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Question Paper Code : 51640

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2014

Fifth Semester

Mechanical Engineering

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

(Regulation 2008/2010)

(Common to PTME 2302 – Dynamics of Machinery for B.E. (Part-Time)
Fourth Semester Mechanical Engineering – Regulation 2009)

Time : Three hours

Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are the requirements of an equivalent dynamical system?
2. Define the terms 'coefficient of fluctuation of speed' and coefficient of fluctuation energy.
3. When is a system said to be completely balanced?
4. What is tractive force?
5. Define damping factor or damping ratio.
6. What is meant by logarithmic decrement?
7. Define magnification factor as applied to forced vibrations.
8. List out the sources of excitation in forced vibration.
9. Differentiate between isochronous governors and sensitiveness of governors.
10. What is meant by reactive gyroscopic couple?

PART B — (5 × 16 = 80 marks)

11. (a) A horizontal steam engine running at 120 rpm has a bore of 250 mm and a stroke of 400 mm. the connecting rod is 0.6 m and mass of the reciprocating parts is 60 kg. When the crank has turned through an angle of 45° from the inner dead centre, the steam pressure on the cover end side is 550 kN/m^2 and that on the crank end side is 70 kN/m^2 . Considering the diameter of the Piston rod equal to 50 mm, determine:
- (i) Turning moment on the crankshaft,
 - (ii) Thrust on the bearing, and
 - (iii) Acceleration of the flywheel, if the power of the engine is 20 kW, mass of the flywheel 60 kg and radius of gyration 0.6 m. (16)

Or

- (b) A shaft fitted with a flywheel rotates at 250 rpm and drives a machine. The torque of machine varies in a cyclic manner over a period of 3 revolutions. The torque rises from 750 Nm to 3000 Nm uniformly during $1/2$ revolution and remains constant for the following revolution. It then falls uniformly to 750 Nm during next $1/2$ revolution and remain constant for one revolution, the cycle being repeated thereafter.

Determine the power required to drive the machine and percentage fluctuation in speed, if the driving torque applied to the shaft is constant and the mass of the flywheel is 500 kg with radius of gyration of 600 mm. (16)

12. (a) A, B, C and D are four masses carried by a rotating shaft at radii 100, 125, 200 and 150 mm respectively. The planes in which the masses revolve are spaced 600 mm apart and the mass of B, C and D are 10 kg, 5 kg and 4kg respectively.

Find the required mass A and the relative angular settings of the four masses so that the shaft shall be in complete balance. (16)

Or

- (b) A four crank engine has the two outer cranks set at 120° to each other, and their reciprocating masses are each 400 kg. The distance between the planes of rotation of adjacent cranks are 450 mm, 750 mm and 600 mm. if the engine is to be in complete primary balance, find the reciprocating mass and the relative angular position for each of the inner crank.

If the length of each crank is 300 mm, the length of each connecting rod is 1.2 m and the speed of rotation is 240 rpm, what is the maximum secondary unbalanced force? (16)

13. (a) (i) Explain the term 'whirling speed' or 'critical speed' of a shaft. Prove that the whirling speed for a rotating shaft is the same as the frequency of natural transverse vibration. (8)
- (ii) Derive an expression for the natural frequency of free transverse and longitudinal vibration by equilibrium method. (8)

Or

- (b) A steel shaft ABCD 1.5 m long has flywheel at its ends A and D. the mass of the flywheel A is 600 kg and has a radius of gyration of 0.6 m. the mass of the flywheel D is 800 kg and has a radius of gyration of 0.9 m. the connecting shaft has a diameter of 50 mm for the portion AB which is 0.4 m long; and has a diameter of 60 mm for the portion BC which is 0.5 m long; and has a diameter of d mm for the portion CD which is 0.6 m long. Determine:
- (i) The diameter ' d ' of the portion CD so that the node of the torsional vibration of the system will be at the centre of the length BC; and
- (ii) The natural frequency of the torsional vibrations.
- (iii) The modulus of rigidity for the shaft material is 80 GN/m^2 . (16)
14. (a) A mass of 10 kg is suspended from one end of a helical spring, the other end being fixed. The stiffness of the spring is 10 N/mm the viscous damping causes the amplitude to decrease to one tenth of the initial value in four complete oscillations. If a periodic force of $150 \cos 50t \text{ N}$ is applied at the mass in the vertical direction, find the amplitude of the forced vibrations. What is its value of resonance? (16)

Or

- (b) (i) Establish an expression for the amplitude of forced vibrations. (8)
- (ii) What do you understand by vibration isolation and transmissibility? Explain with suitable examples. (8)
15. (a) The radius of rotation of the balls of a Hartnell governor is 80 mm at the minimum speed of 300 rpm. Neglecting gravity effect, determine the speed after the sleeve has lifted by 60 mm; also determine the initial compression of the spring, the governor effort and the power. The particular of the governor are given below:
- Length of ball arm = 150 mm, Length of sleeve arm = 100 mm, mass of each ball = 4 kg, and stiffness of the spring = 25 N/mm . (16)

Or

- (b) 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 rpm 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)