B. MECHANICAL 2ND YR 2ND SEM EXAMINATION, 2017

KINEMATICS ANALYSIS AND SYNTHESIS

Time: 3 Hrs | Full Marks: 100

(Assume data if missing)

(Answer question 1 and any four from the rest)

1. Answer the following question in brief (any five).

(a) Explain whether the pressure angle between cam and roller follower is as high as possible or as low as possible.

(b) An internal gear with 60 teeth meshes with a pinion of 20 teeth, module being 6 mm. Find out the centre distance in mm.

(c) Explain the basic purpose of an automobile steering mechanism.

(d) Explain why in case of a helical gear pair, an axial thrust bearing is provided to support axial load generated during operation.

(e) What are the advantages of using involute as gear tooth profile?

(f) In context to gear pair, what do you understand by conjugate profiles?

(g) Explain why differential gear mechanism is required in an automobile.

(h) A slider crank mechanism is a special case of 4-bar mechanism – Explain.

5 x 4 = 20

2. A Slider crank mechanism is shown in Fig. 1. Length of crank and connecting rod are 10cm and 40 cm respectively. If crank rotates anticlockwise with an angular velocity of 20 rad/s, then find out angular velocity and angular acceleration of connecting rod and linear acceleration of the slider. 20

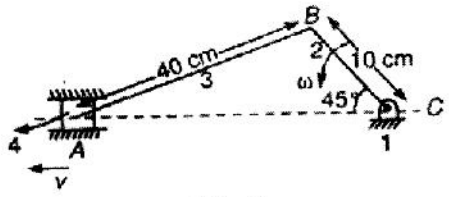

Fig. 1

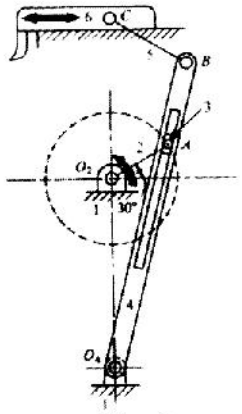

Fig. 2

3. (a) Sketch of a slotted lever mechanism is shown in Fig. 2. O_2A =12 cm, O_2O_4 = 30 cm, O_4B =60 cm, and BC = 15 cm. The line of movement of C is 30 cm above the point O_2. O_2A makes an angle of 30^0 with horizontal axis as shown in figure. Find the time-ratio of cutting stroke to return stroke and the stroke length. Why is it called quick return mechanism? 10

(b) Find out the cases shown in Fig. 3 where input link can make a complete rotation. The number indicates the link length. 4+3+3

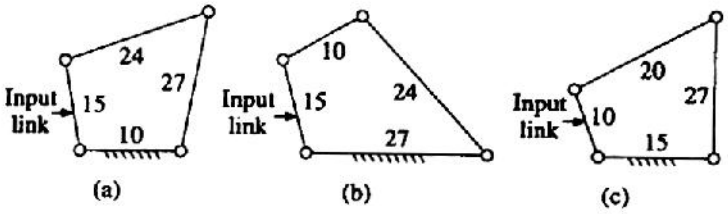

Fig. 3

4.(a) The attached wheel roll without slipping on the plates A and B, which are moving in opposite directions as shown in the Fig. 4. If velocities of plate A and B are given as $V_A = 60\ mm/s$ to the right and $V_B = 200\ mm/s$ to the left, determine the velocities of the center O and the point P shown in the Fig. 4.

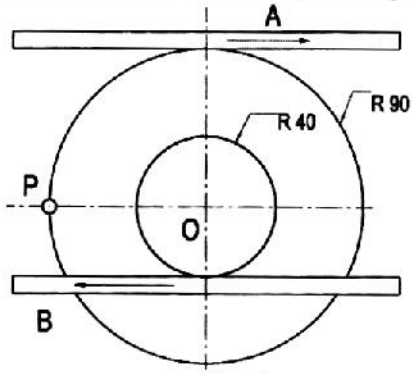

Fig. 4

(b) A follower is having a rise of 40 mm with cycloidal motion for 120° rotation of the cam. Plot the displacement, acceleration and jerk of the follower.

10 + 10

5. Analytically synthesize a function generator consisting of a 4-bar chain to solve the equation $y = \frac{1}{x^2}$ in a domain of $1 \le x \le 5$ using 3-precision Chebyshev model. Assume 45^0 starting position of input link with a total of 90^0-swing angle and a 240^0 starting position of output link with a range of 90^0-swing angle too. 20

6. Establish the expressions for the basic rotation matrices $R_{x,\alpha}$, $R_{y,\phi}$ and $R_{z,\theta}$, where the notations have the usual meanings. What will be the composite rotation matrix if ϕ about OY, θ about OU and finally α about OV? 20

Or

(i) Find out minimum number of binary links required in a constrained mechanism with simple hinges.

(ii) Find out the maximum number of hinges possible on one link in a constrained mechanism with ***n*** links.

(iii) If number of links in a constrained mechanism is 6, find out the possible arrangements of the mechanism .6+6+8

7. Draw the cam profile for the data given below:
Motion of the follower= SHM during ascent and decent.
Types of follower= Knife-edge.
Base circle radius of the cam= 30mm.
Maximum lift of the follower= 40mm.
Angle of ascent, dwell, decent and dwell= 150^0, 60^0, 100^0 and 50^0 respectively.
Speed of the cam= 150rpm. 20

Or

(i) The follower movement in a cam-follower mechanism with a translating flat-faced follower is given by $y(\theta) = 60(1-\cos\theta)$ mm, for $0 \le \theta \le 2\pi$.

The limit on the contact stress requires that the minimum radius of curvature of the cam profile should not be less than 100 mm anywhere and during the rise period the driving effort not have an eccentricity more that 40 mm. Determine the minimum permissible base circle radius and the minimum required offset. What should be the minimum width of the follower if an allowance of 2 mm is desirable on both sides?

(ii) Find out the degree of freedom of the following mechanisms.

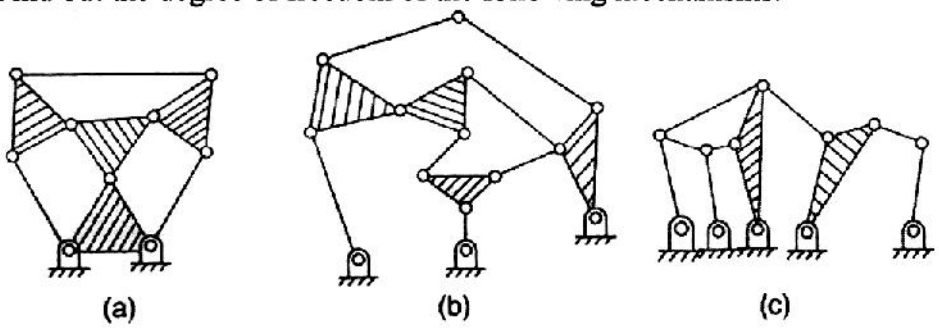

Fig. 5

8. (a) For an involute tooth profile, tooth thickness on the pitch circle is known, determine the tooth thickness at the addendum circle.

(b) In Fig. 6, if B is a shaft coupled to a dynamometer making 2500 rpm, how many revolutions per minute does C make?

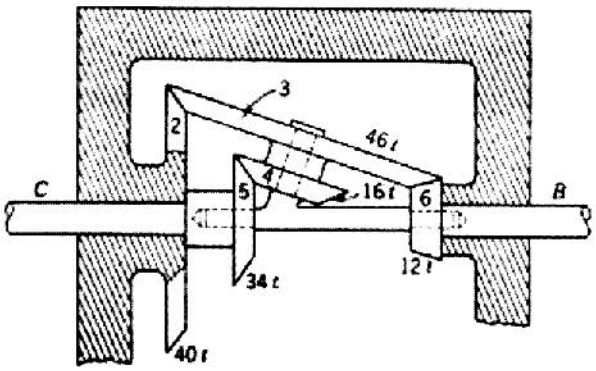

Fig. 6

8+12