Total number of printed pages: 50 **Programme(UG)/8th/UCSE814**

2023

Robotics and Computer Vision

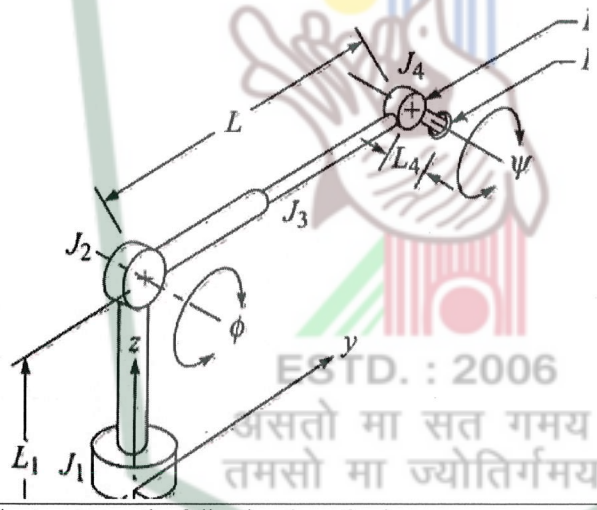
Full Marks : 100

Time : Three hours

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

*Answer **any five** questions.*

1.	**Answer the following questions:**		
	a)	**Fill in the blanks:**	1x10=10
		(i) Modeling of robot mechanisms can understand with _____ and _____. **(ii)** The full form of RCC is _____. **(iii)** The role of AUTOPASS is to _____ and _____. **(iv)** _____ is the process of projecting a known pattern on to a scene. **(v)** _____ range is required for the images. **(vi)** _____ systems provide intruder detection inside the work volume of the robot. **(vii)** _____ is called the surprisal of the outcome x_k. **(viii)** RCC device is typically mounted between the wrists of the robot and its _____. **(ix)** DOF in a plane and space are _____ and _____ respectively. **(x)** _____ is a measurements of the layout of the environment and objects relative to the robot's frame of reference	
	b)	**True or False:**	1x10=10
		(i) Prismatic joint are based on 1-DOF. **(ii)** When the DOF increases the Position accuracy decreases. **(iii)** When the DOF increases then the flexibility increases. **(iv)** The relative position of two links is called link offset. **(v)** In revolute joints, d_i is the joint variable. **(vi)** Proprioception is a measurement of movements relative to an internal frame of reference. **(vii)** Logical redundancy returns identical percepts, but use different modalities. **(viii)** Retroreflector is a device that projecting a known pattern on to a scene. **(ix)** A specular highlight is the bright spot of light that appears on shiny objects when illuminated. **(x)** Level-2 system detects the presence of an intruder in the region between the workcell boundary and the limit of the robot work volume.	
2.	**a)**	How can you explain the 'understanding and modeling of the mechanism' in autonomous robot?	5
	b)	Write down the all the attributes of Sensor Suite with small description.	6
	c)	Draw a diagram of Cylindrical Body-and-Arm Assembly.	3
	d)	Explain all three different methods for collision-free path in the robot program synthesis.	6

3.	**a)**	Explain 2-DOF robot manipulator with a diagram and also define the forward transformation of 2-DOF arm (link1 & link2).	6
	b)	Two points $\mathbf{a}_{uvw} = \mathbf{(6,6,8)}^T$ and $\mathbf{b}_{uvw} = \mathbf{(8,5,6)}^T$ are translated with a distance +6 unit along OX-axis & -4 unit along OZ-axis. Determine the new points $\mathbf{a}_{xyz}$ and $\mathbf{b}_{xyz}$, by applying the homogeneous transformation matrix,	6
	c)	Derive the rotation transformation for the vector, V = 20i + 10j + 10k, which is rotated by an angle of 45^0 about the x- axis.	4
	d)	Describe the role of MTBF and MTTR in PM. What will be availability for MTBF and MTTR values 25 and 5 respectively?	4
4.	**a)**	Draw and explain every function of Machine Vision system.	4
	b)	What are the two key aspects of safety issues in robotics?	4
	c)	Derive the joint angles using inverse transformation of the 4-DOF arm in three dimension Space and the information related to angle are given below here: At Joint1 (Type T): base rotation, θ At Joint2 (Type R): elevation angle, ϕ At Joint3 (Type L): Extension **L**, represents a combination of links 2 and 3 At Joint4 (Type R): angle makes with x-y plane called pitch angle ψ 	12
5.	Write short notes on the following (***any four***):		4x5=20
	a)	Sensor Fusion false positive/negative	
	b)	GDP description of bolt	
	c)	Preventive maintenance	
	d)	Robot cell layouts	
	e)	ENTROPY	
6.	Differentiate between the following (***any four***):		4x5=20
	a)	Sensor fission and sensor fashion	
	b)	Metric and Topological properties of digital images	
	c)	Top surface and Umbra	
	d)	Sampling and Quantization	
	e)	Scaling and shearing transforms	