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Question Paper Code : 60855

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Fifth Semester

Mechanical Engineering

ME 2302/ME 52/ME 1301/10122 ME 503 — DYNAMICS OF MACHINERY

(Regulations 2008/2010)

(Common to PTME 2302/10122 ME 503 – Dynamics of Machinery for
B.E. (Part-Time) Fourth Semester – Mechanical Engineering – Regulations 2009/2010)

Time : Three hours | Maximum : 100 marks

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Define fluctuation of speed.

2. What is the main function of flywheel in a punching press?

3. Differentiate unbalanced shaking force and shaking couple.

4. What do you understand by balancing of revolving masses?

5. A rod 20 mm diameter and 1.5 m long is rigidly fixed at one end and has a mass of 2 kg concentrated at the other end. Ignoring the weight of the rod, calculate the frequency of transverse vibrations. Take $E = 200$ GPa.

6. Define logarithmic decrement.

7. What is the need of measuring vibration?

8. Differentiate critical speed and whirling speed of shaft.

9. The governor control system belongs to which type?

10. List some of the terms used in connection with the motion of naval ships.

PART B — (5 × 16 = 80 marks)

11. (a) The following data relate to a four- bar link mechanism (Fig. 1)

$\omega_2 = 20$ rad/s (cw), $\alpha_2 = 160$ rad/s^2 (cw), OA = 240 mm, OG_2 = 100 mm, AB = 250 mm, AG_3 = 125 mm, BC = 250 mm, CG_4 = 130 mm, OC = 500 mm, $\angle AOC = 60°$. The masses and moment of inertia of the various members are

Link	Mass, m	MMI, kg m^2
2	21.7 kg	0.01872
3	10.66 kg	0.01105
4	24.47 kg	0.0277

Determine

(i) The inertia force of the moving members

(ii) Torque which must be applied to link 2. (16)

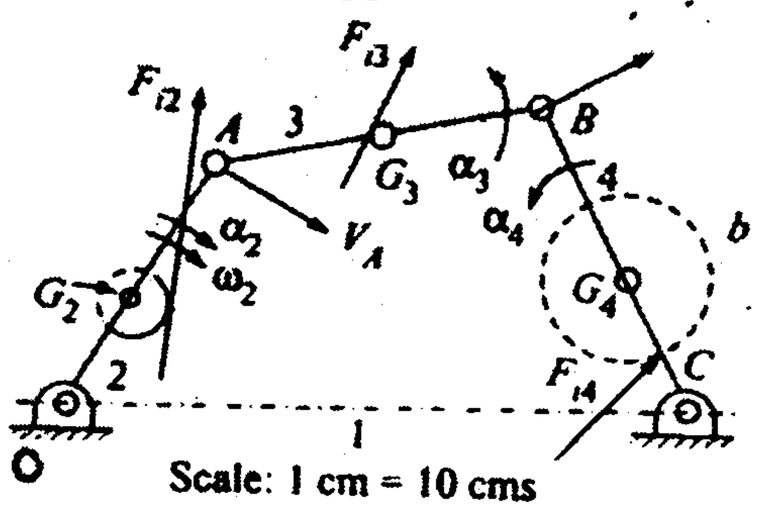

Figure 1

Or

(b) A single cylinder four-stroke petrol engine develops 18 kW power at a mean speed of 350 rpm. The work done during suction and exhaust strokes can be neglected. The work done by the gases during explosion stroke is three times the work done on the gases during the compression strokes and they can be represented by the triangles. Determine the mass of the flywheel to prevent a fluctuation of speed greater than 2% from the mean speed. The flywheel diameter may be taken as 2 m. (16)

12. (a) A mass of 110 kg is fixed to a rotating shaft so that distance of its mass centre from the axis of rotation is 228 mm. Find balancing masses in following two conditions :

(i) Two masses – one on left of disturbing mass at a distance of 100 mm and radius 400 mm, and other on right at a distance of 200 mm and radius of 150 mm.

(ii) Two masses placed on right of the disturbing mass respectively at distance of 100 and 200 mm and radii of 400 and 200 mm. The masses are placed in the same axial plane. (16)

Or

(b) The cylinders of twin V-engine are set at 60° angle with both pistons connected to a single crank through their respective connecting rods. Each connecting rod is 500 mm long and the crank radius is 100 mm. The total rotating mass is equivalent to 1.5 kg at the crank radius and the reciprocating mass is 1.8 kg per piston. A balance mass is also fitted opposite to the crank equivalent to 2 kg at a radius of 140 mm. Determine the maximum and minimum values of the primary and secondary forces due to inertia of the reciprocating and the rotating masses if the engine speed is 700 rpm. (16)

13. (a) (i) A reciprocating IC engine is coupled to a centrifugal pump through a pair of gears. The shaft from the flywheel of the engine to the gear wheel has a 50 mm diameter and is 825 mm long. The shaft from the pinion to the pump has 30 mm diameter and is 265 mm long. The pump speed is four times the engine speed. Moments of inertia of the flywheel, gear wheel, pinion and pump impellor are 1,000 kg.m^2, 14 kg.m^2, 5 kg.m^2 and 18 kg.m^2 respectively. Find the natural frequency of the torsional oscillations of the system. $G = 80$ GN/m^2. (12)

(ii) A steel wire 2 mm diameter is held between chucks 1 m apart. The wire weight 0.241 N/m. The flexural stiffness is 0.157 Nm^2. Calculate the first and second mode frequencies. (4)

Or

(b) A machine weights 20 kg and is supported on springs and dashpots. The total stiffness of the springs is 12 N/mm and the damping is 0.2 N/mm/s. The system is initially at rest and a velocity of 125 mm/s is imparted to the mass. Determine the

(i) Displacement and velocity of mass as a function of time

(ii) Displacement and velocity after 0.5s. (16)

14. (a) (i) The springs of an automobile trailer are compressed 0.2 m under its own weight. Find the critical speed when the trailer is travelling over a road with a profile approximated by a sine wave of amplitude 0.08 m and a wavelength of 15 m. What will be the amplitude of vibration at 60 km/ hr? (8)

(ii) The support is moved with a motion of $y = 6\sin(40t)$ mm. Fig. 2 shows a mass-spring-dashpot system. Determine the amplitude of the mass and the phase angle. (8)

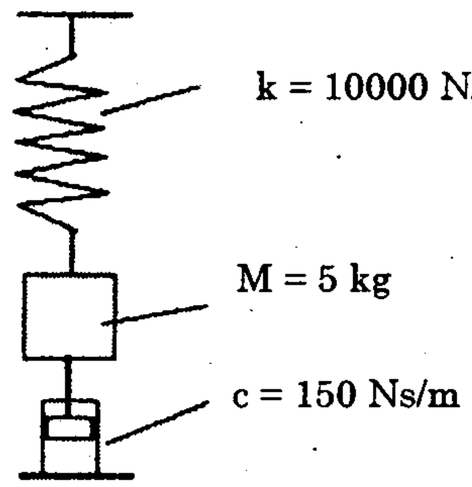

Figure 2

Or

(b) (i) A vertical single stage air compressor having a mass of 550 kg is mounted on springs having a stiffness of 1.96×10^5 N/m and a damping coefficient of 0.1. The rotating parts are completely balanced and the equivalent reciprocating parts have a mass of 25 kg. The stroke is 0.3 m. Determine the dynamic amplitude of vertical motion and the phase difference between the motion and excitation force if the compressor is operated at 300 rpm. (10)

(ii) Write short notes on steady state vibration. (6)

15. (a) What are spring controlled governors? Describe the function of Hartnell governor and deduce a relation to find the stiffness of the spring. (16)

Or

(b) (i) A disc of 5 kg mass with radius of gyration 90 mm is mounted at span on a horizontal shaft spins at 750 rpm in clockwise direction when viewed from the right hand bearing. If the shaft processes about the vertical axis at 40 rpm in clockwise direction when viewed from the top, determine the reactions at each bearing due to mass of the disc and gyroscopic effect. (6)

(ii) An automobile car is travelling along a track of 150 m mean radius. The moment of inertia of 550 mm diameter wheel is 1.8 kg m^2. The engine axis is parallel to the rear axle and crankshaft rotates in the same sense as the wheel. The moment of inertia of rotating parts of the engine is 1 kg m^2. The gear ratio is 4 and the mass of the vehicle is 1800 kg. If the centre of gravity of the vehicle is 480 mm above the road level and width of the track of the vehicle is 1.6 m, determine the limiting speed of the vehicle for condition that all four wheels maintain contact with the road surface. (10)