B.E.(with Credits)-Regular-Semester 2012 - Mechanical Engineering Sem VI

ME605 - Dynamics of Machines

P. Pages : 3 **GUG/W/16/5394**

Time : Three Hours * 3 5 6 2 * Max. Marks : 80

Notes : 1. All questions carry marks as indicated.
2. Answer Q.1 or Q. 2, Q. 3 or Q.4, Q.5 or Q.6, or Q.7 or Q.8, Q.9 or Q10.
3. Due credit will be given to neatness and adequate dimensions.
4. Assume suitable data wherever necessary.
5. Illustrate your answers wherever necessary with the help of neat sketches.
6. Use of Non-programmable calculator is permitted.

1. a) Derive the expression for Gyroscopic couple? **3**

b) A pair of locomotive Wheels with axles have a moment of inertia of 500 kgm^2, the diameter of the wheel treads is 1.9 m and the distance between the wheel centres is 1.525 m. When the locomotive is travelling on a level track at 112 km/hr, defective ballasting causes the wheel to fall 9 mm and to rise again in a total time of 0.12 sec. If displacement of the wheel takes place with simple harmonic motion, find gyroscopic reaction on locomotive rails. **13**

OR

2. a) What are Euler's equation of motion. **3**

b) The rotor of the turbine of a ship has a mass of 2500 kg and rotates at a speed of 3200 rpm counter-clockwise when viewed from stern. The rotor has radius of gyration of 0.4 m Determine the gyroscopic couple and its effect when. **13**

i) The ship steers to the left in a curve of 80-m radius at a speed of 15 knots (1 knot = 1860 m/h)

ii) The ship pitches 5 degrees above and 5 degrees below the normal position and the bow is descending with its maximum velocity, the pitching motion is simple harmonic with a periodic time of 40 sec.

iii) The ship rolls and at the instance its angular velocity is 0.4 rad/s clockwise when viewed from stern.
Also find maximum angular acceleration during pitching.

3. a) Explain dynamically equivalent system and derive the expression for correction couple. **8**

b) For the static equilibrium of the mechanism of figure (a), find the torque to be applied on link AB. **8**

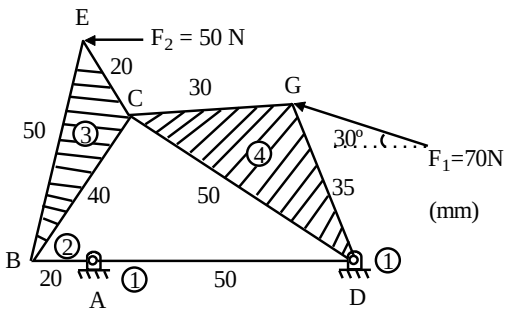

Fig. (a) 3

OR

4. a) Explain cam jump-off phenomenon. **3**

b) The following data relate to a horizontal reciprocating engine. **13**

Mass of reciprocating part = 120 kg
Crank length = 90 mm
Engine speed = 600 rpm
Connecting Rod:
Mass = 90 kg
length between centre = 450 mm
Distance of centre of mass
from big end centre = 180 mm
Radius of gyration about
an axis through centre of mass = 150 mm

Find the magnitude and the direction of the inertia torque on the crankshaft when the crank has turned 30º from the inner dead centre.

5. 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

6. A two cylinder uncoupled locomotive with cranks at 90º has a crank radius of 325 mm. The distance between centres of driving wheel is 1.5 m, the pitch of cylinders is 0.6 m the diameter of driving. wheels is 1.8 m . The radius of centre of gravity of balance masses is 0.65 m. The pressure due to dead load on each wheel is 40 KN. The masses of reciprocating and rotating parts per cylinder are 330 kg and 300 kg respectively. The speed of locomotive is 60 km|hr. **16**

Find:

i) The balancing masses both in magnitude and position required to be placed in the planes of driving wheels to balance whole of the revolving and two-third of the reciprocating masses.

ii) The swaying couple.

iii) The varication in tractive force.

iv) The maximum speed at which in is possible to run the locomotive in order that the wheels are not lifted from the rails.

7. a) The flywheel of a steam engine has a radius of gyration of 1 m and mass 2500 kg. The starting torque of the steam engine is 1500 N-m and may be assumed constant **8**
Determine:-

i) The angular acceleration of the flywheel

ii) The kinetic energy of the flywheel after 10 seconds from the start.

b) A punching press is required to punch 40 mm diameter holes in a plate of 15 mm thickness at the rate of 30 holes per minute. It requires 6 N-m of energy per mm^2 of shared area. If the punching takes 1/10 of a second and the r.p.m. of the flywheel varies from 160 to 140 determine. **8**

i) The power of the motor.

ii) The mass of the flywheel having radius of gyration of 1 meter.

OR

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

a) Stability b) Sensitiveness

c) Isochronism d) Hunting

b) In a Spring- loaded hartnell type of governor, the mass of each ball is 4 kg and the lift of the sleeve is 40 mm. The governor begins to float at 200 rpm when the radius of the ball path is 90 mm. The mean working speed of the governor is 16 times the range of speed when friction is neglected. The length of the ball and roller arms of the bell crank lever arc 100 mm and 80 mm respectively. The pivot centre and the axis of governor arc 115 mm apart. Determine the initial compression of the spring, taking into account the obliquity of arms. **12**

9. a) Define the following terms. **6**

i) Magnification factor. ii) Transmissibility.

iii) Whirling of shafts.

b) A uniform cylinder of mass 'm' is rotated through a small angle θ_o from the equilibrium position and released. Determine the equation of motion and hence obtain the frequency of free vibration. The cylinder rolls without slipping. **10**

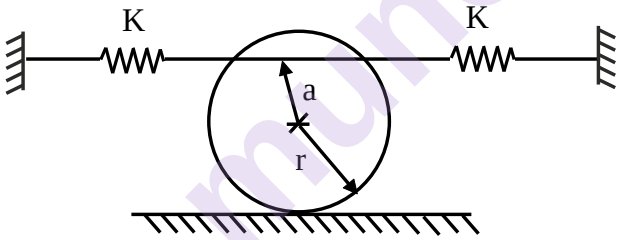

Fig. 9 (a)

OR

10. a) What do you mean by torsionally equivalent shaft? Write expression for torsionally equivalent shaft. **4**

b) A motor drives a centrifugal pump through gearing the pump speed being one third that of the motor. The shaft from the motor to the pinion is 60 mm diameter and 300 mm long. The moment of inertia of the motor is 400 kg m^2. The impellar shaft is 100 mm diameter and 600 mm long. The moment of inertia of the impellar is 1500 kg m^2. Neglecting inertia of the gears and the shaft, determine the frequency of torsional vibration of the system, the modulus of rigidity of the shaft material is 80 GN|m^2 **12**

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