

Reg. No. :

--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Question Paper Code : 30925

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 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 — ($10 \times 2 = 20$ marks)

1. Differentiate between inertia force and inertia torque.
2. State the purpose of turning moment diagrams.
3. What is field balancing? Give examples.
4. What is partial balancing of reciprocating engines?
5. Classify damping.
6. Define critical speed of a shaft.
7. What is forced vibration? Give an example.
8. What is vibration isolation?
9. Classify governors.
10. What is a gyroscope? Give its applications.

PART B — ($5 \times 13 = 65$ marks)

11. (a) A punching press makes 25 holes of 20 mm diameter per minute in a plate 15 mm thick. This causes variation in the speed of the flywheel attached to the press from 240 to 220 rpm. The punching operation takes 2 seconds per hole. Assuming 6 N m of work is required to shear 1 mm² of the area and frictional losses account for 15% of the work supplied for punching, determine
 - (i) the power required to operate the punching press, and (7)
 - (ii) the mass of flywheel with radius of gyration of 0.5 m. (6)

Or

- (b) A single-cylinder vertical engine has a bore of 300 mm and a stroke of 400 mm. The connecting rod is 1 m long. The mass of the reciprocating parts is 150 kg. The gas pressure is 0.7 MPa with the crank at 30° from the top dead centre during the expansion stroke. The speed of the crank is 250 rpm. Determine

- (i) net force acting on the piston, (5)
- (ii) resultant load on the gudgeon pin, and (4)
- (iii) thrust force on the cylinder wall. (4)

12. (a) Three masses $M_1 = 3$ kg, $M_2 = 4$ kg, and $M_3 = 3$ kg are rotating in different planes as shown in Fig.1. Two balancing masses B_1 and B_2 are placed at 100 mm from each end at 80 mm radius. Find the magnitude and angular location of the balancing masses.

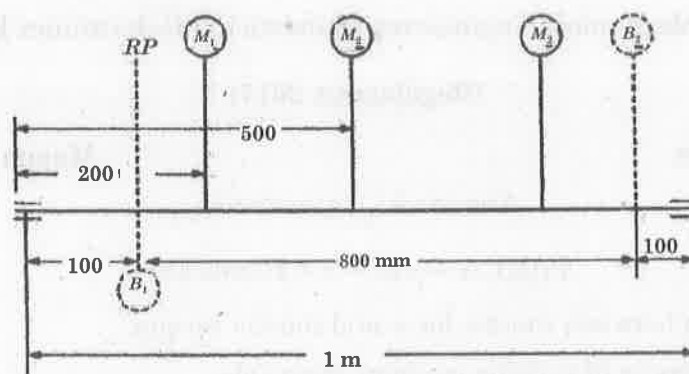


Fig. 1

Or

- (b) A four-cylinder engine has two outer cranks at 120° to each other and their reciprocating masses are each 400 kg. The distance between the planes of rotation of adjacent cranks are 0.4, 0.7, 0.7, and 0.5 m. Find the reciprocating mass and the relative angular position for each of the inner cranks, if the engine is to be in complete primary balance.

13. (a) In a single-degree damped vibrating system, a suspended mass of 10 kg makes 25 oscillations in 15 s. The amplitude decreases to $1/4^{\text{th}}$ of the initial value after 5 oscillations. Determine

- (i) stiffness of the spring, (4)
- (ii) logarithmic decrement, (3)
- (iii) damping factor, and damping coefficient. (6)

Or

- (b) The rotor of a turbine of mass 15 kg is supported at the midspan of a shaft of span 0.4 m. The rotor has an unbalance of 0.003 kg.m. Determine the force exerted on the bearings at a speed of 6000 rpm. The diameter of the steel shaft is 25 mm and $E = 200 \text{ GPa}$.
14. (a) A refrigerator unit having a mass of 40 kg is to be supported on four springs, each having a spring stiffness k . The unit operates at 460 rpm. Find the value of stiffness k if only 10% of the shaking force is allowed to be transmitted to the supporting structure.

Or

- (b) A weight attached to a spring of stiffness 252 N/m has a viscous damping device. When the weight is displaced and released, the period of vibration is found to be 1.8 s, and the ratio of consecutive amplitudes is 4.2 to 1.0. Determine the amplitude and phase when the force $F = 2 \cos 3t \text{ N}$ acts on the system.
15. (a) The arms of a Proell governor are 300 mm long. The pivots of the upper and lower arms are 30 mm from the axis. The load on the sleeve is 250 N and the weight of each ball is 30 N. When the governor sleeve is in mid-position, the extension link of the lower arm is vertical and the radius of rotation of the balls is 160 mm. The vertical height of the governor is 200 mm. If the speed of the governor is 150 rpm when in mid-position, find
- (i) the length of the extension link, and (7)
- (ii) tension in The upper arm. (6)

Or

- (b) A turbine rotor of a ship is of 2000 kg mass and has a radius of gyration of 0.8 m. Its speed is 2000 rpm. The ship pitches 5° above and below the mean position. A complete oscillation takes place in 20 s and the motion is simple harmonic. Determine
- (i) the maximum couple tending to shear the holding down bolts of the turbine, (4)
- (ii) the maximum acceleration of the ship during pitching, and (4)
- (iii) the direction in which the bow will tend to turn while rising, if the rotation of the rotor is clockwise when looking from aft. (5)

PART C — (1 × 15 = 15 marks)

16. (a) The torque exerted on the crankshaft of a two-stroke engine is given by $T = 15000 + 2500 \sin \theta - 2000 \cos 2\theta$ where θ is the crank angle measured from the inner dead centre. Assuming the resulting torque to be constant, determine
- (i) the power of the engine when the speed is 180 rpm, (5)
 - (ii) the moment of inertia of the flywheel if the speed variation is not to exceed $\pm 0.5\%$ of the mean speed, and (5)
 - (iii) the angular acceleration of the flywheel when the crank has turned through 30° from inner dead centre. (5)

Or

- (b) Calculate the natural frequency of a shaft of diameter 100 mm and length 3 m carrying three discs of diameters 1.25 m, 1.5 m, and 2 m and weighing 500 N, 700 N, and 900 N respectively at its left end, mid-point, and right end. For the shaft, $G = 84$ GPa. Also, find the location of nodes for the above system.