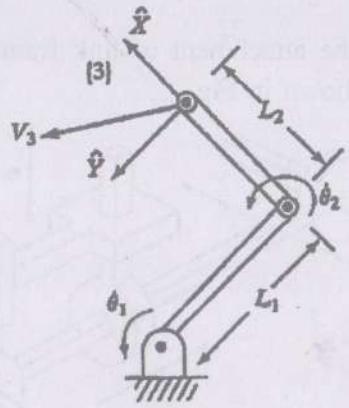
6. (a) Explain concept of velocity propagation from link to link. (5)

(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 messing gear.

(b) The structure of a manipulator's dynamic equations.

(c) Frames with standard names. (15)

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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)

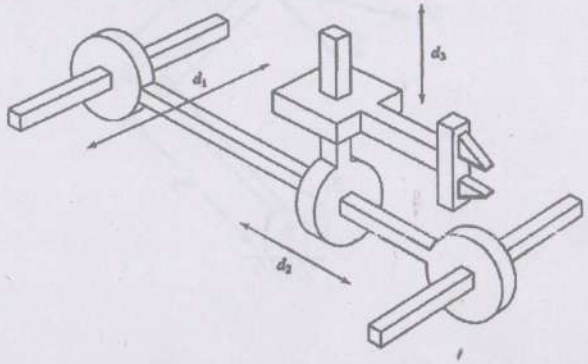
$$A_BT = \begin{bmatrix} 0.866 & -0.500 & 0.000 & 11.0 \\ 0.500 & 0.866 & 0.000 & -3.0 \\ 0.000 & 0.000 & 1.000 & 9.0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

Compute ${}^{A}V$

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)