Marks
Theory	: 100 Marks
Total	: 150 Marks
Duration of Exam	: 3 Hrs.

NOTE: In the semester examination, the paper setter will set 8 questions in all, at least two questions from each unit, and students will be required to attempt only 5 questions, selecting at least one from each unit.

UNIT I

Atmosphere: Properties, standard atmosphere. Classification of aircraft. Airplane (fixed wing aircraft) configuration and various parts.

DRAG ON THE AIRPLANE

International Standard Atmosphere - 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

UNIT II

AIRCRAFT PERFORMANCE

Performance of airplane in level flight - Maximum speed in level flight - Conditions for minimum drag and power required - Range and endurance - Climbing and gliding flight (Maximum rate of climb and steepest angle of climb, minimum rate of sink and shallowest angle of glide) -Turning performance (Turning rate turn radius). Bank angle and load factor - Limitations of pull up and push over - V-n diagram and load factor.

UNIT III

STATIC LONGITUDINAL STABILITY

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 - 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.

UNIT IV

LATERAL AND DIRECTIONAL STABILITY

Dihedral effect - Lateral control - Coupling between rolling and yawing moments - Adverse yaw effects - Aileron reversal - Static directional stability - Weather cocking effect - Rudder requirements - One engine inoperative condition - Rudder lock.

DYNAMIC STABILITY

Dynamic longitudinal stability: Equations of motion - Stability derivatives - Characteristic equation of stick fixed case - Modes and stability criterion - Effect of freeing-the stick - Brief description of lateral and directional. Dynamic stability - Spiral, divergence, Dutch roll, auto rotation and spin.

1. Perkins, C.D., and Hage, R.E., “Airplane Performance stability and Control”, John Wiley & Son:, Inc, New York, 1988.
2. Etkin, B., “Dynamics of Flight Stability and Control”, Edn. 2, John Wiley, New York, 1982.
3. Babister, A.W., “Aircraft Dynamic Stability and Response”, Pergamon Press, Oxford, 1980.
4. Dommasch, D.O., Shelby, S.S., and Connolly, T.F., “Aeroplane Aero dynamics”, Third Edition, Issac Pitman, London, 1981.

5.Nelson, R.C. “Flight Stability and Automatic Control”, McGraw-Hill Book Co., 1998

B. Tech. (Fourth Semester) Aeronautical Engineering
Aerodynamics - Lab
ARE-210E

L	T	P
		2

Sessional : 25Marks
Practical : 25 Marks
Total : 50 Marks
Duration of Exam: 3Hrs.

List of Experiments:

1. Use of Anemometer for measuring velocity.
2. Measurement of velocity profile in favourable and adverse pressure gradient.
3. Pressure distribution over a 2D cylinder and to find lift and drag.
4. Pressure distribution over an airfoil and to find lift and drag.
5. Experiments on potential flow Analogy (Hele-Shaw flow).
6. To study shocks using a water table.
7. To find the displacement thickness for the given aerofoil at low Reynolds number.
8. To plot Cp vs angle of attack for a pitching aerofoil.

Reference Books:

1. Low speed wind tunnel testing, Allen Pope, John Willey &sons
2. Low speed wind tunnel testing, W.E. Rae & Allen Pope, John Willey &sons

Note: At least eight experiments should be performed from the above list. Remaining two experiments may either be performed from the above list or designed & set by the concerned institute as per the scope of the syllabus

B. Tech. (Fourth Semester) Aeronautical Engineering

Aircraft Structures Lab

ARE-212E

L	T	P
		2

Sessional : 25Marks
Practical : 25 Marks
Total : 50 Marks
Duration of Exam: 3Hrs.

List of experiments

1 Study the construction of fuselage and identify the primary load carrying members
2 Study the construction of wings, ailerons, flaps, slits , slats and spoilers.
3 Study the construction of empennage, stabilizers, rudders adjusting tabs etc with detail of honeycomb structure.
4 Study the construction of landing gears and wheel turning mechanism
5 Study of aileron control linkages including artificial feel mechanism, booster and mannual controls and their adjustments
6 Study the measurement techniques with strain gauges
7 Study checks on airframe for life extension
8 Dye penetrant testing for surface crack detection
9 Measurement of deflection of truss using DTI
10 Measurement of deflection of simply supported beam
11 Determination of compressive strength of thin plates

Note: At least eight experiments should be performed from the above list. Remaining two experiments may either be performed from the above list or designed & set by the concerned institute as per the scope of the syllabus

B. Tech. (Fourth Semester) Aeronautical Engineering

Fluid Mechanics Lab

ME- 214 E

L	T	P
-	-	3

Sessional	: 25 Marks
Practical	: 25 Marks
Total	: 50 Marks
Duration of Exam.	: 3 Hrs.

List of Experiments:

1. To determine the coefficient of impact for vanes.
2. To determine coefficient of discharge of an orificemeter.
3. To determine the coefficient of discharge of Notch (V and Rectangular types).
4. To determine the friction factor for the pipes.
5. To determine the coefficient of discharge of venturimeter.
6. To determine the coefficient of discharge, contraction & velocity of an orifice.
7. To verify the Bernoullis Theorem.
8. To find critical Reynolds number for a pipe flow.
9. To determine the meta-centric height of a floating body.
10. To determine the minor losses due to sudden enlargement, sudden contraction and bends.
11. To show the velocity and pressure variation with radius in a forced vertex flow.

Note: At least eight experiments should be performed from the above list. Remaining two experiments may either be performed from the above list or designed & set by the concerned institute as per the scope of the syllabus

B. Tech. (Fourth Semester) Aeronautical Engineering

Aero Modeling Lab

ARE-214E

L T P
0 0 3

Sessional: 25 Marks
Practical: 25 Marks
Total: 50 Marks
Duration of Exam: 3 Hours

Each student is assigned the design of an Airplane (or Helicopter or any other flight vehicle), to a given preliminary specifications. The following are the assignments to be carried out:

List of experiments

1. Comparative studies of different types of airplanes and their specifications and performance details.
2. Preliminary weight estimations, selection of main parameters, Power plant selection, Aerofoil selection, Wing, tail and control surfaces.
3. Preparation of lay outs of balance diagram and three view drawings.
4. Drag estimation, Detailed performance, Calculations and Stability Estimates.V-n diagram.

NOTE

1. Validation of data may be done on wind Tunnel.
2. Suitable Software may be used to develop the design data.