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

JNT University Kakinada

III B.Tech. I Semester Regular/Supplementary Examinations, Dec - 2014/Jan -2015

DYNAMICS OF MACHINERY

(Com. to ME and AME)

Time: 3 Hours Max Marks: 75 Answer any FIVE Questions

All Questions carry equal marks

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1. (a). Differentiate between natural and forced precession.

   (b). An aero plane makes a complete half circle of 60m radius, to left when flying at 200kmph. The rotary engine and the propeller of the aero plane weigh 4000 N with a radius of gyration 30cm the engine runs at 2500 rpm clockwise, when viewed from the rear. Find the gyroscopic couple on the aircraft and state its effect on it. Show gyroscopic effect by sketch.

2. (a). What are the various kinds of friction? Discuss each in brief.

   (b). A vertical screw with single start square thread 50 mm mean diameter and 12.5 mm pitch is raised against a load of 10 kN by means of a hand wheel, the boss of which is threaded to act as a nut. The axial load is taken up by a thrust collar which supports the wheel boss and has a mean diameter of 60 mm. If the coefficient of friction is 0.15 for the screw and 0.18 for the collar and tangential force applied by each hand to the wheel is 100 N; find suitable diameter of the hand wheel.

3. (a).With the help of neat sketch, explain the working of a block or shoe brake

   (b). In a single block brake, the drum diameter is 300mm, the angle of contact is 90^0, and the coefficient of friction between the lining and the drum is 0.30. If the operating force is 400N, applied at the end of a lever 400mm long, determine the torque transmitted by the brake. The distance of the fulcrum from the center of the brake drum is 200mm and assumes that the force of friction passes through the fulcrum.

4. A single acting Otto cycle engine develops 38 kW at 150 r.p.m with 75 explosions/min. The change of speed from the commencement to the end of power stroke must not exceed 0.5% of the mean speed on either side .Design a suitable rim section having width 4 times the depth, so that hoop stress does not exceed 40 kg/sq cm. Assume that the flywheel stores 16/15 times the energy stored by rim and that the work done during power stroke is 1.35m times the work done during cycle. Density of the material is 0.0072 kg/cubic cm.

5. The following particulars refer to a proell governor with open arms: length of all arms equal to 200 mm , distance of pivot of arms from the axis of rotation=40 mm, length of extension of lower arms to which the ball is attached 100 mm, mass of each ball=6 kg and mass of the center load = 150 kg. If the radius of rotation of balls is 180 mm when the arms are inclined at 40 degrees 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 20 N at the sleeve, and

   (iii) The range of speed between which the governor is

6. A,B,C and D are four masses carried by a rotating shaft at radii 100mm, 150mm, 150mm, and 200 mm respectively. The planes in which the masses rotate are spaced at 500 mm apart and the magnitude of the masses B, C and D are 9 kg, 5kg and 4kg respectively. Find the required mass A and the relative angular settings of the four masses so that the shaft shall be in complete balance.

7. The reciprocating masses of the three cylinder engine are 4.1, 6.2 and 7.4 tons respectively. The centre lines of the three cylinders are 5.2m, 3.2m and 1.2 m from the fourth cylinder. If the cranks for all the cylinders are equal, determine the reciprocating mass of the fourth cylinder and the angular position of the cranks such that the system is completely balanced for the primary force and couple .If the cranks are 0.8 m long, the connecting rods 3.8 m and the speed of engine 75 rpm, find the maximum unbalanced secondary force and the crank angle at which it occurs.

8. A shaft 50 mm diameter and 3m long. It is simply supported at the ends and carries three masses 100kg, 120kg and 80kg at 1.0m, 1.75m and 2.5m respectively from the left support. Taking $E=20GN/m^2$. Find the frequency of transverse vibrations using Rayleigh's method.

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1. (a). Explain the effect of precession motion on the stability of moving motor cycle.

   (b). Locomotive moving at a speed of 100 km/hr. turns round a curve of 500m radius to the right. The pair of driving wheels is 2 m in diameter and along with the axle weigh 20kN. The radius of gyration of wheels together with the axle may be taken as 0.6 m. find the gyro effect on pair driving wheels.

2. (a). What is meant by film or viscous friction?

   (b). A screw-jack has a square thread of mean diameter 6 cm and pitch 0.8 cm. The coefficient of friction at the screw thread is 0.09. A load of 3 kN is to be lifted through 12 cm. Determine the torque required and the work done in lifting the load through 12 cm. Find the efficiency of the jack also.

3. Derive the expression for the torque transmitting capacity of a cone clutch by considering uniform pressure.

4. Two isosceles triangles represent the turning moment diagram of an engine, the base of the two triangles being 0 to π and π to 2π the maximum torque being 1000 N-m. The engine runs at 500 r.p.m. The fluctuation of speed is not to exceed ±1.5%. Find the thickness of disc type flywheel required if diameter is0.5 m and density of material is 7.5 gm/cubic cm.

5. A governor of the Hartnell type has equal balls of mass 3 kg, set initially at radius of 200 mm. The arms of a bell crank lever are 110 mm vertically and 150 mm horizontally. Find:(i) The initial compressive force on the spring, if the speed for an initial ball radius of 200 mm is 240 r.p.m.(ii) The stiffness of the spring required to permit a sleeve movement of 4mm on fluctuation of 7.5% in the engine speed.

6. Four masses m1, m2, m3 and m4 having 100,175,200 and 25 kg are fixed to cranks of 20 cm radius and revolve in places 1, 2, 3 and 4. The angular position of the cranks in planes 2, 3 and 4 with respect to crank in plane 1 are 75,135 and 200 degrees taken in the same sense. The distance of planes 2, 3 and 4 from plane 1 are 60cm, 186 cm, and 240 cm respectively. Determine the position and magnitude of the balance mass at a radius of 60 cm in plane L and M located at middle of the plane 1 and 2m and the middle of the plane 3 and 4 respectively.

7. In a four cylinder petrol engine equally spaced, the cranks numbered from the front end are 1, 2, 3 and 4.The cranks 1 and 4 are in phase and 1800 ahead of cranks 2 and 3.The reciprocating mass of each cylinder is 1kg. The cranks are 50 mm radius and the connecting rod is 200mm long. What are the resultant unbalanced forces and couples, primary and secondary, when viewed from the front? Take the reference plane midway between cylinders 2 and 3.

8. (a). Explain the term ‘Damping factor’

   (b). A steel shaft 1.5m long is supported on simply supported bearings at its ends. It carries two rotors, 50kg each at its one third points. The shaft is hollow, external diameters is 8cm and the internal diameter is half of the external diameter. Determine the natural frequency by Dunkerley’s method.

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1. (a).What do you understand by gyroscopic couple? Derive an expression for gyroscopic couple

   (b). A four wheeled trolley car of mass 2500 kg runs on rail, which are 1.5m apart and travels around a curve of 30 m radius at 24km/hr. The rails are at same level. Each wheel of the trolley is 0.75m in diameter and each of the two axles is driven by a motor running in a opposite direction to that of the wheels at a speed of five times the speed of rotation of the wheels. The moment of inertia of each axle with gear and wheels is 18 kg-m^2. Each motor with shaft and gear pinion has a moment of inertia of 12 kg-m^2. The centre of gravity of the car is 0.9m above the rail level . Determine the vertical force exerted by each wheel on the rails taking into consideration the centrifugal and gyroscopic effects. State the centrifugal and gyroscopic effects on the trolley.

2. (a). What is friction circle? Derive an expression for its radius.

   (b). An effort of 1500 Nis required to just move a certain body up an inclined plane of angle 14 degrees ,force acting parallel to the plane. If the angle of inclination is increased to 16 degrees, then the effort required is 1720 N. Find the weight of the body and coefficient of friction.

3. A differential band brake acting on the $3/4^{th}$ of the circumference of a drum 600 mm diameter is to provide a breaking torque of 225 N-m. One end of the band is attached to a pin 100 mm from the fulcrum of the lever and the other end to another pin 25 mm from the fulcrum on the other side of it where the operating force is also acting. If the operating force applied at 500 mm from the fulcrum and the coefficient of friction is 0.25. Find the two values of operating force corresponding to the two directions of rotation of the drum.

4. A vertical petrol engine has a stroke of 11.25 cm and a cylinder diameter of 8.75 cm. The reciprocating parts weigh 15 N and the length of the connecting rod is 23.13 cm. when rotating at 1500 r.p.m and on the explosion stroke with the crank at 20 degrees from the top dead center position. The gas pressure is 8 kg/sq cm. Find,
   (i) Thrust in connecting rod
   (ii) Thrust in cylinder wall.

   Determine the speed above which other conditions remains the same, the thrust in the connecting rod would be reversed in direction.

5. (a) Define EFFROT and POWER of the governor.

   (b) A Porter governor has equal arms each 250mm long and pivoted on the axis of rotation. Each ball has a mass of 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 when friction at the sleeve is neglected.

6. A, B, C and D are four masses carried by a rotating shaft at radii of 10 cm, 12.5 cm, 20 cm and 15 cm respectively. The plane in which masses revolve are 60 cm apart and the mass of B, C and D are 10kg, 5kg, and 4kg respectively. Find the required mass A and the relative angular setting of the four masses so that the shaft is in complete balance (Assuming the plane of mass as a reference plane.

7. The intermediate cranks of a four cylinder symmetrical engine which is at complete balance, are at 90 degrees to each other and each has a reciprocating mass of 400 kg. The center distance between intermediate cranks is 600 mm and between extreme cranks is 1800 mm. Length of connecting rods and cranks are 900 mm and 200 mm respectively. Calculate the masses fixed to extreme cranks with their relative angular positions also find the magnitude of the secondary forces and couples about the center line of the system if the engines speed in 150 r.p.m.

8. (a). Explain briefly the phenomenon of the whirling of shafts.
   (b). The two rotors A and B are attached to the end of a shaft 500mm long. The mass of the rotor A is 300kg and its radius of gyration is 300mm. The corresponding values of the rotor B are 500 kg and 450mm respectively. The shaft is 70mm in diameter for the first 250mm, 120mm for the next 70mm and 100mm diameter for the remaining length. The modulus of rigidity for the shaft material is $80GN/m^2$. Find, (i) The position of the mode (ii). The frequency of torsional vibration.

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1. (a). What will be the effect of the gyroscopic couple on a disc fixed at certain angle to a rotating shaft?

   (b). The rotary engine and the propeller of an aircraft weigh 3600N and have a radius of gyration of 35cms. When viewed from the front of the engine rotates in the clockwise direction at 1500 rpm. When propelling at 560 m/sec. The air craft takes a right hand turn on a circle of 20m radius. Determine the magnitude and direction of the gyroscopic torque acting on the aircraft.

2. (a). Explain lubricated surfaces, boundary lubrication and film lubrication.

   (b).A conical pivot bearing supports a vertical shaft of 200 mm diameter. It is subjected to a load of 30 kN. The angle of the cone is 120 degrees and the coefficient of friction is 0.025. Find the power lost in friction when the speed is 120 r.p.m., assuming uniform pressure and uniform wear conditions.

3. An effective diameter of the cone clutch is 75mm,The semi-angle of the cone is 18°.Find the torque required to produce slipping of the clutch if an axial force applied is 200 N. This clutch is employed to connect an electric motor running uniformly at 100 r.p.m with a flywheel which is initially stationary. The flywheel has a mass of 13.5 kg and its radius of gyration to 150mm.Calculate the time required for the flywheel to attain full speed, and also the energy lost in the slipping of the clutch. Take coefficient of friction as 0.3

4. The crank effort diagram for a four stroke cycle gas engine may be assumed simply to consist of four triangles, the areas of which from the line of zero pressure are, Power stroke 69 sq cm, exhaust stroke 5 sq cm, suction stroke 3 sq cm, compression stroke 15 sq cm, each square cm represents 1 kN-m. Assuming the resistance to be uniform. Find,

   (i) The power of the engine (ii) The energy to be stored by the flywheel

   (iii) Weight of the rim of a flywheel of 100 cm radius to limit the total fluctuation of speed to 4% of the mean speed which is 150 r.p.m.

5. A proell governor has arms of 300 mm length. The upper arms are hinged on the axis of rotation, where as the lower arms are pivoted at a distance of 35 mm from the axis of rotation. The extension of lower arms to which the balls are attached are 100 mm long. The mass of each ball is 8 kg and the mass on the sleeve is 60 kg. At the minimum radius of rotation of 200 mm, the extensions are parallel to the governor axis. Determine the equilibrium speed of the governor for the given configuration. What will be t6he equilibrium speed for the maximum radius of 250 mm?

6. Two weights of 8kg and 14 kg rotate in the same plane at radii of 1.5 and2.25 m respectively. The radii of these weights are 60 degrees apart. Find the position of the third weight of the magnitude of 12 kg in the same plane which can produce static balance of the system.

7. Three cylinders of an air compressor have their axes at 120 degrees to one another and their connecting rods are coupled to a simple crank. The stroke is 10 cm and the length of each connecting rod is 15 cm. Mass of the reciprocating parts per cylinder is 1.5 kg. Determine the primary and secondary forces of the engine running at 3000 r.p.m.

8. The measurements on a mechanical vibrating system show that it has a mass of 8 kg and that the springs can be combined to give an equivalent spring of stiffness 5.4 N/mm. If the vibrating system has a dashpot attached which exerts a force of 40 N when the mass has a velocity of 1m/s , Find: (i) Critical damping coefficient,(ii) Damping factor ,(iii) Logarithmic decrement ,(iv) Ratio of two consecutive amplitudes.

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