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

III B.Tech II Semester Supplimentary Examinations, Aug/Sep 2007
DYNAMICS OF MACHINES
(Common to Mechanical Engineering, Mechatronics, Production Engineering and Automobile Engineering)

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.

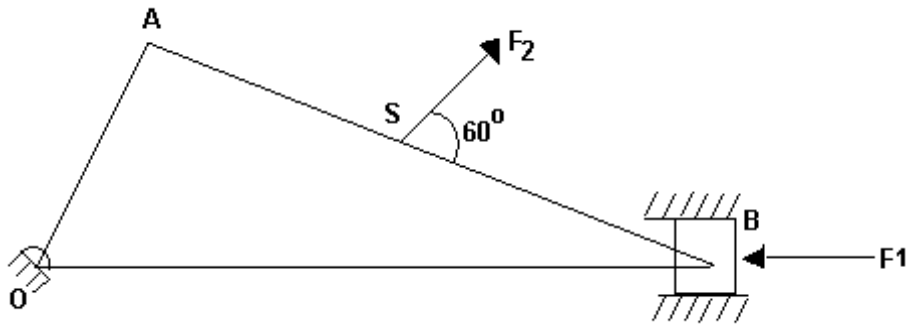

Figure 1

2. A single cylinder steam engine 25 cm stroke, 350 r.p.m has reciprocating masses (including the portion of connecting rod) of 125 kg. The connecting rod has a mass of 175 kg and is 50 cm long. Its centre of gravity is 20 cm from the crank pin and the movement of Inertia about an axis through the centre of gravity perpendicular to the plane of motion is 5 kgm^2. The crank is 30^0 from the inner dead centre and the piston is moving towards the shaft. Calculate:

   (a) The cross-head guide reaction due to inertia of the reciprocating parts.

   (b) The total kinetic energy of the connecting rod. [16]

3. (a) Explain the principle of working of single block brake with the help of a line diagram. Also derive an expression for braking torque different directions of rotation of drum.

   (b) In a prony brake dynamometer, the spring balance reading is 200N. Radius of the brake drum is 300mm and distance between the drum axis and hinge of the blocks is 600mm. Determine the pressure exerted on the drum by tightening the screw, tangential force acting on the brake drum and tile output power of the prime mover if the record speed is 300r.p.m. Take coefficient of friction as 0.25. [8+8]

4. An effort of 3000N is required to just move a certain body up an in clined plane of angle 12^0, force acting parallel to the plane. If the angle of inclination is increased to 15^0 then the effort required is 3500N. Find the weight of the body and the coefficient of friction. [16]

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 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 determined 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) Distinguish between longitudinal, transversed and torsional free vibrations.
   (b) A rotor of mass 10 kg is mounted mi-way on a 2cm diameter horizontal shaft supported at the ends by two bearings. The bearing span is 80 cm. Because of certain manufacturing defect, the centre of gravity of the disc is 0.1 mm away from the geometric centre of the rotor. If the system rotates at 3000 rpm, determine, the amplitude of the steady state vibration and the dynamic load transmitted by the bearing. Take E=200 GN/m^2. [6+10]

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

Answer any FIVE Questions
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1. A horizontal, double acting steam engine has a stroke of 300mm and runs at 240 rpm. The cylinder diameter is 200 mm, connecting rod is 750 mm long and the mass of the reciprocating parts is 70 kg. The steam is admitted at 600 kN/m^2 for one-third of the stroke, after which expansion takes place according to the hyperbolic law p. V = constant. The exhaust pressure is 20 kN/m^2. Neglecting the effect of clearance and the diameter of the piston rod, find:
   (a) Thrust in the connecting rod, and
   (b) Effective turning moment on the crankshaft when the crank has turned through 120^0 from inner dead centre. [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) Explain the principle of working of single block brake with the help of a line diagram. Also derive an expression for braking torque different directions of rotation of drum.
   (b) In a prony brake dynamometer, the spring balance reading is 200N. Radius of the brake drum is 300mm and distance between the drum axis and hinge of the blocks is 600mm. Determine the pressure exerted on the drum by tightening the screw, tangential force acting on the brake drum and tile output power of the prime mover if the record speed is 300r.p.m. Take coefficient of friction as 0.25. [8+8]

4. (a) 20 kW is transmitted at 1000 r.p.m by a cone clutch having average friction diameter of 250 mm and semi-cone angle of 12^0. Determine the axial force for engagement and the width of the friction face. Assume average pressure intensity is 0.7 bar and μ=0.3.
   (b) Determine the axial force required to engage a cone clutch tramitting 25 kW of power at 600 r.p.m. Average friction diameter of the cone is 400 mm, semi cone angle is 12^0 and coefficient of friction 0.25. Also find the width of the friction cone. [8+8]

5. A governor of the Hartnell type has ball arm and sleeve arm of lengths 125mm and 62.5mm respectively; the fulcrum of the bell crank lever being 100mm away from spindle axis. The governor runs at a mean speed of 300rpm, each ball has a mass of 2.3kg, and a 3 percent reduction in speed causes a sleeve movement of 6mm. If the ball-arm is vertical at the mean speed, and gravitational effects are ignored, find the spring stiffness in N/m. Neglect the mass of the arms. By how much must the adjusting nut be screwed down to render the governor isochronous and what will be the resulting operational speed of the governor? [16]

6. The cranks 2 to 9 of a nine cylinder engine running at 1000 r.p.m. make 240, 120, 160, 280, 40, 80, 320 and 2000 respectively with crank 1, when measured in a counter clock direction. The rotating masses for each cylinder are estimated to be 20 kg at 0.15m radius. The distance between centre lines of cranks is 0.4 m. Determine the unbalanced movement due to the rotating parts about the mid plane (cylinder S) of the crank craft. [16]

7. (a) Prove that maximum secondary unbalanced forces is l/n times maximum primary unbalanced for n cylinder reciprocating engine.

   (b) For radial engines with an odd number of cylinders prove that the primary force may be balanced by attaching single mass of km where 'k' is number of cylinders and 'm' is mass of reciprocating parts. [8+8]

8. (a) A steel bar 25mm wide and 50 mm deep is freely supported at two points of meter apart, and carries a mass of 200 kg mid-way between them. Find the frequency of the natural transverse vibrations, neglecting the mass of the bar. Take E= 28 x 10^5 bar. What will be the frequency of vibration, if any additional mass of 200 kg is distributed uniformly along the length of the shaft ?

   (b) A steel shaft 100 mm in diameter is loaded and supported in shaft bearings 0.4m apart. The shaft carries three loads: first mass of 12 kg at the centre, second mass of 10 kg at a distance 0.12 m from the left bearing and third mass of 7 kg at a distance 0.09 m from the right bearing. Find the value of the critical speed by using Dunkerley's method. [8+8]

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1. (a) Derive an expression for gyroscopic couple. [6]
   (b) An aeroplane makes a complete half circle of 60m radius, to the left when flying at 200 Kmph. The rotary engine and the propeller of the aeroplane weigh 4000N with a radius of gyration 30 cm the engine runs at 2500rpm CW, when viewed from rear. Find the gyroscopic couple on the aircraft and state its effect on it. Show gyroscopic effect by a sketch. [10]

2. A single cylinder steam engine 25 cm stroke, 350 r.p.m has reciprocating masses (including the portion of connecting rod) of 125 kg. The connecting rod has a mass of 175 kg and is 50 cm long. Its centre of gravity is 20 cm from the crank pin and the movement of Inertia about an axis through the centre of gravity perpendicular to the plane of motion is 5 kgm^2. The crank is 30^0 from the inner dead centre and the piston is moving towards the shaft. Calculate:
   (a) The cross-head guide reaction due to inertia of the reciprocating parts.
   (b) The total kinetic energy of the connecting rod. [16]

3. (a) Describe with sketches one form of torsion dynamometer and explain in detail the calculations involved in finding the power transmitted.
   (b) In a vertical belt transmission dynamometer the diameter of the driving pulley rotating at 1500 r.p.m. is 80mm. The centre distance of the intermediate pulleys from the fulcrum is also 80mm each. The weighing pan on the lever is at a distance as 250mm. Find the power transmitted when a mass of 20 kg is required in the pan, including its own mass. [8+8]

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 single cylinder engine runs at 250r.p.m. and has stroke of 180mm.. The reciprocating part has a mass of 120 kg and revolving parts are equivalent to mass of 70 kg at a radius of 90 mm. A mass is placed opposite to the crank at a radius of 150 mm to balance the whole of the revolving mass and 2/3 of the reciprocating mass. Determine the magnitude of the balancing mass and the resultant residual unbalance force when crank has turned 300 from the inner dead centre, neglect the obliquity of the connecting rod. [16]

7. (a) Distinguish reverse and direct crank methods of balancing of radial engines.
   (b) Distinguish balancing of inline engines and radial engines with appropriate examples [8+8]

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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1. The ratio of the connecting rod length to crank length for a vertical petrol engine is 4: 1. the bore/ stroke is 80/1 00 mm and mass of the reciprocating parts is 1 kg. The gas pressure on the piston is 0.7 N/mm^2 when it has moved 10 m from T.D.C. on its power stroke. Determine the net load on the gudgeon pin. The engine runs at 1800 rpm. At what engine speed will this load be zero? [16]

2. The torque delivered by two stroke engine represented by T=1000+300 sin 2θ - 500 cosθ N-m where θ is the angle made by the crank from IDC. The engine speed is 250rpm. The mass of flywheel is 400 kg and radius of gyration is 400mm. Determine:
   (a) Total percentage of fluctuation of speed.
   (b) The angular acceleration of flywheel when the crank has rotated through an angle of 60^0 from IDC.
   (c) The maximum angular retardation of flywheel. [16]

3. (a) Name different types of dynamometers. Explain function of prony brake.
   (b) In a band and block Brake, the band is lined with 14 blocks, each of which subtends an angle of 20^0 at the drums centre. One end of the band is attached to the fulcrum of the brake lever and the other to a pin 150mm from the fulcrum. Find the force required at the end of the lever 1m long from the fulcrum to give a torque of 4k N-m. The diameter of the brake drum is 1m and the coefficient of friction between the blocks and the drum is 0.25.[6+10]

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. The cranks 2 to 9 of a nine cylinder engine running at 1000 r.p.m. make 240, 120, 160, 280, 40, 80, 320 and 2000 respectively with crank 1, when measured in a counter clock direction. The rotating masses for each cylinder are estimated to be 20 kg at 0.5m radius. The distance between centre lines of cranks is 0.4 m. It is proposed to balance this engine by two masses, one in the damper at a distance of 0.6 m from cylinder one and the other located in the fly wheel at a distance of 0.6 m from cylinder nine. Determine the kg-m magnitudes and the locations of the balancing masses. [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 determined 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) Define the following terms:
   i. frequency
   ii. period
   iii. amplitude.

   (b) An unknown spring K has a natural frequency of 100 cycles per minute. When 1.2 kg mass is added to m, the natural frequency is lowed to 80 cycles per minute, determine the unknown mass m and the spring constant K in N/cm. [2+2+2+10]

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