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

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S.E. (Mechanical) (IInd Sem.) EXAMINATION, 2011

THEORY OF MACHINES AND MECHANISMS–I

(2008 PATTERN)

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

N.B. **:—** (*i*) Solve *three* questions from each Section.

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

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

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

(*v*) Use of electronic pocket calculator is allowed.

SECTION I

UNIT I

1. (*a*) Fill in the blanks with *correct* alternative and rewrite the complete sentences. [6]

1. One ternary joint is equivalent to.....binary joints.

(*a*) 1

(*b*) 2

(*c*) 3

(*d*) 4

2. A screw pair has.....DOF (degrees of freedom).

(*a*) 1

(*b*) 2

(*c*) 3

(*d*) 4

3. Equivalent Linkage of a 'Cam Follower Pair' with radial cam driving reciprocating follower is a.....and that of a 'Spur gear pair' is a..... .

(*a*) Crank-Rocker mechanism

(*b*) Double slider mechanism

(*c*) Four bar mechanism

(*d*) Slider crank mechanism

4. In a 4 revolute 'Grashoffian chain', if the shortest link is grounded, we get..... .

(*a*) double rocker mechanism

(*b*) crank rocker mechanism

(*c*) double crank mechanism

(*d*) structure

5. Track rod of 'Davis steering gear mechanism' is a.....link.

(*a*) binary

(*b*) ternary

(*c*) quaternary

(*d*) fluid

(*b*) Fig. 1 shows schematic of a mechanism. Redraw the sketch on the answer-book. Find out the total number of kinematic links and number of kinematic pairs. Hence find out the degrees of freedom for the mechanism. [4]

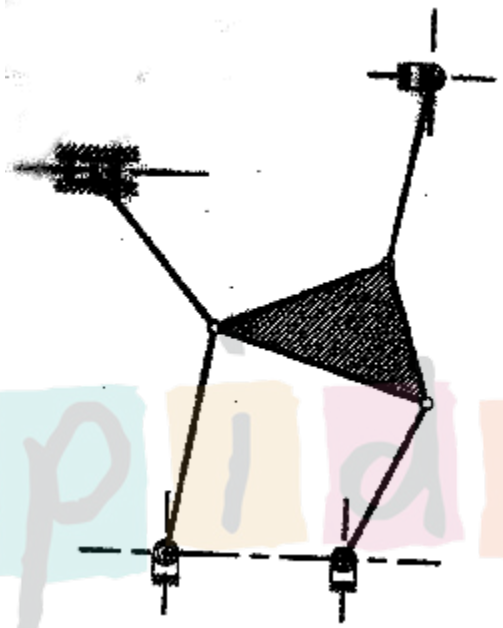

Fig. 1

(*c*) Compare 'Davis' and 'Ackermann' steering gear mechanisms. [6]

Or

2. (*a*) In case of an elliptical trammel, prove that any point on the coupler rod traces perfect ellipse. Hence locate that point on the coupler, which will trace circle. [6]

(*b*) Fig. 2 shows schematic of a mechanism. Redraw the sketch on the answer-book. Find out the total number of kinematic links and number of kinematic pairs. Hence find out the degrees of freedom for the mechanism. [4]

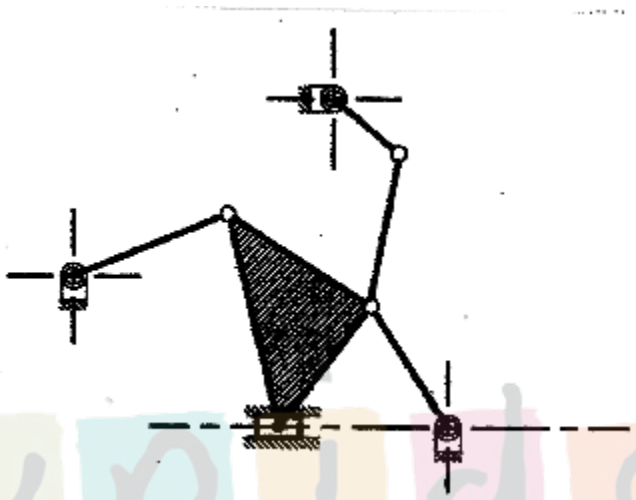

Fig. 2

(*c*) With the help of a neat sketch explain the construction and working of 'Pantograph' or 'Geneva Mechanism'. [6]

UNIT II

3. (*a*) Fig. 3 shows a mechanism in which crank OA is rotating anticlockwise at 20 rad/s. At the instant shown, find out the velocity and acceleration of sliders B and D as well

as the angular acceleration of link AB using relative method (polygon method).

(Use scale 1 mm ° 10 mm/s for the velocity polygon and 1 mm ° 200 mm/s^2 for the acceleration polygon). [12]

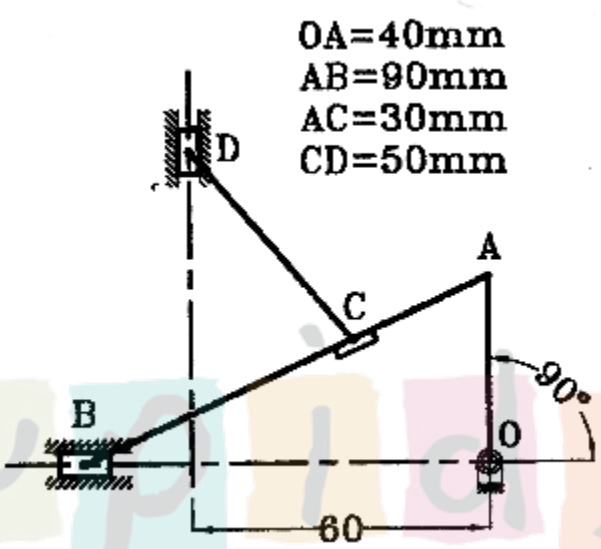

Fig. 3

(*b*) With the help of supporting sketch, explain the concept of 'Velocity Image Principle'. [4]

Or

4. (*a*) Fig. 4 shows a mechanism in which crank OA is rotating clockwise at 240 rpm. At the instant shown, locate all ICRs for the mechanism and find out the velocity of slider E

as well as the angular velocity of link BC using ICR method. [10]

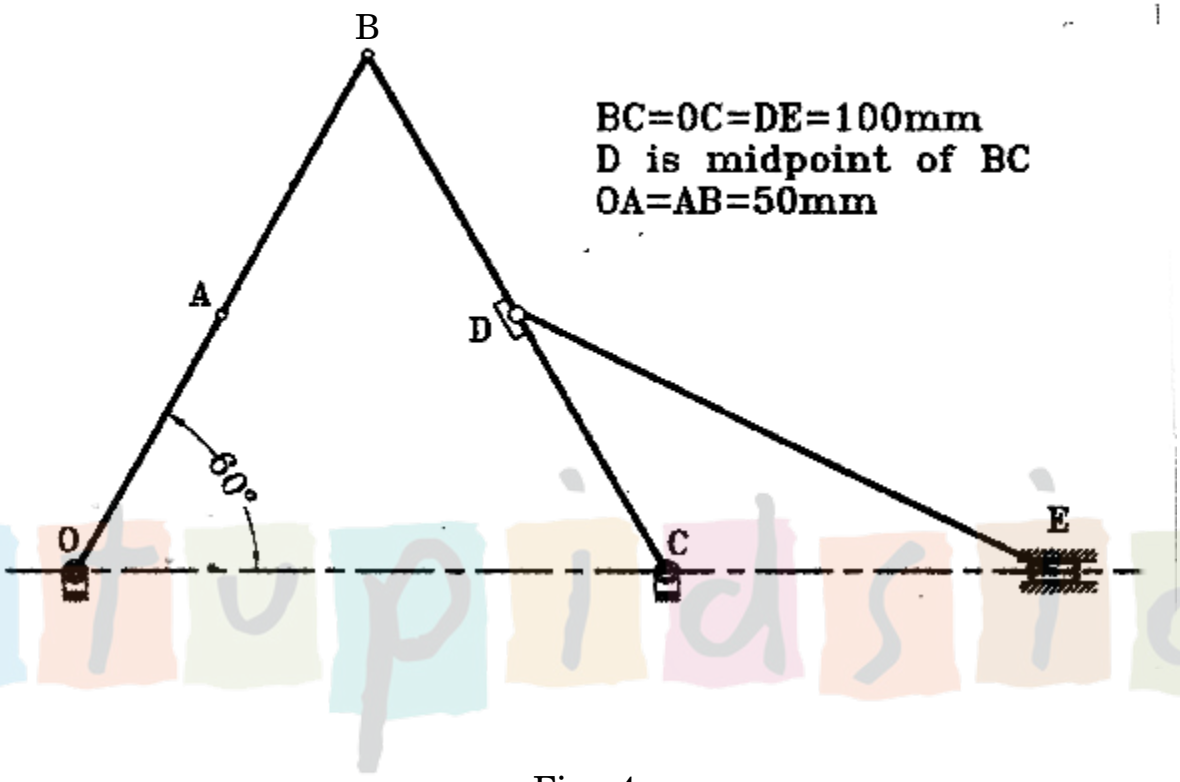

Fig. 4

(*b*) With the help of supporting sketch, explain the concept of 'Body centrode and Space centrode'. [6]

UNIT III

5. Fig. 5 shows a mechanism in which crank OA is rotating clockwise at 30 rad/s. Lever CD drives slider F through coupler EF as shown. At the instant shown, find out the acceleration of slider F as well as the angular acceleration of Link EF.

(Use scale 1 mm = 10 mm/s for the velocity polygon and 1 mm = 300 mm/s^2 for the acceleration polygon). [18]

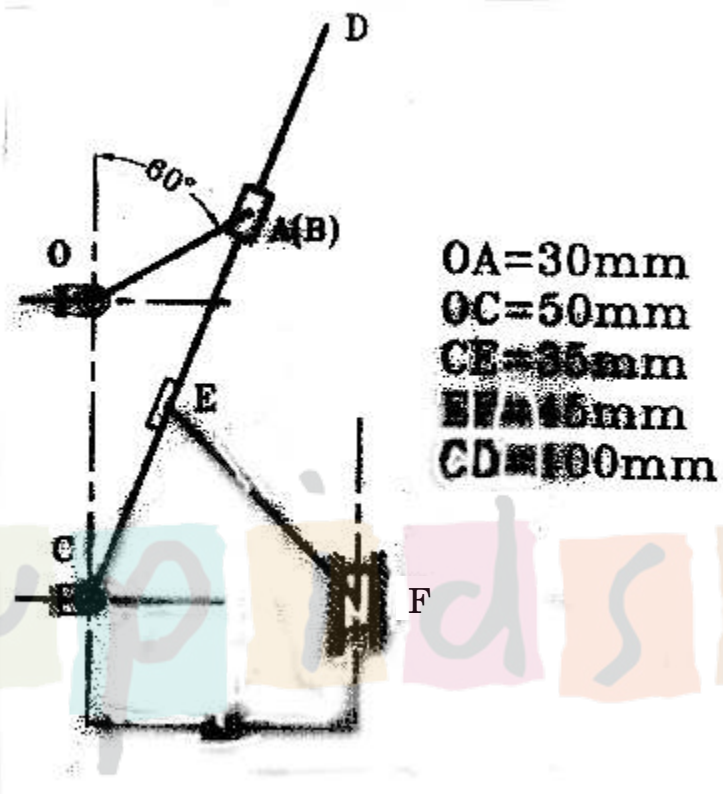

Fig. 5

Or

6. (*a*) State whether the following statements are *true* or *false* and justify your answer : [6]

(1) We will have to consider 'Coriolis component of acceleration' while analyzing a normal scotch yoke mechanism.

(2) Shape of acceleration polygon remains unchanged if we reverse the direction of rotation of input link.

(3) In all mechanisms involving trunnion, coriolis component must be considered in the acceleration analysis.

(*b*) In an IC engine mechanism, crank radius is 40 mm and connecting rod length is 160 mm. The crank is rotating at 10 rad/s clockwise. At a particular instant the crank is at 40° from TDC position. For this position of the mechanism, find out the velocity and acceleration of piston and angular velocity and angular acceleration of connecting rod using Klein's construction method. [12]

SECTION II

UNIT IV

7. (*a*) Show that the velocity ratio of shafts connected by Hooke's joint is given by the following equation, where a is the angle between the shafts and q is the angle turned by driving shaft from the position when its fork lies is the planes of shaft axes :

$$(\cos \alpha) / (1 - \sin^2 \alpha \, . \cos^2 \theta) \, . \qquad [8]$$

(*b*) The four bar mechanism ABCD is shown in the following Fig. 6 which is driven by link 2 at w_2 = 45 rad/sec, counterclockwise.

Find the angular velocities of link 3 and link 4 by using complex number method. [8]

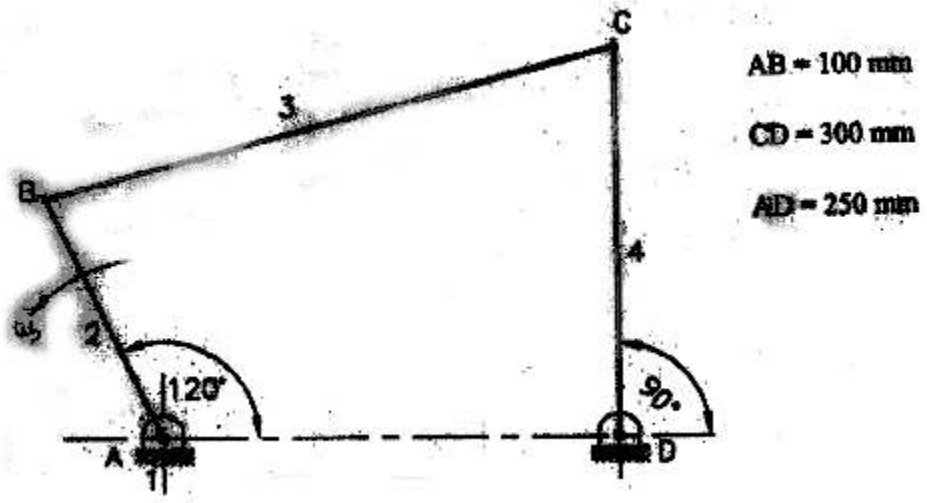

Fig. 6

Or

8. (*a*) In an IC engine mechanism, the stroke of the slider is 180 mm and the obliquity ratio is 4.25. The crank rotates uniformly at 900 rpm clockwise. Find :

(*i*) Velocity and acceleration of piston and

(*ii*) Angular velocity and angular acceleration of connecting rod, when the crank is at 30° past the ODC. [8]

(*b*) Two shafts are connected by a universal joint. The driving shaft rotates at a speed of 1200 rpm. Determine the greatest permissible angle between the shaft axes so that the total fluctuation of speed does not exceed 100 rpm. Also calculate the maximum and minimum speed of shaft. [8]

UNIT V

9. (*a*) Explain with the help of neat sketches : [6]

(*i*) Angle relationship for function generation

(*ii*) Precision positions and structural error

(*iii*) Path generation.

(*b*) Design a four bar mechanism with input link *a*, coupler link *b*, output link *c*. Angle q and j for three successive positions are given in the table below : Use Freudenstein method :

Position	**1**	**2**	**3**
q	30	50	70
j	40	75	100

Draw the mechanism in second position. [10]

Or

10. (*a*) A four bar mechanism is to be designed, by using three precision points, to generate the function $y = x^{1.5}$ for the range $1 \leq x \leq 4$. Assume 30° starting position and 120° finishing position for the input link and 90° starting position and 180° finishing position for the output link, find the values of *x*, *y*, q and j corresponding to the three precision points. [8]

(*b*) Synthesis the four bar mechanism ABCD, in which the length of the fixed link AD is 400 mm and the crank AB is of 120 mm long. The initial position makes an angle 60° with link AD,

the angle between the fixed link AD and 2nd position is 120° and the angle between the third position and link AD is 180°. The angle between the first and second and second and third position of the output link are the 60° and 30° respectively. Draw the mechanism in the first position by inversion method. [8]

UNIT VI

11. (*a*) The following data relate to a connecting rod of a reciprocating engine : [12]

Mass = 55 kg

Distance between bearing centers = 850 mm

Diameter of small end bearing = 75 mm

Diameter of big end bearing = 100 mm

Time of oscillation when the connecting rod is suspended from small end 1.83 seconds. Time of oscillation when the connecting rod is suspended from big end = 1.68 seconds.

Determine :

(1) The radius of gyration of the rod about an axis passing through the centre of gravity and perpendicular to the plane of oscillation;

(2) The moment of inertia of the rod about the same axis; and

(3) The dynamically equivalent system for the connecting rod constituted of two masses, one of which is situated at the small end.

(*b*) Draw and explain turning moment diagram of a 4 stroke cylinder engine. State significance of it. [6]

Or

12. (*a*) With the help of neat schematic diagram, derive frequency equation of bifilar suspension system. [6]

(*b*) The piston diameter of an internal combustion engine is 125 mm and the stroke is 220 mm. The connecting rod is 4.5 times the crank length and has a mass of 50 kg. The mass of the reciprocating parts is 30 kg. The centre of mass of connecting rod is 170 mm from the crank pin centre and the radius of gyration about an axis through the centre of mass is 148 mm. The engine runs at 320 rpm. Find the magnitude and the direction of the inertia force and the corresponding torque on the crankshaft when the angle turned by the crank is 140° from the inner dead centre. [12]