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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fifth Semester, B.E. - Mechanical Engineering

Semester End Examination; February / March - 2023

Dynamics of Machinery

Time: 3 hrs *Max. Marks: 100*

***Note**: Answer **FIVE** full questions, selecting **ONE** full question from each unit.*

UNIT - I

1 a. Define free body diagram with example. 6

b. For the static equilibrium of the quick return mechanism shown in Fig.-1, determine the input torque T_2 to be applied on the link AB for a force of 300 N on the slider D. The dimensions of the various links are OA = 400 mm, AB = 200 mm, OC = 800 mm, CD = 300 mm. 14

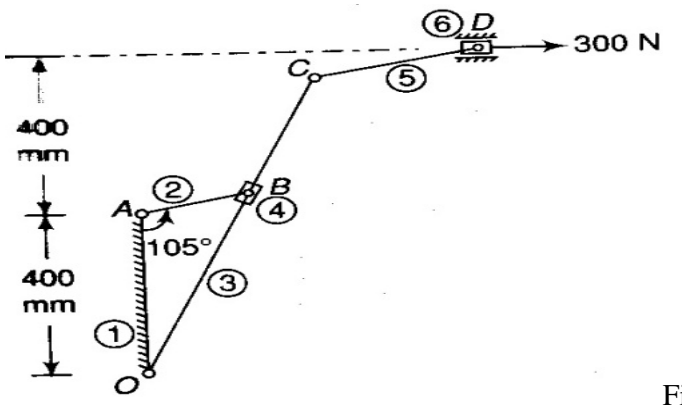

Fig.-1

2 a. State the conditions for a member to be in equilibrium,

i) When two forces act

ii) When three forces act

iii) When two forces and torque acts 6

b. In a four bar mechanism has shown in Fig.-2, torque T_3 and T_4 have magnitude of 3000 Nm and 2000 Nm respectively. Take AD = 800 mm, AB = 300 mm, BC = 700 mm and CD = 400 mm. For static equilibrium of mechanism, find the required input torque on the crank 2. 14

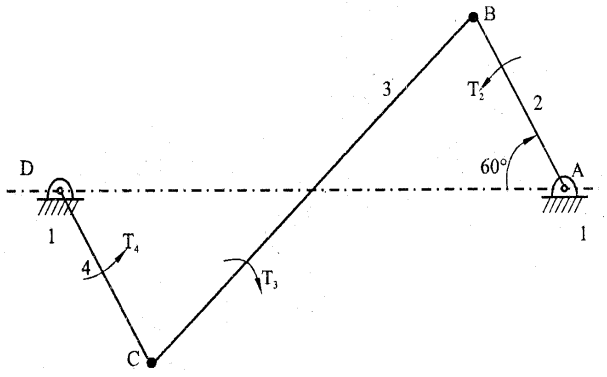

Fig.-2

Contd…2

UNIT - II

3. The connecting rod of a vertical reciprocating engine is 2 m long between centres and weights 250 kg. The mass centre is 800 mm from the big end bearing. When suspended as a pendulum from the gudgeon pin axis, it makes 8 complete oscillations in 22 seconds. Calculate the radius of gyration of the rod about an axis through the mass centre. The crank is 400 mm long and rotates at 200 rpm. Find the inertia torque exerted on the crankshaft when the crank has turned through 40° from the top dead centre and the piston is moving downwards. 20

4 a. State and explain D' Alembert's principle. 4

b. The crank and the connecting rod of a vertical single cylinder gas engine running at 1800 rpm are 60 mm and 240 mm respectively. The diameter of the piston is 80 mm and the mass of the reciprocating part is 1.2 kg. At a point during the power stroke when the piston has moved 20 mm from the top dead centre position, the pressure on the piston is 800 kN/m^2. Determine; 16

i) Net force on the piston

ii) Thrust in the connecting rod

iii) Thrust on the sides of cylinder walls

iv) Engine speed at which the above values are zero

UNIT - III

5 a. Obtain an expression for the hoop stress developed in the rim of a fly wheel. 8

b. The Turning Moment (T.M) diagram for an engine consists of two isosceles triangles. Maximum height for each triangle represents T.M. of 1000 Nm. The base of each triangle is equal to π radians. If the engine runs at 200 rpm and total fluctuation of speed is not to exceed 3% Find; 12

i) Power of the engine

ii) Mass of rim type fly wheel concentrated at 0.25 m radius

6 a. Classify governors and explain the working principle of porter governor with a neat sketch. 8

b. A punching machine carries out 6 holes per minute. Each hole of 40 mm diameter in 35 mm thick plate requires 8 Nm of energy/mm^2 of the sheared area. The punch has a stroke of 95 mm. Find the power of the motor required if the mean speed of the fly wheel is 20 m/s. If total fluctuation of speed is not to exceed 3% of the mean speed, determine the mass of the flywheel. 12

UNIT - IV

7 a. Explain the terms static balancing and dynamic balancing**.** 4

Contd…3

b. Four masses *A*, *B*, *C* and *D* with magnitude of 200 kg, 300 kg, 400 kg and 200 kg respectively are mounted on a shaft in the same order. The radii of rotation of the masses are 80 mm, 70 mm, 60 mm and 80 mm respectively. The distances of the planes of *B*, *C* and *D* from *A* are 300 mm, 400 mm and 700 mm respectively. The angular positions of masses *B*, *C* and *D* are 45°, 115° and 235° respectively from *A* measured anticlockwise. The system is to be balanced by adding balancing masses in planes *L* and *M*, which are at distances 100 mm and 500 mm respectively from the plane *A*. If the balancing masses revolve at a radius of 100 mm, determine their magnitudes and angular positions. 16

8. The firing order in a six cylinder vertical four stroke in-line engine is 1-4-2-6-3-5. The piston stroke is 100 mm and the length of the connecting rod is 200 mm. The pitch distance between the cylinder centre lines are 100 mm, 100 mm, 150 mm, 100 mm and 100 mm respectively. The reciprocating mass per cylinder is 1 kg and the engine runs at 3000 rpm. Determine the out of balance, primary and secondary forces and couple on this engine, taking a plane midway between the cylinder 3 and 4 as the reference plane. 20

UNIT - V

9 a. Drive an expression for heel angle of a motor cycle to avoid skidding. 8

b. The turbine rotor of a ship has a mass of 5000 kg and rotates at 2100 rpm clockwise when viewed from the stern. The radius of gyration of rotor is 500 mm, determine the gyroscopic couple and state the effect when;

i) The ship steer to the right at a speed of 30 kmph in a curve of radius 280 m

ii) The ship pitches 6° above and 6° below the horizontal position. The bow is ascending with its maximum velocity. The motion due to pitching is SHM of periodic time 20 seconds 12

iii) The ship rolls and at a certain instant it has an angular velocity of 0.03 rad/s clock wise when viewed from stern

10 a. Explain the stability of a four wheeler automobile negotiating a curve and drive the necessary condition for stability. 10

b. Each road wheel of a motor cycle has a moment of inertia of 2 kgm^2. The rotating part of the engine of the motor cycle has a moment of inertia of 0.2 kgm^2. The speed of the engine is 5 times the speed of the wheel and in the same sense. The mass of the motor cycle with rider is 200 kg and its CG is 0.5 m above ground level. The diameter of the wheel is 0.5 m. The motor cycle is travelling at 15 m/s on a curve of 30 m radius, find angle of heel of vehicle. 10

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