Code No: 07A42104 **R07** **Set No. 2**

II B.Tech II Semester Examinations,December 2010
MECHANISMS AND MECHANICAL DESIGN
Aeronautical Engineering

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

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) What are interchangeable parts?
   (b) Why tolerances are required on mating parts?
   (c) Define the term :
      i. Tolerance
      ii. Deviation
      iii. Allowance, and
      iv. Design size. [4+4+8]

2. (a) Explain the terms addendum and dedendum. What is clearance?
   (b) Sketch two teeth of a gear and show the following: face, flank, top land, bottom land, addendum, dedendum, tooth thickness, space width, face width and circular pitch. [8+8]

3. The rotor of a turbine installed in a boat with its axis along the longitudinal axis of the boat makes 1500 rpm clockwise when viewed from the stern. The rotor has a mass of 750 kg and a radius of gyration of 300mm. If at an instant, the boat pitches in the in the longitudinal vertical plane so that bow rises form the horizontal plane with an angular velocity of rad/s, determine the torque acting in the boat and the direction in which it tends to turn the boat at the instant. [16]

4. Locate the instant centres of the mechanism shown in figure4 Determine the velocity of B and angular velocity of link 3, when the linear velocity of A is 2 cm/s. AB = 25 cm. [16]

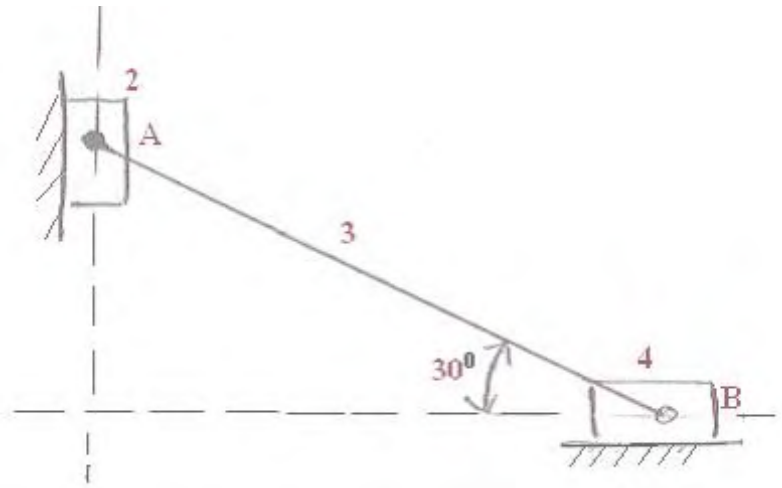

Figure 4

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5. The following particulars relate to a symmetrical tangent cam having a roller follower:
   Minimum radius of the cam = 40mm, Lift = 20mm, speed = 360 rpm, Roller diameter = 44mm, Angle of ascent = 60^0.
   Calculate the acceleration of follower at the beginning of lift. Also find it values when the roller just touches the nose. Sketch the variation of displacement, velocity acceleration during ascent. [16]

6. What is the difference between quick return motion of crank and slotted lever type and that of Whitworth? What is the ratio of time taken on cutting and return strokes? [16]

7. (a) What is the practical significance of evaluating velocity and acceleration of members of mechanisms?
   (b) Figure 7 depicts the structure of Whitworth quick return mechanism used in reciprocating machine tools. The various dimensions of the mechanism for a specified stroke of the tool are : OQ = 12 cm, OP = 24 cm, RQ = 18 cm and RS = 60 cm. Crank OP makes an angle of 60 degrees with the vertical. Determine the velocity of the slider S (cutting tool) when the crank rotates at 120 r.p.m. clockwise. Find also the angular velocity of the link RS and the velocity of the sliding block T on the slotted lever QT. [16]

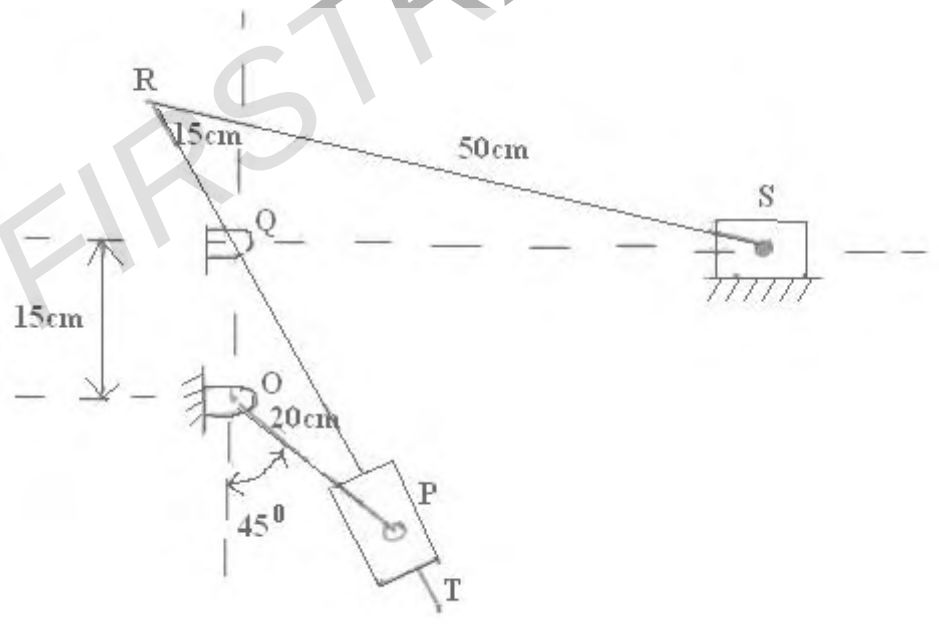

Figure 7

8. Draw the profile of a earn to give the following motion to the reciprocating follower with a flat (or mushroom) contact face:
   (a) follower to move outwards through a distance of 30 mm during 90^0 of earn rotation,
   (b) follower to dwell for 60^0 of earn rotation,
   (c) follower to return to its initial position during 90^0 of earn rotation,

(d) follower to dwell for the remaining 120^0 of earn rotation.

The minimum radius of the earn is 30 mm and the flat face of the follower is at right angles to the line of stroke of the follower. The outward and return strokes of the follower are to take place with S.H.M. [16]

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Code No: 07A42104 **R07** **Set No. 4**

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1. Define arc of contact and deduce the expression to find its magnitude. [16]

2. Differentiate between special cams and ordinary cams. [16]

3. A racing car weighs 20 kN. It has a wheel base of 2m, track width 1m and height of C.G. 300mm above the ground level and lies midway between the front and rear axle. The engine flywheel rotates at 3000 rpm clockwise when viewed from the front. The moment of inertial of the flywheel is 4kg-m2 and moment of inertial of each wheel is 3kg 2. Find the reactions between the wheels and the ground when the car takes a curve of 15 m radius towards right at 30 km/hr, taking into consideration the gyroscopic and the centrifugal effects. Each wheel radius is 400mm. [16]

4. A plate 10mm thick, subjected to a tensile load of 20kN is shown in Figure 4. This plate is made of cast iron (S_{ut} =350 N/mm^2) and the factor of safety is 2.5.Determine the fillet radius. [16]

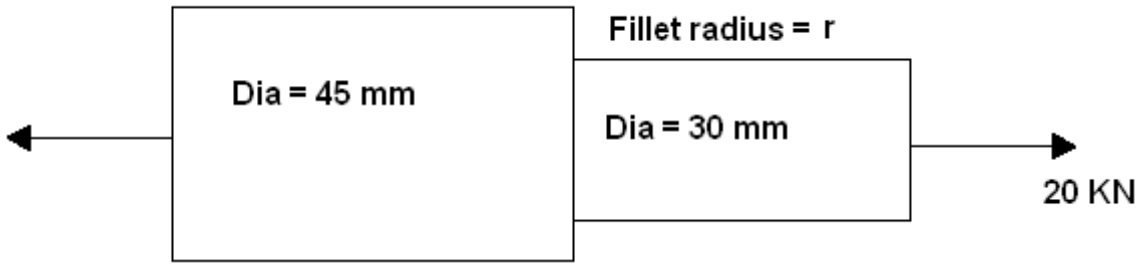

Figure 4

5. (a) Which criterion is used to determine the rotatability of driving link of a 4-bar linkage? Explain.

   (b) The dimensions of 4-links of such a mechanism are 100 mm, 400 mm, 700 mm and 800 mm. Draw the configuration of a crank-crank mechanism and also draw the inversions of the same to obtain two crank-rocker and a rocker-rocker mechanisms. [8+8]

6. Explain the types of instantaneous centres for a mechanism. Locate all the instantaneous centres for the mechanism shown in the figure 6. Determine the velocity of point C and the angular velocity of link 3.

   Take O_2A = BC = 150 mm, AB = O_4B = 250 mm, O_2O_4 = 100 mm, AC = 300 mm. [16]

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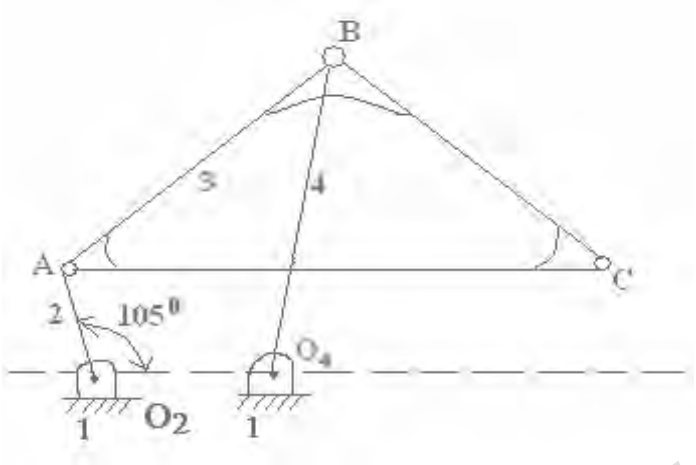

Figure 6

7. Draw the profile of a earn operating a knife-edged follower from the following data.

   (a) It lifts the follower through 3.75c.m. during its 60^0 rotation with S.H.M.

   (b) The follower then remains at rest for next 40^0 rotation of the earn.

   (c) The follower then descends to its original position during the 90^0 rotation of the earnwith S.H.M.

   (d) The follower remains at rest for the rest of the revolution.

   The least radius of the earn is 5c.m. If the earn rotates at 300rpm, find the maximum velocity and acceleration of the follower during the ascent and descent. [16]

8. The figure 8 shows the configuration OCPAQE of a mechanism, Find :

   (a) the velocity of point P, i.e., the piston;

   (b) the angular velocity and acceleration of the link AQ;

   (c) the acceleration of the piston

   when OC rotates uniformly at 120 r.p.m. in anti-clockwise direction. The bell crank lever AQE rocks about the fixed centre Q. OC = 12.5 cm, CP = 50 cm, AQ = 25 cm, QE = 12.5 cm and $\angle POC = 45^0$. [16]

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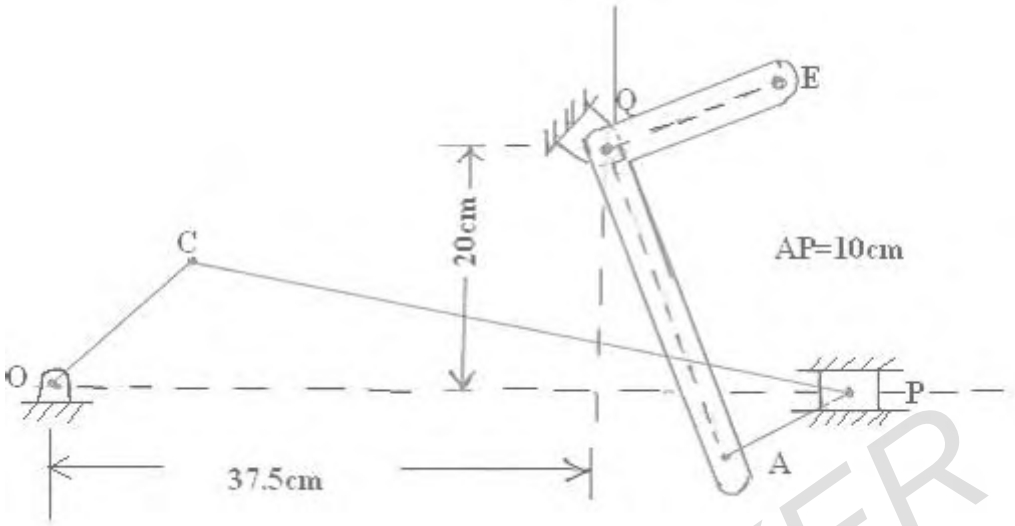

Figure 8

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1. (a) Explain the gyroscopic effect of pitching and rolling of a ship in the sea water.
   (b) A ship is pitching through a total angle of 150, the oscillation may be taken as simple harmonic and the complete period is 32 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 left, in which direction will the bow tend to turn while falling?
   What is the maximum angular acceleration to which the slip is subjected while pitching? [6+10]

2. Differentiate between a crank and a lever. State how their use gives different practical applications of a quadric cycle chain. [16]

3. Explain the importance of special cams in detail. [16]

4. Locate all the instant centres of whit worth quick return motion mechanism (slotter mechanism) for any one configuration and discuss the velocity analysis of the mechanism. Assume the link proportions and the speed of the crank. [16]

5. Draw the profile of a cam operating a knife-edge follower when the axis of the follower passes through the axis of the cam shaft from the following data:
   (a) Follower to move outwards through 30 mm during 90^0 of cam rotation,
   (b) Follower to dwell for the next 45^0,
   (c) Follower to return to its original position during next 60^0,
   (d) Follower to dwell for the rest of the earn rotation.

   The displacement of the follower is to take place with simple harmonic motion during both the outward and the return strokes. The least radius of the cam is 50 mm. If the eam rotates at 600 r.p.m., determine the maximum velocity and acceleration of the follower during outward stroke and return stroke. [16]

6. (a) The velocity ratio of two spur gears in mesh is 0.4 and the centre distance 75 mm. For a module of 1.2 mm, find the number of teeth of the gears. What will be the pitch line velocity if the pinion speed is 800 rpm? Also find the speed of the gear wheel.
   (b) A spur gear has 30 teeth and a module of 1.4 mm. It rotates at 360 rprn. Determine its circular pitch and pitch line velocity. [8+8]

7. In a slider crank mechanism, the length of the crank and connecting rod are 150 mm and 675 mm respectively. The crank position is 60^0 from inner dead centre. The crank shaft speed is 300 r.p.m. clockwise. Using Klein's construction, determine

   (a) Velocity and acceleration of the slider

   (b) Velocity and acceleration of point D on the connecting rod which is 150 mm from crank pin C, and

   (c) angular velocity and angular acceleration of the connecting rod. [16]

8. A helical compression is required to deflect though approximately 25mm when the external force acting on it varies from 500 to 1000N. The spring index is 8. The spring has square and ground ends. There should be a gap of 2mm between adjacent coils when the spring is subjected to the maximum force of 1000 N. The spring is made of cold-drawn steel wire ultimate tensile strength of 1000 N/mm^2 and permissible shear stress for the spring wire can be taken as 50% of the ultimate tensile strength (G = 81307N/mm^2). Design the spring and calculate:

   (a) Wire diameter;

   (b) Mean coil diameter;

   (c) Number of active coils;

   (d) Total number of coils;

   (e) Solid length;

   (f) Free length;

   (g) Required spring rate; and

   (h) Actual spring rate. [16]

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1. An open coiled helical spring and a close coiled helical spring are similar is every respect, except that the elongation of the open coiled spring is 2.5% greater than that of the colsed-coiled spring. Under the same load, determine the angle of inclination of the coils of the open coil spring. Take E/N = 2.5. [16]

2. Find the velocity of point C and the angular velocity of link 3 of the push-link mechanism shown in the figure 2. Link 2 is the driver and rotates at 8 rad/s ccw. Use instant centre method. [16]

   O_2A = 150 mm, AB = O_4B = 250 mm, O_2O_4 = 75 mm, AC = 300 mm, BC = 100 mm

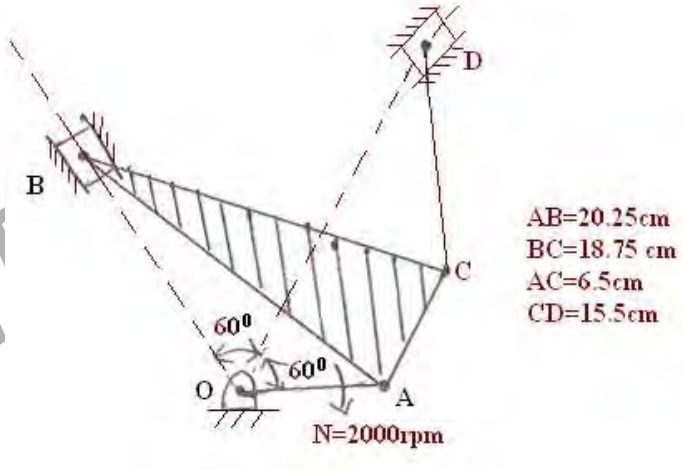

Figure 2

3. A vertical single cylinder, diesel engine running at 300 rpm has a cylinder diameter 250 mm and stroke 400 mm. The mass of the reciprocating parts is 200 kg. The length of the connecting rod is 0.8 m. The ration of compression is 14 and the pressure remains constant during injection of oil for 1/10th of stroke. If the index of the law of expansion and compression is 1.35, find the torque on the crankshaft when it makes an angle of 60^0 with the top dead centre during the expansion stroke. The suction pressure may be taken as 0.1 N/mm^2. [16]

4. A push rod of value of an internal combustion engine ascends with uniform equal acceleration and deceleration along the path inclined to the vertical at 60^0. The same descends with S.H.M. The base circle diameter of the cam is 50m.m. and the push rod has a roller of diameter 16m.m. fitted to its end. The axis of roller and the cam fall on the same vertical straight line. The maximum stroke of the follower is 2c.m. in the direction inclined to the lift as viewed from the front at an

inclination of 60^0 to the vertical. The angle of action for the outstroke and return stroke is 60^0 each interposed by a dwell period of 60^0. Draw the profile of the cam. Cam is rotating in C.C.W. direction. [16]

5. What is the difference between the slider-crank chain and the double slider-crank chain? Draw the three mechanisms which are inversions of each of the above chains and state the purpose for which each mechanism is used. [8+8]

6. (a) Derive the expression for the magnitude of the coriolis component of acceleration.
   (b) The figure 6 shows a parallel-bar linkage, in which opposite links have equal lengths. For this linkage, show that ω_3 is always zero and that $\omega_4 = \omega_2$. How would you describe the motion of link 4 with respect to link 2 ? [16]

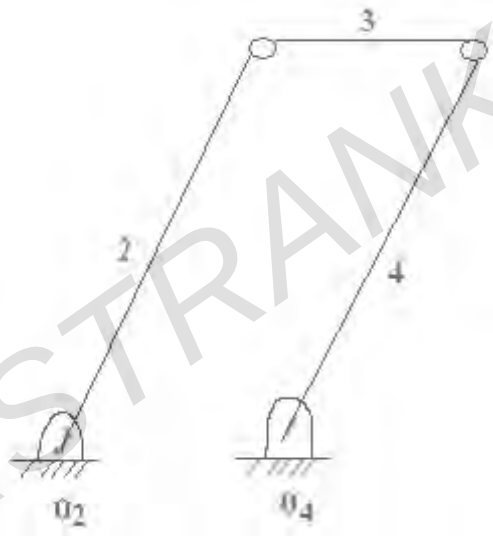

Figure 6

7. The following data relate to a symmetrical circular cam operating a flat - faced follower:
   Minimum radius of the cam 44mm, Lift 26 mm, Angle of lift 80^0
   Nose radius 8mm, Speed of the cam 400 rpm
   Determine the main dimensions of the cam and the acceleration of the follower at the follower at the beginning of the lift,the end contact with the circular flank, the beginning of contact with the nose and at the apex of the nose. [16]

8. The centre distance between two meshing spiral gears is 400 mm approximately and the angle between the two shafts is 50^0. The normal circular pitch of the gears is 18 mm and gear ratio = 3. The frictional angle is 6^0 and spiral angles for the driving and driven wheels are equal. Find:
   (a) Number of teeth on each wheel
   (b) Exact centre distance and
   (c) Efticiel1cy of the drive. [16]

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