**Kinematics of machinery**

**Answer key – set one**

**Part –A Marks 1 x 10 = 10 Marks**

**a) - iii**

**b) -i**

**c) -i**

**d) -ii**

**e) -iii**

**f) -iv**

**g) -ii**

**h) -ii**

**i) -iv**

**j) -ii**

**PART – B 2 x 10 = 20 Marks**

**a)** Kinematic pair is a joint of two links having relative motion between them. The types of kinematic pair are classified according to Nature of contact. (Lower pair, higher pair) Nature of mechanical contact. (Closed pair, unclosed pair) Nature of relative motion. (Sliding pair, turning pair, rolling pair, screw pair, Spherical pair)

**b)** In a four bar chain mechanism the angle between the coupler and the follower link is called as transmission angle

**c)** It is defined as the algebraic sum of the angular velocities of the two links connected by the pin joint multiplied by the radius of the pin **( W1 + /- W2) x r**

**d)** If three bodies move relative to each other then they have three instantaneous centres and lie on a straight line. It is used for locating ICR in the mechanisms such as IC engine, four bar mechanism, quick return mechanisms.

**e)** Each particle of every link of a machine is constrained to move along a definitre path therefore, to design a machine complexity, the velocity and acceleration analysis is needed.

**f)** Function Generation: where the functional requirement is the relative motion between links, which are generally connected to ground pivots (Figure 1.2), or where a specific input position will result in a specific output position;

g) Simple Harmonic Motion or SHM is defined as a motion in which the restoring force is directly proportional to the displacement of the body from its mean position. The direction of this restoring force is always towards the mean position. 

**h)** A tooth system is a standard which specifies the relationship between addendum, dedendum, working depth, tooth thickness and pressure angle to attain interchange ability of gears of tooth numbers but of the same pressure angle and pitch

**i)** It is the distance measured on the circumference of the pitch circle from a point of one tooth to the corresponding point on the next tooth. It is denoted by Pc

Circular pitch Pc= π/DT, Where D = Diameter of pitch circle. T = Number of teeth on the wheel.

**j)** Velocity ratio of a simple gear train is defined as the ratio of the angular velocity of the first gear in the train to the angular velocity of the last gear.

**PART –C 10 x 4 = 40 Marks**

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**3 (a)** For the explanation of elliptical trammel, scotch yoke mechanism and Oldhams coupling with suitable diagram ---- 10 marks

Only explanation without diagram ----- 5 marks

(b) turning pair, sliding pair , screw pair, rolling pair, spherical pair, self closed pair, forced closed pair – for explanation any four ----------- 5 marks

Kinematic chain – It is defined as the combination of kinematic pair is called kinematic chain where relative motion between them is completely constrained ---- 4 marks

Example – single slider crank chain, four bar chain --- 1 mark

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4 (a) for the construction of velocity diagram and acceleration diagram with the procedure and the values of velocity and acceleration of midpoint and angular velocity and acceleration of link CB, CD -10 marks

**Velocity of midpoint – 1.67 m/s, acceleration of midpoint – 110 m/s2, angular velocity of link CB – 8.9 r/s, angular acceleration of CB – 870 r/s2 , angular velocity of link CD- 32.4 r/s, angular acceleration of CD – 1040 r/s2**

(b) Diagram of crank and slotted lever mechanism ----- 3 marks

Construction and working ---- 4 marks

Time ratio and length of stroke formula ----3 marks

**Time ratio = β /∞, length of stroke = 2 AP X CB/AC**

**AP – Slotted lever, CB = Crank, AC = distance between the fixed centres**

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**5(a) for discussing the methods of determining the angles of input link alone – 5 marks**

**Output link - 5 marks**

**(b) Displacement diagram alone for simple harmonic motion --- 4 marks**

**Cam profile ---- 4 marks**

**Maximum velocity and acceleration of valve during raising**

**V = 0.39 m/s , a = 6.17 m/s2 ------- 1 mark**

**Maximum velocity and acceleration of valve during lowering**

**V = 0.78 m/s , a =24.67 m/s2 ----------- 1 mark**

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**6(a) r =mt/2 = 50 mm, R = MT/2 = 100 mm**

ra = 50 + 5 = 55 mm , RA = 100 + 5 = 105 mm

KP = 12.56 mm

PL = 11.5 mm

Length of path of contact = 12.65 + 11.5 = 24.15 mm ----------------------------- 3 marks

Length of arc of contact = 24.15 /cosƟ = 25.7 mm -------1 mark

Angle turned = length of arc of contact x 3600

--------------------------------------------------- = 25.7 x 3600

Circumference of pinion --------------- = 29.450 --- 3 marks

2 x 3.14 x 50

Maximum velocity of sliding

Vs = (w1 + w2) KP

= ( 24 + 12 ) 12.65 = 455.4 mm/sec ----3 marks

(b) when A makes one revolution clockwise and D makes half revolution anticlockwise

From tabular column

-x –y = -1 or x + y = 1 --------eqn 1

X \* TA/TD – Y = 0.5 X \* 40/90 - y = 0.5

40x – 90 y = 45 --------eqn 2

Solving 1 and 2 x = 1.04 and y = 0.04

therefore speed of arm = 0.04 anticlockwise ---- ----------------------------------- 5 marks

x + y = 1 ----eqn 1

x \* TA/TD - Y = 0

X \* 40/90 – Y = 0 40X – 90 Y = 0 ---eqn 2

From eqn 1 and 2 x = 0.692 y = 0.308

Speed of arm = 0.308 revolution anticlockwise ----------------------------5 marks

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