B.E. (Mechanical Engineering / Power Engineering) Sixth Semester (C.B.S.)

Dynamics of Machines

P. Pages : 4 **NIR/KW/18/3483/3509**

Time : Three Hours * 1 2 9 3 * Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Illustrate your answers whenever necessary with the help of neat sketches.
11. Use of non programmable calculator is permitted.

1. a) Define gyroscopic couple with example. **3**

b) A ship has a rotor of mass 3 tones rotating at 2500 rpm and its radius of gyration is 300 mm. If the rotation of the rotor is c/w looking from stern. Calculate the gyroscopic couple that is set on the ship by rotor when (a) the ship takes a left hand turn with a radius of 400 m at a speed of 50 km/hr. (b) pitching of the bow at an angular velocity of 2 rad/sec (c) ship rolls due to wave with a velocity of 0.1 rad/sec. **10**

OR

2. a) Define D'Alembert principle. **3**

b) A four – wheel trolley car of mass 2500 kg runs on rails, which are 1.5 m apart and travels around a curve of 30m radius at 24 km/hr. The rails are at the same level. Each wheel of the trolley is 0.75m in diameter and each of the two axles is driven by a motor running in a direction opposite to that of the wheels at speed of five times the speed of rotation of the wheels. The moment of inertia of each axle with gear and the wheels is $18\,kg-m^2$. Each motor with shaft and gear pinion has a moment of inertia of $12\,kg-m^2$. The centre of gravity of car is 0.9 m above the rail level. Determine the vertical force exerted by each wheel on the rails taking into consideration the centrifugal and gyroscopic effect state the centrifugal and gyroscopic effects on the trolley. **10**

3. For the figure 3 determine the drive torque required to be applied on crank O_2A to overcome an inertia effect of link AB having mass 4.2 kg, the centre of gravity at 330 mm from 'A' and a mass moment of inertia $0.152\,kg-m^2$. **14**

$O_2A = 500mm,\ O_4B = 560mm,\ O_2O_4 = 1000\,mm, AB = 660\,mm, W_2 = 10.5\,rad/s\,(c.c.w),$

$\alpha_2 = 26\,rad/s^2\,(c.w)$

Acceleration of G_3 as shown in figure 3 and angular acceleration $\alpha_3 = 34.1 \text{rad/s}^2 (\text{ccw})$.

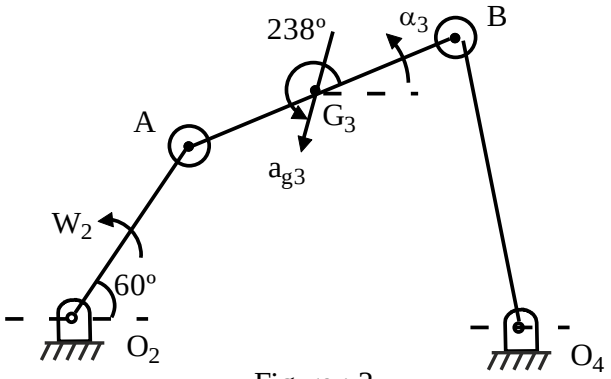


Figure : 3

OR

4. a) State and explain the conditions of static equilibrium for : **4**
i) Two force member.
ii) Three force member.

b) A cam mechanism has following particulars cam speed is 1100 rpm follower Stroke is 45 mm, cam angles for outstroke and return stroke are 145° and 85° respectively. Follower motion is with uniform acceleration and retardation during outstroke and with SHM during return stroke. Mass of the follower is 2.1 kg. Find out the necessary spring stiffness so as to ensure the contact of the follower and cam throughout the cycle. Assume no preload on the spring. **10**

5. a) Discuss the static and dynamic balancing in machines. **3**

b) A, B, C & D are four masses carried by a rotating shaft of radii X mm, 160mm, 160mm and 180mm respectively. The planes in which the masses rotate are spaced at 425 mm apart and magnitude of masses A, B, C, D are 8 kg, 10 kg, 6 kg and 2.5 kg respectively. Make the system in complete dynamic balance condition by adjusting radius 'X'mm and find (A) magnitude of radius X in mm (B) Relative angular position of masses A, B, C and D. **10**

OR

6. a) Discuss balancing of V – Engines. **3**

b) An inside cylinder locomotive has its cylinder centre lines 0.7 m apart and has a stroke of 0.6 m. The rotating masses per cylinder are equivalent to 150 kg at the Crank pin, and the reciprocating masses per cylinder to 180 kg. The wheel centre lines are 1.5 m apart. The cranks are at right angles. The whole of the rotating and 2/3 of the reciprocating masses are to be balanced by masses placed at a radius of 0.6 m. Find the magnitude and direction of the balancing masses. Find the fluctuation in rail pressure under one wheel, variation of tractive effort and the magnitude of swaying couple at a crank speed of 300 rpm. **10**

7. a) Derive equation for energy stored in flywheel. **3**

b) The turning moment diagram of a four stroke engine may be assumed for the sake of simplicity to be represented by four triangles in each stroke. Areas of these triangles are as follows : Suction stroke $=5\times10^{-5}m^2$, Compression stroke $=21\times10^{-5}m^2$, Expansion stroke $=85\times10^{-5}m^2$, Exhaust stroke $=8\times10^{-5}m^2$. All the areas excepting expansion are negative. Each m^2 area represents 14 MN – m of work. Assuming resisting torque to be constant, determine moment of inertia of the flywheel to keep the speed between 98 rpm and 102 rpm. **10**

OR

8. a) What is function of governor? How it's different from flywheel?

b) A Proell governor has equal arms of length 300 mm. The upper and lower ends of the arms are pivoted on the axis of the governor. The extension arms of the lower links are each 80mm long and parallel to the axis when the radii of rotation of the balls are 150 mm and 200 mm. The mass of each ball is 10 kg and the mass of central load is 100 kg. Determine the range of speed of the governor.

9. a) Explain in brief : **6**

i) Transmissibility

ii) Logarithmic decrement.

iii) Critical speed of shaft.

b) A rotor of mass 12kg is mounted in the middle of a 25mm diameter shaft supported between two bearings placed at 900 mm from each other. The rotor is having 0.02 mm eccentricity. If the system rotates at 3000 rpm. Determine the amplitude of the steady state vibration and the dynamic force on the bearing E = 200 GPa. **7**

OR

10. a) The measurements on a mechanical vibrating system show that it has a mass of 8 kg and that the springs can be combined to give an equivalent spring of stiffness 5.4 N/mm. If the vibrating system have a dashpot attached which exerts a force of 40 N when the mass has velocity of 1 m/s. Find (i) critical damping coefficient (ii) damping factor (iii) logarithmic decrement (iv) ratio of two consecutive amplitude. **8**

b) Determine natural frequency of the spring mass pulley system shown in figure 10 (b). **5**

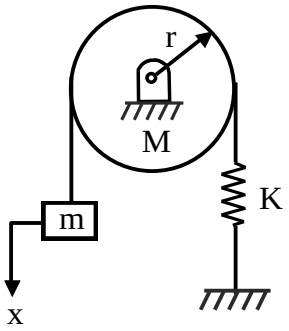
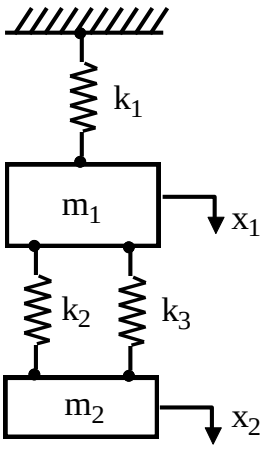


Figure 10 (b)

11. Determine the natural frequencies of torsional oscillation for the following system. The system is a reciprocating I.C. Engine coupled to a centrifugal pump through a pair of gears. The shaft from the flywheel of the engine to the gear wheel is of 60 mm diameter and 950 mm length. The shaft from the pinion to the pump is 40 mm diameter and 300 mm length. The engine speed is $\frac{1}{4}$th of the speed pump. Moment of inertia of flywheel is $= 800\,\text{kg}-\text{m}^2$. Moment of inertia of gear wheel is $15\,\text{kg}-\text{m}^2$. Moment of inertia of pinion is $4\,\text{kg}-\text{m}^2$. moment of inertia of the pump is $17\,\text{kg}-\text{m}^2$. $G = 84\,\text{GN/m}^2$. **14**

OR

12. Figure 12 shows two degrees of freedom system. Determine natural frequencies. Where, **14**



$m_1 = 3000\,\text{kg}$ $\quad m_2 = 700\,\text{kg}$

$K_1 = 8\times10^6\,\text{N/m}$ $\quad K_2 = K_3 = 13\times10^6\,\text{N/m}$

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