B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2010

Fifth Semester

Mechanical Engineering

ME 2302 — DYNAMICS OF MACHINERY

(Regulation 2008)

Time: Three hours Maximum: 100 Marks

Answer ALL questions

PART A — (10 × 2 = 20 Marks)

1. Distinguish between crank effort and piston effort.
2. Define co-efficient of fluctuation of energy.
3. When is a system said to be completely balanced?
4. Name the efforts caused by the unbalanced primary force acting along the line of stroke due to partial balancing of locomotives.
5. Name the types of motion exhibited by critically damped or over damped vibrating systems.
6. Define logarithmic decrement.
7. Define transmissible.
8. When does resonance take place in a system?
9. When is a governor said to be Isochronous?
10. When is a governor said to be stable?

PART B — (5 × 16 = 80 Marks)

11. (a) The lengths of crank and connecting rod of horizontal steam engine are 300 mm and 1.2 m respectively. When the crank has moved 30° from the inner dead center, the acceleration of piston is 35 m/s2. The average frictional resistance to the motion of piston is equivalent to a force of 550 N and net effective steam pressure on piston is 500 kN/m2. The diameter of piston is 0.3 m and mass of reciprocating parts is 160 kg. Determine (i) Reaction on the cross-head guides; (ii) Thrust on the crankshaft bearings; and (iii) Torque on the crank shaft. [Marks 16]

Or

(b) The torque delivered by two-stroke engine is represented by T = (1000 + 300 sin 2? — 500 cos 2?) N.m where is the angle turned by the crank from the inner-dead center. The engine speed is 250 rpm. The mass of the flywheel is 400 kg and radius of gyration 400 mm. Determine (i) the power developed; (ii) the total percentage fluctuation of speed; (iii) the angular acceleration of flywheel when the crank has rotated through an angle of 60° from the inner-dead center; and (iv) the maximum angular acceleration and retardation of the flywheel. [Marks 16]

12. (a) A shaft carries four rotating masses A, B, C and D in this order along its axis. The mass of B, C and D are 30 kg, 50 kg and 40 kg respectively. The planes containing B and C are 30 cm apart. The angular spacing of the planes containing C and D are 90° and 210° respectively relative to B measured in the same sense. If the shaft and masses are to be in complete dynamic balance, find (i) the mass and the angular position of mass A; and (ii) the position of planes A and D. [Marks 16]

Or

(b) The firing order in a 6 cylinder vertical four stroke engine in-line engine is 1-4-2-6-3-5. The piston stroke is 100 mm and the length of each connecting rod is 200 mm. The pitch distances between the cylinder center lines are 100 mm, 100 mm, 150 mm, 100 mm, and 100 mm respectively. The reciprocating mass per cylinder is 1 kg and the engine runs at 3000 rpm. Determine the out-of-balance primary and secondary forces and couples on this engine, taking a plane midway between the cylinder 3 and 4 as the reference plane. [Marks 16]

13. (a) Determine: (i) the critical damping co-efficient, (ii) the damping factor, (iii) the natural frequency of damped vibrations, (iv) the logarithmic decrement and (v) the ratio of two consecutive amplitudes of a vibrating system which consists of a mass of 25 kg, a spring of stiffness 15 kN/m and a damper. The damping provided is only 15% of the critical value. [Marks 16]

Or

(b) A shaft of length 1.25 m is 75 mm in diameter for the first 275 mm of length, 125 mm in diameter for the next 500 mm length, 87.5 mm in diameter for the next 375 mm length and 175 mm in diameter for the remaining 100 mm of its length. The shaft carries two rotors at two ends. The mass moment of inertia of the first rotor is 75 kgm2 whereas of the second rotor is 50 kgm2. Find the frequency of natural torsional vibrations of the system. The modulus of the rigidity of the shaft material may be taken as 80 GN/m2. [Marks 16]

14. (a) A body having a mass of 15 kg is suspended from a spring which deflects 12 mm under weight of the mass. Determine the frequency of the free vibrations. What is the viscous damping force needed to make the motion a periodic at a speed of 1 mm/s? If, when damped to this extent, disturbing force having a maximum value of 100 N and vibrating at 6 Hz is made to act on the body, determine the amplitude of the ultimate motion. [Marks 16]

Or

(b) A machine supported symmetrically on four springs has a mass of 80 kg. The mass of the reciprocating parts is 2.2 kg which move through a vertical stroke of 100 mm with simple harmonic motion. Neglecting damping, determine the combined stiffness of the springs so that the force transmitted to the foundation is 1/20th of the impressed force. The machine crankshaft rotates at 800 rpm. If, under actual working conditions, the damping reduces the amplitudes of successive vibrations by 30%, find: (i) the force transmitted to the foundation at 800 rpm, and (ii) the force transmitted to the foundation at resonance. [Marks 16]

15. (a) The turbine rotor of a ship has a mass of 2.2 tonnes and rotates at 1800 rpm clockwise when viewed from the aft. The radius of gyration of the rotor is 320 mm. Determine the gyroscopic couple and its effect when (i) The ship turns right at a radius of 250 m with a speed of 25 km/h., (ii) The ship pitches with the bow rising at an angular velocity of 0.8 rad/s., and (iii) The ship rolls at an angular velocity of 0.1 rad/s. [Marks 16]

Or

(b) The following particulars refer to a pro-ell governor with open arms: Length of all arms = 200 mm, distance of pivot of arms from the axis of rotation = 40 mm, length of extension of lower arms to which each ball is attached =100 mm, mass of each ball = 6kg and mass of the central load = 150 kg. If the radius of rotation of the balls is 180 mm when the arms are inclined at an angle of 40° to the axis of rotation, find the equilibrium speed for the above configuration. [Marks 16]