

Reg. No. :

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

Question Paper Code : 40924

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 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 × 2 = 20 marks)

1. Write the expression for D'Alembert's Principle and its significance in inertia force analysis.
2. Differentiate between static force analysis and dynamic force analysis.
3. State the difference between primary and secondary unbalanced forces in a reciprocating engine.
4. Mention the purpose of balancing a rotating mass.
5. Define the terms damping co-efficient and critical damping co-efficient.
6. What do you mean by whirling of shafts?
7. State the equation of motion for a spring-mass-dashpot system.
8. Define 'logarithmic decrement'.
9. State the difference between centrifugal governor and inertia governor.
10. State the effect of gyroscopic couple on an aeroplane during a left turn.

PART B — ($5 \times 13 = 65$ marks)

11. (a) In a vertical double-acting steam engine, the connecting rod is 4.5 times the crank. The weight of the reciprocating parts is 120 kg and the stroke of the piston is 440 mm. The engine runs at 250 rpm. If the net load on the piston due to steam pressure is 25 kN when the crank has turned through an angle of 120° from the top dead centre, determine the
- (i) Thrust in the connecting rod (3)
 - (ii) Pressure on slide bars (2)
 - (iii) Tangential force on the crank pin (3)
 - (iv) Thrust on the bearings (2)
 - (v) Turning moment on the crankshaft (3)

Or

- (b) The turning moment diagram for a multi-cylinder 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 mm², 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. (13)
12. (a) A rotating shaft carries four unbalanced masses 18 kg, 14 kg, 16 kg and 12 kg at radii 50 mm, 60 mm, 70 mm and 60 mm respectively. The 2nd, 3rd and 4th masses revolve in planes 80 mm, 160 mm and 280 mm respectively measured from the plane of the first mass and are angularly located at 60° , 135° and 270° respectively measured clockwise from the first mass looking from this mass end of the shaft. The shaft is dynamically balanced by two masses, both located at 50 mm radii and revolving in planes mid-way between those of 1st and 2nd masses and midway between those of 3rd and 4th masses. Determine, graphically or otherwise, the magnitudes of the masses and their respective angular positions. (13)

Or

- (b) Why is single reciprocating mass engine only partially balanced? Derive the expression for the unbalanced force due to reciprocating mass. Explain the significance of each term in the equation. Support your answer with a neat and well-labelled sketch. (13)

13. (a) In a single degree damped vibrating system, the suspended mass of 4 kg makes 24 oscillations in 20 seconds. The amplitude decreases to 0.3 of the initial value after 4 oscillations. Find the stiffness of the spring, the logarithmic decrement, the damping factor and damping coefficient. (13)

Or

- (b) A 1.2-m long shaft has a diameter of 45 mm for half the length and 60 mm for the remaining length. One end of the shaft is fixed and the other carries a rotor of 200-kg mass with a radius of gyration of 45 mm. Find the frequency of free torsional vibration neglecting the inertia of the shaft. Take $G = 84 \text{ GN/m}^2$. (13)
14. (a) Define the terms vibration isolation and transmissibility. Explain with the help of transmissibility vs. frequency ratio curves at various damping ratios. (13)

Or

- (b) Explain the working principle of different vibration measuring instruments. How are vibrations measured in real systems? (13)
15. (a) The controlling force in a spring controlled governor is 1500 N when the radius of rotation of the balls is 200 mm and 887.5 N when it is 130 mm. The mass of each ball is 8 kg. If the controlling force curve is a straight line, determine the controlling force and the speed of rotation when the radius of rotation is 150 mm. Also find the increase in the initial tension so that the governor is isochronous. What will be the isochronous speed? (13)

Or

- (b) The rotor of a marine turbine has a moment of inertia of 750 kg.m^2 and rotates at 3000 rpm clockwise when viewed from aft. If the ship pitches with angular simple harmonic motion having a periodic time of 16 seconds and an amplitude of 0.1 radian, find the
- (i) Maximum angular velocity of the rotor axis (5)
 - (ii) Maximum value of the gyroscopic couple (4)
 - (iii) Gyroscopic effect as the bow dips (4)

PART C — ($1 \times 15 = 15$ marks)

16. (a) In a machine, intermittent operations require varying torque over a 4-revolution cycle. During the first half-revolution, the torque increases uniformly from 800 N.m to 3000 N.m. For the next full revolution the torque remains constant at 3000 Nm. This is followed by a full revolution during which the torque decreases uniformly from 3000 Nm to 800 Nm. In the final half-revolution, the torque again remains constant at 800 Nm. The machine is driven by a motor delivering constant torque at a mean speed of 250 rpm. A fly wheel with a mass of 1800 kg and a radius of gyration of 500 mm is mounted on the shaft. Based on this setup, determine :
- (i) The power output of the motor, and (8)
 - (ii) The total fluctuation of speed of the machine shaft during the cycle. (7)

Or

- (b) A centrifugal pump rotating at 400 rpm is driven by an electric motor at 1200 rpm through a single stage reduction gearing. The moments of inertia of the pump impeller and the motor are 1500 kg.m^2 and 450 kg.m^2 respectively. The length of the pump shaft and the motor shaft are 500 mm and 200 mm, and their diameters are 100 and 50 mm respectively. Neglecting the inertia of the gears, find the frequency of the torsional oscillations of the system. $G = 85 \text{ GN/m}^2$. (15)