**53 (IT 813) RBCV**

**2017**

# ROBOTICS AND COMPUTER VISION

Paper : IT 813

*Full Marks : 100*

Time : Three hours

***The figures in the margin indicate full marks for the questions.***

*Answer **any five** questions.*

1. *(a)* Define Anatomy of robot and also draw a diagram of robot manipulator which consist links and joints.

   *(b)* Write down the manipulator joints with their notations and diagrams. Sketch the following manipulator configurations :

   *(i)* LOO

   *(ii)* TRR

   *(iii)* TRL.

(c) Describe the wrist configurations with a diagram. Mention the Co-ordinate systems with a diagram.

6+8+6=20

2. (a) Describe a 2-DOF robot manipulator (R-R) and also define the position of end arm in the world space (Forward transformation) using the vector of links $L$ & $L_1$. Calculate the reverse transformation $(Q_A \& Q_B)$ from the *Figure-1* given below :

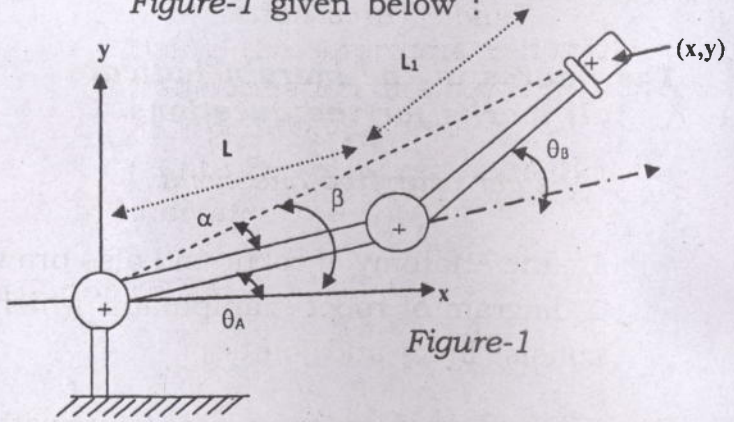


*Figure-1*

(b) Two points $a_{uvw} = (7,6,4)^T$ and $b_{uvw} = (5,4,7)^T$ are to be translated a distance +7 unit along *OX*-axis & –2 unit along *OY*-axis.

Using the appropriate homogeneous transformation matrix, determine the new points $a_{xyz}$ and $b_{xyz}$.

(Hint : Forward transformation *i.e.* Co-ordinates $x$ & $y$).

14+6=20



3. (a) For the vector, $V = 24i + 18j + 35k$, rotate by an angle of 45° about the $x$-axis. Derive the rotation transformation.

(b) Explain the kinematics function of link. Describe the method to measure Link length and Link twist.

(c) Calculate the matrix '$T$' for the given parameters values in table '1' using D-H transformation.

**Table-1**

| Joint $i$ | $a_i$ | $\alpha_i$ | $d_i$ | $\theta_i$ |
|---|---|---|---|---|
| 1 | 0 | $a_0$ | 0 | $\theta_0$ |
| 2 | –60 | $a_1$ | 0 | $\theta_1$ |
| 3 | 0 | 0 | $d_2$ | $\theta_2$ |
| 4 | 60 | 0 | $d_3$ | $\theta_3$ |

6+6+8=20

4. (a) A robot performs a loading and unloading operation for a machine tool as follows :

(i) A Robot pick up part from conveyor and loads into machine (Time=4·5 *sec*)

(ii) Machining cycle in automatic manner with Time =22·0*sec*

(iii) Robot reclaim part from machine and deposits to outgoing conveyor with Time=3·5*sec*

(iv) Finally Robot moves back to pickup position with in Time=1·2 *sec.*

Every 25 work parts, the cutting tools in the machine are changed which takes 3·0 minutes. The uptime efficiency of the robot is 95% ; and the uptime efficiency of the machine tool is 96% which rarely overlap. Determine the hourly production rate.

(b) Write down the *five* steps for developing the program in robot level language with the diagram.

***Or***

Explain the Convolution in digital image property. 8+12=20



5. Write down the short notes on the following : 5×4=20
***(any four)***

(i) INS and GPS applications

(ii) Sensor Fashion

(iii) Kinematics

(iv) Denavit-Hartenberg (D-H) Representation

(v) DOF in a plane and space.

6. Differentiate between the following : ***(any four)*** 5×4=20

(i) Powered Lead through *Vs* Manual Lead through

(ii) Passive sensor *Vs* Logical Sensor

(iii) Humanoid robot *Vs* Industrial robot

(iv) Revolute joint and Prismatic joint

(v) Joint-Arm robot and SCARA robot

(vi) Metric property *Vs* Topological property of digital image.

---