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

(An Autonomous Institution affiliated to VTU, Belgaum)

Fifth Semester, B.E. - Mechanical Engineering

Semester End Examination; Dec. - 2015

Dynamics of Machines

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each **unit**.*
ii) Assume suitably missing data if required.

UNIT - I

1 a. Recognize the conditions for static equilibrium of a body. 2

b. What are the free body diagrams of a mechanism? 3

c. Solve graphically and determine the static forces acting in different links and couple T_2 shown in Fig. 1(c). AB = 300 mm, BC = 600 mm, BD = 200 mm. 15

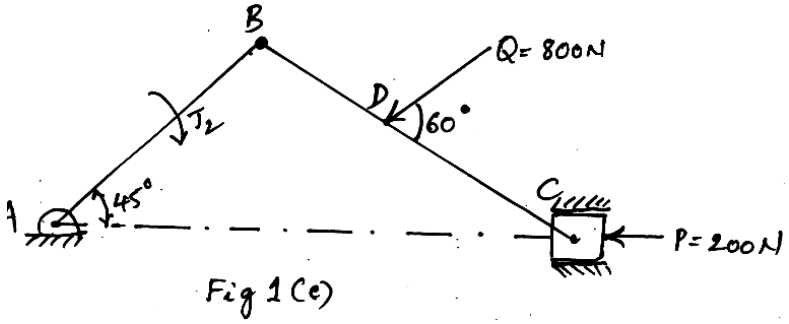

Fig 1 (c)

2 a. Draw vector diagram of forces for the member shown in Fig. 2(a) and determine the resultant of forces 3

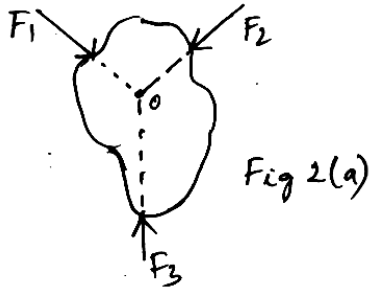

Fig 2(a)

b. In a four bar mechanism shown in Fig. 2(b), Find the required input torque on the crank. 17

AD = 800 mm AB = 300 mm BC = 700 mm CD = 400 mm T_3 = 3000 Nm T_4 = 2000 Nm

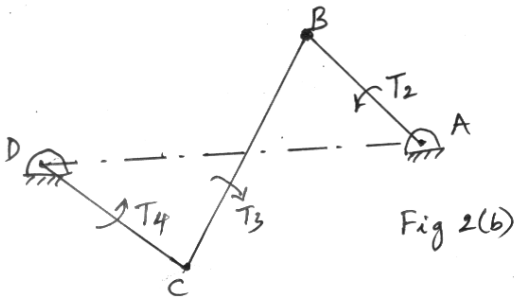

Fig 2(b)

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UNIT - II

3 a. Explain the D'Alembert's principle. 4

b. Explain Dynamically equivalent system with neat sketch. 6

c. A connecting rod has a mass of 1.2 kg and the length between centres is 250 mm. The distance of C.G from the small end centre (Gudgeon pin) is 170 mm and the radius of gyration about an axis through C.G is 108 mm. find the equivalent dynamic system if one of the masses coincide in position with small end centre. 10

4. The following data relate to a horizontal reciprocating engine:

Mass of reciprocating parts = 120 kg

Crank length = 90 mm

Engine speed = 600 rpm

Connecting rod mass = 90 kg

Length between centres = 450 mm

Distance of centre of mass = 180 mm

From big end centre radius of gyration about an axis through centre of mass = 150

Find the magnitude and the direction of the inertia torque on the crankshaft when the crank has turned 30º from inner dead centre. 20

UNIT - III

5 a. Explain TMD. Write a neat sketch of TMD for single cylinder double acting steam engine. 4

b. A printing press is driven by a constant torque electric motor. The press is provided with a fly wheel that rotates at a maximum speed of 225 rpm. The radius of gyration of the flywheel is 0.5 m. The press punches 720 holes per hour, each punching operation takes 2 seconds and requires 15 kN-m energy. Find the power of the motor and the minimum mass of flywheel if speed of the same is not to fall below 200 rpm. 16

6. a. Neglecting the effect of arms, show that the minimum mass 'M' of flywheel required may be expressed in the form $M = \frac{(K_e)(\rho)(E)}{(K_s)\, f}$

Where, K_e and K_s are coefficients of fluctuation of energy and speed 4

ρ = density of rim material

f = hoop stress

E = Avg WD/cycle

b. A vertical double acting steam engine develops 73.6 kW at 250 rpm. The maximum fluctuation of energy is 30% of WD/stroke. The maximum and minimum speeds are not to vary more than 1% on either side of mean speed. Find the mass of flywheel required, if the radius of gyration is 0.6 m. 16

Contd…3

UNIT - IV

7. A shaft is supported in bearings 1.8 m apart and projects 0.45 m beyond bearings at each end. The shaft carries three pulleys one at each end and one at middle of its length. The mass of end pulleys are 48 kg and 20 kg and their centre of gravity are 15 mm and 12.5 mm respectively from the shaft axis, the centre pulley has the mass of 56 kg and its centre of gravity is 15 mm from shaft axis. If the pulleys are so arranged as to give static balance, determine; 20
   i) The relative angular positions of the pulleys
   ii) Dynamic forces produced on the bearings when the shaft rotates at 300 rpm.
8. The firing order in a six cylinder four stroke inline engine is 1 – 4 – 2 – 6 – 3 – 5. The piston stroke is 100 mm and length of each connecting rod is 200 mm. the pitch distance between 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 engine runs at 300 rpm. Determine the output of primary and secondary forces and couples on the engine, taking a plane midway between the cylinders 3 and 4 as reference plane. 20

UNIT - V

9 a. Explain the working principle of a simple centrifugal governor with a neat sketch. 4

b. The motor of a marine having a mass of 1000 kg and radius of gyration 300 mm rotates at 1550 rpm clockwise when looking from the bow. Determine the gyroscopic couple and its effect on the ship in the following cases:
   i) When the ship pitches with an angular velocity of 1 rad/s when the bow ia) Rise ib) Fall.
   ii) When the ship is speeding at 40 km/hr and takes right turn in a circular path of 200 m radius. 16
   iii) When the ship rolls at certain instant, it has an angular velocity of 0.5 rad/sec when viewed from the stress.

10. A four wheel motor car weighing 15 kN has its CG 0.5m above ground level. The rotating parts of the engine and transmission have their axes coincident with the longitudinal axis of the car and are equivalent to a flywheel of mass 80 kg with radius of gyration 150 mm. These parts rotate in anticlockwise direction when viewed from the rear of the car. The car negotiates a curve of 60 m radius at 72 km/hr with the gear lever in such a position that there is no reduction in the speed in gear box. The gear ratio of engine to back axle is 4: 1. Road wheel radius is 300 mm. Allowing for centrifugal and gyroscopic action, determine the reaction at the wheels, when the car takes a right turn. The distance between the wheel on the same axle is 1.5 m and the wheel base is 3 m 20

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