

AE-601 ENGINEERING VIBRATION

UNIT-1 BASICS OF VIBRATION

History of vibration, important terminology and classification, degree of freedom, harmonic motion, vectorial representation, complex number representation.

Single degree of freedom system: derivation of equation of motion for one dimensional longitudinal, transverse and torsional vibration without damping using Newton's second law, D' Alembert's principle and principle of conservation of energy, compound pendulum.

UNIT-2 DAMPED VIBRATIONS

Damped vibrations of single degree of freedom system: viscous damping, under-damped, critically damped and over-damped systems, logarithmic decrement, vibration characteristics of coulomb damped and hysteretic damped systems.

UNIT-3 FORCED VIBRATIONS

Forced vibrations of single degree of freedom system: forced vibration with constant harmonic excitation, steady state and transient parts, frequency response curve and phase angle plot, forced vibration due to excitation of support. Vibration isolation and transmissibility: force transmissibility, motion transmissibility, forced vibration with rotating and reciprocating unbalance, materials used in vibration isolation.

UNIT-4 TWO DEGREE OF FREEDOM SYSTEM

System with two degree of freedom: principle mode of vibration, mode shapes, undamped forced vibrations of two degree of freedom system with harmonic excitation, vibration absorber, undamped dynamic vibration absorber and centrifugal pendulum absorber.

UNIT-5 MULTI DEGREE OF FREEDOM SYSTEM

Many degree of freedom system: introduction, influence coefficient, generalized coordinate, matrix method.

Vibration of continuous systems: introduction, lateral vibrations of a string, longitudinal vibrations of a bars, torsional vibration of a uniform shaft, transverse vibration of beams, effect of shear deformation and rotary inertia.

TEXT BOOKS:-

1. Mechanical Vibrations, Singh V.P., Dhanpat Rai & Co. (Pvt) Ltd.
2. Mechanical Vibrations, Rao S.S., Pearson Education.
3. Mechanical Vibrations, and Noise Engineering, Ambekar A.G., Prentice Hall India.

REFERENCE BOOKS:-

1. Elements of Vibration Analysis, Leonard Meirovitch, Tata Mcgraw-Hill, New Delhi.
2. Principle of Vibration, Benson H.Tongue, Oxford Publication.

LIST OF EXPERIMENTS:-

1. To find out effect of load on natural frequency of vibrations of a lever pin supported at one end carrying adjustable load on a vertical screwed bar and spring supported at some intermediate point (i) When the dead weight of rods is neglected and (ii) when their dead weight is taken into account .
2. To find out frequency of damped free vibration and rate of decay of vibration-amplitude in the system.
3. To find out natural frequency and damped free frequency of a torsion pendulum and , hence to find out coefficient of damping of the oil.
4. To observe the phenomenon of whirl in a horizontal light shaft and to determine the critical speed of the shaft.
5. To observe the mode shapes of a spring-connected, double pendulum and hence to demonstrate the phenomenon of beats.
6. To demonstrate the principle of tuned Undamped Dynamic Vibration Absorber and to determine the effect of mass-ratio (of main and auxiliary mass) on the spread of the resulting natural frequencies.
7. To take measurements of sound Pressure Level (SPL) and to carry out octave band analysis of a machine using Noise Level Meter.

AE-602 AIRCRAFT DESIGN

UNIT-1

Preliminaries: Aircraft Design Requirements, specifications, role of users. Aerodynamic and Structural Consideration, Importance of weight. Airworthiness requirements and standards. Classifications of airplanes. Special features of modern airplane.

Air Loads in Flight: Symmetrical measuring loads in flight, Basic flight loading conditions, Load factor, Velocity - Load factor diagram, gust load and its estimation, Structural limits.

UNI-2

Airplane Weight Estimation: Weight estimation based on type of airplane, trends in wing loading, weight-estimation based on mission requirements, iterative approach.

Basic Wing Design: Selection of airfoil selection, influencing factors. Span wise load distribution and planform shapes of airplane wing. Stalling take-off and landing considerations. Wing drag estimation. High lift devices.

Structural Design: Cockpit and aircraft passenger cabin layout for different categories, types of associated structure, features of light airplanes using advanced composite materials. Structural aspects of design of airplane, Bending moment and shear force diagram. Design principles of all metal stressed skin wing for civil and military applications.

UNIT-3

Landing Gears: Different kinds of landing gears, and associated arrangement for civil and military airplanes. Preliminary calculations for locating main and nose landing gears.

UNIT-4

Integration of Structure and Power Plant: Estimation of Horizontal and Vertical tail volume ratios. Choice of power plant and various options of locations, considerations of appropriate air-intakes. Integration of wing, fuselage, empennage and power plant. Estimation of centre of gravity.

UNIT-5

Introduction of advanced concepts: Supercritical Wings, relaxed static Stability, controlled configured vehicles, V/STOL aircraft and rotary wing vehicles. Design and layout of flying controls and engine controls.

TEXT BOOK :-

1. Daniel P Raymer, Aircraft Design: A conceptual approach, AIAA Series, 1992.
2. John D Anderson (Jr.), Airplane Performance and Design, mcgraw Hill.

REFERENCE BOOKS:-

1. L M Nicholal, Fundamentals of airplane Design, Univ. Of Dayton DHIO.
2. Aircraft Design K.D.Wood, Johnson Publishing Company.

LIST OF EXPERIMENTS:-

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:

1. Comparative configuration study of different types of airplanes.
2. Comparative study on specification and performance details of aircraft.
3. Comparative graphs preparation and selection of main parameters for the desin.
4. Preliminary weight estimations, selection of main parameters.
5. Power plant selection, Aerofoil selection, Wing tail and control surfaces.
6. Preparation of layouts of balance diagram and three view drawings.
7. Drag estimation
8. Detailed performance calculations and stability estimates.

AE-603 AIRCRAFT STRUCTURE- II

UNIT-1 FUNDAMENTALS OF STRUCTURAL ANALYSIS

Basic Elasticity: stress, notation for forces and stresses , equation of equilibrium, plane stress, boundary conditions, determination of stresses on inclined planes, principal stresses, strain, compatibility equations, plane strain, determination of strains on inclined planes principal strains, stress-strain relationship.

UNIT-2 BENDING OF THIN WALLED BEAMS

Bending of open and closed thin walled beams: Symmetrical bending, unsymmetrical bending, deflection due to bending, calculation of section properties, application of bending theory, temperature effects, numerical problems.

UNIT-3 TORSION OF THIN WALLED BEAMS

Torsion of beams: torsion of closed section beams, torsion of multi-cell section, shear centre, properties of shear centre , numerical problems.

UNIT-4 SHEAR FLOW

Bredt-Batho formula, Shear flow in open section, Shear flow in closed section, shear flow in boom section, combination of open and close section.

UNIT-5 AIRWORTHINESS AND AIRFRAME LOADS

Airworthiness, factor of safety-flight envelope, load factor determination, loads on an aircraft, safe life and fail safe structure, fatigue, creep and relaxation, materials used in an aircraft.

TEXT BOOKS:-

1. Megson T.H.G., Aircraft Structure for engineering students, Edward Arnold.
2. Perry D.J. and Azar J.J., Aircraft Structures, Mcgraw hill.

REFERENCE BOOKS:-

1. Analysis of A/C Structure by Bruce K. Donaldson (Cambridge Aerospace Series).
2. 'Theory & Analysis of Flight Structure' by Rivello, R.M., mcgraw Hill.

LIST OF EXPERIMENTS:-

1. Verification of Maxwell's Reciprocal theorem & principle of superposition.
2. Shear centre location for open sections.
3. Deflection of beams with various end conditions for different load.
4. Shear centre location for closed sections.

5. Compression tests on long and short columns, Critical buckling loads, South well plot.
6. Determination of Young's modulus of aluminum.
7. Beam with combined loading.

AE-604 AIRCRAFT RULES & REGULATION -I

UNIT-1

Knowledge of Aircraft Rules as far as they relate to airworthiness and safety of aircraft. Knowledge of Privileges and responsibilities of the various categories of AME Licence and approved persons.

UNIT-2

Knowledge of “Civil Airworthiness Requirements”, “Aeronautical Information Circulars (relating to airworthiness)”, “Advisory Circulars” and AME Notices issued by DGCA. Knowledge of various mandatory documents like Certificate of Registration, Certificate of Airworthiness, Flight Manual, Export Certificate of Airworthiness.

UNIT-3

Method of identifying approved material on Aircraft. Knowledge of various documents/certificates issued to establish airworthiness of Aircraft parts. Various logbooks required to be maintained for Aircraft. Method of maintaining the logbook. Procedure for making entries in logbooks; Journey logbook, Technical logbook etc. Use of schedules, its certification, preservation.

UNIT-4

Stores : Bonded and Quarantine stores, storage of various aeronautical products including rubber goods, various fluids. Knowledge of various terms such as Certificate of Flight Release, Certificate of Maintenance, Approved Certificates.

UNIT-5

Condition under which Aircraft is required to be test flown; Certificate to be issued by AME for test flight. Circumstances under which C of A is suspended. Ferry Flight, MEL, CDL.

TEXT BOOKS:-

1. Civil Aviation Requirements, Section-II by DGCA, Published by English Book Store.
2. Aircraft Manual, The Aircraft Act, 1934.
3. Aeronautical Information Circular, DGCA.

REFERENCE BOOKS:-

1. Airworthiness Advisory Circular.
2. Aircraft Maintenance Engineers Notices.

AE-605 SPACE DYNAMICS

UNIT-1 HISTORY OF SPACE FLIGHT

Introduction: History of space vehicles:- world history, Indian history, comparison, Initial works, first space flight, man in space, profile of flight from earth to a destination in space and back, space shuttle.

UNIT-2 ORBIT EQUATION

Introduction, differential equation, Lagrange's equation, Newton's law of gravitation, orbit equation, energy and angular momentum, Kepler's laws, orbit determination and satellite tracking.

UNIT-3 THE EARTH SATELLITE OPERATIONS

The Hohman transfer, inclination change maneuver, launch to rendezvous, decay life time, earth oblateness effect, low thrust orbit transfer,

UNIT-4 SATELLITE ATTITUDE DYNAMICS

Torque, free axisymmetric rigid body, the general torque free rigid body, semi rigid spacecraft, attitude control, spinning and non spinning spacecraft, the Yo-Yo mechanism, gravity gradient, satellite, the dual spin spacecraft.

UNIT-5 RE-ENTRY DYNAMICS

Introduction, ballistic re-entry, skip re-entry, double dip re-entry, aero braking, lifting re-entry.

space environment: introduction, atmosphere, light and spacecraft temperature, charged particle motion.

TEXT BOOK:-

1. Space Flight Dynamics, William E. Wiesel, McGraw Hill.

REFERENCE BOOK:-

1. Materials for missiles and spacecraft, Parker E.R.

AE-606 BASIC TRAINING ELEMENTS (SIMULATOR)

LIST OF EXPERIMENTS:-

- A. Trimming an airplane that has three-axis trim (elevator, rudder, aileron).
- B. Introduction to the four step scan.
- C. Demonstrating the graveyard spiral and the importance of using the triangles of knowledge
- D. Flying with hands-off the yoke.
 - 1. Controlling the airplane with rudder.
 - 2. Pitch trimming with power.
- E. Straight and level flight.
 - 1. Slow cruise
 - 2. Normal cruise.
- F. Elevator/throttle coordination.
 - 1. When maintaining a constant airspeed.
 - 2. When maintaining constant altitude or vertical speed.
- G. Climbs and level-offs.
 - 1. Normal cruise – best rate climb – normal cruise.
 - 2. Normal cruise – cruise climb – normal cruise.
 - 3. Slow cruise – best rate climb – slow cruise.
- H. Descents and level-offs
 - 1. Normal cruise – cruise descent – slow cruise
 - 2. Normal cruise – slow cruise descent – slow cruise.
- I. Descending and climbing turns with intermediate level-offs and roll-outs to specific headings.
- J. Vertical S with and without the attitude indicator.
- K. Vertical S-1 with and without the attitude indicator.
- L. Oscar pattern with and without the attitude indicator.
- M. Multiengine (if applicable)—using the rudder to initiate engine failure procedures.