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

Dynamics of Machines

P. Pages : 3 **NRJ/KW/17/4538/4564**

Time : Three Hours * 0 1 4 1 * 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) State and explain D'Alembert principle. **3**

b) A uniform disc of 20cm diameter and mass 20kg is mounted on the shaft that rotates in two bearings with bearing span of 2.5m. The disc is mounted at 1m. from left hand bearing and the shaft is maintained in horizontal plane. The bearings are bolted to a horizontal platform which itself rotates in horizontal plane. **10**

The disc rotates at 2000 rpm in counterclockwise sense when viewed from left hand side bearing and the platform rotates in counterclockwise sense when viewed from the top.

At what limiting speed the platform carrying the shaft can be rotated so that the maximum bearing reaction do not exceed 1500N.

Consider both weight of disc and gyroscopic effect. Neglect other effect.

OR

2. a) A rear engine automobile is travelling along a track of 100m mean radius. Each of the four wheels has moment of inertia of 2.5kg-m^2 and an effective diameter of 0.6m. The rotating parts of engine have moment of inertia of 1.2kg - m^2. The engine axis is parallel to the rear axle and the crankshaft rotates in the same sense as the road wheels. The ratio of engine speed to back axle speed is 3:1. The automobile has a mass of 1600kg and has its C.G. 0.5m above the road level. The width of the track of the vehicle is 1.5m. **10**

Determine the limiting speed of the vehicle around the curve for all four wheels to Maintain contact with road surface.

b) What will happen if there is no gyroscope in an aeroplane. **3**

3. Following data relate to a horizontal reciprocating engine: **13**

Mass of reciprocating parts = 120kg.
Crank length = 90mm ; Engine speed = 600rpm.
Connecting rod Mass = 90kg. Length between Centres = 450mm.
Distance of Centre of mass from big end Centre = 180mm.
Radius of gyration about an axis through Centre of mass = 150mm.
Find the magnitude and the direction of the inertia torque on the crankshaft when the crank has turned 30º from the inner-dead Centre.

OR

4. A plate cam drives a reciprocating follower through a distance of 40mm with parabolic motion in 120º of cam rotation and return with the parabolic motion in 180º. The dwell between rise & return is 30º and the motion is with equal accl^{n} & retardation. The load on the cam is 50N and the mass of follower is 2.5kg. The Shffners of spring is 4kN/m. Determine the speed at which the follower begins to lift from the cam surface. **13**

Draw the approximate acceleration and force diagram showing the angular position of cam where the lift begins.

5. A, B, C, and D, are 4 masses carried by a rotating shaft at radii x, 160mm, 130mm, and 180mm respectively. The planes in which the masses rotate are spaced 425mm apart and the magnitude of masses A, B, C, & D are 8kg, 10kg, 6kg, and 2.5kg respectively. Make the system in complete dynamic balance condition by adjusting radius x, and find **13**

i) Magnitude of radius x in mm.
ii) Relative angular position of masses A, B, C and D.

OR

6. The following data refers to a two cylinder locomotive with crank at 90º. **13**
Reciprocating mass per cylinder = 400kg.
Crank radius = 350mm; Driving wheel diameter = 2.1m
distance between cylinder center lines = 600mm.
Distance between driving wheel central planes = 1.5m
Determine

i) The fraction of reciprocating masses to be balanced if the hammer blow is not to exceed 50kN at 120km/hr.
ii) Variation in tractive effort.
iii) Swaying couple.

7. A three cylinder single acting engine has its cranks set equally at 120º and it runs at 600rpm. The torque-crank angle diagram for each cycle is a triangle for the power stroke with a maximum torque of 90N-m at 60º from dead Centre of corresponding crank. The torque on return stroke is sensibly zero. Determine. **13**

i) Power developed
ii) Coefficient of fluctuation of speed, if the mass of flywheel is 12kg and has a radius of gyration of 80mm.
iii) Coefficient of fluctuation of energy, and
iv) Maximum angular acceleration of the flywheel.

OR

8. The following particulars refer to a Proell governor with open arms: **13**
Length of all arms = 200mm, distance of pivot of arms from the axis of rotation = 40mm, length of extension of lower arms to which the ball is attached = 100mm, mass of each ball = 6 kg and mass of central load = 150kg. If the radius of rotation of the balls is 180mm when the arms are inclined at 40º to the axis of rotation, find

i) The equilibrium speed for the above configuration.
ii) The coefficient of insensitiveness if the friction of the governor mechanism is equivalent to a force of 20N at the sleeve. and
iii) Range of speed between which the governor is inoperative.

9. a) Explain in brief **any two.** **9**

i) Magnification factor. ii) Critical speed of shaft.
iii) Transmissibility

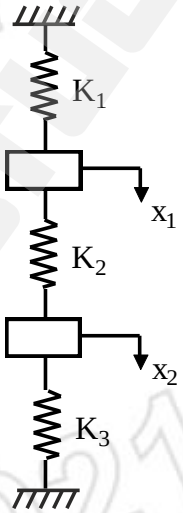
b) A mass of 1kg is to be supported on a spring having constant of K = 9800N/m. The damping coefficient is 4.9 Ns/m. Determine the damped natural frequency of the system. Find also the logarithmic decrement and amplitude of vibration after 8^{th} cycle if the initial displacement is 0.4cm. **5**

OR

10. a) Determine the total stiffness of the spring for mounting a bench grinder of mass 50kg and rated speed 2500 rpm so that the transmissibility is equal to or less than 0.2. If the unbalance in the rotor is estimated to be 0.1kg-cm. What will be the dynamic amplitude of the grinder and the force transmitted to the foundation. **8**

b) A shaft 1.5m long, supported in flexible bearings at the ends carries two wheels each of 50kg mass. One wheel is situated at the Centre of the shaft and the other at a distance of 375mm from the Centre towords left. The shaft is hollow of external diameter 75mm and internal diameter 40mm. The density of shaft material is 7700kg/m^3, and its modulus of elasticity is 200GN/m^2, find the lowest whirling speed of shaft, taking into account the mass of shaft. **6**

11. a) Derive expression for amplitude ratio and natural frequencies of two degree of freedom system shown in fig 11. **8**



b) Write short note on **any two.** **6**

i) Vibration absorber ii) Torsionally equivalent shaft
iii) FFT analyzer

OR

12. Three rotors A, B, and C having moment of inertia 2000; 6000; and 3500kg-m^2 respectively are carried on a uniform shaft of 0.35m diameter. The length of the shaft between the rotor A and B is 6m and between B and C is 32m. Find the natural frequency of the torsional vibrations. The modulus of rigidity for the shaft material is 80GN/m^2. **14**

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