Code No: RR320304 **Set No. 1**

III B.Tech II Semester Regular Examinations, Apr/May 2006
DYNAMICS OF MACHINES
(Common to Mechanical Engineering, Mechatronics and Production Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Each road wheel of a motor cycle has a mass moment of inertia of 1.5 kg-m^2. The rotation parts of the engine of the motorcycle have a mass moment of inertia of 0.25 kg-m^2. The speed of the engine is 5 times the speed of the wheels and is in the same sense. The mass of the motor cycle is traveling at 50kmlh and its center of gravity is 0.6 m above the ground level.
   Find the angle of heel if the cycle with its rider is 250 kg and is taking a turn of m radius. The wheel diameter is 0.6m. [16]

2. A horizontal steam engine 20 cm diameter by 40 cm stroke, connecting rod 100 cm makes 160 r.p.m. The mass of the reciprocating parts is 50 kg. When the crank has turned through an angle of 30 degrees, the steam pressure is 4.5 bar.
   (a) Calculate the turning moment on crank shaft.
   (b) If the mean resistance torque is 30 N-m and the mass of fly7wheel is 50 kg and the radius of gyration 70 cm Calculate the acceleration of the flywheel. [16]

3. (a) Derive expression for total braking torque about fulcrum in differential band brake, when brake drum rotating in counter-clockwise direction.
   (b) Distinguish between brakes and Dynamometers.
   (c) Explain function of absorption type dynamometer. [8+4+4]

4. (a) Among V threads and Square threads which are preferable for screw-jack? Why?
   (b) A cone clutch with a cone semi-angle 14^0 is to transmit 12 kW at 750 r.p.m. The width of the face is 1/4th of the mean diameter and the normal pressure between the contact faces is not to exceed 0.85 bar. Taking coefficient of friction between contact surfaces as 0.2,determine the mean dimensions of the clutch and the axial force. [4+12]

5. (a) Derive an expression for the height of Pro ell governor.
   (b) Calculate the minimum speed of a Proell governor, which has equal arms each 200mm and are pivoted on the axis of rotation. The mass of each ball is 4kg and the central mass on the sleeve is 20kg. The extension arms of the lower links are each 60mm long and parallel to the axis when the minimum radius of the ball is 100mm. [8+8]

6. A four cylinder crank engine has the two outer cranks set at 120^o to each other, and their reciprocating masses are each 350kgs. The distances between the planes of rotation of adjacent cranks are 45, 75 and 60 cm. If the engine is to be in complete primary balance, find the reciprocating masses and the relative angular position for each of the inner cranks. If the length of each crank is 30cm, the length of each connecting rod is 120 cm, and the speed of rotation is 250 r.p.m., determine the maximum secondary unbalanced force. [16]

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 150mm radius, the connecting rods 500mm long and the cylinder centre line 400mm apart. The mass of the reciprocating parts of each cylinder is 22.5kg and the speed of rotation is 400r.p.m. 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. [16]

8. A coil of spring stiffness 40 N/mm supports vertically a load of 200N at the free end. The motion is resisted by the oil dashpot. It is found that the amplitude at the beginning of the fourth cycle is 0.8 times the amplitude of the previous vibration. Find the ratio of the frequencies of damped and undamped vibrations. [16]

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Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. In the figure 1 given below the slider crank mechanism, the forces Fl and F2 are known. Determine the torque that may be applied on the crank shaft to maintain equilibrium. [16]

   Fl = 100kgf, F2 = 80 kgf, Ab = 36 cm, OA=9cm,AS = 16cm ∠AOB =45^0.

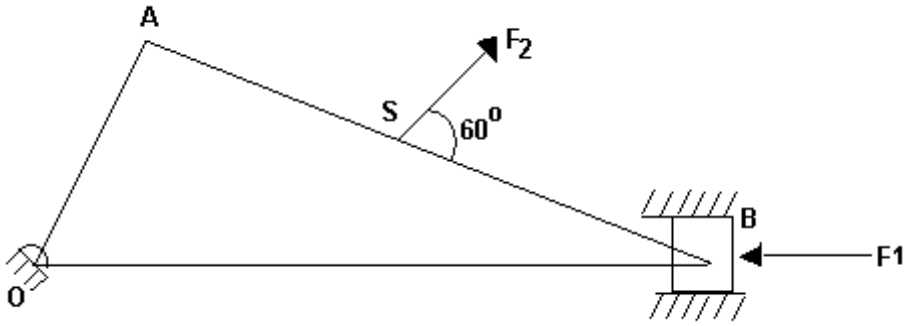

Figure 1:

2. An engine is coupled to a machine. The engine produces a torque given by the expression $T_E = (8000 + 1000 \sin 2\theta)$ N-m where θ is the angle of rotation of shaft. The machine requires a torque to run it and is given by the expression $T_M = (8000 + 800 \sin \theta)$ N-m where θ is angle of rotation of shaft. The engine runs at a mean speed of 250 rpm and has a flywheel of mass 400 kg and radius of gyration 0.4 m fixed to it. Determine

   (a) The fluctuation of energy

   (b) Percentage fluctuation of speed, and

   (c) The maximum and minimum acceleration of the flywheel and the corresponding angular positions of the engine shaft. [16]

3. A band brake used for a winch is wound round a drum of 0.75 m diameter, keyed to the shaft. The two ends of the band are attached to the pins on the opposite sides of the fulcrum of the brake lever at distances of 25 mm and 100 mm from the fulcrum. The angle of lap on the drum is 240^0. The coefficient of friction is 0.25. Find the torque which can applied by the brake when a force of 500 N applied to the lever upwards at a distance of 1 m from the fulcrum. Consider clockwise and counter-clockwise directions of rotation. [16]

4. Derive as expression for the effort to be applied of on a body to move it up on a rough inclined plane when

   (a) effort applied is horizontal

   (b) effort applied is parallel to the plane.

   Also derive an equation for the efficiency of the inclined plane. [16]

5. (a) A spring controlled governor of the Hartnell type has the following data: Mass of the ball = 1.8 kg; Mall of the sleeve= 6kg; Ball and sleeve arms of the bell crank lever = 150 mm and 120 mm respectively. The equilibrium speed and radius of rotation for the lowest position of the sleeve are 400r.p.m. and 150mm respectively. The sleeve lift is 10 mm and the change in speed for full sleeve lift is 5%. During an overhaul, the spring was compressed 2 mm more than the correct compression for the initial setting. Determine the stiffness of the spring and the new equilibrium speed for the lowest position of the sleeve.

   (b) The upper arms of a Porter governor are pivoted on the axis of rotation and the lower arms are pivoted to the sleeve at a distance of 30 mm from the axis of rotation. The length of each arm is 300 mm and the mass of each ball is 6 kg. If the equilibrium speed is 200 r.p.m. when the radius of rotation is 200 mm, find the required mass on the sleeve. If the friction is equivalent to a force of 40 N at the sleeve, find the coefficient of insensitiveness at 200 rpm radius. [8+8]

6. A single cylinder horizontal engine runs at 120 r.p.m. The length of stroke is 400 mm. The mass of the revolving parts assumed concentrated at the crank pin is 100 kg and mass of reciprocating parts is 150 kg. Determine the magnitude of the balancing mass required to be placed opposite to the crank at a radius of 150mm which is equivalent to all the revolving and 2/3rd of the reciprocating masses. If the crank turns 300 from the inner dead centre, find the magnitude of the unbalanced force due to the balancing mass. [16]

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 150mm radius, the connecting rods 500mm long and the cylinder centre line 400mm apart. The mass of the reciprocating parts of each cylinder is 22.5kg and the speed of rotation is 400r.p.m. 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. [16]

8. The two rotors A and B are attached to the end of a shaft 500 mm long. The mass of the rotor A is 300 kg and its radius of gyration is 300 mm. The corresponding values of the rotor B are 500 kg and 450 mm respectively. The shaft is 70 mm in diameter for the first 250 mm, 120 mm for the next 70 mm and 100 mm diameter for the remaining length. The modulus of rigidity for the shaft material is 80 GN/m^2. Find

(a) the position of the mode

(b) the frequency of torsional vibration. [16]

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1. (a) State the three useful applications of the gyroscopic action. [4]
   (b) A gear engine automobile is traveling along a curved track of 120m radius. Each of the four wheels has a moment of inertia of 2.2kg-m^2 and an effective diameter of 600mm. The rotating parts of the engine have a moment of inertia of 1.25kgm^2. The gear ratio of the engine to the back wheel is 3:2. The engine axis is parallel to the gear axle and the crank shaft rotates in the same sense as the road wheels. The mass of the vehicle is 2,050kg and the center of mass is 520mm above the road level. The width of the track is 1.6m. What will be the limiting speed of the vehicle if all the four wheels maintain contact with the road surface? [12]

2. A single cylinder signle acting four stroke cycle gas engine develop 22 kW at 300rpm. The flywheel weighs 1000kg. Hoop stress developed is 5 MPa. Density of material of rim of flywheel is 8000kg/m^3. The speed variation on either side is 1% of mean speed. Determine ratio of work done during expansion and compression strokes.Work done in suction and exhaust stroke is negligible. - [16]

3. A vehicle has a 3.5m wheel base and the centre or gravity is 1.5m in the front or the rear axle and 1m, above the ground level. The coefficient of adhesion between tyre and road surface is 0.6 and brakes are applied to the rear wheels.
   Find the distance traveled by the vehicle before coming to rest when traveling at ' 45kmph.
   (a) up an inclined plane of 1 in 15 and
   (b) down an inclined plane of 1 in 15. [16]

4. (a) A screw jack is used to raise a load of 10 tonnes. The pitch of single start square threads used for the screw is 30 mm. The mean diameter is 90 mm. Determine the force to be applied at the end of a 1.4 m long handle when the load is lifted with constant velocity and rotates with the spindle. Take μ=0.21. Also calculate the mechanical efficiency of the screw jack.
   (b) A cone clutch is to transmit 7.5 kW at 900 r.p.m. The cone has a face angle 12^0. The width of the face is half of the mean radius and the normal pressure between the contact faces is not to exceed 0.09 N/m^2. Assuming uniform wear and the coefficient of friction between contact faces as 0.2, find the main dimensions of the clutch and the axial force required to engage the clutch. [8+8]

5. (a) Derive an expression for the height of Pro ell governor.
   (b) Calculate the minimum speed of a Proell governor, which has equal arms each 200mm and are pivoted on the axis of rotation. The mass of each ball is 4kg and the central mass on the sleeve is 20kg. The extension arms of the lower links are each 60mm long and parallel to the axis when the minimum radius of the ball is 100mm. [8+8]

6. (a) Explain role of reference plane in balancing masses of rotation in different planes.
   (b) Explain why two balancing weights are required to balance the weights rotating in different planes, compared to single balance weight required to balance weights rotating in one plane.
   (c) Describe reasons in detail for partial balancing of reciprocating masses. [5+6+5]

7. A three cylinder radial engine driven by a common crank has the cylinders spaced at 120^0. The stroke is 100 mm, length of the connecting rod 200 mm and the reciprocating mass per cylinder 1.5 kg. Calculate the primary and secondary forces at crank shaft speed of 1500 r.p.m. [16]

8. (a) Derive an equation for the transverse vibration of a uniformly loaded shaft.
   (b) A rigid massless bar of length L is hinged at its end and carries a spring K_2 with mass at its right end. The bar is also supported by a spring K_1 at a distance from the left hinge. Determine the natural frequency of the bar. [8+8]

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Code No: RR320304 **Set No. 4**

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Time: 3 hours **Max Marks: 80**

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1. In the figure 1 given below the slider crank mechanism, the forces Fl and F2 are known. Determine the torque that may be applied on the crank shaft to maintain equilibrium. [16]

   Fl = 100kgf, F2 = 80 kgf, Ab = 36 cm, OA=9cm,AS = 16cm ∠AOB =45^0.

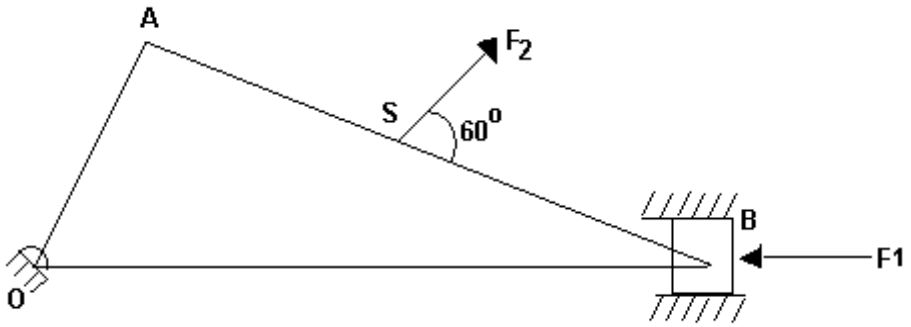

Figure 1:

2. (a) Define:
   i. Coefficient of fluctuation of speed.
   ii. Coefficient of fluctuation of energy.

   (b) The T-θ diagram for an engine consists of 2 Isosceles triangles and the maximum height for each triangle represents a turning moment equal to 1000 N-m, where base of each triangle is π radians. If the engine runs at 200 rpm and total Coeff Fluctuation of Speed not to exceed 3% find Power of the engine. - [6+10]

3. A motor car weighs 14000 N and has a wheel base of 2.7 m. The centre of gravity is 2.27 m behind the front axle and 0.81 m above the ground level. Neglecting the wind and rolling resistance during braking, the vehicle is brought to stop in a distance of 22 m from the initial speed of 60 km/hr by applying brakes which bring all the four wheels at impending slip.

   (a) Determine the coefficient of friction at impending slip between the tyre and the road.

   (b) How will the results get modified if the vehicle is ascending. [16]

4. (a) Define "Friction". Explain with examples, whether friction is friend or foe to human.
   (b) Derive an expression for the horizontal force 'F', necessary to move a load 'w' up a plane, which is inclined at an angle 'a' to the horizontal. [8+8]

5. (a) Derive an expression for the height of Pro ell governor.
   (b) Calculate the minimum speed of a Proell governor, which has equal arms each 200mm and are pivoted on the axis of rotation. The mass of each ball is 4kg and the central mass on the sleeve is 20kg. The extension arms of the lower links are each 60mm long and parallel to the axis when the minimum radius of the ball is 100mm. [8+8]

6. (a) What is the necessity of the balancing
   (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 165^0 counter clock wise from m_1, and m_3 = 8 kgs at angle 85^0 clock wise from m_1. The radii a_1 = 20 cm, a_2=8 cm, a_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. [4+12]

7. The six cylinders of a single acting, two stroke cycle diesel engines are pitched 1m apart and the cranks are spaced at 60^0. The connecting rod length 300 mm and the crank is 60mm. The reciprocating mass per line is 1.35 kg and the rotating mass is 1kg. The speed is 250 r.p.m. Find out the unbalanced primary and secondary moment, if the firing order is 1-5-3-6-2-4. [16]

8. (a) Derive an equation for the transverse vibration of a uniformly loaded shaft.
   (b) A rigid massless bar of length L is hinged at its end and carries a spring K_2 with mass at its right end. The bar is also supported by a spring K_1 at a distance from the left hinge. Determine the natural frequency of the bar. [8+8]

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