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Code No: 135SB

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
B. Tech III Year I Semester Examinations, January/February - 2023
DYNAMICS OF MACHINERY
(Mechanical Engineering)

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) Write the conditions for replacing any distributed mass by two point masses to have the same dynamical properties. [2]
b) What are the effects of gyroscopic couple on a two-wheeled vehicle when taking a turn? [3]
c) What is 'Inertia force' in reciprocating engines, and what is it due to? [2]
d) In a diesel generating set, is it possible to use only a flywheel or a governor? Give your answer with justification. [3]
e) What is the difference between self-locking brake and self-energizing brake? [2]
f) Which wear theory do you use in old clutch and new clutch, and why? When do you use a multi-plate clutch? [3]
g) What is meant by Hunting of a governor? [2]
h) Explain briefly why two balancing weights are required in two different planes to balance the unbalanced masses revolving in different planes. [3]
i) What are the basic assumptions in deriving the Dunkerlay's formula? [2]
j) Explain briefly the difference between Energy method and Rayleigh's method in finding the natural frequency of free longitudinal vibrations. [3]

PART – B

(50 Marks)

2.a) State and explain D'Alembert's principle for (i) Rectilinear motion, and (ii) Angular motion.
b) Each paddle wheel of a steamer has a mass of 1600 kg and a radius of gyration of 1.2 m. The steamer turns to port in a circle of 160 m radius at 24 kmph, the speed of the paddles being 90 rpm. Find the magnitude and effect of the gyroscopic couple acting on the steamer. [4+6]

OR

3.a) Explain why a gyroscope precesses, and obtain the relation between the rate of precession, the speed of rotation, the M.I. of the flywheel, and the applied torque.
b) The dimensions of a four – link mechanism are: AB = 400 mm, BC = 600 mm, CD = 500 mm, AD = 900 mm, and ∠ DAB = 60^0. AD is the fixed link. E is a point on link BC such that BE = 400 mm and CE = 300 mm (BEC clockwise). A force of $150 < 45^0$ N acts on DC at a distance of 250 mm from D. Another force of magnitude $100 < 180^0$ acts at point E. Find the required input torque on link AB for static equilibrium of the mechanism. [4+6]

4.a) Draw and explain the tuning moment diagram for a multi-cylinder engine, neglecting the effect of inertia of connecting rod.

b) A vertical petrol engine having a piston of 100 mm diameter and stroke 120 mm has a connecting rod 250 mm long. Mass of the piston is 1.1 kg. The speed is 2000 rpm on the expansion stroke with the crank at 20^0 from TDC. The gas pressure is 700 kN/m^2. Determine the net force on the piston, resultant load on the gudgeon pin, and thrust on the walls. [4+6]

OR

5. A multi-cylinder engine is to run at a speed of 600 r.p.m. On drawing the turning moment diagram to a scale of 1 mm = 250 N-m and 1 mm = 3^0, the areas above and below the mean torque line in mm^2 are : +160, -172, +168, -191, +197, -162. The speed is to be kept within + or – 1% of the mean speed of the engine. Calculate the necessary moment of inertia of the flywheel. Determine the suitable dimensions of a rectangular flywheel rim if the breadth is twice its thickness. The density of the cast iron is 7250 kg/m^3 and its hoop stress is 6 Mpa. Assume that the rim contributes 92% of the flywheel effect. [10]

6.a) A torsion dynamometer is fitted on a turbine shaft to measure the angle of twist. It is observed that the shaft twists 2^0 in a length of 5 m at 600 rpm. The shaft is solid and has a diameter of 250 mm. If the modulus of rigidity is 84 GPa, find the power transmitted by the turbine.

b) What is friction circle? Deduce an expression for the radius of friction circle in terms of the radius of journal and angle of friction. [5+5]

OR

7.a) What is the principle of torsion dynamometer? Explain the calculations involved in finding the power transmitted.

b) A conical pivot bearing 150 mm in diameter has a cone angle of 120^0. If the shaft supports an axial load of 20 kN and the coefficient of friction is 0.03, find the power lost in friction when the shaft rotates at 200 rpm assuming *uniform wear*. [4+6]

8. A twin cylinder V-engine has the cylinders set at an angle of 45^0, with both pistons connected to a single crank. The crank radius is 62.5 mm and the connecting rods are 275 mm long. The reciprocating mass per line is 1.5 kg, and the total rotating mass is equivalent to 2 kg at the crank radius. A balance mass fitted opposite to the crank is equivalent to 2.25 kg at a radius of 87.5 mm. Determine, for an engine speed of 1800 rpm, the minimum and maximum values of primary and secondary forces due to the inertia of rotating and reciprocating masses. [10]

OR

9. The mass of each ball of a Proell governor is 3 kg and the weight on the sleeve is 20 kg. Each arm is 220 mm long, and the pivots of the upper and the lower arms are 20 mm from the axis. For the mid-position of the sleeve, the extension links of the lower arms are vertical, the height of the governor is 180 mm and the speed is 150 rpm. Determine the lengths of the extension links and the tension in the upper arms. [10]

10.a) In the case of free torsional vibrations of two-rotor system, prove that the *node* divides the length of the shaft in the inverse ratio of the moments of inertia of the corresponding rotors.

b) A shaft is simply supported at the ends, and is of 20 mm in diameter and 600 mm in length. The shaft carries a load of 9.81 N at its center. The weight of shaft per meter is 124.1 N. Find the critical speed of the shaft. Take Young's modulus = 200 GN/m^2. [5+5]

OR

11. A shaft of length 1.25 m is 75 mm in diameter for the first 275 mm of its length, 125 mm in diameter for the next 500 mm length, 87.5 mm in diameter for the next 375 mm length, and 175 mm in diameter for the remaining 100 mm of its length. The shaft carries two rotors, one at each end. The mass moment of inertia of the first rotor is 75 kg-m^2 whereas of the second rotor is 50 kg-m^2. Find the frequency of natural torsional vibrations of the system. The modulus of the rigidity of shaft material may be taken as 80 GN/m^2. [10]

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