VIT
Vellore Institute of Technology

Final Assessment Test – November 2019

Course: MEE2004 - Mechanics of Machines

Class NBR(s): 0776 / 0884 / 1540 Slot: A2+TA2+V3

Time: Three Hours Max. Marks: 100

KEEPING MOBILE PHONE/SMART WATCH, EVEN IN 'OFF' POSITION, IS EXAM MALPRACTICE

Answer any FIVE Questions

(5 X 20 = 100 Marks)

1. a) For each of the fourbar mechanisms with the following link lengths, determine if the mechanism is Grashoff or Non-Grashoff. Also classify each inversion of the fourbar mechanism as crank-rocker or double-rocker or double-crank type of mechanisms. **[10]**

   i) L1 = 1, L2 = 3, L3 = 2, L4 = 3

   ii) L1 = 8, L2 = 7, L3 = 6, L4 = 10

   iii) L1 = 6, L2 = 3, L3 = 6, L4 = 7

   iv) L1 = 7, L2 = 2, L3 = 5, L4 = 7

   b) In each of the above fourbar mechanisms a(i) through a(iv), for the inversion where L1 is the fixed link, L2 is the input link, L3 the coupler and L4 is the output link, find the maximum and minimum transmission angles. **[10]**

2. Figure 1 shows a slider moving outwards on a rod AB with a velocity of 4 m/s. At this instance, the velocity of the slider is increasing at a rate of 10 m/s^2. The rod has an angular velocity of 6 rad/s counter-clockwise about A and an angular acceleration of 20 rad/sec^2 clockwise. Determine velocities and accelerations of (i) point B (which is at a distance of 1.8 m from A), (ii) point Q which is a point fixed on AB at a distance of 1.5 m from A and (iii) Point P which is a point on the slider at a distance 1.5 m from A at the given instance. Draw the velocity and acceleration diagrams. **[20]**

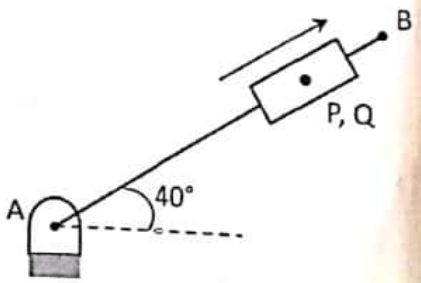

Figure 1

3. a) A cam with a minimum radius of 25 mm is to be designed for a knife-edge follower with the following data: **[10]**

   - To raise the follower through 35 mm during 60° rotation of the cam
   - Dwell for the next 40° rotation of the cam
   - Descending of the follower during the next 90° rotation of the cam
   - Dwell during the rest of the cam rotation.

   Draw the profile of the cam if the ascending and descending of the cam is with simple harmonic motion and the line of stroke of the follower is offset 10 mm from the axis of the cam shaft.

b) The annulus A in the gear shown in the figure 2 rotates at 300 rpm about the axis of the fixed wheel S which has 80 teeth. The three-armed spider is driven at 180 rpm. Determine the number of teeth required on wheel P. [10]

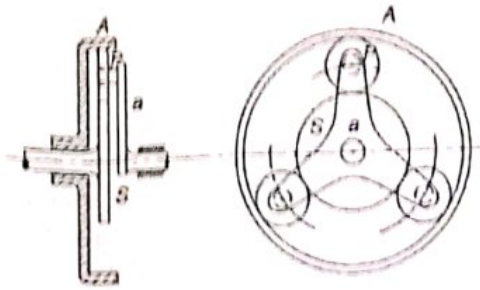

Figure 2

4. Design a four-link mechanism if the motions of the input and the output links are governed by a function $y = x^{1.8}$ and x varies from 1 to 4. Assume θ to vary from 30° to 120° and φ from 60° to 130°. The length of the fixed link is 30 mm. Use Chebychev spacing of accuracy points. [20]

5. a) The crank and connecting rod of a vertical petrol engine, running at 1800 rpm are 60 mm and 270 mm long respectively. The diameter of the piston is 100 mm and the mass of the reciprocating parts is 1.2 kg. During the expansion stroke when the crank has turned 20° from the top dead centre, the gas pressure is 650 kN/m^2 (In the expansion stroke, the gas pressure is relatively large on the cover side). Determine the (i) net force on the piston, (ii) Force in the connecting rod (iii) thrust on the cylinder walls, (iv) crank effort and (v) thrust on the crankshaft bearings. [10]

b) A machine weighs 18 kg and is supported on springs and dashpots. The total stiffness of the springs is 12 N/mm and the damping is 0.2 N/mm/s. The system is initially at rest and a velocity of 120 mm/s is imparted to the mass. Determine the displacement and velocity of mass as a function of time and find the displacement and velocity after 0.4 s. [10]

6. Four masses A, B, C and D are completely balanced. Masses C and D make angles of 90° and 195° respectively with that of mass B in the counterclockwise direction. The rotating masses have the following properties: m_b = 25 kg, m_c = 40 kg, m_d = 35 kg, r_a = 150 mm, r_b = 200 mm, r_c = 100 mm and r_d = 180 mm. [20]

Planes B and C are 250 mm apart. Determine (i) mass A and its angular position with that of mass B (ii) positions of all the planes relative to plane of mass A.

7. a) Each arm of a Porter governor is 250 mm long. The upper and lower arms are pivoted to links of 40 mm and 50 mm respectively from the axis of rotation. Each ball has a mass of 5 kg and the sleeve mass is 50 kg. The force of friction on the sleeve of the mechanism is 40 N. Determine the range of speed of the governor for extreme radii of rotation 125 mm and 150 mm. [10]

b) The rotor of a turbine ship has a mass of 2500 kg and rotates at a speed of 3200 rpm counter clockwise when viewed from stern. The rotor has radius of gyration of 0.4 m. Determine the gyroscopic couple and its effect when (i) the ship steers to the left in a curve of 80 meter radius at a speed of 15 knots (1 knot = 1860 m/h). (ii) the ship pitches 5 degrees above and 5 degree below the normal position and the bow is descending with its maximum velocity – the pitching motion is simple harmonic with a periodic time of 40 seconds. (iii) the ship rolls and at the instant, its angular velocity is 0.4 rad/s clockwise when viewed from stern. Also find maximum angular acceleration during pitching. [10]