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Question Paper Code : 80918

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2024.

Fourth / Fifth Semester

Mechanical Engineering

ME 8594 — DYNAMICS OF MACHINES

(Common to : Mechanical Engineering (Sandwich)/ Mechatronics Engineering)

(Regulations 2017)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State any two significances of inertia force analysis of mechanisms.

2. How cams are classified? List any two applications of cam?

3. "Reciprocating masses are generally partially balanced" – Justify.

4. What is meant by static and dynamic unbalance in machinery? How can the balancing be done?

5. Distinguish between longitudinal and transverse vibrations.

6. Write a short note on critical speed of shaft.

7. What is logarithmic decrement?

8. Give any four examples of forced vibration.

9. What are centrifugal governors? How do they differ from the inertia governors?

10. Mention any two gyroscopic effect on ships.

PART B — (5 × 13 = 65 marks)

11. (a) A horizontal steam engine running at 240 r.p.m has a bore of 30 cm and a stroke of 60 cm, the connecting rod is 105 cm long and reciprocating parts have a mass of 60 kg. When the crank is 60° apart from its inner dead centre, the steam pressure on the cover side of the piston is 11.15 bar while that on the crank side is 1.25 bar. Neglecting the area of the piston rod, determine

(i) The force in the piston rod; (7)

(ii) The turning moment on the crank shaft. (6)

Or

(b) The turning moment diagram for a multicylinder engine has been drawn to a scale 1 mm = 600 N-m vertically and 1 mm = 3° horizontally. The intercepted areas between the output torque curve and the mean resistance line, taken in order from one end, are as follows : +52, –124, +92, –140, +85, –72 and +107 mm^2, when the engine is running at a speed of 600 r.p.m. If the total fluctuation of speed is not to exceed ±1.5% of the mean, find the necessary mass of the flywheel of radius 0.5 m.

12. (a) Shaft carries four masses A, B, C, and D of magnitude 200 kg, 300 kg, 400 kg and 200 kg respectively, and revolving at radii 80 mm, 70 mm, 60 mm and 80 mm in planes measured from A at 300 mm, 400 mm and 700 mm. The angles between the cranks measured anticlockwise are A to B 45°, B to C 70°, and C to D 120°. The balancing masses are to be placed in planes X and Y. The distance between the planes A and X is 100 mm, between X and Y is 400 mm and between Y and D is 200 mm. If the balancing masses revolve at a radius of 100 mm, find their magnitudes and angular positions.

Or

(b) The reciprocating masses of the first three cylinders of a four-cylinder inline engine are 40 kg, 60 kg and 70 kg respectively. The centre lines of three cylinders are 520 mm, 320 mm and 120 mm from that of the 4^{th} cylinder respectively. If the cranks for all cylinders are similar, determine the reciprocating mass of 4^{th} cylinder and angular position of all the cranks such that the system is completely balanced for the primary force and couple. The crank radius is 80 mm, connecting rod length is 400 mm and the speed of the engine is 100 rpm. Also find the secondary crank positions.

13. (a) A machine mounted on springs and fitted with a dashpot has a mass of 60 kg. There are three springs, each of stiffness 12 N/mm. The amplitude of vibrations reduces from 45 to 8 mm in two complete oscillations. Assuming that the damping force varies as the velocity, determine the

(i) damping coefficient (4)

(ii) ratio of frequencies of damped and undamped vibrations (5)

(iii) periodic time of damped vibrations. (4)

Or

(b) 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 48-mm diameter and is 800 mm long. The shaft from the pinion to the pump has 32-mm diameter and 280-mm long. The pump speed is four times the engine speed. Moments of inertia of the flywheel, gear wheel, pinion and pump impeller are 1000 $kg.m^2$, 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.

14. (a) A refrigerator unit having a mass of 35 kg is to be supported on three springs, each having a spring stiffness *s*. The unit operates at 480 rpm. Find the value of stiffness *s* if only 10% of the shaking force is allowed to be transmitted to the supporting structure.

Or

(b) An air compressor having a mass of 80 kg and operating at a speed of 600 rpm was recently purchased by ABC Corporation. The company is investigating into suitable isolators to mount the compressor on the foundation. It is desired to limit the force transmitted to the base to a Transmissibility Ratio (TR) of 2.5 at resonance during startup. In addition, isolation of 90% (i.e. 10% TR) is to be achieved at the operating speed of the machine. Design a suitable isolator for the above compressor. The designer is expected to specify both viscous damping coefficient (c), and spring constant (k) for the isolator.

15. (a) With a neat sketch discuss in detail the working principle of watt and proell governors.

Or

(b) Describe the use of gyroscopes in aircraft and ships. Also, explain the working principle of gyrocompasses and Altitude indicators.

PART C — (1 × 15 = 15 marks)

16. (a) A 4 cylinder engine and flywheel coupled to a propeller are approximated to a three rotor system in which the engine is equivalent to a rotor of moment of inertia 800 kgm², the flywheel to a second rotor of 320 kgm² and the propeller to a third rotor of 200 kgm². The first and second rotor being connected by 50 mm diameter and 3 m long shaft and the second and third rotors being connected by a 25 mm diameter and 2 m long shaft. Neglecting the inertia of shaft, find

(i) Natural frequency of torsional vibrations. (5)

(ii) The positions of node. (5)

(iii) The relative amplitude of vibrations. G = 84 CPa. (5)

Or

(b) Four masses A, B, C and D as shown in table below are to be completely balanced.

	A	B	C	D
Mass (Kg)	–	30	50	40
Radius (mm)	180	240	120	150

The planes containing masses B and C are 300 mm apart. The angle between planes containing B and C is 90°. B and C make angle of 210° and 120° respectively with D in the same sense. Find

(i) Magnitude and angular position of mass A (8)

(ii) The position of the planes A and D. (7)