SRM VALLIAMMAI ENGINEERING COLLEGE
(An Autonomous Institution)
SRM Nagar, Kattankulathur – 603 203

DEPARTMENT OF ELECTRONICS AND INSTRUMENTATION ENGINEERING

QUESTION BANK

VII SEMESTER

1909718 - ROBOTICS
(Open Elective)
Common to CSE, ECE, IT, ME & MECHANICAL

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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.		

Q.No	Questions	BT Level	Competence
	PART - A		
1.	Define a Robot.	BTL 1	Remember
2.	Name the commonly used robot configurations.	BTL 1	Remember
3.	Sketch rotational joint.	BTL 3	Apply
4.	What is meant by work volume?	BTL 1	Remember
5.	List out the types of joint notations.	BTL 1	Remember
6.	What is meant by Pitch?	BTL 1	Remember
7.	Define base and tool coordinate system	BTL 1	Remember
8.	Give the benefits of robots.	BTL 2	Understand
9.	Infer robot anatomy.	BTL 4	Analyze
10.	Describe work envelope	BTL 2	Understand
11.	Write the benefits of industrial automation systems.	BTL 6	Create
12.	Give the specifications of industrial robot.	BTL 2	Understand
13.	Evaluate work space.	BTL 5	Evaluate
14.	Analyze spatial resolution in robotics.	BTL 4	Analyze
15.	Classify the motion control of robot arm.	BTL 4	Analyze
16.	Define Yaw, Pitch and Roll	BTL 2	Understand

17.	Examine accuracy of robot.	BTL 3	Apply
18.	Write any two laws of robotics.	BTL 6	Create
19.	Sketch linear joint.	BTL 3	Apply
20.	Compare work volume with workspace.	BTL 5	Evaluate
21.	State the limitations of robot.	BTL 1	Remember
22.	Justify the need of robots.	BTL 4	Analyze
23.	Define the term repeatability with respect to robot.	BTL 2	Understand
24.	Analyze the importance of the specification payload	BTL 4	Analyze

PART - B				
1.	Describe any four work envelop of a robot with suitable diagram and mention its applications. **(13)**		BTL 1	Remember
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
3.	**(i)**	Sketch a robot wrist and indicate wrist pitch, wrist yaw and wrist roll. **(6)**	BTL 3	Apply
	(ii)	Explain about major parts of a robot with their functions. **(7)**	BTL 4	Analyze
4.	**(i)**	Discuss about the need for Robots. **(3)**	BTL 2	Understand
	(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
6.	Explain the following:			
	(i)	Robot anatomy. **(7)**	BTL 5	Evaluate
	(ii)	Robot wrist. **(6)**		
7.	Write short notes on the following:		BTL 3	Apply
	(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
	(ii)	Explain base and tool Coordinate system. **(6)**		

9.	Illustrate with neat sketch about the basic robot motions. **(13)**	**BTL 3**	Apply
10.	Summarize the advantages of four common robot configuration and deduce their simple sketches. **(13)**	**BTL 6**	Create
11.	**(i)** Discuss about robot machine interface with neat diagram. **(7)**	**BTL 2**	Understand
	(ii) With neat sketch describe the multiple robot coordination in manufacturing. **(6)**	**BTL 1**	Remember
12.	With neat sketches explain the classification of robot based on	**BTL 5**	Evaluate
	(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
14.	Describe salient features of robot in different fields of applications. **(13)**	**BTL 1**	Remember
15.	Analyze the industrial uses of robots. **(13)**	**BTL 4**	Analyze
16.	With neat sketch explain the six degrees of freedom associated with robot wrist. **(13)**	**BTL 2**	Understand
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
PART C			
1.	Analyze the structure of robot in detail. **(15)**	**BTL 4**	Analyze
2.	Write short notes on application of robot in various fields in emerging technology. **(15)**	**BTL 6**	Create
3.	Generalize the evolution of robots and robotics. **(15)**	**BTL 6**	Create
4.	Explain the various specifications that one should look forward to purchase a commercial robot. **(15)**	**BTL 4**	Analyze
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

UNITII - 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
1.	What is an actuator?	BTL 1	Remember
2.	Discriminate the factors which must be considered while choosing the drive system for robots.	BTL 5	Evaluate
3.	What is meant by gripper? Give the types of grippers.	BTL 2	Understand
4.	List the advantages and dis-advantages of hydraulic drive.	BTL 1	Remember
5.	List the advantages and disadvantages of pneumatic actuators.	BTL 1	Remember
6.	Point out types of joints.	BTL 1	Remember
7.	List the advantages and dis-advantages of Electrical actuator.	BTL 1	Remember
8.	Why servomotors are preferred with stepper motor in robot applications?	BTL 3	Apply
9.	Which type of drive system is more suitable for heavy load robot application?	BTL 4	Analyze
10.	What is end effector? Give some examples of Robot End Effector.	BTL 2	Understand
11.	Enumerate the difference between open loop and closed loop control system.	BTL 6	Create
12.	In what ways do end effectors differ from the human hand?	BTL 6	Create
13.	Examine the difference between internal grippers and external grippers.	BTL 3	Apply
14.	Infer any four important factors to be considered in the selection and design of grippers.	BTL 4	Analyze
15.	Point out any two unique features of a stepper motor.	BTL 4	Analyze
16.	Give any two limitations of magnetic grippers.	BTL 2	Understand
17.	Classify the types of mechanical gripper.	BTL 3	Apply
18.	List the types of drive systems used in robots.	BTL 1	Remember
19.	Assess the characteristics of actuating systems.	BTL 5	Evaluate
20.	Predict the application of stripping device.	BTL 2	Understand

21.	State the components of the Electrical actuator.	BTL 2	Understand
22.	Assess the features of servomotors.	BTL 5	Evaluate
23.	Compare AC and DC servomotors.	BTL 4	Analyze
24.	Analyze the limitations of Adhesive grippers.	BTL 4	Analyze

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
2.	Classify the end effector. Draw the different mechanism used in the gripper and give its application. **(13)**		BTL 5	Evaluate
3.	Explain with neat sketch about following:		BTL 4	Analyze
	(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
	(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
6.	**(i)**	Explain vacuum grippers, with reference to the principle and applications. **(7)**	BTL 5	Evaluate
	(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
8.	**(i)**	Discuss about various considerations for selection and design of a gripper. **(6)**	BTL 2	Understand
	(ii)	Explain working principle, salient features and applications of A.C. and D.C. Servo motor as robot drive system. **(7)**	BTL 4	Analyze
9.	Compare the servo motor with stepper motor, choose suitable drive system for industrial robot along with your justification. **(13)**		BTL 4	Analyze
10.	**(i)**	Write note on gripper selection and design. **(3)**	BTL 2	Understand
	(ii)	Describe the magnetic grippers in robot. **(10)**	BTL 2	Understand
11.	**(i)**	Illustrate Pneumatic actuators system with neat sketch. **(7)**	BTL 3	Apply
	(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

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

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**
1.	Define vision and vision system.	**BTL 1**	Evaluate
2.	Classify the vision systems? What are the common imaging devices used for robot vision system?	**BTL 1**	Remember
3.	Give an application example of a proximity sensor.	**BTL 2**	Understand
4.	Define machine vision.	**BTL 1**	Remember

5.	List the machine vision stages.	BTL 1	Remember
6.	What is segmentation? What is thresholding?	BTL 1	Remember
7.	Define sensor.	BTL 1	Remember
8.	Classify sensors for robot applications.	BTL 3	Apply
9.	Infer the use of inductive type proximity sensor.	BTL 4	Analyze
10.	Give some feedback devices used in robotics.	BTL 2	Understand
11.	Generalize various techniques in image processing and analysis.	BTL 6	Create
12.	Enumerate the areas of application of image processing in the field of robots.	BTL 6	Create
13.	Write about hall effect sensors.	BTL 3	Apply
14.	Infer the types of light sensors in robot applications.	BTL 4	Analyze
15.	Mention any two examples for contact and non-contact sensor.	BTL 4	Analyze
16.	Classify the position sensors.	BTL 3	Apply
17.	Differentiate between pyroelectric sensor and piezoelectric sensors.	BTL 2	Understand
18.	Give the benefits of LVDT.	BTL 2	Understand
19.	Assess any two algorithms for image enhancement application.	BTL 5	Evaluate
20.	Assess the use of frame grabber.	BTL 5	Evaluate
21.	Examine the uses of resolver in robotics.	BTL 5	Evaluate
22.	List out the classifications of range sensing.	BTL 3	Apply
23.	Justify the applications of optical encoders	BTL 4	Analyze
24.	What is meant by binary sensors.	BTL 1	Remember

PART - B				
1.	Describe the following range sensing techniques		BTL 1	Remember
	(i)	Triangulations technique. **(7)**		
	(ii)	Structured lighting approach. **(6)**		
2.	With neat sketch explain the following:		BTL 5	Evaluate
	(i)	Touch sensor. **(7)**		
	(ii)	Analog sensor. **(6)**		

3.	(i)	Describe the piezo electric sensors. (7)	BTL 2	Understand
	(ii)	Explain in detail about tactile and non-tactile sensors. (6)	BTL 5	Evaluate
4.		With neat sketch explain the following:	BTL 5	Evaluate
	(i)	Resolvers. (6)		
	(ii)	Optical Encoders. (7)		
5.		Describe the working principle of Proximity sensors with neat sketch. (13)	BTL 1	Remember
6.		Explain mono and stereo vision in the context of robot vision digital convolution. (13)	BTL 5	Evaluate
7.		Explain how image segmentation helps to improve quality of images in vision system. (13)	BTL 4	Analyze
8.	(i)	What do you mean by robot vision? Explain in detail. (7)	BTL 4	Analyze
	(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
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
11.		With suitable sketch citing appropriate application describe the following	BTL 2	Understand
	(i)	Wrist sensor. (7)		
	(ii)	Binary sensor. (6)		
12.		With suitable sketch citing appropriate application describe the following	BTL 2	Understand
	(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
14.		How are the images processed and analyzed in a machine vision system? Explain with suitable example. (13)	BTL 4	Analyze
15.		Explain any two position sensing methods used in Robots with suitable sketches. (13)	BTL 2	Understand
16.		Mention and explain the applications of image processing and analysis in robot. (13)	BTL 4	Analyze

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
	PART C		
1.	Explain the working principle of range finders, laser range meters along with respective circuit. **(15)**	BTL 4	Analyze
2.	Prepare the factors to be considered for selection of sensors and write down the classifications of sensors. **(15)**	BTL 4	Analyze
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
4.	Tabulate various illumination techniques and their uses. **(15)**	BTL 4	Analyze
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
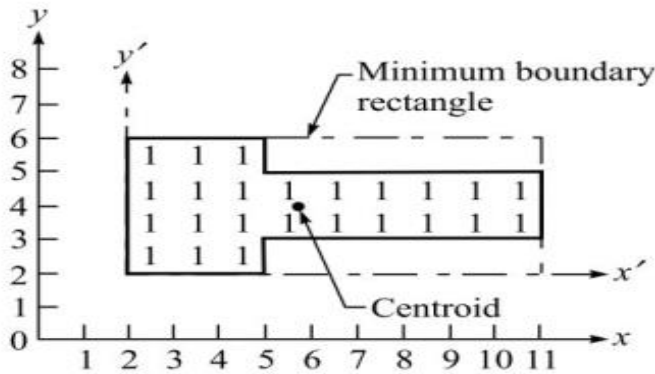
UNIT IV   ROBOT KINEMATICS AND ROBOT PROGRAMMING
Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics, 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
1.	Why kinematic study of the robot is important?	BTL 4	Analyze
2.	List out the typical motion command.	BTL 1	Remember
3.	Write the meaning of the command	BTL 6	Create

	DMOVE (<4, 5, 6> <30, -45, 90>).		
4.	Classify the methods of Robot programming.	BTL 3	Apply
5.	Define a manipulator.	BTL 1	Remember
6.	Differentiate between Forward kinematics and reverse kinematics.	BTL 2	Understand
7.	Mention the disadvantages of lead through programming.	BTL 5	Evaluate
8.	Define Degrees of freedom.	BTL 1	Remember
9.	List the limitations of online robot programming.	BTL 1	Remember
10.	Illustrate irregular smooth motions.	BTL 3	Apply
11.	Write end effectors commands.	BTL 5	Evaluate
12.	What is teach pendant?	BTL 1	Remember
13.	Predict the reason for defining points in a program.	BTL 2	Understand
14.	What is meant by kinematics?	BTL 3	Apply
15.	What are the ways of accomplishing lead through programming?	BTL 4	Analyze
16.	Write the meaning of the command DMOVE (1, 10).	BTL 6	Create
17.	What are the commands used to execute the speed of the robot in VAL programming?	BTL 2	Understand
18.	Explain position representation.	BTL 4	Analyze
19.	State the reason for homogeneous transformation	BTL 2	Understand
20.	List the limitations of offline robot programming.	BTL 1	Remember
21.	Define the term singularity.	BTL 2	Understand
22.	What is meant by joint space and world space	BTL 1	Remember
23.	List the methods of defining positions in space.	BTL 2	Understand
24.	State the DH parameters used in transformation.	BTL 2	Understand
PART B			
1.	i) Write about sensors and end effectors commands with **(7)** example.	BTL 6	Create
	ii) Differentiate forward and reverse transformation with **(6)** example	BTL 4	Analyze
2.	i) Write note on motion commands of robots **(7)**	BTL 6	Create
	ii) Explain detail manual lead through programming method in **(6)** robot application	BTL 5	Evaluate
3.	i) Describe the capabilities of and limitations of lead through **(6)** programming	BTL 2	Understand
	ii) Describe the methods of defining positions in space **(7)**	BTL 2	Understand
4.	Explain WAIT, DELAY, SIGNAL, and command with suitable **(13)** example	BTL 4	Analyze
5.	Derive the forward and reverse kinematics with two degree of **(13**) freedom.	BTL 5	Evaluate
6.	Write the list of commands used in VAL programming and describe **(13)** any two in detail.	BTL 1	Remember
7.	Classify the different types of programming methods and illustrate **(13)** any one in detail.	BTL 3	Apply
8.	Describe the teach pendant for Robot system **(13)**	BTL 1	Remember
9.	Classify various programming languages used in computer **(13)** controlled robots and illustrate any one in detail.	BTL 3	Apply

10.	Derive the forward and reverse kinematics with four degree of freedom.	(13)	BTL 5	Evaluate
11.	Explain the function of inverse kinematics with example.	(13)	BTL 4	Analyze
12.	Derive the forward and reverse kinematics for RRR robot.	(13)	BTL 5	Evaluate
13.	Derive the forward and reverse kinematics with three degree of freedom.	(7)	BTL 5	Evaluate
14.	Explain manipulator kinematics with neat sketch.	(13)	BTL 4	Analyze
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
16.	Derive the forward and reverse kinematics for RR robot.	(13)	BTL 5	Evaluate
17.	With suitable examples explain some motion and speed control commands	(13)	BTL 5	Evaluate
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
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
3.	Derive the forward and reverse kinematics for RRL robot.	(15)	BTL 5	Evaluate
4.	Analyze the features of Generations of robot programming Languages	(15]	BTL 4	Analyze
5.	Derive the forward position kinematics with three degree of freedom by using matrix form.	(15)	BTL 5	Evaluate

UNIT V IMPLEMENTATION AND ROBOT ECONOMICS

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

PART A			
Q.No	Question	BT Level	Competence
1.	What is AGV?	BTL 1	Remember
2.	Classify the four basic categories for industrial robot application?	BTL 3	Apply
3.	What are the three basic modes of operation in a robot language operating system?	BTL 3	Apply
4.	Evaluate the robot economics by return of investment method.	BTL 5	Evaluate
5.	List out any two important factors in the selection of robot for an application	BTL 1	Remember

6.	How does RGV differs from AGV?	BTL 4	Analyze
7.	List out various methods used in economic analysis of robot.	BTL 1	Remember
8.	Give some applications of AGV.	BTL 2	Understand
9.	Asses the typical technical features required for material transfer.	BTL 5	Evaluate
10.	Examine palletizing and depalletizing operation.	BTL 2	Understand
11.	Analyze the causes of human injury in a robotic environment.	BTL 4	Analyze
12.	Mention the limitations of implementing robots in industry.	BTL 3	Apply
13.	Write the reasons for the use of robots in welding operation.	BTL 6	Create
14.	What are the three levels of safety sensors used in a robot?	BTL 1	Remember
15.	Write the functions of work cell controller.	BTL 6	Create
16.	Differentiate palletizing and depalletizing.	BTL 2	Understand
17.	Define Payback period.	BTL 1	Remember
18.	Give some important factors in the selection of robot for an application.	BTL 2	Understand
19.	Point out few safety precautions necessary for robotic application.	BTL 4	Analyze
20.	What do you mean by part presentation?	BTL 1	Remember
21.	List out some general considerations while robots are used for material handling	BTL 2	Understand
22.	Evaluate the applications of robots in Assembly operations.	BTL 5	Evaluate
23.	Define the three levels of safety sensor systems in robotics.	BTL 3	Apply
24.	Differentiate investment costs and operating costs.	BTL 4	Analyze

PART B			
1.	i) Explain the working of AGV with component based DCS. **(7)**	BTL 4	Analyze
	ii) Explain the logical sequence steps in the implementation of robots in industries. **(6)**	BTL 4	Analyze
2.	i) Explain the economic analysis of the robot using EUAC method. **(6)**	BTL 5	Evaluate
	ii) Explain safety sensors and safety monitoring of robot. **(7)**	BTL 5	Evaluate
3.	Explain with an example procedure of applying payback method in the economic analysis of robots. **(13)**	BTL 4	Analyze
4.	Write shorts on the following:	BTL 6	Create
	i) Method of payback period. **(7)**		
	ii) Return on investment method. **(6)**		
5.	Write shorts on the following:	BTL 6	Create
	i) Discounted cash flow method **(7)**		
	ii) Equivalent uniform annual cost method. **(6)**		
6.	Describe the workplace design consideration for safety of Robots in detail. **(13)**	BTL 1	Remember
7.	Classify the AGV and RGV types of robots in detail. **(13)**	BTL 3	Apply
8.	Explain the obstacle detection an avoidance in AGV. **(13)**	BTL 4	Analyze
9.	Illustrate the various cost associated with robot project. **(13)**	BTL 3	Apply
10.	Explain various step involved for implementing robots in industries **(13)**	BTL 4	Analyze

11.	Discuss the implementation issues of robots in an assembly environment.	(13)	BTL 2	Understand
12.	Describe various factors to be considered for industrial application of robots.	(13)	BTL 2	Understand
13.	List and explain indirect costs and savings in a robot application project.	(13)	BTL 4	Analyze
14.	What is meant by blocking in AGV? Explain the methods used in commercial AGV to accomplish blocking.	(13)	BTL 5	Evaluate
15.	Write the importance and operations of safety sensors and safety monitoring	(13)	BTL 2	Understand
16.	Explain about selection of robot for an application also illustrate with suitable examples.	(13)	BTL 4	Analyze
17.	Analyze various Cost data required for economic analysis.	(13)	BTL 4	Analyze
PART C				
1.	Explain the safety consideration for robot operation in detail.	(15)	BTL 5	Evaluate
2.	Present a comparative study of different methods of economic analysis.		BTL 4	Analyze
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
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
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 depreciation to be Rs. 75,000 and added value of increased output be Rs. 1,00,000. Determine the pay back period.	(15)	BTL 6	Evaluate