B.E. Mechanical Engineering (Model Curriculum) Sem-VI

PCCME308 : Dynamics of Machines

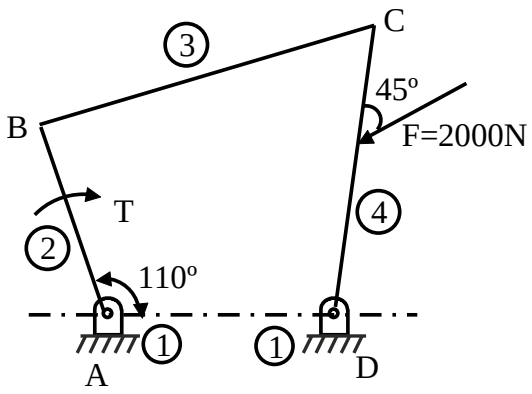
P. Pages : 3 **GUG/W/22/14076**

Time : Three Hours * 3 3 0 5 * 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. Use of slide rule, Drawing instruments is permitted. Non programmable calculator.
5. Solve Q. 1 or Q. 2 / Q. 3 or Q. 4 / Q. 5 or Q. 6 / Q. 7 or Q. 8 / Q. 9 or Q. 10.
6. Illustrate your answers wherever necessary with the help of neat sketches.

1. a) Explain Euler's equation of motion. **4**

b) 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. **12**



OR

2. a) What are various Dynamic stresses in machine elements? Explain in short D′ Alembert principle. **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) Explain turning moment diagram for 4-stroke IC engine with neat sketch. **4**

b) In a single acting four-stroke engine, the work done by the gases during the expansion stroke is three times the work done during the compression stroke. The work done during the suction and exhaust strokes is negligible. The engine develops 14 KW at 280 rpm. The fluctuation of speed is limited to 1.5% of the mean speed on either side. The turning moment diagram during the compression and the expansion strokes may be assumed to be triangular in shape. Determine the inertia of the flywheel. **12**

OR

4. a) Write a short note on **4**
i) Stability & sensitiveness ii) Hunting and Isochronism.

b) Discuss the effect of reactive gyroscopic effect on air craft. **4**

c) 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: **8**
i) Ship steers to the left in a curve of 125m radius at a speed of 40km/hr.
ii) Ship pitches in simple harmonic motion & how falling with its maximum velocity. The period of pitching is 44 seconds and the total angular displacement between two extreme positions of pitching is 120.

5. a) A steel bar 22 mm wide and 45 mm deep is freely supported at two points 800 mm apart and carries a load of 180 kg midway between them. Determine the natural frequency of transverse vibration neglecting the weight of the bar. **8**
Also find the frequency of vibration, if an additional load of 180 kg is distributed uniformly along the length of the shaft. Take $E = 250\ GN/m^2$

b) 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**

OR

6. a) Derive an expression for the natural frequency of free transverse vibrations for a beam fixed at both ends and carrying a uniformly distributed mass of m kg per unit length. **8**

b) A shaft of 30 mm diameter and 1m long carries a mass of 1.5 kg at a distance 0.4 m 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**

7. a) Describe the method of finding the natural frequency of Torsional vibrations for a three rotor system. **6**

b) Determine the natural frequency of 'Torsional vibration' of a shaft with two circular disks of uniform thickness at its ends. The masses of the discs are m1=500 kg and m2=1000 kg and their outer diameter are 1250 mm and 1900 mm respectively. The length of the shaft is 3m and its diameter is 100mm. Modulus of rigidity for shaft material is $G = 0.83 \times 10^{11} N/m^2$. Also determine in what proportion the natural frequency of the shaft gets changed if along half the length of the shaft the diameter is increased from 100mm to 200mm. **10**

OR

8. a) 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 $80\,GN/m^2$. **8**

b) 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 it's frequencies and state the conditions under which single node frequency and two node frequency are obtained. **8**

9. a) A rotating shaft carries four unbalanced masses 18 kg, 14 kg, 16 kg and 12 kg at radii 50 mm, 60 mm, 70 mm and 60 mm respectively. The 2nd, 3rd and 4th masses revolve in planes 80 mm, 160 mm and 280 mm respectively measured from the plane of the first mass and are angularly located at 60º, 135º, and 270º respectively measured clockwise from the first mass looking from the end of shaft. The shaft is dynamically balanced by the masses, both located at 50 mm radii and revolving in planes mid way between those of 1st and 2nd masses and mid way between those of 3rd and 4th masses. Determine graphically or otherwise, magnitude of the balancing masses and their respective angular positions. **16**

OR

10. The following particulars relate to a two-cylinder locomotive with two coupled wheels on each side: **16**

Stroke = 620 mm; Mass of reciprocating parts per cylinder = 250 kg, Mass of revolving Parts per cylinder = 180 kg, Mass of each coupling rod = 220 kg, Radius of centre of coupling rod pin = 225 mm, Distance between cylinder = 0.6 m, Distance between wheels = 1.6 m, Distance between coupling rods = 2m.

The main cranks of the locomotive are at right angles and the coupling rod pins are at 180º to their respective main cranks. The balance masses are to be placed in the wheels at a mean radius of 680 mm in order to balance whole of the revolving and $3/4^{th}$ of the reciprocating masses. The balance mass for the reciprocating masses are to be divided equally between the driving wheels and the coupled wheels.

Find:

i) The magnetic and angular positions of the masses required for the driving and trailing wheels, and

ii) The hammer blow at 120 km/hr if the wheels are 2 m diameter.

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