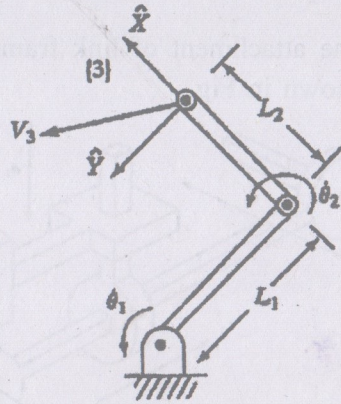


6. (a) Explain concept of velocity propagation from link to link. (5)
- (b) A two-link manipulator with rotational joints is shown in Fig. Calculate the velocity of the tip of the arm as a function of joint rates. Give the answer in two forms i.e. in terms of frame {3} and also in terms of frame {O}. (10)



7. Describe the following :
- (a) Derivation for path of contact of two meshing gear.
- (b) The structure of a manipulator's dynamic equations.
- (c) Frames with standard names. (15)

Roll No.

Total Pages : 4

020401

May 2024

**B.Tech. (RAI) IV SEMESTER
KINEMATICS OF ROBOTS (PCC-RAI-401/21)**

Time : 3 Hours]

[Max. Marks : 75

Instructions :

1. It is compulsory to answer all the questions (1.5 marks each) of Part-A in short.
2. Answer any four questions from Part-B in detail.
3. Different sub-parts of a question are to be attempted adjacent to each other.
4. Any missing data can be suitably assumed.

PART-A

1. (a) Differentiate between closed and open kinematic chain. (1.5)
- (b) What is kutchback criteria? (1.5)
- (c) What do you understand by description of frame? (1.5)
- (d) How is rotational operator represented? (1.5)
- (e) What do you know by Z—Y—X Euler angles ? (1.5)
- (f) What do you mean by Inverse manipulator kinematics? (1.5)
- (g) What is Jacobian of the manipulator? (1.5)

- (h) Define interference in gearing. (1.5)
- (i) Define force and torque acting on a link in terms of two equations. (1.5)
- (j) Define mapping. (1.5)

PART-B

2. (a) Derive an expression for DOF. Explain Inversions of Double slider crank mechanism. (10)
- (b) Describe the six possible lower-pair joints used in robotic manipulator. (5)
3. (a) Explain Link parameters used in manipulator with neat diagram. (5)

(b) A velocity vector is given by $Bv = \begin{bmatrix} 10.0 \\ 20.0 \\ 30.0 \end{bmatrix}$ (10)

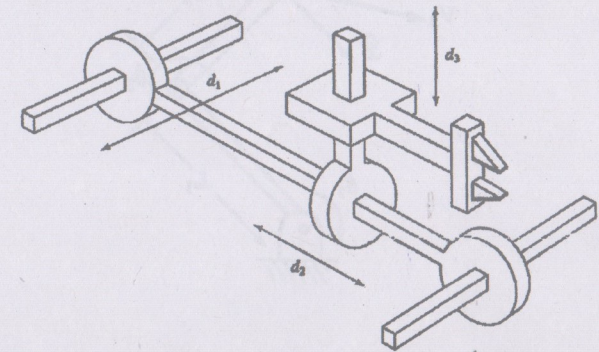
$$A_B T = \begin{bmatrix} 0.866 & -0.500 & 0.000 & 11.0 \\ 0.500 & 0.866 & 0.000 & -3.0 \\ 0.000 & 0.000 & 1.000 & 9.0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Compute AV

4. (a) Explain functioning of cam and follower with suitable diagram. (5)

- (b) In an epicyclic gear train pinion A is fixed to the driving shaft. A drives the gear B. Gear B and C are compounded, gear C drives the internal gear D and the Gear B drives the internal gear D. Arm F rotates at 500 rpm ccw while the driving shaft rotates at 100 rpm cw. Find the number of teeth on gears D and E and their speed of rotation. Also sketch the arrangement. Given $t_A = 20, t_B = 40, t_C = 30$. (10)

5. (a) Show the attachment of link frames on the three-link robot shown in Fig. (5)



- (b) Sketch the fingertip workspace of the 3-DOF manipulator of given fig. (10)

