**Code: 20A03601** **R20**

B.Tech III Year II Semester (R20) Regular Examinations August 2023

**DYNAMICS OF MACHINERY**

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

**PART – A**

(Compulsory Question)

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1 Answer the following: (10 X 02 = 20 Marks)

(a) Friction is self adjusting phenomenon. Justify the statement. 2M

(b) Differentiate between boundary friction and fluid friction. 2M

(c) Explain the terms: steering, pitching and rolling in a ship. 2M

(d) Write the relationship between coefficient of fluctuation of speed, maximum fluctuation of energy and kinetic energy of flywheel. 2M

(e) What are the limitations of a Watt governor? 2M

(f) What is meant by the controlling force curve of a governor? 2M

(g) What is the necessity of balancing high speed machinery? 2M

(h) Define hammer blow and swaying couple. 2M

(i) Distinguish between longitudinal, transverse and torsional vibrations. 2M

(j) Show that the ratio of two successive amplitudes of oscillations is constant in a damped vibratory system. 2M

**PART – B**

(Answer all the questions: 05 X 10 = 50 Marks)

2 (a) State the assumptions of 'uniform pressure intensity' and 'uniform rate of wear'. What is the need for these two assumptions? 3M

(b) A body of weight 500 N is placed on a rough plane inclined at an angle of 25° with the horizontal. It is supported by an effort parallel to the plane. Determine the minimum and maximum values of the effort for which the equilibrium can exist, if the angle of friction is 20°. What happens to these values if the friction is neglected? 7M

**OR**

3 A vertical screw with single-start square threads 50 mm mean diameter and 10 mm pitch is raised against a load of 6 kN by means of a hand wheel, the boss of which is threaded to act as a nut. The axial load is taken by a thrust collar that supports the wheel boss and has a mean diameter of 70 mm. If the coefficient of friction is 0.15 for the screw and 0.20 for the collar, find the suitable diameter of hand wheel. Assume that a person can apply a force of 150 N by each hand. 10M

4 One of the driving axles of a locomotive with its two wheels has a moment of inertia of 350 kg-$m^2$. The wheels are of 1.85 m diameter. The distance between the planes of the wheels is 1.5 m. When travelling at 100 km/h the locomotive passes over a defective rail which causes the right hand wheels to fall 10 mm and rise again in a total time of 0.1 s, the vertical movement of the wheel being SHM. Find the maximum gyroscopic couple. 10M

**OR**

5 A four stroke engine develops 15 kW at 250 rpm. The turning moment diagram is rectangular for the expansion and compression strokes. The turning moment diagram during the expansion stroke is 2.8 times of that during the compression stroke. Assuming constant load, determine the moment of inertia of the flywheel to keep total speed fluctuation within ±1 per cent of the average speed. Also evaluate the mean torque. 10M

**Contd. in page 2**

6 A Porter governor has all four arms 200 mm long. The upper arms are attached on the axis of rotation and the lower arms are attached to the sleeve at a distance of 25 mm from the axis. The mass of each ball is 5 kg and the mass of sleeve is 40 kg. The extreme radii of rotation are 150 mm and 200 mm. Determine the range of speed of governor. Also find the effort and power of the governor. 10M

**OR**

7 Draw the schematic diagram of the Hartnell governor. Explain its working principle. Draw the forces acting on the bell crank lever in two extreme positions. Derive an expression for spring stiffness of the governor. 10M

8 Four masses A, B, C and D are required to be completely balanced. The planes containing masses B and C are 300 mm apart. The angle between planes containing masses B and C is 90°. The masses D and B make angles of 120° and 210° respectively with C in the same sense. The details of rotating masses are: 10M

| | *Mass* (kg) | *Radius* (mm) |
|---|---|---|
| ***A*** | – | **180** |
| ***B*** | **30** | **240** |
| ***C*** | **50** | **120** |
| ***D*** | **40** | **150** |

Find: (i) the mass and angular position of mass A and
(ii) the position of planes A and D.

**OR**

9 (a) Explain the 'direct and reverse crank' method for determining unbalanced forces in radial engines. 4M

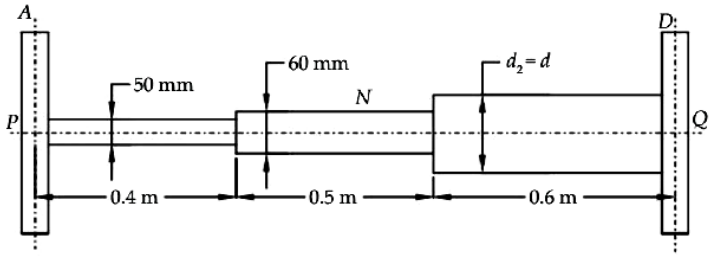
(b) A single cylinder reciprocating engine rotating at 250 rpm has a stroke length of 300 mm. The mass of reciprocating parts is 50 kg and mass of revolving parts at 150 mm radius is 30 kg. If two third of the reciprocating parts and all the revolving parts are to be balanced, find the balance mass required at a radius of 400 mm, and the residual unbalanced force when the crank has rotated 60° from top dead centre. 6M

10 (a) Calculate the whirling speed of a shaft 20 mm diameters and 1 m long carrying a mass of 1 kg at its midpoint. The density of the shaft material is 40 Mg/m$^3$, and Young's modulus is 200 GPa. Assume that the shaft is simply supported. 6M

(b) A spring-mass system has a natural frequency of 10 Hz. When the spring constant is reduced by 800 N/m, the frequency is altered by 45 percent. Find the mass and spring constant of the original system. 4M

**OR**

11 A steel shaft shown in figure has flywheel A and B at its ends. 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 0.9 m. Determine the diameter d of the portion CD so that the node of the torsional vibration of the system will be at the centre of length BC and the natural frequency of the torsional vibrations. The modulus of rigidity for the shaft material is 80 GPa. 10M

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**Code: 20A03601** **R20**

B.Tech III Year II Semester (R20) Supplementary Examinations January 2024

**DYNAMICS OF MACHINERY**

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

**PART – A**

(Compulsory Question)

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1 Answer the following: (10 X 02 = 20 Marks)

| | | |
|---|---|---|
| (a) | Define uniform pressure. | 2M |
| (b) | Draw various types of pivot and collar bearings. | 2M |
| (c) | How a four-wheeled vehicle is affected by gyroscopic couple? | 2M |
| (d) | Explain the function of a flywheel with reference to turning moment diagram. | 2M |
| (e) | What is the function of a governor? How is it different from that of a flywheel? | 2M |
| (f) | What the meaning of sensitiveness and stability of a governor. | 2M |
| (g) | Does a rotor which is statically balanced require dynamic balancing? | 2M |
| (h) | What are in-line engines? | 2M |
| (i) | Differentiate between overdamped and underdamped system. | 2M |
| (j) | What is torsionally equivalent shaft? | 2M |

**PART – B**

(Answer all the questions: 05 X 10 = 50 Marks)

2 (a) Derive an expression for frictional torque of a truncated conical pivot bearing assuming uniform wear. 4M

(b) An applied force of 1500 N is required to be able to move the body up, with uniform velocity, on an inclined plane of 15° with force acting parallel to the plane. When inclination angle of the plane is increased to 20°, the applied force required is 1800 N. Determine the weight of the body and coefficient of friction. 6M

**OR**

3 A square threaded screw is required to work against an axial force of 6 kN and has following dimensions. Major diameter, d = 32 mm, pitch p = 4 mm with single start, coefficient of friction μ = 0.08. Axial force rotates with the screw. Calculate: 10M

(i) Torque required when screw moves against the load.

(ii) Torque required when screw moves in the same direction as the load.

(iii) Efficiency of the screw.

4 A rotor of the marine ship having a mass of 750 kg and radius of gyration 300 mm is rotating at 1500 rpm clockwise when viewed from stern (rear end). Determine the gyroscopic couple and its effect on the ship in the following conditions: 10M

(a) When the ship pitches with angular velocity 1 rad/s and the bow (front end) is (i) rising, (ii) falling,

(b) When the ship is moving at 30 kmph and takes left turn of 200 m radius,

(c) When the ship rolls and at a certain instant, it has an angular velocity of 0.04 rad/s.

**OR**

5 The areas of the turning moment diagram for one revolution of multi-cylinder engine with reference to mean torque in $mm^2$ are -32, 408, -267, 333, -310, 226, -374, 260 and -244. The scale for abscissa and ordinate are 1 mm = 2.4° and 1 mm = 650 Nm respectively. The mean speed is 300 rpm with percentage speed fluctuation of 1.5%. Determine the mass of the flywheel if the maximum speed is 25 m/s. Also identify the location of maximum and minimum speed. 10M

**Contd. in Page 2**

6 Draw the schematic diagram of the Porter governor. Explain its working principle. Derive an expression for the height of the governor considering the friction at the sleeve. Also evaluate effort and power of a porter governor. 10M

**OR**

7 The controlling force curve of a spring controlled governor is straight line. The weight of each governor ball is 40 N and the extreme radii of rotation are 120 mm and 180 mm. If the values of the controlling force at the above radii be respectively 200 N and 360 N and the friction of the mechanism is equivalent to 2 N at each ball, find: 10M
(i) The extreme equilibrium speeds of the governor,
(ii) Equilibrium speed,
(iii) The coefficient of insensitiveness at radius of 150 mm.

8 Four masses A, B, C and D are attached to a rotating shaft with radii 50 mm, 65 mm, 100 mm and 75 mm respectively. The distances between planes A and B; between planes B and C and between planes C and D are 600 mm each. The masses B, C and D are 20 kg, 10 kg and 8 kg respectively. If the shaft is in complete balance, then find the magnitude of mass A and angular positions of the four masses. 10M

**OR**

9 A four crank engine has two outer cranks set at 120° to each other and their reciprocating masses are each 400 kg. The distances between the planes of rotation of adjacent crank 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 30 mm and length of each connecting rod is 120 mm, find the maximum secondary unbalanced force. The engine speed is 240 rpm. 10M

10 (a) The following data refer to a vibratory system with viscous damping. Mass 2.5 kg; spring constant 3 N/mm and the amplitude decreases to 0.25 of the initial value after five consecutive cycles. Determine the damping coefficient of the damper in the system. 5M

(b) A shaft of 100 mm diameter and 1 m long is fixed at one end, and the other end carries a flywheel of mass 1 tonne. The radius of gyration of the flywheel is 0.5 m. Find the frequency of torsional vibrations, if the modulus of rigidity of the shaft material is 80 GPa. 5M

**OR**

11 A shaft 1.5 m long supported in flexible bearings at the ends carries two wheels each of mass 50 kg. One wheel is situated at the centre of the shaft and the other at a distance of 375 mm from the centre towards left. The shaft is hollow of external diameter 75 mm and internal diameter 40 mm. The density of the shaft material is 7500 kg/m$^3$ and its modulus of elasticity is 200 GPa. Find the frequency of transverse vibration. Also determine the critical speed of the shaft. 10M

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