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

Dynamics of Machines

P. Pages : 4 **NRT/KS/19/3483/3509**

Time : Three Hours * 0 6 1 6 * 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. Assume suitable data whenever necessary.
9. Illustrate your answers whenever necessary with the help of neat sketches.
10. Use of non programmable calculator is permitted.

1. a) Explain the effect of Gyroscopic couple on aeroplane. **4**

b) The mass of the turbine rotor of a ship is 10 tonnes and has a radius of gyration 0.8 m. It rotates at 1600 rpm clockwise when looking from stern. Determine the gyroscopic effect in **9**

i) If the ship travelling at 120 kmph steers to left in a curve of 80 m radius.

ii) If the ship is pitching and the bow is descending with the maximum velocity. The pitch is SHM, the periodic time is 20 seconds. The total angular movement between the extreme positions is 10^{o}.

iii) If the ship is rolling and at a certain instant has an angular velocity of 0.04 rad/sec clockwise when looking from stern.

iv) Also find maximum angular acceleration during pitching.

OR

2. a) State and explain D'Alembert principle. **3**

b) Each wheel of a four wheeled rear engine automobile has a moment of inertia $2.4\,kg\,m^2$ and an effective diameter of 660 mm. The rotating parts of the engine have a moment of inertia $1.2\,kg\,m^2$. The gear ratio of engine to the back wheel is 3 : 1. The engine axle is parallel to the rear axle and the Crankshaft rotates in the same sense as the road wheels. The mass of the vehicle is 2200 kg and the centre of mass is 550 mm above the road level. The track width of the vehicle is 1.5 m. Determine the limiting speed of the vehicle around a curve with 80 m radius so that all the four wheels maintain contact with the road surface. **10**

3. For the fig. 3 shown, 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**

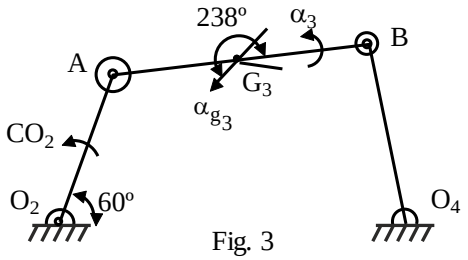


Fig. 3

$O_2A = 500\,mm;\ AB = 660\,mm;$

$O_4B = 560\,mm;\ O_2O_4 = 1000\,mm$

acceleration of G_3 as shown in fig. is $16\,m/s^2$ and angular acceleration $\alpha_3 = 34.1\,rad/s^2\,(ccw)$.

OR

4. A plate cam drives a reciprocating follower through a distance of 40 mm with simple harmonic motion in 120° cam rotation and return with the parabolic motion in 180°. The dwell between rise and return is 30° and the parabolic motion is with equal acceleration and retardation. The load on the cam is 50 N. and the mass of the follower is 2.5 kg. The stiffness of spring is 4 kN/m. Determine the speed at which the follower begins to lift from the cam surface. Also draw displacement, velocity, and acceleration diagram showing the angular position of cam where the lift begins. **14**

5. Four masses A, B, C and D as shown below are to be completely balanced. **13**

	A	B	C	D
Mass (kg)	--	30	50	40
Radius (mm)	180	240	120	150

The planes containing masses B and C are 300 mm apart. The angle between the planes containing B and C is 90°, B and C making angles of 210° and 120° respectively with D in the same sense. Find

i) The magnitude and angular position of mass A and

ii) The position of planes A and D.

OR

6. The following data refer to two cylinder locomotive with Cranks at 90° Reciprocating mass per cylinder = 300 kg **13**
Crank radius = 0.3 m
Driving wheel diameter = 1.8 m
Distance between cylinder centre lines = 0.65 m.
Distance between the driving wheel centre planes = 1.55 m. Determine

i) The fraction of the reciprocating masses tobe balanced, if the hammer blow is not to exceed 46 kN at 96.5 kmph

ii) The variation in tractive effort &

iii) The maximum swaying couple.

7. The turning moment curve for an engine is represented by the equation $T = (20,000 + 9500\sin 2\theta - 5700\cos 2\theta)\,N-m$ where θ is the angle moved by the Crank from inner dead centre. If the resisting torque is constant, find : **13**

i) Power developed by the engine.

ii) Moment of inertia of the flywheel in $kg-m^2$, if the total fluctuation of speed is not to exceed 1% of mean speed which is 180 rpm and

iii) Angular acceleration of the flywheel when the Crank has turned through 45° from inner dead centre.

OR

8. a) With the help of neat sketch explain the working of Hartnell Governor. **6**

b) A porter governor has all four arms 30 cm long. The upper arms are pivoted on the axis of rotation and the lower arms are attached to the sleeve at a distance of 3.5 cm from the axis. Mass of each ball is 7 kg and the mass of the sleeve is 50 kg. Determine the equilibrium speeds for the two extreme radii of 20 cm and 24 cm of rotation of the governor balls and the range of speed. **7**

9. a) Explain the following terms : **6**

i) Longitudinal vibration.

ii) Transverse vibration.

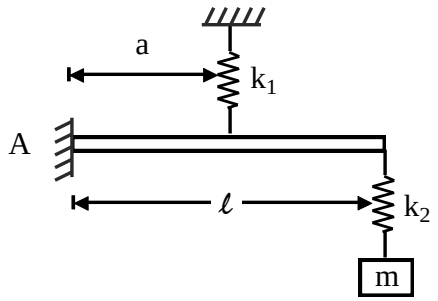
iii) Torsional vibration

b) A steel shaft, 10 cm diameter supported by bearings. 1.2 m apart carries 2 pulleys weighing 300 N and 800 N are placed 0.25 m and 0.65 m from left hand bearing respectively. Determine the critical speed of the shaft. Take $E = 2\times10^{11}\,N/m^2$. **7**

OR

10. a) A mass of 1 kg is tobe supported on a spring having constant of $K = 9800\,N/m$. The damping coefficient is $4.9\,N-s/m$. 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 0.4 cm. **6**

b) Determine the expression for natural frequency of the system shown in fig. 10 (b). **7**



11. a) Explain what is meant by torsionally equivalent shaft system. **4**

b) A centrifugal pump rotating at 400 rpm is driven by an electric motor at 1200 rpm through a single stage reduction gearing. The moments of inertia of the pump impeller and the motor are $1500\,kg-m^2$ and $450\,kg-m^2$ respectively and the lengths of the pump shaft and motor shaft are 500 mm and 200 mm and diameters are 100 mm and 50 mm respectively. Neglecting the inertia of the gears, find the frequency of torsional vibration of the system. Take $G = 85\,GN/m^2$. **10**

OR

12. a) Explain FFT analyser in short. **4**

b) There rotors A, B and C having moment of inertia $2000\,kg\,m^2$, $6000\,kg\,m^2$ and $3500\,kg-m^2$ respectively are carried on a uniform shaft of 0.35 m diameter. The length of the shaft between the rotor A and B is 6 m and between B and C is 32 m. Find the natural frequency of the torsional vibration. Take $G = 80\,GN/m^2$. **10**

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