Final Assessment Test – November 2019

VIT
Vellore Institute of Technology

Course: MEE2004 - Mechanics of Machines

Class NBR(s): 1180 / 1363 / 1536

Time: Three Hours

Slot: A1+TA1+V1

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. In the toggle mechanism shown in *Figure 1*, the crank OA rotates at 210 rpm counter-clockwise **[20]** increasing at the rate of 60 rad/s². For the given configuration, determine
   (i) velocity of slider D and the angular velocity of link BD
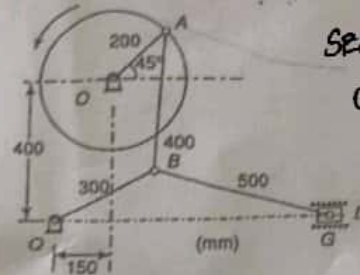   (ii) acceleration of slider D and the angular acceleration of link BD

SEARCH VIT QUESTION PAPERS
ON TELEGRAM TO JOIN

Figure 1

2. a) The following data relate to a cam profile in which the follower moves with uniform acceleration **[15]** and retardation during ascent and descent:

   Minimum radius of cam = 50 mm
   Roller radius = 10 mm
   Lift = 30 mm
   Offset of follower axis = 20 mm towards right
   Angle of ascent = 60°
   Angle of descent = 90°
   Angle of dwell between ascent and descent = 45°
   Speed of the cam = 500 r.p.m.

   Draw the profile of the cam and determine the maximum velocity and acceleration of the follower during outstroke and return stroke.

   b) With neat sketches write the difference between Whitworth and crank and slotted lever quick **[5]** return mechanisms.

3. a) A crank-rocker mechanism ABCD has the dimensions AB = 30 mm, BC = 90 mm, CD = 75 mm and AD **[10]** (fixed link) = 100 mm. Determine the maximum and minimum values of the transmission angles. Locate the toggle positions and indicate the corresponding crank angles and the transmission angles.

   b) An epicyclic gear consists of three gears A, B and C as shown in *Figure 2*. The gear A has 80 internal **[10]** teeth and gear C has 30 external teeth. The gear B meshes with both A and C and is carried on an arm EF which rotates about the centre of A at 20 r.p.m. If the gear A is fixed, determine the speed of gears B and C.

Figure 2

4. Four masses A, B, C and D have masses 2 kg, 4 kg, 3 kg and m_D respectively. These masses are revolving with the shaft at radii 30 mm, 40 mm, 50 mm and 30 mm located from the axis of shaft. Distance between planes B and C are 250 mm apart. Angular position of mass C and mass A are 90° and 250° respectively measured anticlockwise from mass B. **[20]**

Find

(i) The mass and angular position of mass D

(ii) The distance of masses A and mass D from mass B so that the shaft will be in complete balance.

5. a) In a Porter Governor, the upper and lower arms are 200 mm and 250 mm respectively and pivoted on the axis of rotation. The mass of the central load is 15 kg, the mass of each ball is 5 kg and friction of the sleeve together with the resistance of the operating gear is equal to a load of 40 N at the sleeve. If the limiting inclinations of the upper arms to the vertical are 30° and 45°, find, taking friction into account, range of speed of the governor. **[12]**

b) The crank-pin circle radius of a horizontal engine is 300 mm. The mass of the reciprocating parts is 250 kg. When the crank has travelled 60° from I.D.C., the difference between the driving and the back pressures is 0.35 N/mm². The connecting rod length between centres is 1.2m and the cylinder bore is 0.5 m. If the engine runs at 250 r.p.m. and if the effect of piston rod diameter is neglected, calculate: (i) pressure on slide bars, (ii) thrust in the connecting rod, (iii) tangential force on the crank-pin. **[8]**

6. a) The mass of turbine rotor of a ship is 3500 kg. It has a radius of gyration of 45 cm and a speed of 3000 r.p.m. clockwise, when looking from the stern. Estimate the gyroscopic couple and its effects upon the ship under the following two conditions: **[10]**

   (i)   When the ship is steering to the left in a curve of 100m radius at a speed of 36 km/hr.
   (ii) When the ship is pitching in a SHM, the bow falling with its maximum velocity. The period of pitching 40 seconds and the total angular displacement between the two extreme positions of pitching is 12 degrees.

b) In a turning moment diagram, the areas above and below the mean torque line taken in order are 4400, 1150, 1300 and 4550 mm² respectively. The scales of the turning moment diagram are: **[10]**

   Turning moment, 1 mm = 100 N-m ; Crank angle, 1 mm = 1°

   Find the mass of the flywheel required to keep the speed between 297 and 303 r.p.m., if the radius of gyration is 0.525 m.

7. a) Design a four-link mechanism when the motion of the input and the output links are governed by a function $y = x^3$ and x varies from 0 to 2. Assume the input angle to vary from 50° to 150° and output angle vary from 80° to 160°. Assume input link length as 100 mm. **[14]**

b) The following data are given for a vibratory system with viscous damping:

   Mass = 2.5 kg

   Spring constant = 30 N/cm

   The amplitude decreases to 0.25 of the initial value after five consecutive cycles. Determine the coefficient of the damping in the system. **[6]**

⇔⇔⇔