Total No. of Questions—**12**] [Total No. of Printed Pages—**8**

| Seat No. | |
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# [4857]-116

**S.E. (Mechanical/Automobile Engg./Mech. S/W.) (Second Semester) EXAMINATION, 2015**

**THEORY OF MACHINES—I**

**(2008 PATTERN)**

**Time : Four Hours** **Maximum Marks : 100**

***N.B.* :—** (*i*) Answer Q. No. **1** *or* Q. No. **2,** Q. No. **3** *or* Q. No. **4,** Q. No. **5** *or* Q. No. **6**, Q. No. **7** *or* Q. No. **8,** Q. No. **9** *or* Q. No. **10**, Q. No. **11** *or* Q. No. **12**.

(*ii*) Neat diagrams must be drawn wherever necessary.

(*iii*) Figures to the right indicate full marks.

(*iv*) Use of non-programmable calculator is allowed.

(*v*) Assume suitable data, if necessary.

(*vi*) Answers to the two sections should be written in separate answer-books.

(*vii*) The problems having graphical solutions should have preferably complete solution on drawing sheets.

## SECTION I

## UNIT I

**1.** (*a*) Define : [4]

(*i*) Kinematic chain

(*ii*) Grashoff's law

(*iii*) Machine

(*iv*) Degree of freedom.

(*b*) With the help of a neat sketch, explain Whitworth quick return motion mechanism. [4]

P.T.O.

(*c*) What is condition for correct steering ? Distinguish between Ackermann and Davis steering gear mechanism with the help of at least *four* important points. [8]

*Or*

**2.** (*a*) Define : [4]

(*i*) Kinematic link

(*ii*) Structure

(*iii*) Kinematic pair

(*iv*) Inversion.

(*b*) Write a short note on crank and slotted lever quick return motion mechanism. [4]

(*c*) (*i*) The length of the fixed link of a crank and slotted lever mechanism is 250 mm and that of the crank is 100 mm. Determine :

(1) Inclination of the slotted lever with the vertical in extreme position.

(2) Ratio of time of cutting stroke to the time of return stroke.

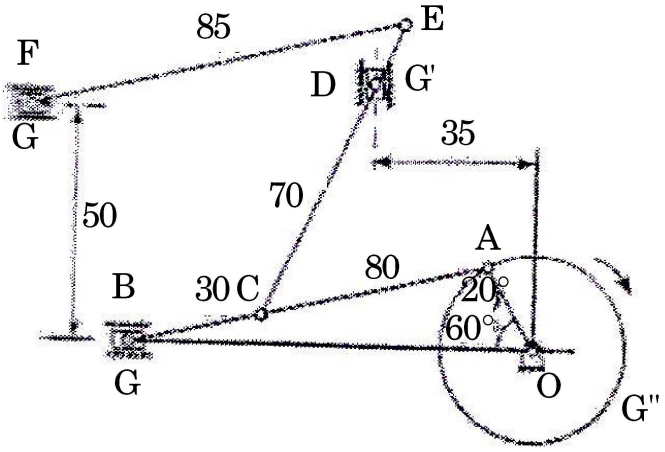
(3) Length of the slotted lever is 450 mm and the line of stroke passes through the extreme position of the free end of the lever. [4]

(*ii*) In an Oldham's coupling, the speed of rotation is 600 rpm. The distance between the shaft axes is 50 mm. Find the maximum speed of sliding of each tongue in its slot. [2]

(*iii*) In a Whitworth quick return mechanism, if length of driving link is 400 mm, what should be the distance between the fixed pivots if required time ratio of forward stroke to return stroke is 2 : 1. [2]

## UNIT II

**3.** In the mechanism shown in Fig. 1, the crank OA rotates at 210 rpm clockwise. For the given configuration, determine the velocities and accelerations of the sliders B, D and F. [16]




AB = 80 (mm)
BC = 30
CE = 70
CD = 55

Fig. 1

*Or*

**4.** Fig. 2 shows the mechanism of a sewing machine needle box. For the given configuration, find the velocity of the needle fixed to the slider D when the crank OA rotates at 40 rad/s. [16]

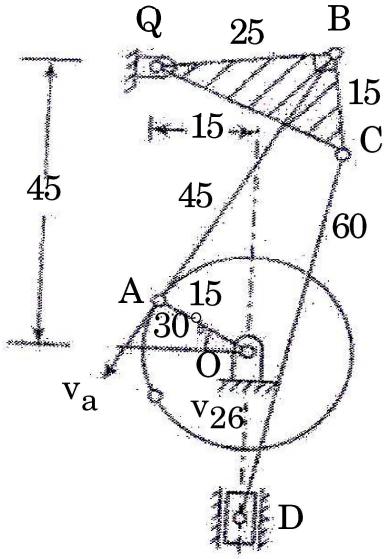



Fig. 2

## UNIT III

**5.** In the swiveling joint mechanism shown in Fig. 3, AB is the driving crank rotating at 300 rpm clockwise. The lengths of the various links are AD = 650 mm, AB = 100 mm, BC = 800 mm, DC = 250 mm, BE = CE, EF = 400 mm, OF = 240 mm, FS = 400 mm.
For the given configuration of the mechanism, determine the acceleration of the sliding of the link EF in the trunnion. [18]

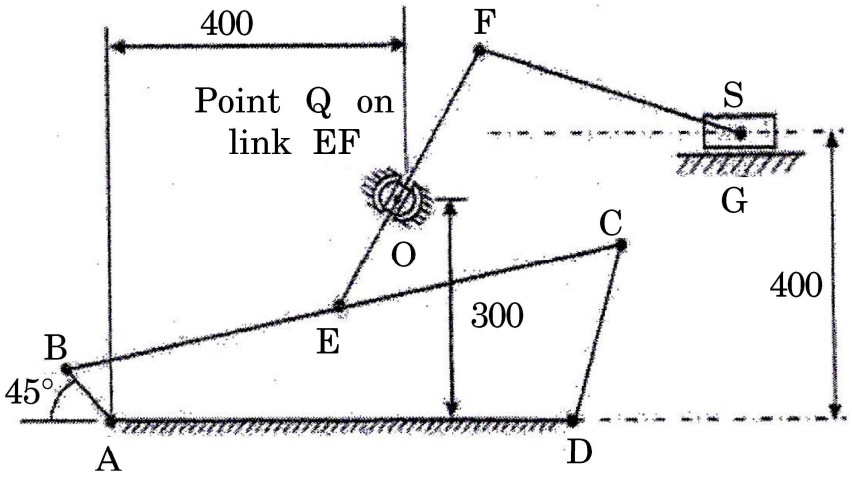



Fig. 3

*Or*

**6.** (*a*) In a four stroke cycle engine, the crank is 100 mm and the obliquity ratio is 4.5. The engine speed is 800 rpm. Determine by Klein's construction, the velocity and acceleration of the piston when the crank is at 45° from i.d.c. [6]

(*b*) Fig. 4 shows a crank and slotted lever quick return mechanism, in which the distance between the fixed centres O and C is 210 mm. The driving crank CP is 105 mm long and it rotates clockwise at 90 of rpm. The length of the slotted link OD is 420 mm and the length of the link DE is 165 mm. The line of stroke of the ram E is horizontal and 205 mm above

the fixed centre C. At the instant when the angle OCP is 110°, find the velocity and acceleration of ram E. [12]

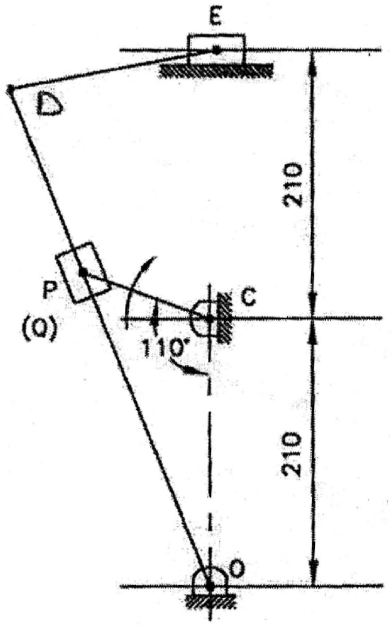



Fig. 4

## SECTION II
## UNIT IV

**7.** (*a*) The four bar mechanism ABCD is shown in Fig. 5 below which is driven by link 2 at $\omega_2$ = 45 rad/s, counter-clockwise. Find the angular velocities of links 3 and 4 by using complex algebra method. AB = 100 mm, CD = 300 mm, AD = 250 mm. [12]

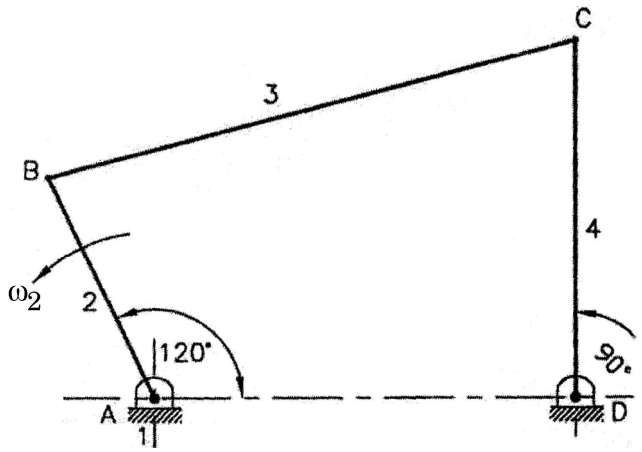



Fig. 5

(*b*) State the applications of Hooke's joint. [4]

*Or*

**8.** (*a*) The crank and connecting rod of IC engine mechanism are 250 mm and 800 mm long respectively. The angular velocity of crank is 18 rad/s and increasing at a rate of 14 rad/s$^2$. If the angle turned by crank from IDC is 50°, find :

(*i*) Linear velocity and acceleration of piston.

(*ii*) Angular velocity and angular acceleration of the connecting rod. [6]

(*b*) Angle between two shafts is 25° connected by a Hooke's joint is rotating at 100 rpm, find out :

(*i*) Minimum speed of driven shaft in rpm.

(*ii*) Maximum speed of driven shaft in rpm.

(*iii*) The driving shaft rotation angles at which driven and driving shaft speeds are same. Also draw schematic polar diagram for the above Hooke's joint indicating all important values. [10]

## UNIT V

**9.** (*a*) What do you understand by the synthesis of mechanism ? Explain in short :

(*i*) Type of synthesis;

(*ii*) Number synthesis;

(*iii*) Dimensional synthesis. [4]

(*b*) Determine the Chebyshev spacing for function $y = 2x^3 - x$ for the range $0 \leq x \leq 4$ where four precision points are required. Assuming 30° starting position and 75° finishing position for input link and 90° starting position and 180° finishing position for the output link. Find the values of $x$, $y$, $\theta$ and $\phi$ corresponding to the four precision positions. [12]

*Or*

**10.** (*a*) Write short notes on the following : [6]

(*i*) Precision positions and structural error

(*ii*) Chebyshev spacing

(*iii*) Angle relationships for function generator.

(*b*) Design a four bar mechanism to coordinate three positions of the input and output links as follows (Refer Fig. 6) : [10]

$\theta_1 = 20°$, $\phi_1 = 35°$

$\theta_2 = 35°$, $\phi_2 = 45°$

$\theta_3 = 50°$, $\phi_3 = 60°$.

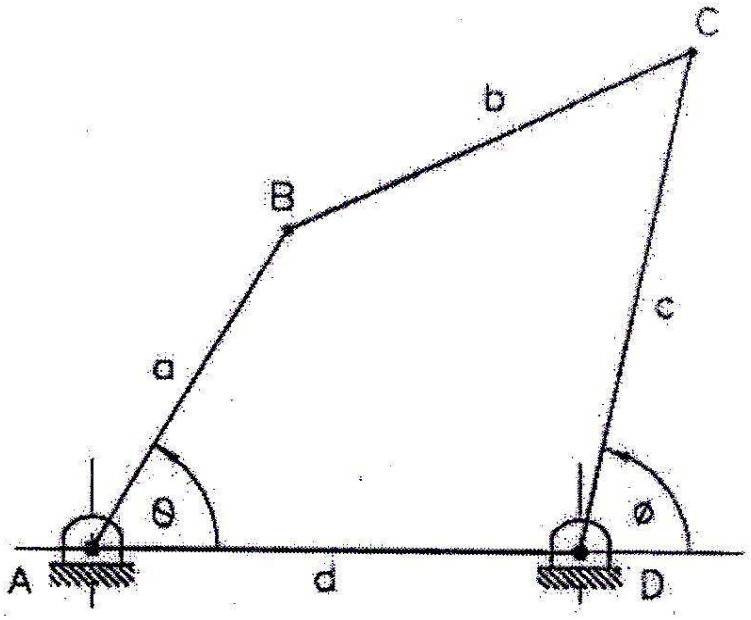



Fig. 6

## UNIT VI

**11.** (*a*) A connecting rod of IC engine as 3160 mm long and mass 380 kg. The stroke length is 2000 mm and mass of reciprocating parts is 700 kg. The mass moment of inertia about an axis through C.G. is 160 kg-$m^2$. The C.G. is at a distance 1.3 m from small end center. Determine the torque on the crankshaft if engine runs at 150 rpm. The crank position is 45° from IDC. Consider the inertia of reciprocating parts of engine. [12]

(*b*) A connecting rod of mass 35 kg is suspended at small end 600 mm above its CG. The frequency of oscillation is 0.55 Hz. Determine the dynamically equivalent masses if one of the mass is kept at small end centre. [6]

*Or*

**12.** (*a*) Derive frequency equation of Bifilar suspension system. [8]

(*b*) A connecting rod of IC engine is 3160 mm long and mass 380 kg. The stroke length is 2000 mm and mass of reciprocating parts is 700 kg. The mass moment of inertia about an axis through C.G. is 160 kg-$m^2$. The C.G. is at a distance of 1.3 m from the small end centre. Determine the torque on the crankshaft if engine runs at 150 rpm. The crank position is 45° from IDC. Consider the inertia of the reciprocating parts of engine. [10]