11/12/13

B.E / B.Tech (Full Time) DEGREE END SEMESTER EXAMINATIONS, NOV/DEC 2013

MECHANICAL ENGINEERING

FOURTH SEMESTER

ME236/ME373/ME 9253 DYNAMICS OF MACHINES

(REGULATION 2002/2004/2009)

Time : 3 hr. Max. Mark :100

Answer ALL Questions

Part A (10 x 2 = 20 Marks)

1 What is free body diagram? How is it helpful in finding the various forces acting on members of a mechanism?

2 Define 'inertia force' and 'inertia torque'

3 Give reasons why it is very essential that all the rotating and reciprocating parts should be completely balanced as far as possible.

4 What is meant by dynamic balancing and state the necessary condition to achieve them.

5 Draw neat sketches of the longitudinal, transverse and torsional vibration.

6 Draw neat sketches of the under damping, critical damping and over damping with regard to free vibration.

7 Explain the terms 'fluctuation of energy' and 'fluctuation of speed' as applied to flywheels.

8 What is the basic functional difference between a flywheel and a governor?

9 What is stability of a governor ? Sketch the controlling force versus radius diagrams for a stable, unstable and isochronous governor.

10 Briefly write the application of gyroscopic principles to aircrafts.

PART B (5 x 16 = 80 Marks)

11 The following data refer to a steam engine:
Diameter of piston = 240 mm; stroke = 600 mm ; length of connecting rod = 1.5 m ; mass of reciprocating parts = 300 kg; mass of connecting rod = 250 kg; speed=125

r.p.m ; centre of gravity of connecting rod from crank pin = 500 mm ; radius of gyration of the connecting rod about an axis through the centre of gravity = 650 mm. Determine the magnitude and direction of the torque exerted on the crankshaft when the crank has turned through 30° from inner dead centre. (16)

12a A shaft is supported in bearings 1.8 m apart and projects 0.45 m beyond bearings at each end. The shaft carries three pulleys one at each end and one at the middle of its length. The mass of end pulleys is 48 kg and 20 kg and their centre of gravity are 15 mm and 12.5 mm respectively from the shaft axis. The centre pulley has a mass of 56 kg and its centre of gravity is 15 mm from the shaft axis. If the pulleys are arranged so as to give static balance, determine :
1. Relative angular positions of the pulleys, and 2. dynamic forces produced on the bearings when the shaft rotates at 300 r.p.m. (16)

[OR]

12b The following data refer to two cylinder locomotive with cranks at 90°: Reciprocating mass per cylinder = 300 kg ; Crank radius = 0.3 m ; Driving wheel diameter = 1.8 m ; Distance between cylinder centre lines = 0.65 m ; Distance between the driving wheel central planes = 1.55 m. Determine : 1. the fraction of the reciprocating masses to be balanced, if the hammer blow is not to exceed 46 kN at 96.5 km. p.h. ; 2. the variation in tractive effort ; and 3. the maximum swaying couple. (16)

13a A machine part of mass 2 kg vibrates in a viscous medium. Determine the damping coefficient when a harmonic exciting force of 25 N results in a resonant amplitude of 12.5 mm with a period of 0.2 second. If the system is excited by a harmonic force of frequency 4 Hz what will be the percentage increase in the amplitude of vibration when damper is removed as compared with that with damping. (16)

[OR]

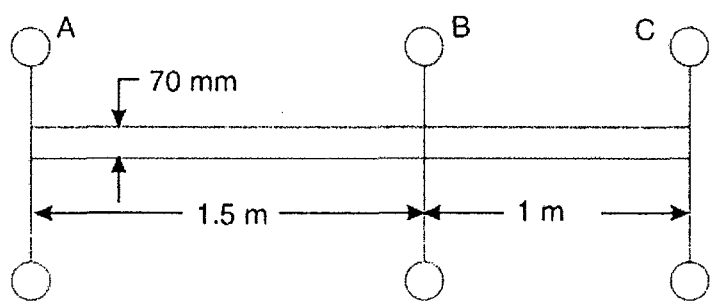
13b A single cylinder vertical petrol engine of total mass 300 kg is mounted upon a steel chassis frame and causes a vertical static deflection of 2 mm. The reciprocating parts of the engine has a mass of 20 kg and move through a vertical stroke of 150

mm with simple harmonic motion. A dashpot is provided whose damping resistance is directly proportional to the velocity and amounts to 1.5 kN per metre per second. Considering that the steady state of vibration is reached ; determine : 1. the amplitude of forced vibrations, when the driving shaft of the engine rotates at 480 r.p.m., and 2. the speed of the driving shaft at which resonance will occur. (16)

14a The mass of a single degree damped vibrating system is 7.5 kg and makes 24 free oscillations in 14 seconds when disturbed from its equilibrium position. The amplitude of vibration reduces to 0.25 of its initial value after five oscillations. Determine : 1. stiffness of the spring, 2. logarithmic decrement, and 3. damping factor, i.e. the ratio of the system damping to critical damping. (16)

[OR]

14b A single cylinder oil engine drives directly a centrifugal pump. The rotating mass of the engine, flywheel and the pump with shaft is equivalent to a three rotor system as shown below. The mass moment of inertia of the rotors A,B, and C are 0.15, 0.3 and 0.09 kgm^2. Find the natural frequency of the torsional vibration. The modulus of rigidity for the shaft material is 84 kN/mm^2.



(16)

15a A Porter governor has equal arms 200 mm long pivoted on the axis of rotation. The mass of each ball is 3 kg and the mass on the sleeve is 15 kg. The ball path is 120 mm when the governor begins to lift and 160 mm at the maximum speed. Determine the range of speed. If the friction at the sleeve is equivalent to a force of 10 N, find the coefficient of insensitiveness. (16)

[OR]

15b The turbine rotor of a ship has a mass of 3500 kg. It has a radius of gyration of 0.45 m and a speed of 3000 r.p.m. clockwise when looking from stern. Determine the gyroscopic couple and its effect upon the ship:

(i) when the ship is steering to the left on a curve of 100 m radius at a speed of 36 km/h.

(ii) when the ship is pitching in a simple harmonic motion, the bow falling with its maximum velocity. The period of pitching is 40 seconds and the total angular displacement between the two extreme positions of pitching is 12 degrees. (16)