Code No: R31033 **R10** **Set No: 1**

III B.Tech. I Semester Supplementary Examinations, May 2013

DYNAMICS OF MACHINERY

(Common to Mechanical Engineering & Auto Mobile Engineering)

Time: 3 Hours **Max Marks: 75**

Answer any FIVE Questions

All Questions carry equal marks

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1. A four wheeled trolley car of total mass 2000 kg running on rails of 1.6 m gauge, rounds a curve of 30 m radius at 54 km/h. the track is banked at 8°. The wheels have an external diameter of 0.7 m and each pair with axle has a mass of 200 kg. The radius of gyration of each pair is 0.3 m. the height of centre of gravity of the car above the rails is 1 m. Determine, allowing for centrifugal force and gyroscopic couple actions, the pressure on each rail.

2. (a) Explain the terms friction circle, friction couple and friction axis.
   (b) A load of 20 kN is supported by a conical pivot. The angle of cone is 1200 and intensity of pressure is not to exceed 3.5 bar. The external radius is 3 times the internal radius. Find the diameter of the bearing surface. If coefficient of friction is 0.06 and speed of the shaft is 120 rpm, find the power absorbed by friction.

3. The engine of an automobile is rated to give 80 kW at 200 rpm with a maximum torque of 600 N-m. Design a dry single-plate clutch assuming the outer radius of the friction plate to be 1.2 times the inner radius. The coefficient of friction is 0.25 and the intensity of pressure between the plates is not to exceed 80 kN/m^2. Six springs are used to provide axial force necessary to engage the clutch and each spring has a stiffness of 50 N/mm. Find the initial compression in the springs and dimensions of the friction plate.

4. The turning moment diagram for the engine is drawn to the following scales:
   Turning moment, 1 mm = 1000 N-m, and for crank angle is 1 mm = 6°.
   The areas above and below the mean turning moment line taken in order are: 530, 330, 380, 470, 180, 360, 350, 280 mm^2. The mean speed of the engine is 150 rpm and the total fluctuation of speed must not exceed 3.5% of mean speed. Determine the diameter and mass of the flywheel rim, assuming that total energy of the flywheel is to be 15/14 that of rim. The peripheral velocity of the flywheel is 15 m/s. Find also the suitable cross sectional area of the rim of the flywheel. Take density of the rim material as 7200 kg/m^3.

5. (a) Give the difference between the working of a flywheel and governor.
   (b) The arms of a Porter governor are pivoted on the axis of rotation and are 300 mm long. The central load acting on the sleeve has a mass of 45 kg and each rotating ball has a mass of 5 kg. The arms are inclined at an angle of 30° to the axis of rotation in lowermost position of the sleeve. The sleeve lift is 50 mm. Determine the force of friction at the sleeve if the speeds at the moment the sleeve start lifting from the lowermost position, is same as the speed at the moment it falls from the uppermost position. Determine also the range of the governor.

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6. (a) What is the necessity of the balancing? Explain.
   (b) A rigid rotor has all its unbalance in one plane and can be considered to consist of three masses m_1 = 5kg, m_2=3 kg at an angle 165° counter clock wise from m_1, and m_3 = 8 kg at angle 85° clock wise from m_1. The radii r_1 = 20 cm, r_2=8 cm, r_3 = 14 cm. Determine the balancing mass required at a radius of 10 cm. Specify the location of this mass with respect to m_1.

7. An air compressor has four vertical cylinders 1, 2, 3 and 4 inline and the driving cranks at 90 intervals reach their upper most positions in this order. The cranks are of 150 mm radius, the connecting rods 500 mm long and the cylinder centre line 400 mm apart. The mass of the reciprocating parts of each cylinder is 22.5 kg and the speed of rotation is 400 rpm. Show that there are no out-of-balance primary or secondary forces and determine the corresponding couples, indicating the positions of No. 1 crank for maximum values. The central plane of the machine may be taken as reference plane.

8. Two rotors A and B are connected to the ends of a circular rod of 4 cm diameter and 180 cm long. The rotor A has a mass of 18 kg and is 25 cm in diameter. The rotor B has a mass of 70 kg and is 40 cm in diameter. The rod is held in a horizontal position by a clamp at a point C between A and B such that the frequency of transverse vibration of the part of the system on either side of C is equal. Determine the:
   (a) Distance of C from A
   (b) Frequency of transverse vibration of the system
   (c) Ratio of the frequencies of the torsional vibrations.

   Take E=200 GN/m^2. Neglect the inertia of the rod and the effect of obliquity of discs.

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1. Determine the torque required to be applied to the link AB (clockwise rotation) for the static equilibrium of the mechanism shown in figure 1.

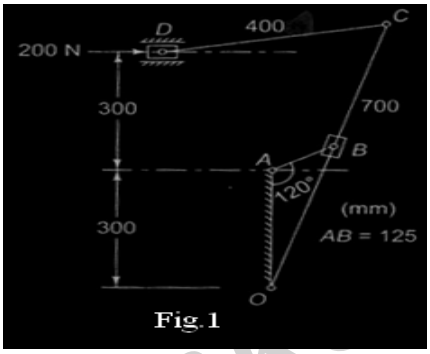

Fig.1

2. (a) Which of the two assumptions-uniform pressure or uniform wear, would you make use of in designing friction clutch and why?
(b) A shaft carrying a load of 12 tonnes and running at 120 rpm has a number of collars integral with it. Shaft diameter is 240 mm and the external diameter of the collar is 360 mm. Intensity of the uniform pressure is 400 kN/m^2 and the coefficient of friction is 0.06. Determine the power absorbed in overcoming the friction and the number of collars required.

3. (a) What is self locking? Derive the conditions for self locking when force is applied at the end lever on a differential band brake when the brake drum is rotating in counter clockwise direction.
(b) The distance between the center of driving pulley and dead weights in belt transmission dynamometers is 1.5m. If it is required to keep the lever in horizontal position and if power transmitted is 7 kW find the value of dead weights required. The diameter of each of the driving as well as intermediate pulley is equal to 300mm. The driving pulley runs at 300rpm.

4. The turning moment requirement of a machine is represented by T= (1000+500sin2θ – 300cos2θ) N-m. Where θ is the angle turned by the crankshaft of the machine. If the supply torque is constant, determine:
(a) The moment of inertia by the flywheel. The total fluctuation of speed is not to exceed one percent of the mean speed of 300 rpm.
(b) The maximum and minimum angular acceleration of the flywheel.
(c) The power required to drive the machine.

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5. (a) What are the limitations of a simple Watt governor? Why has this type of governor become obsolete?
(b) A Porter governor has all four arms 300 mm long. The upper arms are pivoted on the axis of rotation and the lower arms are attached to the sleeve at a distance of 35 mm from the axis. The mass of each ball is 7 kg and the mass on the sleeve is 50 kg. If the extreme radii of rotation of the balls are 200mm and 250mm, find the range of speed of the governor.

6. (a) Explain clearly the terms 'static balancing' and 'dynamic balancing'. State the necessary conditions to achieve them.
(b) A rotating shaft carries four masses A, B, C and D at a ratio of 100 mm, 125 mm, 200 mm and150 mm respectively. The masses rotate in the planes which are spaced at 600 mm apart and the magnitude of masses B, C and D are 10 kg, 5 kg, and 4 kg respectively. Find the mass of A and the angular settings of all the masses to have complete balance of shaft.

7. A three cylinder radial engine driven by a common crank has the cylinders spaced at 120°. The stroke is 125 mm, length of the connecting rod 225 mm and the mass of the reciprocating parts per cylinder is 2 kg. Calculate the primary and secondary forces at crank shaft speed of 1200 rpm.

8. A shaft of 50 mm diameter and 3 m long, is simply supported at its ends, carries three masses of 100 kg, 140 kg and 70 kg at 1.25 m, 2 m, and 2.5 m respectively from the left support. Taking E = 200 GN/m^2, find the frequency of the transverse vibration using energy method.

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Code No: R31033 **R10** **Set No: 3**

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DYNAMICS OF MACHINERY

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Time: 3 Hours **Max Marks: 75**

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1. (a) Explain the gyroscopic effect of steering and pitching of a ship in the sea water.
(b) A ship is pitching through a total angle of 15, the oscillation may be taken as simple harmonic and the complete period is 18 sec. The turbine rotor weighs 6 tones, its radius of gyration is 45 cm and it is rotating at 2400 rpm. Calculate the maximum value of gyroscopic couple set up by the rotor. If the rotation of the rotor is clockwise looking from stern, in which direction will the bow tend to turn while falling? What is the maximum angular acceleration to which the ship is subjected while pitching?

2. (a) Define the terms coefficient of friction and limiting angle of friction.
(b) An effort of 1500 N is required to just move a certain body up an inclined plane of angle 12°, force acting parallel to the plane. If the angle of inclination is increased to 15°, then the effort required is 1720 N. find the weight of the body and the coefficient of friction.

3. A machine is driven from a constant speed shaft rotating at 300 rpm by means of a friction clutch. The moment of inertia of the rotating parts of the machine is 5 kg.m^2. The clutch is of disc type both sides of the disc being effective in producing driving friction. The diameters of the friction plate are 20 cm and 12.5 cm. The intensity of the axial pressure applied to the disc is 0.7 bar. Assuming uniform pressure and coefficient of friction to be 0.25, determine the time required for the machine to attain full speed when the clutch is suddenly engaged.
Determine also the energy lost in the slipping of the clutch.
Determine the ratio of power transmitted with uniform wear to that of uniform pressure and the maximum intensity of pressure in case of uniform wear.

4. The cranks of a three cylinder single acting engine are set equally at 120°. The engine speed is 540 rpm. The turning moment diagram for each cylinder is a triangle for the power stroke with maximum torque of 80 N-m at 60° after dead-centre of the corresponding crank. On the return stroke, the torque is sensibly zero. Determine the
(a) Power developed
(b) Coefficient of fluctuation of speed if flywheel has a mass of 7 kg with radius of gyration of 70 mm.
(c) Coefficient of fluctuation of energy
(d) Maximum angular acceleration of the fly wheel.

5. (a) Define the terms sensitiveness and hunting relating to governors.
(b) The length of a ball arm and the sleeve arm of spring controlled Hartung type governor is 80 mm and 120 mm. The total lift of the sleeve in 24 mm each spring is compressed by 50 mm and the radius of rotation of the mass center is 125 mm in the mid position. The mass of each ball is 5kg and the spring stiffness if 12 N/mm in compression. The operating governor and gear friction are equivalent to a mass of 25 kg at the sleeve. Determine
(i) The speed in mid position
(ii)The ratio of the range of speed to the mean speed neglecting the moment due to revolving masses when the arms are inclined.

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6. Four masses A, B, C and D are completely balanced. Masses C and D make angles of 90° and 210° respectively with B in the same sense. The planes containing B and C are 300 mm apart. Masses A , B, C and D can be assumed to concentrated at radii of 360, 480, 240, and 300 mm respectively. The masses B, C, and D are 15 kg, 25 kg, and 20 kg respectively. Determine the
   (i) Maas A and its angular position
   (ii) Position of planes A and D.

7. The cylinders of a V-engine are set at an angle of 60° with both cylinders connected to common crank. The length of each connecting rod is 240 mm and stroke is 120 mm. The mass of the reciprocating parts is 1.5 kg per cylinder and the crank speed is 2000 rpm. Find the values of the primary and the secondary forces.

8. (a) Distinguish between longitudinal, transverse and torsional fee vibrations.
   (b) In a single degree damped vibrating system, the suspended mass of 4 kg makes 24 oscillations in 20 seconds. The amplitude decreases to 0.3 of the initial value after 4 oscillations. Find the stiffness of the spring, the logarithmic decrement, the damping factor and damping coefficient.

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1. A rear engine automobile is travelling along a curved track of 150 m radius. Each of the four wheels has a moment of inertia of 2.2 kg-m^2 and effective diameter of 600 mm. the rotating parts of the engine have a moment of inertia of 1.25 kg-m^2. The engine axis is parallel to the rear axle and the crank shaft rotates in the same sense as the road wheels. The mass of the vehicle is 2000 kg and the centre of gravity is 550 mm above the road level. The width of the track is 1.6 m. what will be the limiting speed of the vehicle if all the four wheels maintain contact with the road surface.

2. Neglecting the collar friction, from first principles, prove that the maximum efficiency of a square threaded screw moving in a nut is $\frac{1-\sin\phi}{1+\sin\phi}$ where ϕ is the friction angle.

3. A simple band brake is operated by a lever of length 450 mm. The brake drum has a diameter of 600 mm, and the brake band embraces 5/8th of the circumference. One end of the band is attached to the fulcrum of the lever while the other end is attached to a pin on the lever 120 mm from the fulcrum. The effort applied to the end of the lever is 2 kN, and the coefficient of friction is 0.3. Find the
   (a) Maximum braking torque on the drum and
   (b) Number of revolutions of the flywheel mounted on the drum shaft rotating at 250 rpm before it comes to rest if the mass and radius of gyration of the flywheel are 250 kg and 300 mm.

4. A punch press pierces 35 holes per minute in a plate using 10 kN-m of energy per hole during each revolution. Each piercing takes 40 percent of the time needed to make one revolution. A cast iron flywheel used with the punching machine is driven by a constant torque motor. The flywheel rotates at a mean speed of 210 rpm and the fluctuation of speed is not to exceed 1percent either way from the mean speed. Find:
   (a) Power of the electric motor
   (b) Mass of the flywheel
   (c) Cross-sectional dimensions of the rim when the width is twice its thickness. Take hoop stress for cast iron = 4 MPa and density =7200 kg/m^3.

5. A Proell governor has all four arms of length 250 mm. The upper arms are pivoted on the axis of rotation and the lower arms are attached to the sleeve at a distance of 30 mm from the axis of rotation. The mass of each ball is 4 kg and the mass of the sleeve is 40 kg. The extensions of the lower arms to which the balls are attached are 100 mm long and are vertical at the minimum radius. The minimum and maximum radii are 160 mm and 220 mm. Determine the range of speed of the governor.

Code No: R31033 **R10** **Set No: 4**

6. (a) Discuss how a single revolving mass is balanced by two masses revolving in deferent planes?
(b) Four masses A, B, C and D are attached to a shaft and revolve in the same plane. The masses are 12 kg, 10 kg, 18 kg and 15 kg respectively. And their radii of rotation are 40 mm, 50 mm, 60 mm and 30 mm. The angular position of the masses B, C and D are 60°, 135° and 270° from A. Find the magnitude and position of the balancing mass at a radius of 100 mm.

7. A two cylinder uncoupled locomotive with cranks at 90° has a crank radius of 325 mm. The distance between the centers of driving wheels is 1.5 m. The pitch of cylinders is 0.6 m. the diameter of treads of driving wheels is 1.8 m. The radius of centers 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 rotting parts per cylinder are 330 kg and 300 kg respectively. The speed of the locomotive is 60 kmph. Find the:
(i) 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 reciprocating masses.
(ii) Swaying couple
(iii) Variation tractive force
(iv) Maximum and minimum pressure on rails.

8. (a) Define and explain briefly the terms vibration isolation and transmissibility.
(b) The mass of an electric motor is 100 kg and it runs at 1240 rpm. The armature mass is 30 kg and centre of mass is 0.5 m from the axis of rotation. The motor is mounted on four springs of negligible damping so that the force transmitted is one-tenth of the impressed force. Assume that the mass of the rotor is equally distributed among the four springs. Find:
(i) Stiffness of each spring
(ii) Dynamic force transmitted to the base at the operating speed.

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