B.E. / B.Tech. Mechanical Engineering (Model Curriculum) Semester-VI

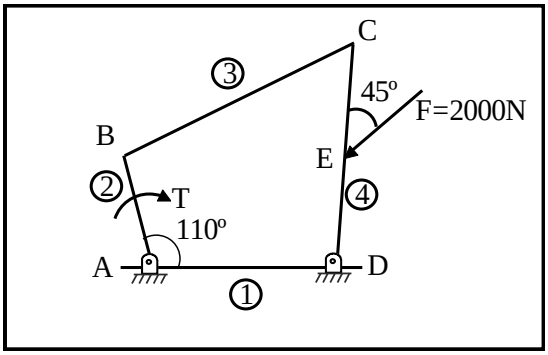
PCC-ME308 / DYNOFMA1 - Dynamics of Machines

P. Pages : 3 **GUG/S/25/14076**

Time : Three Hours * 2 3 9 3 * Max. Marks : 80

Notes : 1. All questions carry equal marks.
2. Due credit will be given to neatness and adequate dimensions.
3. Assume suitable data wherever necessary.
4. Diagrams and Chemical equation should be given wherever necessary.
5. Illustrate your answers wherever necessary with the help of neat sketches.
6. Solve : Q1 or Q2, Q3 or Q4, Q5 or Q6, Q7 or Q8, Q9 or Q10

1. A four bar chain mechanism ABCD is shown in fig. below. Calculate the value of torque required (T) and all the constraint forces in links for the static equilibrium of the mechanism, if F = 2000 N in the direction shown . The dimensions of linkages are given as : AB = 200 mm, BC = 370, CD = 250 mm, AD = 215 mm, CE = 100 mm. **16**



OR

2. a) What is equivalent dynamical system and what are its requirements? **4**

b) The crank and connecting rod of a vertical petrol engine, running at 1800 rpm are 60mm and 270 mm respectively. The diameter of piston is 100 mm and mass of reciprocating parts is 1.2 kg during the expansion stroke when the crank angle has turned 20 degree from the TDC, the gas pressure is 650 kN/m^2. Determine : **12**

1) Net force on the piston
2) Net load on the gudgeon pin
3) Thrust on the cylinder walls
4) The speed at which gudgeon pin load is reversed in direction.

3. a) Turning moment diagram for 4-stroke IC engine with neat sketch. **4**

b) Derive an expression for the Moment of inertia of Flywheel. **4**

c) The flywheel of the engine has a mass 2800 kg and radius of gyration 1.2m. The starting torque of an engine is 1600N-m and remains constant. **8**
Determine:

i) The angular acceleration of the flywheel, and
ii) The kinetic energy of the flywheel after 12 seconds from the start.

OR

4. a) Explain the following terms related to governors. **4**
i) Stability
ii) Sensitiveness

b) The turbine rotor of a ship rotates at 3000 r.p.m. clockwise when looking from the stern. The mass of turbine rotor is 4000 kg and has a radius of gyration 50 cm. Determine the gyroscopic couple and its effect upon the ship if: **12**

i) Ship steers to the left in a curve of 125m radius at a speed of 40 km/hr.
ii) Ship pitches in simple harmonic motion & how falling with its maximum velocity. The period of pitching is 44 second and the total angular displacement between two extreme positions of pitching is 12º.

5. a) Explain the term 'whirling speed' of the shaft. Prove that the whirling speed for a rotating shaft is the same as a frequency of natural transverse vibration. **8**

b) A shaft of 30 mm diameter and 1m long carries a mass of 1.5 kg at a distance 0.4m from its left and density of shaft material is 40 mg/m^3 and young's modulus is 200 GN/m^3. Determine the whirling speed of shaft taking into account its mass. Assume the shaft to be freely supported. **8**

OR

6. a) A shaft of 20mm diameter and 60cm long carries a mass of 1kg at its midpoint and is freely supported at both ends. Calculate the whirling speed of the shaft if the density of shaft material is 408*10^3 kg/m3 and Young's modulus is 200 GN/m^2. **6**

b) A shaft 1.5 m long supported in flexible bearings at the ends carries two wheels each of 50 kg mass. One wheel is situated at the centre of the shaft and the other at a distance of 375 mm from the centre towards left. The shaft is hollow of external diameter 75 mm and internal diameter 40 mm. The density of the shaft material is 7.700 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**

7. a) What do you mean by single node frequency and two node frequency as referred to torsional vibrations of a three rotor system? Drive the expression for its frequencies and state the conditions under which single node frequency and two node frequencies are obtained. **8**

b) A steel shaft 2m long is 90 mm in diameter for the first 0.8 m of its length, 70 mm in diameter for the next 0.7 m of the length and 50 mm in diameter for the remaining 0.5 m of its length. The shaft carries two flywheels at two ends, the first having a mass of 1000 kg and 0.9 m radius of gyration located at 90 mm diameter end and second having a mass of 800 kg and 0.5 m radius of gyration located at the other end. Determine the natural frequency of free torsional vibration of the system and the location of the node. The modulus of rigidity of shaft material is 80GN/m^2. **8**

OR

8. a) Derive an expression for the frequency of free torsional vibrations for a shaft fixed at one end and carrying load on the free end. **8**

b) The mass of a single degree damped vibrating system is 7.5 kg and makes 24 free oscillations in 14 seconds when disturbed from its equilibrium position. The amplitude of vibration reduces to 0.25 of its initial value after five oscillations. Determine : 1. stiffness of the spring, 2. logarithmic decrement, and 3. damping factor, i.e. the ratio of the system damping to critical damping. **8**

9. A shaft carries four masses in parallel planes, A, B, C and D in this order along its length. The masses at B and C are 18 kg and 12.5 kg respectively, and each has an eccentricity of 60 mm. The masses at A and D have an eccentricity of 80 mm. The angle between the masses at B and C is 100º and that between the masses at B and A is 190º, both being measured in the same direction. The axial distance between the planes A and B is 100 mm and that between B and C is 200 mm. If the shaft is in complete dynamic balance, determine: **16**

1) The magnitude of the masses at A and D
2) The distance between planes A and D and
3) The angular position of the mass at D.

OR

10. The cranks and connecting rods of a 4-cylinder in-line engine running at 1800 r.p.m. are 60 mm and 240 mm each respectively and the cylinders are spaced 150 mm apart. If the cylinders are numbered 1 to 4 in sequence from one end, the cranks appear at intervals of 90º in an end view in the order 1-4-2-3. The reciprocating mass corresponding to each cylinder is 1.5 kg. **16**

Determine :

1) Unbalanced primary and secondary forces, if any, and
2) Unbalanced primary and secondary couples with reference to central plane of the engine.

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