B.E. Mechanical Engineering Sixth Semester

ME605 - Dynamics of Machines

P. Pages : 3 **GUG/W/18/1716**

Time : Three Hours * 1 3 5 0 * 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, Q. 7 OR Q. 8, Q. 9 OR Q. 10
3. Due credit will be given to neatness and adequate dimensions.
4. Assume suitable data wherever necessary.
5. Diagrams and Chemical equation should be given wherever necessary.
6. Illustrate your answers wherever necessary with the help of neat sketches.
7. Use of slide rule, Logarithmic tables, Steam tables, Mollier's chart, Drawing instruments, Thermodynamic tables for moist air, Psychrometric charts and Refrigeration charts is permitted.

1. a) Derive Euler Equation of motion. **6**

b) A rail car has a total mass 4 tonnes. There are two axles, each of which together with its wheels and gearing has total moment of inertia of 30kg-m^2. The centre distance between the two wheels on an axle is 1.5 meters and each wheel is 375 mm radius. Each axle is driven by a motor, the speed ratio between the two being 1:3. Each motor with its gear has a moment of inertia of 15kg-m^2 and runs in opposite direction to that of its axle. The centre of gravity of car is 1.05m above the rails. **10**

Determine the limiting speed of this car when it rounding a curve of 240 meters radius such that no wheel leaves the rails. Consider the centrifugal and gyroscopic effect completely. Assume no cant is provided to outer rail.

OR

2. a) Explain the effect of the gyroscopic couple on a two wheeled vehicle when taking a turn. **6**

b) A disc has a mass of 35kg and a radius of gyration about its axis of symmetry 120mm. While its radius of gyration about a diameter of the disc at right angle to the axis of symmetry is 75mm. The disc is pressed on the shaft but due incorrect boring, the angle between the axis of symmetry and the actual axis of rotation 0.25º, though both these axis pass through the centre of gravity of the disc. **10**

Assuming that the shaft is rigid and is carried between bearings 200 mm apart, determine the bearing forces due to the misalignment at a speed of 5000 rpm.

3. a) What is difference between static and dynamic force analysis? Under what circumstances this force analysis is justified. **6**

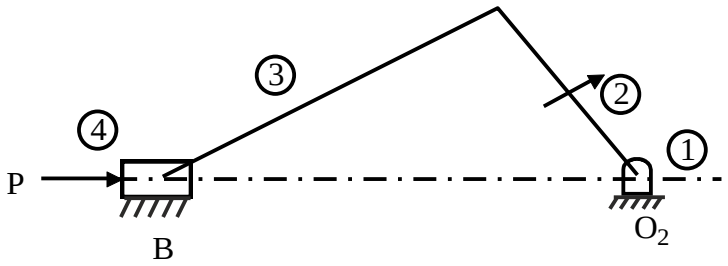
b) A cam-follower mechanism with flat face follower has the cam profile such that follower will rise by 40mm with parabolic motion in first 120º of rotation, dwell for 30º, then return with parabolic motion in the remaining cam angle. The follower spring stiffness is 5kN/m and the mechanism is assembled with 35N preload. **10**

The follower mass is 18kg and friction is negligible.

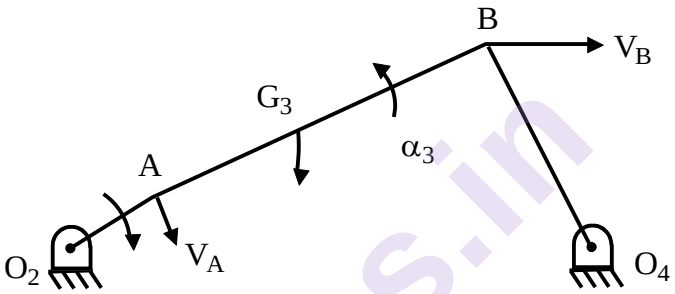
i) Sketch appropriate graphs of the displacement motion and acceleration Vs cam angle.
ii) On this graph show where jump off is likely to begin.
iii) At what cam speed would jump off begin.

OR

4. a) Draw Free body diagram for following reciprocating engine mechanism. **6**



b) Following are specification of a four bar, length of crank $O_2A = 15cm$. Coupler AB = 60cm follower $O_4B = 55cm$ and fixed link $O_2O_4 = 65cm$. Cross-section of the coupler is square with 3cm sides. Material weight density is $8 \times 10^{-2} N/CC$. Neglect weight of other links. Crank is rotating with uniform velocity of 600rpm clockwise. Find out torque to be supplied to input link to overcome inertia of coupler when crank is at 60º with O_2O_4 CCW . **10**



5. a) Write a short note on **any two.** **6**

i) Variation of tractive forces.
ii) Swaying Couple
iii) Hammer blow.

b) The crank and connecting rods of 4-cylinder inline engine running at 1800 rpm are 60mm and 240mm each respectively and cylinders are spaced 150mm apart. If cylinder are numbered 1 to 4 in sequence from one end. The cranks appears at intervals of 90º in an end veiw in the order ↥ – 4 – 2 – 3. The reciprocating mass corresponding to each cylinder is 1.2kg. **10**

Determine:

1) Unbalanced primary and secondary forces, if any and
2) Unbalanced primary and secondary couples with reference to central plane of the engine.

OR

6. Four revolving masses A, B, C and D as shown below are to be completely balanced. **16**

	A	B	C	D
Mass (kg)	-	35	60	30
Radius	160	240	120	150

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

1) The magnitude and angular position of mass A and
2) The position of planes A and D.

7. a) Explain turning moment diagram of 4-stroke I-C engine with neat sketch. **6**

b) A single cylinder, single acting, four stroke gas engine develop 20kw at 350 rpm. The workdone by the gases during the expansion stroke is three times the work done on the gases during compression stroke, the workdone during suction and exhaust stroke being negligible. If the total fluctuation of speed is not to exceed $\pm 2\%$ of the mean speed and the turning moment diagram during compression and expansion is assumed to be triangular in shape. Find the moment of inertia of the flywheel. **10**

OR

8. a) What is stability of governor? Sketch the controlling force versus radius diagram for a stable, unstable and isochronous governor. Derive the conditions for stability. **6**

b) A porter governor has equal arms each 250mm long and pivoted on the axis of rotation. Each ball has a mass 5kg and the mass of the central load on the sleeve is 25kg. The radius of rotation of the ball is 150mm when the governor begins to lift and 200mm when the governor is at maximum speed. Find the range of speed, sleeve lift, governor effort and power of the governor in the following casses **10**

1) When friction of sleeve neglected
2) When friction of sleeve is equivalent to 10N

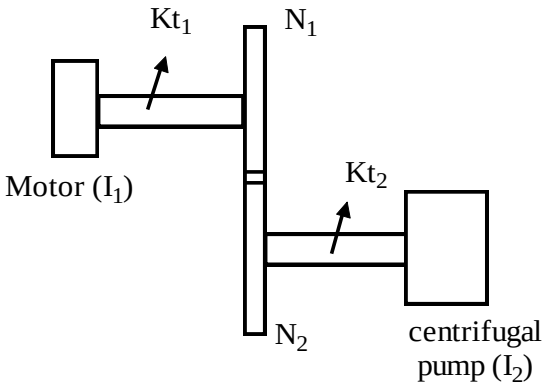
9. a) A shaft of 30mm diameter and 1m long carries a mass of 1.5kg at a distance 0.4m from its left and density of shaft material is $40mg/m^3$ and young's modulous is 200 GN/m^3 Determine the whirling speed of shaft taking into account its mass. Assume the shaft to be freely supported. **8**

b) Write a short note on **any two**. **8**

i) Logarithmic decrement.
ii) Forced vibration of single degree freedom
iii) Vibration isolation.

OR

10. A centrifugal pump rotating at 500rpm is driven by an electric motor at 1500rpm through a single stage reduction gearing. The moment of inertia of pump impels and motor are $1400kgm^2$ and $400kgm^2$ respectively. The lengths of the pump shaft and motor shaft are 500 and 250mm and their diameter are 100mm and 50mm respectively. Find the frequency of torsional vibration of the system. Take G = 84 GN/m^2. Neglect inertia of gears. **16**



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