Code No: 115DY **R13**

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD

B. Tech III Year I Semester Examinations, January/February - 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) Define gyroscopic stabilization. [2]

b) Define *Static Equilibrium* of a body. What are the conditions to be satisfied for a body to be in static equilibrium? [3]

c) State the conditions which must be satisfied in order that film lubrication may be obtained. [2]

d) Distinguish between 'self-locking brake' and 'self-energized brake'. [3]

e) What is controlling force diagram in a governor? [2]

f) Draw the tuning moment diagrams for the following engines, neglecting the effect of inertia of the connecting rod:
i) Single – cylinder double – acting steam engine,
ii) Single – cylinder four stroke cycle I.C. engine. [3]

g) What is dynamic balancing of rotating shaft? [2]

h) A mass is attached to a shaft which is rotating at an angular speed of ω rad/s. Describe the procedure of balancing this mass by a single mass only. [3]

i) What is a *torsionally equivalent shaft*? [2]

j) How do you find the natural frequency of free longitudinal vibrations by the *Equilibrium method*? [3]

PART - B

(50 Marks)

2.a) Explain in what way the gyroscopic couple affects the motion of an aircraft while taking a turn.

b) A uniform disc of 150 mm diameter has a mass of 5 N. It is mounted on one end of an arm of length 50 cm. The other end of the arm is free to rotate in a universal bearing. If the disc rotates about the arm with a speed of 400 rpm anticlockwise looking from the front, with what speed will it precess about the vertical axis? [5+5]

OR

3.a) Explain the terms spin and precession. How do they differ from each other?

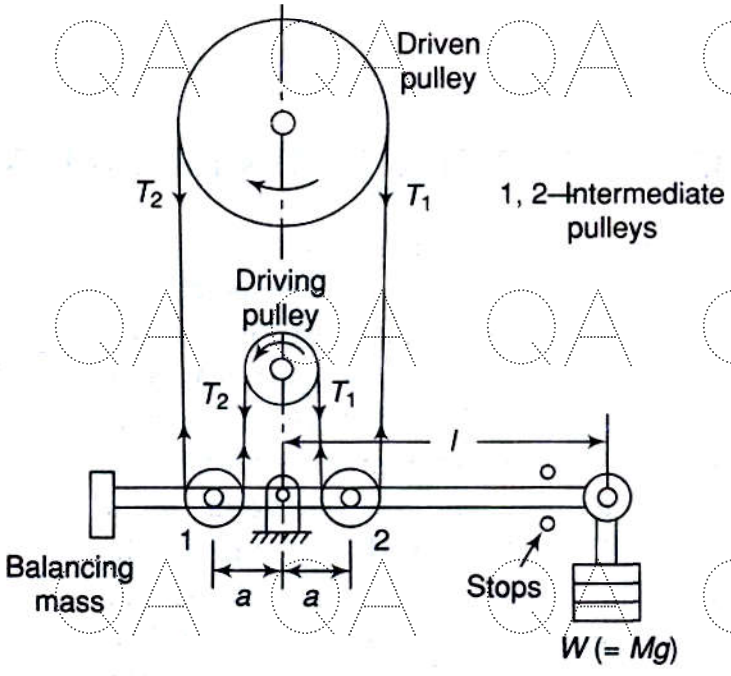
b) The dimensions of a four-link mechanism are: AB = 400 mm, BC = 600 mm, CD = 500 mm, AD = 900 mm and $\angle DAB = 60^0$. AD is the fixed link. E is a point on the link BC such that BE = 400 mm and CE = 300 mm (BEC clockwise). A force of 50 $\angle 45^0$ N acts on DC at a distance of 250 mm from D. Find the required input torque on the link AB for static equilibrium of the mechanism. [5+5]

4.a) A plain collar type thrust bearing having inner and outer diameters of 200 mm and 450 mm is subjected to an axial thrust of 40 kN. Assuming coefficient of friction between the thrust surfaces as 0.025, find the power absorbed in overcoming friction at a speed of 120 rpm. The rate of wear is considered to be proportional to the pressure and rubbing speed.

b) Explain the terms of friction circle, friction couple and friction axis. [5+5]

OR

5. The essential features of a transmission dynamometer are shown in figure. The driving pulley runs at 600 r.p.m. 1 and 2 are jockey pulleys mounted on a horizontal beam pivoted at the hinge point shown, about which the complete beam is balanced when at rest. All portions of the belt between the pulleys are vertical. Both the jockey pulleys and driving pulley are each of 300 mm diameter, and the thickness and weight of the belt are neglected. The length ***l*** is 750 mm. Find a) the value of the weight W to maintain the beam in a horizontal position when 4.5 kW is being transmitted and b) the value of W, when the belt just begins to slip on driving pulley. The coefficient of friction is 0.2 and maximum tension in the belt 1.5 kN. All dimensions are in mm. [10]



6. The turning moment diagram for a four stroke gas engine may be assumed for simplicity to be represented by four triangles, the areas of which from the line of zero pressure are as follows: Expansion stroke = 3550 mm^2; Exhaust stroke = 500 mm^2; Suction stroke = 350 mm^2; and compression stroke = 1400 mm^2. Each mm^2 represents 3 N-m. Assuming the resisting moment to be uniform, find the mass of the rim of a fly wheel required to keep the mean speed 200 rpm within ±2%. The mean radius of the rim may be taken as 0.75 m. Also determine the crank positions for the maximum and minimum speeds. [10]

OR

7.a) With a neat sketch, explain the working of a Hartnell governor.

b) Calculate the minimum speed, maximum speed and range of speed of a Porter governor, which has equal arms each 250 mm long and pivoted on the axis of rotation. The mass of each ball is 6 kg and the central mass on the sleeve is 18 kg. The radius of rotation of ball is 150 mm when the governor begins to lift and 200 mm when the governor is at the maximum speed. [5+5]

8.a) What do you understand by period of vibration, cycle, frequency, and resonance as applied to vibratory motion? Explain.

b) A shaft carries four rotating masses A of 5 kg, B of m_B kg, C of 4.5 kg, and D of 3.5 kg in this order from left to right. The effective radius of rotation of these masses from the left are respectively 30 cm, 40 cm, 35 cm and 25 cm. The plane of rotation of A and B are 35 cm apart and that between Band C are 45 cm apart. The angle between the A and C is 120^0.

Determine:

i) The angle between A and B and that between A and D.

ii) Distance between the planes of revolution of C and D,

iii) The mass m_B, so that the system is incomplete balance. [5+5]

OR

9. A three cylinder radial engine driven by a common crank has the cylinders spaced at 120^0. The stroke is 100 mm, length of the connecting rod 200 mm and the reciprocating mass per cylinder 1.5 kg. Calculate the primary and secondary forces at crank shaft speed of 1500 r.p.m. [10]

10.a) Explain the inherent mechanism in the oscillatory motion of a simple pendulum.

b) A shaft 2 m long has a diameter of 8 cm for the first 120 cm, and a diameter of 10 cm for the remaining length. If one end of the shaft is fixed, and the other end carries a rotor weighing 2.5 kN with a radius of gyration of 60 cm, what is the frequency of free torsional vibrations of the system? Take G = 84 GN/m^2. [5+5]

OR

11. A shaft, 1.5 m long, which is supported by flexible bearings at the ends, carries two wheels each of 50 kg mass. One wheel is situated at the center of the shaft and the other at a distance of 375 mm from the center towards left. The shaft is hollow of external diameter 75 mm and internal diameter 40 mm. The density of the shaft material is 7700 kg/m^3 and its modulus of elasticity is 200 GN/m^2. Find the lowest whirling speed of the shaft, taking into account the mass of the shaft. [10]

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