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Question Paper Code : 10927

B.E./B.Tech. DEGREE EXAMINATIONS, APRIL/MAY 2025.

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 — ($10 \times 2 = 20$ marks)

1. Distinguish between 'inertia force' and 'inertia torque'.
2. What is the difference between piston effort, crank effort?
3. Why is balancing of rotating parts necessary for high speed engines?
4. How a single revolving mass is balanced by two masses revolving in different planes?
5. Write any two examples for each of the bad and the good effects of vibration.
6. What is called Torsional vibration?
7. Mention the assumptions made in finding the natural frequency of a single-degree-of freedom system using the energy method.
8. Define mode shape. How is it computed?
9. What is the function of a governor? How does it differ from that of a flywheel?
10. Highlight the effects of friction and of adding a central weight to the sleeve of a Watt governor?

PART B — ($5 \times 13 = 65$ marks)

11. (a) A horizontal steam engine running at 240 r.p.m. has a bore of 300 mm and stroke 600 mm. The connecting rod is 1.05 m long and the mass of reciprocating parts is 60 kg. When the crank is 60° past its inner dead centre, the steam pressure on the over side of the piston is 1.125 N/mm^2 while that on the crank side is 0.125 N/mm^2 . Neglecting the area of the piston rod, determine:

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

(ii) the turning moment on the crankshaft. (6)

Or

- (b) The turning moment diagram for a multicylinder engine has been drawn to a scale $1 \text{ mm} = 600 \text{ N-m}$ vertically and $1 \text{ mm} = 3^\circ$ 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 $+107 \text{ mm}^2$, when the engine is running at a speed of 600 r.p.m. If the total fluctuation of speed is not to exceed $\pm 1.5\%$ of the mean, find the necessary mass of the flywheel of radius 0.5 m.

12. (a) 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) A, B, C and D are four masses carried by a rotating shaft at radii 100 mm, 150 mm, 150 mm and 200 mm respectively. The planes in which the masses rotate are spaced at 500 mm apart and the magnitude of the masses B, C and D are 9 kg, 5 kg and 4 kg respectively. Find the required mass A and the relative angular settings of the four masses so that the shaft shall be in complete balance.

13. (a) Calculate the natural frequency of vibration of a two rotor system as shown in *Figure 1*. Neglect the weight of the shaft.

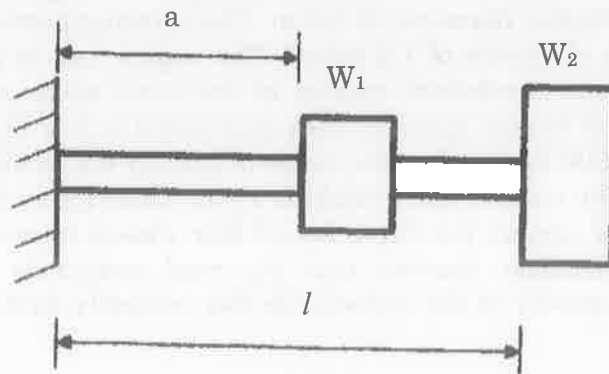


Figure.1

Take $W_1 = 60 \text{ kg}$, $W_2 = 92 \text{ kg}$, $l = 25.6 \text{ cm}$, $a = 15 \text{ cm}$, $I = 6.25 \text{ cm}^4$, $E = 196133 \text{ MPa}$.

Or

- (b) What is damping? Explain in detail with sketches the different types of damping.
14. (a) A vibratory body of mass 150 kg supported on springs of total stiffness 1050 kN/m has a rotating unbalance force of 525 N at a speed of 6000 rpm . If the damping factor is 0.3 determine
- The amplitude caused by the unbalance and its phase angle (5)
 - Transmissibility and (4)
 - Actual force transmitted and its phase angle. (4)

Or

- (b) What is vibration isolation? And explain the vibration measurement in detail.
15. (a) In a Hartnell governor, the lengths of ball and sleeve arms of a bell crank lever are 120 mm and 100 mm respectively. The distance of the fulcrum of the bell crank lever from the governor axis is 140 mm . Each governor ball has a mass of 4 kg . The governor runs at a mean speed of 300 r.p.m. with the ball arms vertical and sleeve arms horizontal. For an Increase of speed of 4 per cent , the sleeve moves 10 mm upwards. Neglecting friction, find
- The minimum equilibrium speed if the total sleeve movement is limited to 20 mm (3)
 - The spring stiffness (3)
 - The sensitiveness of the governor, and (3)
 - The spring stiffness if the governor is to be isochronous at 300 r.p.m. (4)

Or

- (b) A rear engine automobile is travelling along a track of 100 metres mean radius. Each of the four road wheels has a moment of inertia of 2.5 kg-m^2 and an effective diameter of 0.6 m. The rotating parts of the engine have a moment of inertia of 1.2 kg-m^2 . The engine axis is parallel to the rear axle and the crankshaft rotates in the same sense as the road wheels. The ratio of engine speed to back axle speed is 3:1. The automobile has a mass of 1600 kg and has its centre of gravity 0.5 m above road level. The width of the track of the vehicle is 1.5 m. Determine the limiting speed of the vehicle around the curve for all four wheels to maintain contact with the road surface. Assume that the road surface is not cambered and centre of gravity of the automobile lies centrally with respect to the four wheels.

PART C — ($1 \times 15 = 15$ marks)

16. (a) Explain the principle of gyroscopic couple and its effect in a moving ship.

Or

- (b) Explain the term 'whirling speed' or 'critical speed' of a shaft. Prove that the critical speed for a rotating shaft is the same as the frequency of natural transverse vibrations.