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

PCCME308 - Dynamics of Machines

P. Pages : 3 **GUG/W/23/14076**

Time : Three Hours * 7 6 6 3 * Max. Marks : 80

Notes : 1. All questions carry equal marks.
2. Due credit will be given to neatness and adequate dimensions.
3. Illustrate your answers wherever necessary with the help of neat sketches.
4. 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.
5. Assume suitable data wherever necessary.

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

b) The crank and connecting rod of a vertical petrol engine, running at 1800 rpm are 60 mm 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**

i) Net force on the piston
ii) Net load on the gudgeon pin
iii) Thrust on the cylinder walls.
iv) The speed at which gudgeon pin load is reversed in direction.

OR

2. a) State and explain D-Alembert's principle. **4**

b) A horizontal steam engine running at 210 r.p.m has a bore diameter of 190 mm and stroke 350 mm. The piston rod is 20 mm in diameter and connecting rod length is 950 mm. Mass of reciprocating part is 8 kg and frictional resistance is equivalent to a force of 350 N. Determine the following when crank is at 115 degree from IDC. The mean pressure being $4500\,N/m^2$ on cover side and $100\,N/m^2$ on crank side : **12**

i) Thrust on connecting rod
ii) Thrust on the cylinder walls
iii) Load on the bearings
iv) Turning moment on crankshaft

3. A turbine rotor of a ship has a mass of 1000 kg and a radius of gyration 700 mm. It rotates at 2000 r.p.m. clockwise when looking from stern. Determine the gyroscopic couple and its effect when : **16**

i) The ship is travelling at 50 km/hr and steers to the left in a curve of 120 m radius.
ii) The ship is pitching and the bow is descending with maximum velocity. The pitching is simple harmonic, the time period being 30 seconds and the total angular movement between the extreme positions is 12º.

OR

4. a) Write a short note : **8**

i) Turning moment diameter for 4-stroke IC engine with neat sketch.

ii) Hunting and Isochronism.

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

c) Define and explain the following terms relating to governors. **4**

i) Stability ii) Sensitiveness

5. a) Explain the following term **8**

i) Logarithmic decrement ii) Transmissibility

iii) Critical speed for rotor iv) Vibration asorber

b) 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**

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) Determine the frequency of longitudinal and transverse vibrations of a cantilever shaft of 60 mm diameter and 350 mm long carrying a disc of mass 120 kg at its free end. The young's modulus for the shaft material is $200\,\mathrm{GN/m^2}$. **8**

7. a) What is meant by torsionally equivalent length of a shaft as referred to a stepped shaft. Derive an expression for the equivalent length of a shaft which has several steps. **8**

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 3 m and its diameter is 100 mm. Modulus of rigidity for shaft materials is $G = 0.83 \times 10^{11}\,\mathrm{N/m^2}$. 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 100 mm to 200 mm. **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) A steel shaft 2 m long is 90 mm in diameter for the first 0.8 m of its length, 70 mm in diameter for the next 0.7m 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 shat material is $80\ \mathrm{GN/m^2}$. **8**

9. The following data apply to an outside cylinder uncoupled locomotive: **16**

i) Mass of rotating parts per cylinder = 360 kg
ii) Mass of reciprocating parts per cylinder = 300 kg
iii) Angle between the cranks = 90^o
iv) Crank radius = 0.3 m
v) Cylinder centers = 1.75 m
vi) Radius of balance masses = 0.75 m
vii) Wheel centres = 1.45 m.

If the whole of the rotating and $2/3^{rd}$ of reciprocating parts are to be balanced in planes of the driving wheels, find :

i) Magnitude and angular positions of balance masses.
ii) Speed in km/h at which the wheel will lift off the rails when the load on each driving wheel is 30 kN and the diameter of tread of driving wheels is 1.8 m. Also determine the swaying couple at this speed.

OR

10. a) Explain the terms 'static balancing' and 'dynamic balancing' state the necessary conditions to achieve them. **4**

b) A shaft carries five masses A, B, C, D and E which revolve at the same radius in planes which are equidistant from one another. The magnitude of the masses in planes A, C and D are 50 kg, 40 kg, and 80 kg respectively. The angle between A and C is 90^o and that between C and D is 135^o. Determine the magnitude of the masses in planes B and E and their positions to put the shaft in complete rotating balance. **12**

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