SRM VALLIAMMAI ENGINEERING COLLEGE

(An Autonomous Institution)

SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

VII SEMESTER

1909718 - ROBOTICS
(Open Elective)

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Prepared by

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UNIT I - FUNDAMENTALS OF ROBOT				
Robot - Definition - Robot Anatomy – Co-ordinate Systems, Work Envelope Types and Classification- Specifications- Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load- Robot Parts and their Functions- Need for Robots- Different Applications.				
PART - A				
Q.No	**Questions**	**BT Level**	**Competence**	**CO**
1.	Define a Robot.	**BTL 1**	Remember	CO1
2.	Name the commonly used robot configurations.	**BTL 1**	Remember	CO1
3.	Sketch rotational joint.	**BTL 3**	Apply	CO1
4.	What is meant by work volume?	**BTL 1**	Remember	CO1
5.	List out the types of joint notations.	**BTL 1**	Remember	CO1
6.	What is meant by Pitch?	**BTL 1**	Remember	CO1
7.	Define base and tool coordinate system	**BTL 1**	Remember	CO1
8.	Give the benefits of robots.	**BTL 2**	Understand	CO1
9.	Infer robot anatomy.	**BTL 4**	Analyze	CO1
10.	Describe work envelope	**BTL 2**	Understand	CO1
11.	Write the benefits of industrial automation systems.	**BTL 6**	Create	CO1
12.	Give the specifications of industrial robot.	**BTL 2**	Understand	CO1
13.	Evaluate work space.	**BTL 5**	Evaluate	CO1
14.	Analyze spatial resolution in robotics.	**BTL 4**	Analyze	CO1
15.	Classify the motion control of robot arm.	**BTL 4**	Analyze	CO1
16.	Define Yaw, Pitch and Roll	**BTL 2**	Understand	CO1
17.	Examine accuracy of robot.	**BTL 3**	Apply	CO1
18.	Write any two laws of robotics.	**BTL 6**	Create	CO1
19.	Sketch linear joint.	**BTL 3**	Apply	CO1
20.	Compare work volume with workspace.	**BTL 5**	Evaluate	CO1
21.	State the limitations of robot.	**BTL 1**	Remember	CO1

22.	Justify the need of robots.	**BTL 4**	Analyze	CO1
23.	Define the term repeatability with respect to robot.	**BTL 2**	Understand	CO1
24.	Analyze the importance of the specification payload.	**BTL 4**	Analyze	CO1
25.	List the limitations in fixing payload for robots.	**BTL 3**	Apply	CO1

PART - B					
1.	Describe any four work envelop of a robot with suitable diagram and mention its applications.**(13)**		**BTL 1**	Remember	CO1
2.	Explain the important specifications of a robot and choose a suitable robot configuration for transferring 200gram aluminium rod of 150 mm length. Give your justification.**(13)**		**BTL 5**	Evaluate	CO1
3.	**(i)**	Sketch a robot wrist and indicate wrist pitch, wrist yaw and wrist roll.**(6)**	**BTL 3**	Apply	CO1
	(ii)	Explain about major parts of a robot with their functions. **(7)**	**BTL 4**	Analyze	CO1
4.	**(i)**	Discuss about the need for Robots. **(3)**	**BTL 2**	Understand	CO1
	(ii)	Present a brief survey on how robots are applied in inspection work.**(10)**			
5.	Describe any four basic robot configurations with neat sketch and narrate individual merits, demerits.**(13)**		**BTL 1**	Remember	CO1
6.	Explain the following:			Evaluate	CO1
	(i)	Robot anatomy. **(7)**	**BTL 5**		
	(ii)	Robot wrist. **(6)**			
7.	Write short notes on the following:		**BTL 3**	Apply	CO1
	(i)	Types of robot Controls. **(5)**			
	(ii)	Spatial resolution. **(4)**			
	(iii)	Repeatability. **(4)**			
8.	**(i)**	Explain about the construction of robot cell with neat sketch.**(7)**	**BTL 4**	Analyze	CO1
	(ii)	Explain base and tool Coordinate system. **(6)**			
9.	Illustrate with neat sketch about the basic robot motions.**(13)**		**BTL 3**	Apply	CO1
10.	Summarize the advantages of four common robot configuration and deduce their simple sketches.**(13)**		**BTL 6**	Create	CO1
11.	**(i)**	Discuss about robot machine interface with neat diagram.**(7)**	**BTL 2**	Understand	CO1
	(ii)	With neat sketch describe the multiple robot coordination in manufacturing.**(6)**	**BTL 1**	Remember	CO1
12.	With neat sketches explain the classification of robot based on		**BTL 5**	Evaluate	CO1
	(i)	Configuration. **(4)**			

	(ii)	Degrees of Freedom. **(3)**			
	(iii	Work volume. **(3)**			
	(iv)	Controls. **(3)**			
13.	Prepare the selection criteria and factors in the design of a robot. **(13)**		**BTL 4**	Analyze	CO1
14.	Describe salient features of robot in different fields of applications.**(13)**		**BTL 1**	Remember	CO1
15.	Analyze the industrial uses of robots. **(13)**		**BTL 4**	Analyze	CO1
16.	With neat sketch explain the six degrees of freedom associated with robot wrist.**(13)**		**BTL 2**	Understand	CO1
17.	A cylindrical robot can reach any point in a cylinder of height L and radius 2L, except for the points in an inner cylinder of height L and radius L. Determine the volume for the cylindrical robot work envelope.**(13)**		**BTL 6**	Create	CO1
18.	Explain in detail about pay load calculation for robots. **(13)**		**BTL 2**	Understand	CO1
	PART C				
1.	Analyze the structure of robot in detail. **(15)**		**BTL 4**	Analyze	CO1
2.	Write short notes on application of robot in various fields in emerging technology.**(15)**		**BTL 6**	Create	CO1
3.	Generalize the evolution of robots and robotics. **(15)**		**BTL 6**	Create	CO1
4.	Explain the various specifications that one should look forward to purchase a commercial robot.**(15)**		**BTL 4**	Analyze	CO1
5.	Compare the size work volumes of the robots having polar, cylindrical and Cartesian anatomy configuration. Assume the robots have equal link lengths. Which configuration has the largest work volume?**(15)**		**BTL 6**	Create	CO1

UNIT II – ROBOT DRIVE SYSTEMS AND END EFFECTORS

Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Selection and Design Considerations

PART – A

Q.No	Questions	BT Level	Competence	CO
1.	What is an actuator?	**BTL 1**	Remember	CO2
2.	Discriminate the factors which must be considered while choosing thedrive system for robots.	**BTL 5**	Evaluate	CO2
3.	What is meant by gripper? Give the types of grippers.	**BTL 2**	Understand	CO2
4.	List the advantages and dis-advantages of hydraulic drive.	**BTL 1**	Remember	CO2
5.	List the advantages and disadvantages of pneumatic actuators.	**BTL 1**	Remember	CO2
6.	Point out types of joints.	**BTL 1**	Remember	CO2
7.	List the advantages and dis-advantages of Electrical actuator.	**BTL 1**	Remember	CO2
8.	Why servomotors are preferred with stepper motor in robot applications?	**BTL 3**	Apply	CO2
9.	Which type of drive system is more suitable for heavy load robot application?	**BTL 4**	Analyze	CO2
10.	What is end effector? Give some examples of Robot End Effector.	**BTL 2**	Understand	CO2
11.	Enumerate the difference between open loop and closed loop control system.	**BTL 6**	Create	CO2
12.	In what ways do end effectors differ from the human hand?	**BTL 6**	Create	CO2
13.	Examine the difference between internal grippers and external grippers.	**BTL 3**	Apply	CO2
14.	Infer any four important factors to be considered in the selection and design of grippers.	**BTL 4**	Analyze	CO2
15.	Point out any two unique features of a stepper motor.	**BTL 4**	Analyze	CO2
16.	Give any two limitations of magnetic grippers.	**BTL 2**	Understand	CO2
17.	Classify the types of mechanical gripper.	**BTL 3**	Apply	CO2
18.	List the types of drive systems used in robots.	**BTL 1**	Remember	CO2
19.	Assess the characteristics of actuating systems.	**BTL 5**	Evaluate	CO2
20.	Predict the application of stripping device.	**BTL 2**	Understand	CO2
21.	State the components of the Electrical actuator.	**BTL 2**	Understand	CO2
22.	Assess the features of servomotors.	**BTL 5**	Evaluate	CO2

23.	Compare AC and DC servomotors.	**BTL 4**	Analyze	CO2
24.	Analyze the limitations of Adhesive grippers.	**BTL 4**	Analyze	CO2
25.	Give an example for stepper motor control system.	**BTL 2**	Understand	CO2

PART - B					
1.	Define end effector. Draw the different mechanism used in the gripper and describe any two mechanism in detail.**(13)**		**BTL 1**	Remember	CO2
2.	Classify the end effector. Draw the different mechanism used in the gripper and give its application.**(13)**		**BTL 5**	Evaluate	CO2
3.	Explain with neat sketch about following:		**BTL 4**	Analyze	CO2
	(i)	AC servo motors. **(7)**			
	(ii)	DC servo motors. **(6)**			
4.	**(i)**	Discuss about the features of the various drive systems for an Industrial robot.**(7)**	**BTL 2**	Understand	CO2
	(ii)	Discuss about the features of the various drive systems for an Industrial robot.**(6)**			
5.	Describe the factors to be considered while selecting the grippers for robot with example.**(13)**		**BTL 1**	Remember	CO2

6.	**(i)**	Explain vacuum grippers, with reference to the principle and applications.**(7)**	**BTL 5**	Evaluate	CO2
	(ii)	Explain the robot and end effector interface functions. **(6)**			
7.	Examine the features of hydraulic and pneumatic actuators systems in detail.**(13)**		**BTL 3**	Apply	CO2
8.	**(i)**	Discuss about various considerations for selection and design of a gripper.**(6)**	**BTL 2**	Understand	CO2
	(ii)	Explain working principle, salient features and applications of A.C. and D.C. Servo motor as robot drive system.**(7)**	**BTL 4**	Analyze	CO2
9.	Compare the servo motor with stepper motor, choose suitable drive system for industrial robot along with your justification.**(13)**		**BTL 4**	Analyze	CO2
10.	**(i)**	Write note on gripper selection and design. **(3)**	**BTL 2**	Understand	CO2
	(ii)	Describe the magnetic grippers in robot. **(10)**	**BTL 2**	Understand	CO2
11.	**(i)**	Illustrate Pneumatic actuators system with neat sketch. **(7)**	**BTL 3**	Apply	CO2
	(ii)	Illustrate hydraulic actuators system with neat sketch. **(6)**			
12.	Generalize vacuum cups, adhesive grippers, hooks, scoops and other miscellaneous grippers in detail.**(13)**		**BTL 6**	Create	CO2
13.	Explain the working of a stepper motor with suitable diagrams. **(13)**		**BTL 4**	Analyze	CO2
14.	Justify whether the following statement is true or false. Degrees of freedom depend upon the number of actuators used in a robot.**(13)**		**BTL 4**	Analyze	CO2

15.	**(i)** With neat sketch, explain the working of a stepper motor.**(7)** **(ii)** With suitable illustration, explain the working of internal and external grippers.**(6)**	**BTL 2**	Understand	CO2
16.	Analyze the working of different types of mechanical grippers.**(13)**	**BTL 4**	Analyze	CO2
17.	Design a direction control scheme for DC motors using H bridge, illustrate it with neat sketches.**(13)**	**BTL 6**	Create	CO2
18.	Design a suitable gripper for a laddle in foundry (Weight = 1 Ton)	**BTL 6**	Create	CO2
	PART C			
1.	Analyze about the robot drive system selection procedure in detail. **(15)**	**BTL 4**	Analyze	CO2
2.	Enumerate the design and selection of various grippers in robotics.**(15)**	**BTL 4**	Analyze	CO2
3.	Discuss the design and selection parameters of three fingered grippers.**(15)**	**BTL 6**	Create	CO2
4.	Discriminate the salient features, capabilities, applications, merits and limitations of non-servo and servo controlled robots.**(15)**	**BTL 5**	Evaluate	CO2
5.	Develop a stepper control system and explain with necessary schematic.**(15)**	**BTL 6**	Create	CO2

UNIT - III SENSORS AND MACHINE VISION

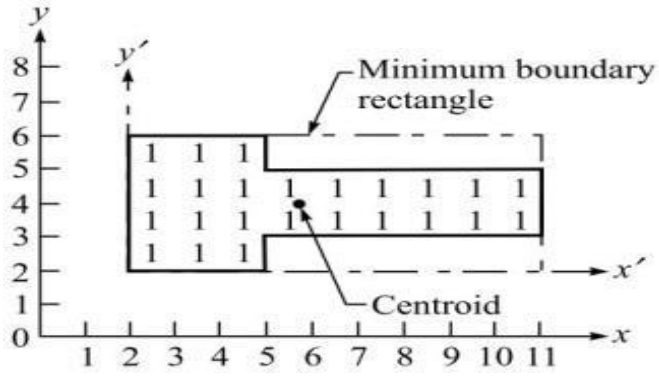
Requirements of a sensor, Principles and Applications of the following types of sensors- Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range Finders, Laser Range Meters, Touch Sensors ,binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data- Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications- Inspection, Identification, Visual Serving and Navigation.

PART - A

Q.No	Questions	BT Level	Competence	CO
1.	Define vision and vision system.	**BTL 1**	Evaluate	CO3
2.	Classify the vision systems? What are the common imaging devices usedfor robot vision system?	**BTL 1**	Remember	CO3
3.	Give an application example of a proximity sensor.	**BTL 2**	Understand	CO3
4.	Define machine vision.	**BTL 1**	Remember	CO3
5.	List the machine vision stages.	**BTL 1**	Remember	CO3
6.	What is segmentation? What is thresholding?	**BTL 1**	Remember	CO3
7.	Define sensor.	**BTL 1**	Remember	CO3
8.	Classify sensors for robot applications.	**BTL 3**	Apply	CO3
9.	Infer the use of inductive type proximity sensor.	**BTL 4**	Analyze	CO3
10.	Give some feedback devices used in robotics.	**BTL 2**	Understand	CO3
11.	Generalize various techniques in image processing and analysis.	**BTL 6**	Create	CO3
12.	Enumerate the areas of application of image processing in the fieldof robots.	**BTL 6**	Create	CO3
13.	Write about hall effect sensors.	**BTL 3**	Apply	CO3
14.	Infer the types of light sensors in robot applications.	**BTL 4**	Analyze	CO3
15.	Mention any two examples for contact and non-contact sensor.	**BTL 4**	Analyze	CO3
16.	Classify the position sensors.	**BTL 3**	Apply	CO3
17.	Differentiate between pyroelectric sensor and piezoelectric sensors.	**BTL 2**	Understand	CO3
18.	Give the benefits of LVDT.	**BTL 2**	Understand	CO3
19.	Assess any two algorithms for image enhancement application.	**BTL 5**	Evaluate	CO3
20.	Assess the use of frame grabber.	**BTL 5**	Evaluate	CO3
21.	Examine the uses of resolver in robotics.	**BTL 5**	Evaluate	CO3
22.	List out the classifications of range sensing.	**BTL 3**	Apply	CO3

23.	Justify the applications of optical encoders.	**BTL 4**	Analyze	CO3
24.	What is meant by binary sensors?	**BTL 1**	Remember	CO3
25.	List the type of encoders.	**BTL 1**	Remember	CO3

PART - B						
1.	Describe the following range sensing techniques			**BTL 1**	Remember	CO3
	(i)	Triangulations technique. **(7)**				
	(ii)	Structured lighting approach. **(6)**				
2.	With neat sketch explain the following:			**BTL 5**	Evaluate	CO3
	(i)	Touch sensor. **(7)**				
	(ii)	Analog sensor. **(6)**				
3.	**(i)**	Describe the piezo electric sensors. **(7)**		**BTL 2**	Understand	CO3
	(ii)	Explain in detail about tactile and non-tactile sensors. **(6)**		**BTL 5**	Evaluate	
4.	With neat sketch explain the following:			**BTL 5**	Evaluate	CO3
	(i)	Resolvers. **(6)**				
	(ii)	Optical Encoders. **(7)**				
5.	Describe the working principle of Proximity sensors with neat sketch.**(13)**			**BTL 1**	Remember	CO3
6.	Explain mono and stereo vision in the context of robot vision digital convolution. **(13)**			**BTL 5**	Evaluate	CO3
7.	Explain how image segmentation helps to improve quality of images in vision system.**(13)**			**BTL 4**	Analyze	CO3
8.	**(i)**	What do you mean by robot vision? Explain in detail. **(7)**		**BTL 4**	Analyze	CO3
	(ii)	Explain and compare various lighting techniques used in machine vision.**(6)**				
9.	Write notes on (a) Thresholding (b) Edge detection (c) Object recognition (d) Smoothing. **(13)**			**BTL 3**	Apply	CO3
10.	What is image analysis? What are the various techniques in image processing and analysis? Write any two algorithms for image enhancement application in brief.**(13)**			**BTL 6**	Create	CO3
11.	With suitable sketch citing appropriate application describe the following			**BTL 2**	Understand	CO3
	(i)	Wrist sensor. **(7)**				
	(ii)	Binary sensor. **(6)**				
12.	With suitable sketch citing appropriate application describe the following			**BTL 2**	Understand	CO3
	(i)	Compliance sensors. **(7)**				
	(ii)	Slip sensors. **(6)**				

13.	For an image digitized at 128 points per line and 128 lines, determine (a)the total number of bits to represent the gray level values required if an 8 bit A/D converter is used to indicate various shades of gray, and (b)the reduction in data volume if only black and white values are digitized. **(13)**	**BTL 6**	Create	CO3
14.	How are the images processed and analyzed in a machine vision system? Explain with suitable example.**(13)**	**BTL 4**	Analyze	CO3
15.	Explain any two position sensing methods used in Robots with suitable sketches.**(13)**	**BTL 2**	Understand	CO3
16.	Mention and explain the applications of image processing and analysis in robot.**(13)**	**BTL 4**	Analyze	CO3
17.	A continuous video voltage signal is to be converted into 5V. The A/D converter has an 8 bit capacity. Determine the number of quantization levels, the quantization level spacing, the resolution and the quantization error.**(13)**	**BTL 6**	Create	CO3
18.	Illustrate the impact of pixel concentration in image processing and analysis.**(13)**	**BTL 4**	Analyze	CO3
	PART C			
1.	Explain the working principle of range finders, laser range meters along with respective circuit.**(15)**	**BTL 4**	Analyze	CO3
2.	Prepare the factors to be considered for selection of sensors and write down the classifications of sensors.**(15)**	**BTL 4**	Analyze	CO3
3.	Write any one algorithm for the edge detection and segmentation of an image. Describe the industrial applications of image processing in the field of mechanical engineering.**(15)**	**BTL 6**	Create	CO3
4.	Tabulate various illumination techniques and their uses.**(15)**	**BTL 4**	Analyze	CO3
5.	Consider the schematic of the image in the figure. Determine the area, the minimum aspect ratio, the diameter, the centroid, and the thinness measures of the image.**(15)** 	**BTL 6**	Create	CO3

UNIT IV ROBOT KINEMATICS AND ROBOT PROGRAMMING

Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design-Derivations and problems. Lead through Programming, Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effector commands and simple Programs.

PART A

Q.No	Question	BT Level	Competence	CO
1.	Why kinematic study of the robot is important?	**BTL 4**	Analyze	CO4
2.	List out the typical motion command.	**BTL 1**	Remember	CO4
3.	Write the meaning of the command DMOVE (<4, 5, 6> <30, -45, 90>).	**BTL 6**	Create	CO4
4.	Classify the methods of Robot programming.	**BTL 3**	Apply	CO4
5.	Define a manipulator.	**BTL 1**	Remember	CO4
6.	Differentiate between Forward kinematics and reverse kinematics.	**BTL 2**	Understand	CO4
7.	Mention the disadvantages of lead through programming.	**BTL 5**	Evaluate	CO4
8.	Define Degrees of freedom.	**BTL 1**	Remember	CO4
9.	List the limitations of online robot programming.	**BTL 1**	Remember	CO4
10.	Illustrate irregular smooth motions.	**BTL 3**	Apply	CO4
11.	Write end effectors commands.	**BTL 5**	Evaluate	CO4
12.	What is teach pendant?	**BTL 1**	Remember	CO4
13.	Predict the reason for defining points in a program.	**BTL 2**	Understand	CO4
14.	What is meant by kinematics?	**BTL 3**	Apply	CO4
15.	What are the ways of accomplishing lead through programming?	**BTL 4**	Analyze	CO4
16.	Write the meaning of the command DMOVE (1, 10).	**BTL 6**	Create	CO4
17.	What are the commands used to execute the speed of the robot in VAL programming?	**BTL 2**	Understand	CO4
18.	Explain position representation.	**BTL 4**	Analyze	CO4
19.	State the reason for homogeneous transformation	**BTL 2**	Understand	CO4
20.	List the limitations of offline robot programming.	**BTL 1**	Remember	CO4
21.	Define the term singularity.	**BTL 2**	Understand	CO4
22.	What is meant by joint space and world space	**BTL 1**	Remember	CO4
23.	List the methods of defining positions in space.	**BTL 2**	Understand	CO4
24.	State the DH parameters used in transformation.	**BTL 2**	Understand	CO4
25.	List the applicatons of simple Programs.	**BTL 2**	Understand	CO4

	PART B				
1.	**i)** Write about sensors and end effectors commands with example.	**(7)**	**BTL 6**	Create	CO4
	ii) Differentiate forward and reverse transformation withexample	**(6)**	**BTL 4**	Analyze	CO4
2.	**i)** Write note on motion commands of robots	**(7)**	**BTL 6**	Create	CO4
	ii) Explain detail manual lead through programming method in robot application	**(6)**	**BTL 5**	Evaluate	CO4
3.	**i)** Describe the capabilities of and limitations of lead through programming	**(6)**	**BTL 2**	Understand	CO4
	ii) Describe the methods of defining positions in space	**(7)**	**BTL 2**	Understand	CO4
4.	Explain WAIT, DELAY, SIGNAL, and command with suitable example	**(13)**	**BTL 4**	Analyze	CO4
5.	Derive the forward and reverse kinematics with two degree of freedom.	**(13**)	**BTL 5**	Evaluate	CO4
6.	Write the list of commands used in VAL programming and describe any two in detail.	(**13)**	**BTL 1**	Remember	CO4
7.	Classify the different types of programming methods and illustrate any one in detail.	**(13)**	**BTL 3**	Apply	CO4
8.	Describe the teach pendant for Robot system	**(13)**	**BTL 1**	Remember	CO4
9.	Classify various programming languages used in computer controlled robots and illustrate any one in detail.	**(13)**	**BTL 3**	Apply	CO4
10.	Derive the forward and reverse kinematics with four degree of freedom.	**(13)**	**BTL 5**	Evaluate	CO4
11.	Explain the function of inverse kinematics with example.	**(13)**	**BTL 4**	Analyze	CO4
12.	Derive the forward and reverse kinematics for RRR robot.	**(13)**	**BTL 5**	Evaluate	CO4
13.	Derive the forward and reverse kinematics with three degree of freedom.	**(7)**	**BTL 5**	Evaluate	CO4
14.	Explain manipulator kinematics with neat sketch.	**(13)**	**BTL 4**	Analyze	CO4
15.	For the vector v= 25i+10j+20k, Determine the translated vector for a translation by a distance of 8 cm in x direction, 5 cm in y direction and 0 cm in z direction.	**(13)**	**BTL 6**	Create	CO4
16.	Derive the forward and reverse kinematics for RR robot.	**(13)**	**BTL 5**	Evaluate	CO4
17.	With suitable examples explain some motion and speed control commands	**(13)**	**BTL 5**	Evaluate	CO4
18.	Explain the function of kinematics inversion in robotic links with example.	**(13)**	**BTL 4**	Analyze	CO4
	PART C				
1.	Write a VAL program for pick- and-place operation on the conveyor system. it consists of two conveyors running parallel with centre distance of 600 mm at same level. An industrial robot is fixed centrally between the conveyors. The robot is used to transfer work pieces from conveyor 1 to 2 at a constant speed. Draw a schematic view of the system. Assume all necessary dimension.	**(15)**	**BTL 6**	Evaluate	CO4

2.	A vector v= 2i+5j+3k is rotated by 60 degrees about Z-axes and translated by 3,4 and 5 units in the x, y and z directions respectively. Find the vector with reference to the reference frame.	**(15)**	**BTL 5**	Evaluate	CO4
3.	Derive the forward and reverse kinematics for RRL robot.	**(15)**	**BTL 5**	Evaluate	CO4
4.	Analyze the features of Generations of robot programmingLanguages	**(15)**	**BTL 4**	Analyze	CO4
5.	Derive the forward position kinematics with three degree of freedom by using matrix form.	**(15)**	**BTL 5**	Evaluate	CO4

UNIT V IMPLEMENTATION AND ROBOT ECONOMICS

RGV, AGV; Implementation of Robots in Industries-Various Steps; Safety Considerations for RobotOperations - Economic Analysis of Robots.

PART A

Q.No	Question	BT Level	Competence	CO
1.	What is AGV?	**BTL 1**	Remember	**CO5**
2.	Classify the four basic categories for industrial robot application?	**BTL 3**	Apply	**CO5**
3.	What are the three basic modes of operation in a robot language operating system?	**BTL 3**	Apply	**CO5**
4.	Evaluate the robot economics by return of investment method.	**BTL 5**	Evaluate	**CO5**
5.	List out any two important factors in the selection of robot for an application	**BTL 1**	Remember	**CO5**
6.	How does RGV differs from AGV?	**BTL 4**	Analyze	CO5
7.	List out various methods used in economic analysis of robot.	**BTL 1**	Remember	CO5
8.	Give some applications of AGV.	**BTL 2**	Understand	CO5
9.	Asses the typical technical features required for material transfer.	**BTL 5**	Evaluate	CO5
10.	Examine palletizing and depalletizing operation.	**BTL 2**	Understand	CO5
11.	Analyze the causes of human injury in a robotic environment.	**BTL 4**	Analyze	CO5
12.	Mention the limitations of implementing robots in industry.	**BTL 3**	Apply	CO5
13.	Write the reasons for the use of robots in welding operation.	**BTL 6**	Create	CO5
14.	What are the three levels of safety sensors used in a robot?	**BTL 1**	Remember	CO5
15.	Write the functions of work cell controller.	**BTL 6**	Create	CO5
16.	Differentiate palletizing and depalletizing.	**BTL 2**	Understand	CO5
17.	Define Payback period.	**BTL 1**	Remember	CO5
18.	Give some important factors in the selection of robot for an application.	**BTL 2**	Understand	CO5
19.	Point out few safety precautions necessary for robotic application.	**BTL 4**	Analyze	CO5
20.	What do you mean by part presentation?	**BTL 1**	Remember	CO5
21.	List out some general considerations while robots are used for materialhandling	**BTL 2**	Understand	CO5
22.	Evaluate the applications of robots in Assembly operations.	**BTL 5**	Evaluate	CO5
23.	Define the three levels of safety sensor systems in robotics.	**BTL 3**	Apply	CO5

24.	Differentiate investment costs and operating costs.		**BTL 4**	Analyze	CO5
25.	List the precautions while robots are used for material handling.		**BTL 2**	Understand	CO5

	PART B				
1.	**i)** Explain the working of AGV with component based DCS.	**(7)**	**BTL 4**	Analyze	CO5
	ii) Explain the logical sequence steps in the implementation of robots in industries.	**(6)**	**BTL 4**	Analyze	CO5
2.	**i)** Explain the economic analysis of the robot using EUAC method.	**(6)**	**BTL 5**	Evaluate	CO5
	ii) Explain safety sensors and safety monitoring of robot.	**(7)**	**BTL 5**	Evaluate	CO5
3.	Explain with an example procedure of applying payback methodin the economic analysis of robots.	**(13)**	**BTL 4**	Analyze	
4.	Write shorts on the following:		**BTL 6**	Create	CO5
	i) Method of payback period.	**(7)**			
	ii) Return on investment method.	**(6)**			
5.	Write shorts on the following:		**BTL 6**	Create	CO5
	i) Discounted cash flow method	**(7)**			
	ii) Equivalent uniform annual cost method.	**(6)**			
6.	Describe the workplace design consideration for safety of Robotsin detail.	**(13)**	**BTL 1**	Remember	CO5
7.	Classify the AGV and RGV types of robots in detail.	**(13)**	**BTL 3**	Apply	CO5
8.	Explain the obstacle detection an avoidance in AGV.	**(13)**	**BTL 4**	Analyze	CO5
9.	Illustrate the various cost associated with robot project.	**(13)**	**BTL 3**	Apply	CO5
10.	Explain various step involved for implementing robots in industries	**(13)**	**BTL 4**	Analyze	CO5
11.	Discuss the implementation issues of robots in an assembly environment.	**(13)**	**BTL 2**	Understand	CO5
12.	Describe various factors to be considered for industrial application of robots.	**(13)**	**BTL 2**	Understand	CO5
13.	List and explain indirect costs and savings in a robot application project.	**(13)**	**BTL 4**	Analyze	CO5
14.	What is meant by blocking in AGV? Explain the methods used in commercial AGV to accomplish blocking.	**(13)**	**BTL 5**	Evaluate	CO5
15.	Write the importance and operations of safety sensors and safety monitoring	**(13)**	**BTL 2**	Understand	CO5
16.	Explain about selection of robot for an application also illustrate with suitable examples.	**(13)**	**BTL 4**	Analyze	CO5
17.	Analyze various Cost data required for economic analysis.	**(13)**	**BTL 4**	Analyze	CO5
18.	Discuss the implementation issues of robots in mass production.	**(13)**	**BTL 2**	Understand	CO5
	PART C				
1.	Explain the safety consideration for robot operation in detail.	**(15)**	**BTL 5**	Evaluate	CO5

2.	Present a comparative study of different methods of economic analysis.		**BTL 4**	Analyze	CO5
3.	Suppose the total investment on the robot is estimated to be Rs. 50,000. There is one shift operation of 2000 hours and 1 man replaced. Assuming labour rate inducing direct overheads to be Rs. 80/hour, robot running costs including maintenance and depreciation to be Rs. 1,00,000 and added value of increased output be Rs. 1,20,000. Determine the payback period.	**(15)**	**BTL 6**	Evaluate	CO5
4.	The total investment required for a new robot installation is Rs. 65,000 including the price of tooling robot and accessories. The estimate expense on annual maintenance robot operating and programming is Rs. 5500 for one shift operation and Rs. 7500 for two shift operation. The robot replaces one worker whose salary and other benefits amount to be Rs.28,000 per annum.	**(15)**	**BTL 6**	Evaluate	CO5
5.	The total investment on the robot is estimated to be Rs. 4,00,000. There is 1 shift operation of 1800 hours and one 1 man replaced. Assuming labour rate including direct overheads to be Rs. 75 per hour, robot running costs including maintenance and depreciationto be Rs. 75,000 and added value of increased output be Rs. 1,00,000. Determine the pay back period.	**(15)**	**BTL 6**	Evaluate	CO5