R18

Code No: 155BA

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech III Year I Semester Examinations, July/August - 2023

DYNAMICS OF MACHINERY

(Common to ME, MCT)

Time: 3 Hours **Max. Marks: 75**

Note: i) Question paper consists of Part A, Part B.
ii) Part A is compulsory, which carries 25 marks. In Part A, Answer all questions.
iii) In Part B, Answer any one question from each unit. Each question carries 10 marks and may have a, b as sub questions.

PART – A

(25 Marks)

1.a) The gyroscopic effect is not present during one of the motions of pitching, rolling, and steering. Which motion, and why? [2]

b) Distinguish between space diagram and free body diagram. [3]

c) What do you mean by crank effort or crankshaft turning moment? [2]

d) For a flywheel which is retarding, let T be the torque on the crankshaft at any instant and T_{mean} the mean resisting torque. Is $(T - T_{mean})$ positive or negative? Give reason for the answer. [3]

e) In a flat collar bearing, why are a number of collars provided to carry a fixed axial load? [2]

f) To avoid self-engagement in cone clutch, is its semi-cone angle always kept smaller than or greater than the angle of static friction? Give reason for the answer. [3]

g) Is the watt governor suitable for high speeds? Give reason for the answer. [2]

h) Explain why only a part of the unbalanced force due to reciprocating masses is balanced by revolving mass. [3]

i) What is node? [2]

j) What do you mean by whirling of shaft? Why and where it is necessary to check the whirling speed of the shaft? [3]

PART – B

(50 Marks)

2.a) Define and explain the superposition theorem as applicable to a system of forces acting on a mechanism.

b) The total mass of a four-wheel trolley car is 1800 kg. The car runs on rails of 1.6 m gauge, and round a curve of 24 m mean radius at 36 km/hr. The track is banked at 10^0. The diameter of the wheels is 600 mm. Each pair of wheels with axle has a mass of 180 kg and radius of gyration of 240 mm. The height of the C.G. of car above the wheelbase is 950 mm. Determine the pressure on each rail. [5+5]

OR

3.a) What is gyroscopic couple? Derive a relation for its magnitude.

b) A reciprocating engine mechanism with two external forces P and F_3 is shown in figure 1. For the configuration shown, the impending motion of the slider is to the right, and the friction angle is φ. Determine the couple C_2 on link 2 for static equilibrium. [5+5]

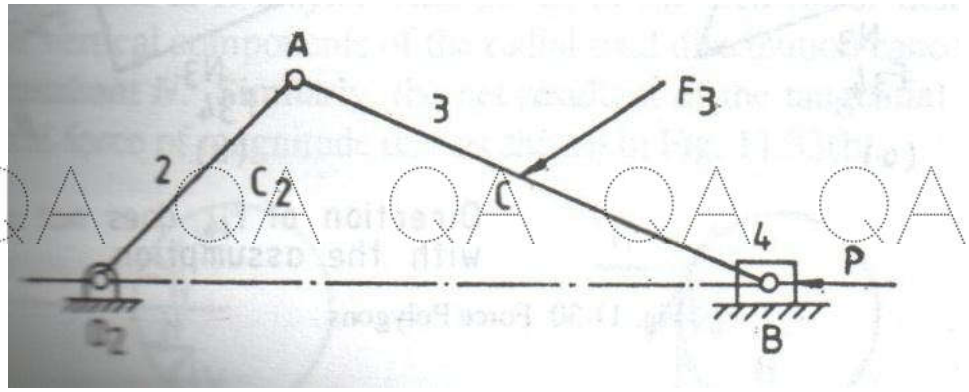

Figure 1

4.a) Distinguish between the functions of flywheel and governor, giving examples of situations demanding the use of one or the other or both on stationary engines.

b) A vertical double acting steam engine has a cylinder of 300 mm diameter and 450 mm stroke, and runs at 200 r.p.m. The reciprocating parts has a mass of 225 kg and the piston rod is of 50 mm diameter. The connecting rod is 1.2 m long. When the crank has turned through 125^0 from the top dead center, the steam pressure above the piston is 30 kN/m^2 and below the piston is 1.5 kN/m^2. Calculate the effective turning moment on the crank shaft. [5+5]

OR

5.a) The inertia of a connecting rod can be replaced by two masses concentrated at two points and connected rigidly together. How to determine the two masses so that it is dynamically equivalent to the connecting rod?

b) A riveting machine is driven by a constant torque 3 kW motor. The moving parts including the flywheel are equivalent to 150 kg at 0.6 m radius. One riveting operation takes 1 second and absorbs 10,000 N-m of energy. The speed of the flywheel is 300 r.p.m. before riveting. Find the speed immediately after riveting. How many rivets can be closed per minute? [5+5]

6.a) Derive the condition for a differential band brake to be self-locking for clockwise rotation of the brake drum.

b) A conical pivot supports a load of 20 kN, the cone angle is 120^0 and the intensity of normal pressure is not to exceed 0.3 N/mm^2. The external diameter is twice the internal diameter. Find the outer and inner radii of the bearing surface. If the shaft rotates at 200 r.p.m. and the coefficient of friction is 0.1, find the power absorbed in friction. Assume uniform pressure. [5+5]

OR

7.a) In bearings, how do the *coefficient of friction* (μ) and the *intensity of normal pressure* (p) vary with the radius r? Explain.

b) A single block brake, as shown in figure 2, has the drum diameter 250 mm. The angle of contact is 90^0, and the coefficient of friction between the drum and the lining is 0.35. If an operating force of 650 N is applied at the end of the lever, determine the torque that may be transmitted by the block brake (All dimensions are in mm). [5+5]

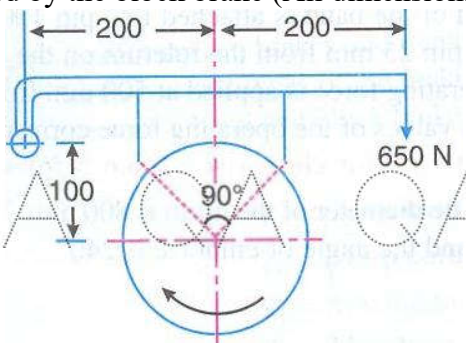

Figure 2

8.a) How do you determine the relation between 'h' and the angular speed of the balls (ω) of a Porter governor by the *Instantaneous center method*? Explain.

b) The reciprocating mass per cylinder in a 60^0 with V-engine is 2.5 kg. The stroke is 100 mm. if the engine runs at 2500 rpm, determine the maximum and minimum values of the primary forces and find the corresponding crank position. [5+5]

OR

9. The following data refers to a Hartnell governor. Length of horizontal arms of bell crank lever = 40 mm and Length of vertical arms of bell crank lever = 80 mm; Mass of each flying ball = 1.2 kg; Maximum radius of rotation = 100 mm, Minimum radius of rotation = 70 mm. The distance of fulcrum to axis of rotation = 75 mm, Minimum equilibrium speed = 400 rpm, Maximum equilibrium speed is 5% higher than minimum equilibrium speed. Neglecting obliquity of arms determine the: (a) spring stiffness, and (b) initial compression. [10]

10.a) Describe the free torsional vibrations of three-rotor system, with suitable sketches. Explain the terms single-node frequency (or) fundamental frequency, and two-node frequency.

b) Find the frequency of transverse vibrations of a shaft which is simply supported at the ends, and is of 40 mm in diameter. The length of the shaft is 5 m. The shaft carries three point loads of masses 15 kg, 35 kg and 22.5 kg at 1 m, 2 m and 3.4 m respectively from the left support. The Young's modulus for the material of the shaft is 200 GN/m^2. The weight of the shaft is 18.394 N per meter length. [5+5]

OR

11.a) Describe the method of finding the natural frequency of torsional vibrations for a three-rotor system.

b) A rotor of mass 4 kg is mounted on a 1 cm diameter shaft at a point 10 cm from one end. The 25 cm long shaft is supported in bearings. Calculate the critical speed. If the center of gravity of the disc is 0.03 mm away from the geometric center of rotor, find the deflection of the shaft when its speed of rotation is 5000 r.p.m. Take $E=1.96\times10^{11}$N/m^2. [5+5]

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