SREENIVASA INSTITUTE of TECHNOLOGY and MANAGEMENT STUDIES
(AUTONOMOUS)

(AUTOMATION AND ROBOTICS)

16MEC325A

QUESTION BANK

III - B.TECH / II - SEMESTER REGULATION: R16

PREPARED BY
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DESIGNATION : ASSISTANT PROFESSOR
DEPARTMENT : MECHANICAL

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III B.Tech II Semester

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16MEC325A AUTOMATION AND ROBOTICS

Course Educational Objectives:

- To study the various fundamental concepts of automation.
- To understand the basic concepts associated with the design and functioning and applications of robots.
- To study about the drives and sensors used in robots.
- To learn about analysing robot kinematics, dynamics and robot programming.

UNIT – 1: BASICS OF AUTOMATION

Basic elements of an automated system – Need – Types – Advanced automation function – Levels of automation – Hardware components for automation and process control – Automated storage and retrieval system – Material transport system and equipments – Over view of automated identification technique – Bar code technology.

UNIT – 2: AUTOMATED FLOW LINES AND LINE BALANCING

Automated flow lines: Part transfer methods and mechanisms – Types of flow lines – Flow line with/without buffer storage – Qualitative analysis. **Assembly line balancing:** Assembly process and systems assembly line – Line balancing methods – Ways of improving line balance and flexible assembly lines.

UNIT – 3: INDUSTRIAL ROBOTICS AND DRIVE SYSTEM

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 functions – Need for robots – Different applications. **Robot Drive System:** Pneumatic drives – Hydraulic drives – Mechanical drives – Electrical drives – Servo motors and stepper motor – Grippers – Mechanical grippers, pneumatic and hydraulic grippers, magnetic grippers, vacuum Grippers; two fingered and three fingered grippers; internal grippers and external grippers.

UNIT – 4: KINEMATICS AND DYNAMICS OF ROBOTS

Robot Kinematics: Homogeneous transformations as applicable to rotation and translation – D-H notation – Forward and inverse kinematics. **Robot Dynamics:** Differential transformation – Jacobians, Lagrange-Euler and Newton-Euler formations. **Trajectory Planning:** Trajectory planning and avoidance of obstacles – Path planning – Skew motion – Joint integrated motion – Straight line motion.

UNIT – 5: ROBOT PROGRAMMING AND APPLICATION

Robot Sensors: Range sensor – Proximity sensor – Touch sensor – Force and torque sensor. **Robot Programming:** Teach pendant programming, lead through programming, robot programming languages – VAL programming – Motion commands, sensor commands, end effecter commands and simple programs. **Robot Applications:** Robot application in manufacturing industry – Applications in assembly and inspection.

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Course Outcomes:

Upon completion of this course, the students will be able to:

- ✓ Understand the concept of automation in manufacturing industries.
- ✓ Have knowledge on the fundamentals of Robotics, Robot Kinematics and Programming which help them to build and work with Robots.

Text Books:

1. Robotics Control, Sensing, Vision and Intelligence, Fu.K.S. Gonzalz.R.C., and Lee C.S.G., 1987, McGraw-Hill Book Co.,
2. Automation, Production Systems and CIM, M.P.Groover, 3/e, 2008, Prentice- Hall of India, Pvt. Ltd., New Delhi.

Reference Books:

1. Fundamentals of Robotics Analysis and Control, C Robert J Schilling, 2009, Pearson Education.
2. Introduction to Robotics Mechanics and Education, Craig J.J., 2008.
3. Robotics Technology and Flexible Automation, Deb S.R. and Deb S., 2010, McGraw Hill Education.
4. Industrial Robotics-Technology, Programming and Applications, M.P.Groover, 2001, McGraw-Hill.
5. Foundation of Robotics: Analysis and Control, Yoshikawa, 2004, Prentice Hall of India.

On successful completion of the course, students will be able to:

Course Outcomes		POs related to Cos
CO1	**Summarize the various fundamental and advanced concepts of automation in industry**	**PO1**
CO2	**Understand the line balancing and flow line of robotics in automated**	**PO1, PO2**
CO3	**Demonstrate the basic concepts associated with industrial robots and driving system used in robots**	**PO1**
CO4	**Compare the kinematics and Dynamics of robots**	**PO1, PO2**
CO5	**Explain about sensors used in robots, Robot programming and applications**	**PO1**

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Question No	Questions			
	UNIT-I BASICS OF AUTOMATION			
	PART-A(TWO MARK QUESTIONS)	CO	BL	PO
1.	Define production system.	**CO1**	**1**	**PO1**
2.	List various levels in automation.	**CO1**	**1**	**PO1**
3.	Define automation?	**CO1**	**1**	**PO1**
4.	What are the hardware components required for automation?	**CO1**	**1**	**PO1**
5.	List the basic elements of an automated system.	**CO1**	**1**	**PO1**
6.	Give examples of automation system.	**CO1**	**1**	**PO1**
7.	What are the various controllers used in automation?	**CO1**	**1**	**PO1**
8.	Define open loop system?	**CO1**	**1,2**	**PO1**
9.	What conditions favors to flexible automation.	**CO1**	**1**	**PO1**
10.	What are the circumstances under which fixed automation is suitable?	**CO1**	**1,2**	**PO1**
	PART-B (TEN MARKS QUESTIONS)			
1.	What are the various types of automation explain in detail	**CO1**	**1**	**PO1**
2.	Describe briefly advanced automation functions	**CO1**	**1,2**	**PO1**
3.	a) Explain different Levels of automation b) Discuss briefly need of automation	**CO1**	**1.2,3**	**PO1**
4.	Explain briefly Analog-to-Digital Conversion and Digital Conversion -to-Analog	**CO1**	**1,2**	**PO1**
5.	Explain AS (Automated Storage) and RS (Retrieval System) components and terminology	**CO1**	**1,2**	**PO1**
6.	Explain analysis AS (Automated Storage) and RS (Retrieval System)	**CO1**	**1**	**PO1**
7.	Discuss various types of material handling equipment	**CO1**	**2,3**	**PO1**
8.	Define material handling system and explain Principles of Material Handling	**CO1**	**1,2**	**PO1**
9.	Describe briefly Automated Guided Vehicles (AGVs)	**CO1**	**1,2**	**PO1**
10	Explain Bar code Technology.	**CO1**	**1,2**	**PO1**

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Question No	Questions			
	UNIT-2: AUTOMATED FLOW LINES AND LINE BALANCING			
	PART-A(TWO MARK QUESTIONS)	CO	BL	PO
1.	What is buffer storage?	**CO2**	**1**	**PO1**
2.	What is line balancing?	**CO2**	**1**	**PO1**
3.	What are the objectives of automated flow line?	**CO2**	**1**	**PO1**
4.	What are the reasons to include buffer storage in production line?	**CO2**	**1**	**PO1,PO2**
5.	What are the different types of flowlines?	**CO2**	**1**	**PO1**
6.	List out the rotary indexing mechanisms.	**CO2**	**1**	**PO1**
7	List out various methods of transporting workpieces on flow lines	**CO2**	**1,2**	**PO1**
8.	What do you mean by synchronous and asynchronous work transport system?	**CO2**	**1,2**	**PO1,PO2**
9.	Define automated flow line and List out automated flow lines	**CO2**	**1**	**PO1**
10.	Write down advantages and dis-advantages of buffer storage	**CO2**	**1**	**PO1**
	PART-B (TEN MARKS QUESTIONS)			
1.	Explain briefly work part transfer methods	**CO2**	**1,3**	**PO1**
2.	Explain linear transfer mechanisms with neat sketch	**CO2**	**1,3**	**PO1**
3.	What are the various types of rotary transfer mechanisms and describe any two mechanisms in brief?	**CO2**	**2,3**	**PO1**
4.	Explain reasons for using storage buffers in automated flow lines?	**CO2**	**1,3**	**PO1**
5.	Describe briefly automated storage and retrieval system	**CO2**	**1,3**	**PO1**
6.	Discuss flow line with and without buffer storage	**CO2**	**1,3**	**PO1**
7.	Given the following tasks, time and sequence develop a balanced line capable of operating with a 10 minutes cycle time, using Rank Positional Weight (RPW) method and calculate the i)efficiency of that line (ii) balance delay (iii) smoothness index	**CO2**	**1,2,3**	**PO1,PO2**

Task element	A	B	C	D	E	F	G	H
Time (min)	3	5	7	5	3	3	5	6
Element Predecessor	-	A	B	-	C	B,D	D	G

<table>
<tr><td>8.</td><td>Toy assemblies should be done as per the information given in the table below and cycle time is 1minute balance the line using kill bridge and wester’s method. Determine (i)efficiency of line (ii) balance delay (iii) smoothness index
<table>
<tr><td>Task Element</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td></tr>
<tr><td>Time (min)</td><td>0.5</td><td>0.3</td><td>0.8</td><td>0.2</td><td>0.1</td><td>0.6</td><td>0.4</td><td>0.5</td><td>0.3</td><td>0.6</td></tr>
<tr><td>predecessors</td><td>-</td><td>1</td><td>1</td><td>2</td><td>2</td><td>3</td><td>4,5</td><td>3,5</td><td>7,8</td><td>6,9</td></tr>
</table></td><td>CO2</td><td>1,2,3</td><td>PO1,PO2</td></tr>
<tr><td>9.</td><td>Given the following data describe line balancing problem, develop a solution using largest candidate rule method allowing a cycle time of 3 minutes. Calculate i) efficiency of line (ii) balance delay (iii) smoothness index
<table>
<tr><td>Task Element</td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td><td>G</td><td>H</td><td>I</td></tr>
<tr><td>Time (min)</td><td>1</td><td>1</td><td>2</td><td>1</td><td>3</td><td>1</td><td>1</td><td>2</td><td>1</td></tr>
<tr><td>predecessors</td><td>-</td><td>A</td><td>B</td><td>B</td><td>G, D</td><td>A</td><td>F</td><td>G</td><td>F, H</td></tr>
</table></td><td>CO2</td><td>1,2,3</td><td>PO1,PO2</td></tr>
<tr><td>10</td><td>Explain largest candidate rule line balancing method with an example.</td><td>CO2</td><td>1,2,3</td><td>PO1,PO2</td></tr>
</table>

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Question No	Questions			
UNIT-3: INDUSTRIAL ROBOTICS AND DRIVE SYSTEM				
	PART-A(TWO MARK QUESTIONS)	CO	BL	PO
1.	Mention any 4 components of a robot.	**CO3**	**1,2**	**PO1**
2.	Define degrees of freedom of a robot.	**CO3**	**1**	**PO1**
3.	Differentiate between joint and link.	**CO3**	**1**	**PO1**
4.	List out any two common Robot configurations	**CO3**	**1,2**	**PO1**
5.	What is meant by work envelope?	**CO3**	**1**	**PO1**
6.	Define a drive system in robot.	**CO3**	**1**	**PO1**
7.	What are the various types of drives used in robot?	**CO3**	**1**	**PO1**
8.	State any two advantages and disadvantages of pneumatic drive?	**CO3**	**1**	**PO1**
9.	What are the various types of grippers used in robot?	**CO3**	**1**	**PO1**
10	What are the advantages of magnetic gripper?	**CO3**	**1**	**PO1**
11.	What are the various types of gripper mechanisms used in robot?	**CO3**	**1**	**PO1**
12.	Mention any two uses of vacuum grippers.	**CO3**	**1,2**	**PO1**
PA.RT-B (TEN MARKS QUESTIONS)				
1.	Explain anatomy of robot with a neat sketch.	**CO3**	**1,2**	**PO1**
2.	Elaborate co-ordinate systems in robots.	**CO3**	**2,3**	**PO1**
3.	Write short notes on the following: (i) Types of robot controls (ii) Spatial resolution (iii) Repeatability.	**CO3**	**1**	**PO1**
4.	Explain briefly working of pneumatic drive and state advantages and disadvantages of pneumatic drive.	**CO3**	**1**	**PO1**
5.	Elaborate the working of hydraulic drives. State their merit and demerits.	**CO3**	**1**	**PO1**
6.	Classify Mechanical Drives used in Robots and explain them briefly.	**CO3**	**2**	**PO1**
7.	Explain the different types of electrical servo motors used in robot actuation.	**CO3**	**1**	**PO1**
8.	Discuss three types of mechanical gripper mechanism.	**CO3**	**2**	**PO1**
9.	Discuss about magnetic and vacuum grippers.	**CO3**	**1**	**PO1**
10.	With suitable illustration explain working on external and internal grippers.	**CO3**	**1**	**PO1**
11.	Discuss in detail the selection and design considerations of grippers in robots.	**CO3**	**1,3**	**PO1**

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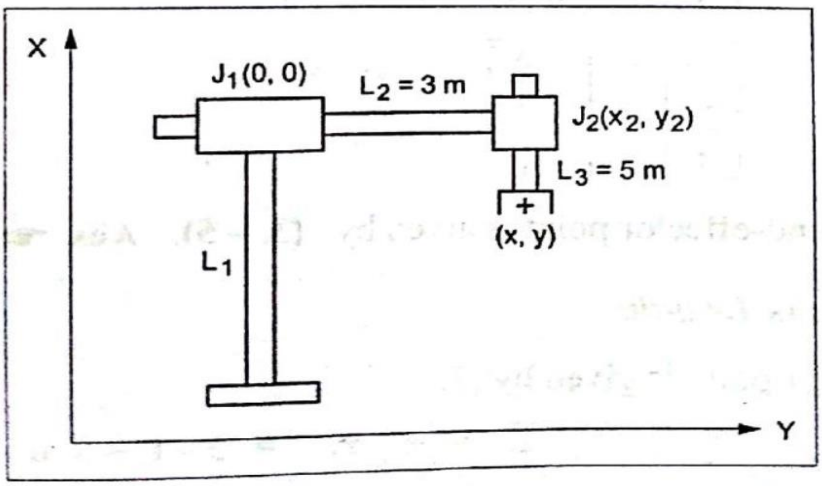
Question No	Questions			
	UNIT-4: KINEMATICS AND DYNAMICS OF ROBOTS			
	PART-A(TWO MARK QUESTIONS)	CO	BL	PO
1.	What is robot arm kinematics?	**CO4**	**1**	**PO1**
2.	What is trajectory planning?	**CO4**	**1**	**PO1**
3.	Define transformation matrix?	**CO4**	**1**	**PO1**
4.	Define D-H notation	**CO4**	**2**	**PO1,PO2**
5.	Write any two differences between forward and inverse kinematics?	**CO4**	**1,2**	**PO1**
6.	What is robot arm Dynamics?	**CO4**	**1**	**PO1**
7.	Write about forward and inverse dynamics?	**CO4**	**1**	**PO1**
8.	What is meant by Skew motion of a robot manipulator	**CO4**	**1**	**PO1**
9.	Write short note on forward and backward iteration?	**CO4**	**1,2**	**PO1,PO2**
10.	Differentiate between Newton-Euler Formulation and Euler-Lagrangian Formulation	**CO4**	**1,2**	**PO1,PO2**
11.	What are the steps involved to obtain a dynamic equation?	**CO4**	**1,3**	**PO1**
	PART-B (TEN MARKS QUESTIONS)			
1.	Determine a composite rotation matrix for the following sequence of rotations i)Rotation of angle α about X-axis, ii) Rotation of angle β about Y-axis and iii) Rotation of angle γ about Z-axis	**CO4**	**1,2,3**	**PO1**
2.	Obtain the homogeneous transformatin matrix that represents a rotation of **α** degrees about the current X-axis followed by a translation of **b** units along the current X-axis, followed by a translation **d** unit along the current Z-axis followed by a rotation of **θ** degrees about the current Z-axis	**CO4**	**1,2,3**	**PO1,PO2**
3.	An LL robot has two links of variable length Assuming that the origin of the global coordinate system defined at joint J1 determine the following a) The coordinate of the end effector point if the variable link lengths are 3m and 5m b) Variable link lengths if end effector is located at (3,5) ? 	**CO4**	**1,2,3**	**PO1,PO2**

4.	Explain Forward kinematics of manipulators with two degrees of freedom in LL Robot, RR Robot and TL Robot?	**CO4**	**1,2**	**PO1,PO2**
5.	Explain briefly reverse kinematics of manipulators with two degrees of freedom in LL Robot, RR Robot and TL Robot?	**CO4**	**1,2**	**PO1,PO2**
6.	For the point $P_{XYZ} = (0,5,2)^T$ perform following operations i) rotate 30^o about Y-axis followed by translation of 4 units along Z-axis ii) Translate 6 units along Z-axis followed by rotation of 60^o along Y-axis	**CO4**	**1,2,3**	**PO1,PO2**
7.	Explain newton Euler formulation for a robot arm with advantages and dis advantages	**CO4**	**2,3**	**PO1,PO2**
8.	Derive the expression for the joint torques of a two-link planar revolute jointed robotic manipulator using Lagrange Euler formation	**CO4**	**1,2**	**PO1,PO2**
9.	Explain 4-3-4 trajectory	**CO4**	**1,2,3**	**PO1,PO2**
10	Explain trajectory planning system with reference to robots	**CO4**	**1,2**	**PO1,PO2**
11.	Discuss the cartesian space techniques	**CO4**	**2,3**	**PO1,PO2**
12.	What are the different types of motion that a robot manipulator can make in travelling from point to point? Explain.	**CO4**	**1,2**	**PO1,PO2**

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Question No	Questions			
	UNIT-5: ROBOT PROGRAMMING AND APPLICATION			
	PART-A(TWO MARK QUESTIONS)	CO	BL	PO
1.	What is a sensor?	**CO5**	**1**	**PO1**
2.	Define transducer.	**CO5**	**1**	**PO1**
3.	Define actuator.	**CO5**	**1**	**PO1**
4.	What are the advantages of using robots in spray painting?	**CO5**	**1**	**PO1**
5.	What are the sensors used in industrial robots?	**CO5**	**1**	**PO1**
6.	List out online robot programming methods.	**CO5**	**1**	**PO1**
7.	What are the various types of techniques in range sensor?	**CO5**	**1**	**PO1**
8.	What are the advantages and dis-advantages of Force and Torque sensor	**CO5**	**1**	**PO1**
9.	Write any four commands in VAL programming	**CO5**	**1,2**	**PO1**
10	List out various applications of robot in manufacturing industry	**CO5**	**1**	**PO1**
	PART-B (TEN MARKS QUESTIONS)			
1.	Explain the working of range sensor in detail.	**CO5**	**1**	**PO1**
2.	Explain the working of proximity sensor in detail	**CO5**	**1**	**PO1**
3.	Explain the working of Touch sensor in detail with advantages and dis-advantages	**CO5**	**1**	**PO1**
4.	Explain the working of Force and Torque sensor in detail with advantages and dis-advantages	**CO5**	**1**	**PO1**
5.	Explain different types of sensors used in industrial robots.	**CO5**	**1**	**PO1**
6.	Discuss briefly different applications of Industrial robot.	**CO5**	**1**	**PO1**
7.	Explain teach pendant method of robot programming	**CO5**	**1,2**	**PO1**
8.	Explain the applications of industrial robots in manufacturing area.	**CO5**	**1**	**PO1**
9.	Explain lead through programming method.	**CO5**	**1**	**PO1**
10.	Explain VAL programming commands.	**CO5**	**1,2**	**PO1**
11.	What are the role of robots in loading and unloading?	**CO5**	**1**	**PO1**
12.	With schematic diagram, explain the robotic applications in welding industry.	**CO5**	**1**	**PO1**

*****ALL THE BEST*****