

b) Find out the degree of freedom of the planar mechanism shown in Fig. 2 above. 3+3+4

7. a) The gear B of the planetary gear train shown in Fig. 3 below is fixed. The arm A carries a planet gear C. The arm A and the gears D and E are free to turn on the shaft. The number of teeth on each gear is indicated in the figure. The gears B, D, and E are cut from gear blanks of the same diameter. Determine the number of turns of the gears D and E if the arm A is given one counter-clockwise rotation.

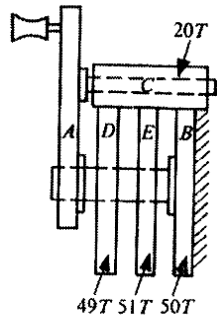


Fig. 3

10

b) Describe the procedure to design a slider-crank mechanism by Relative Pole Method when three positions of the input link ($\theta_1, \theta_2, \theta_3$) and the slider (S_1, S_2, S_3) are known.

Or

Assume the follower displacement y as a polynomial function of θ as shown below.

$$y = C_0 + C_1 \theta + C_2 \theta^2 + C_3 \theta^3 + \dots + C_5 \theta^5$$

Satisfying the following boundary conditions, namely,

$$y = 0, y' = 0, y'' = 0 \text{ at } \theta = 0 \text{ and}$$

$$y = L, y' = 0, y'' = 0 \text{ at } \theta = \beta,$$

find out the expression for velocity and acceleration of the follower motion. 10

B. Mech. Engg. 2nd Yr 2nd Semester Exam 2019
KINEMATICS ANALYSIS AND SYNTHESIS

Time: 3 Hrs

Full Marks: 100

(Assume data if missing)

(Answer Q. no. 1 and any 5 from the rest)

1. Choose the correct answer/s. 1x20=20
 1. Quick return mechanism is an inversion of
 - (a) Four bar chain, (b) Single slider crank chain
 - (b) Double slider crank chain, (d) Crossed slider crank chain
 2. Minimum Number of Teeth on the Pinion in Order to Avoid Interference for 20° Full depth involute gear teeth system
 - (a) 12 (b) 32 (c) 18 (d) 14
 3. Consider the following statement: coriolis component of acceleration depends on the
 - (1) Velocity of the slider
 - (2) Angular velocity of the link
 - (3) Acceleration of the slider
 - (4) Angular acceleration of the link
 - (a) 1 and 2 are correct, (b) 1 and 3 are correct
 - (b) 2 and 4 are correct, (d) 1 and 4 are correct
 4. The angle, which represents the cam profile and is most important in cam design, is
 - (a) cam angle, (b) pressure angle
 - (c) angle of dwell (d) angle of descent
 5. An involute pinion and gear are in mesh. If both have the same size of addendum, then there will be an interference between the
 - (a) Tip of the gear tooth and flank of the pinion
 - (b) Tip of the pinion and flank of the gear
 - (c) Flanks of both pinion and gear
 - (d) Tips of both pinion and gear

[Turn over

6. The instantaneous centre of rotation of a rigid thin disc rolling on a plane rigid surface is located at
 - (a) Centre of the disc
 - (b) An infinite distance on the plane surface
 - (c) The point of contact
 - (d) The point on the circumference situated vertically opposite to the contact point
7. Which of the following is a higher pair?
 - (a) Turning pair, (b) Screw pair
 - (c) Belt and pulley, (d) Sliding pair
8. In spur gears, the circle on which the involute is generated is called
 - (a) Pitch circle (b) Clearance circle
 - (c) Base circle (d) Addendum circle
9. Transmission angle is the angle between
 - (a) Input link and coupler (b) Input link and fixed link
 - (c) Output link and coupler (d) Output link and fixed link
10. A fixed gear having 200 teeth is in mesh with another gear having 50 teeth. The two gears are connected by an arm. The number of turns made by the smaller gear for one revolution of arm about the centre of bigger gear is
 - (a) 2 (b) 4 (c) 3 (d) None of the above
11. In which of the following type of gear train the first gear and the last gear are co-axial?
 - (a) Simple gear train (c) Compound gear train
 - (b) Reverted gear train (d) None of the above
12. Which gear train is used for higher velocity ratios in a small space?
 - (a) Simple gear (c) Compound gear train
 - (b) Reverted gear train (d) Epicyclic gear train
13. Consider the following statements:
 Coriolis acceleration component appears in the acceleration analysis of the following planar mechanisms:
 - i. Whitworth quick return mechanism

5. In a cam mechanism with a flat-faced translating follower, the total rise of the follower is 30 mm and the cam rotates through 180° during the rise period. During the first 90° of the cam rotation, the follower rises with constant acceleration and it decelerates uniformly during the second half of the rise period. The return of the follower is a simple harmonic motion during which the cam rotates through another 180° .
 - a) If the minimum radius of curvature of the cam profile is not to be less than 40 mm during the rise, determine the minimum required radius of the base circle.
 - b) Find out the minimum required width of the follower face with a 2.5 mm allowance on each side.
 - c) What should be the minimum offset if the maximum eccentricity of the driving effort during the rise is not to exceed 15 mm? 20

6. a) The coordinates of a point at the tip of a robotic tool are given by $(0, 0, 10)^T$ in terms of the tool frame. If the sequence of rotation of the tool is: yaw by π , pitch by $-\pi/2$ and roll by $\pi/2$, find the location of the tool tip in wrist coordinates frame.

Or

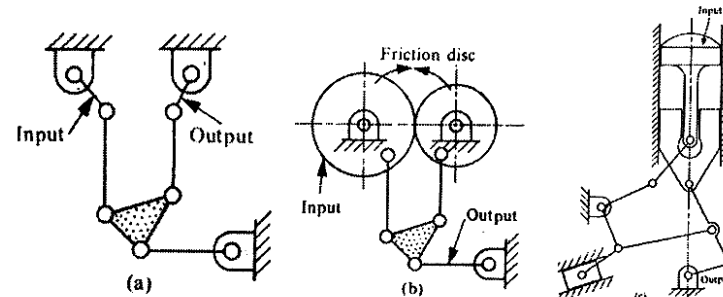


Fig. 2

- Find out the expression for minimum number of binary links in a constrained mechanism with simple hinges.
 For a six-link mechanism with constrained movement, find out the number of binary and ternary links in the mechanism. 10

2. The various dimensions of the mechanism, as shown in Fig.1, are $OA=120\text{mm}$, $AB=500\text{mm}$, $BC=120\text{mm}$, $CD=300\text{mm}$ and $DE=150\text{mm}$. the crank OA rotates at 150 rpm in CCW direction. The bell crank lever is DE . Determine the absolute velocity of point E and absolute acceleration of point B . Use graphical method. 20

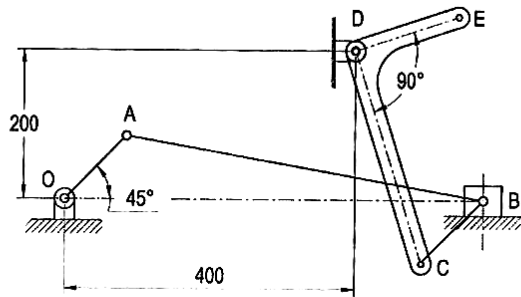


Fig. 1

3. Analytically synthesize a function generator consisting of a 4-bar chain to solve the equation $y = \frac{1}{x^2}$ in a domain of $1 \leq x \leq 5$ using 3-precision Chebyshev model. Assume 45° starting position of input link with a total of 90° -swing angle and a 240° starting position of output link with a range of 90° -swing angle too. 20
4. a) What is path of contact and arc of contact? Derive relation for its magnitude. 10
 b) Two gears in mesh have a module of 8 mm and a pressure angle of 20° . The larger gear has 57 while the pinion has 23 teeth. If the addenda on the pinion and gear wheels are equal to 1.0 module, find
 I. The number of pairs of teeth in contact;
 II. The angle of action of the pinion and the gear wheel;
 III. The ratio of sliding to rolling velocity at the pitch point. 10

- ii. Slider crank mechanism
 iii. Scotch Yoke mechanism
 Which of these statements is/are correct?
 (a) 1, 2 and 3 (b) 1 and 2 (c) 2 and 3 (d) 1 only
14. Idler gear is used for
 (a) Changing the direction of motion of the gear
 (b) Decreasing -velocity ratio
 (c) Increasing -velocity ratio
 (d) Avoiding the interference
15. To avoid axial thrust, following gear drive is used
 (a) Double helical gears having opposite teeth
 (b) Double helical gears having identical teeth
 (c) Single helical gear in which one of the teeth of helix angle is more
 (d) Mutter gears
16. For S.H.M. of cam follower, the acceleration of the follower at the ends of the stroke and at the mid stroke respectively, is
 (a) Maximum and zero (b) Zero and maximum
 (c) Minimum and maximum (d) Zero and minimum
17. Tchebichef mechanism has
 (a) Eight links (b) Six links (c) Four links (d) Twelve links
18. In its simplest form, a cam mechanism consists of following number of links
 (a) 1 (b) 2 (c) 3 (d) 4
19. For simple harmonic motion of the of follower, a cosine curve represents
 (a) Displacement diagram (b) Velocity diagram
 (c) Acceleration diagram (d) All of the above
20. According to Kennedy's theorem, if three bodies have plane motions, their instantaneous centers lie on
 (a) A triangle (b) A point (c) Two lines (d) A straight line