

**B.Tech. IV Semester VII**

**Subject Name: Robotics and Machine Vision**

**Subject Code: BTIC14703**

**Type of course: PEC(Professional Elective Course)**

**Prerequisite (if any):** Coordinate geometry, Engineering Mechanics

**List of Courses where this course will be prerequisite :** Automation & Control

**Rationale: (should also include Description of the relevance of this course in the Program)**

Robotics is a branch of engineering that involves the conception, design, manufacture and operation of robots. The objective of the robotics field is to create intelligent machines that can assist humans in a variety of ways.

**Teaching and Examination Scheme:**

TEACHING SCHEME				Theory Marks			Practical Marks		Total
L	T	P	C	TEE	CA1	CA2	TEP	CA3	
3	0	2	5	60	25	15	30	20	150

**CA1: Continuous Assessment (assignments/projects/open book tests/closed book tests** **CA2: Sincerity in attending classes/class tests/ timely submissions of assignments/ self-learning attitude/solving advanced problems** **TEE: Term End Examination** **TEP: Term End Practical Exam (Performance and viva on practical skills learned in course)** **CA3: Regular submission of Lab work/Quality of work submitted/Active participation in lab sessions/viva on practical skills learned in course**

**Content:**

<b>Sr. No.</b>	<b>Content</b>	<b>Total Hrs</b>	
<b>1</b>	<b>Fundamental</b> Introduction, what is a Robot? , Classification of Robots ,What is Robotics? ,History of Robotics ,Advantages and Disadvantages of Robots, Robot Components, Robot Degrees of Freedom, Robot Joints, Robot Coordinates, Robot Reference Frames ,Programming Modes ,Robot Characteristics ,Robot Workspace ,Robot Languages ,Robot Applications Other Robots and Applications	<b>6</b>	<b>11%</b>
<b>2</b>	<b>Robot Kinematics: Position Analysis</b> Introduction, Robots as Mechanisms, Conventions, Matrix Representation, Homogeneous Transformation, Matrices Representation of Transformations, Inverse of Transformation Matrices ,Forward and Inverse Kinematics of Robots Denavit-Hartenberg Representation of Forward Kinematic Equations of Robots,The Inverse Kinematic Solution of Robots ,Degeneracy and Dexterity ,The Fundamental Problem with the Denavit-Hartenberg Representation Problems	<b>8</b>	<b>19%</b>
<b>3</b>	<b>Trajectory Planning</b> Introduction, Path vs. Trajectory,Joint-Space vs. Cartesian-Space Descriptions Basics of Trajectory Planning Joint-Space Trajectory Planning ,Cartesian-Space Trajectories	<b>7</b>	<b>13%</b>
<b>5</b>	<b>Actuators and Drive Systems</b> Introduction ,Characteristics of Actuating Systems ,Comparison of Actuating Systems ,Hydraulic Actuators ,Pneumatic Devices ,Electric Motors	<b>7</b>	<b>11%</b>

<b>6</b>	<p><b>Sensors</b></p> <p>Introduction ,Sensor Characteristics ,Position Sensors, Velocity Sensors ,Acceleration Sensors ,Force and Pressure Sensors, Torque Sensors , Micro switches, Visible Light and Infrared Sensors , Touch and Tactile Sensors ,Proximity Sensors , Range Finders ,Sniff Sensors ,Vision Systems Voice-Recognition Devices Voice Synthesizers,Remote Center Compliance (RCC) Device</p>	<b>8</b>	<b>13%</b>
<b>7</b>	<p><b>Image Processing and Analysis with Vision Systems</b></p> <p>Introduction , Image Processing versus Image Anlysis, Two and three Dimensional Image Types,what is an Image, Acquisition of Images,Digital Images,Frequency domain versus Spatial Domain, Fourier Transform and Frequency Content of a Signal, Frequency Content of an Image: Noise and Edges Resolution and Quantization Sampling Theorem , Image-Processing Techniques, Histograms of Images , Thresholding , Connectivity, Noise Reduction , Edge Detection, Hough Transform, Segmentation , Segmentation by Region Growing and Region Splitting, Binary Morphology Operations ,Gray Morphology Operations ,Image Analysis, Object Recognition by Features ,Depth Measurement with Vision Systems , Specialized Lighting, Image Data Compression, Color Images ,Heuristics</p>	<b>9</b>	<b>13%</b>

**Suggested Specification table with Marks (Theory):**

<b>Distribution of Theory Marks</b>					
R Level	U Level	A Level	N Level	E Level	C Level
<b>20%</b>	<b>30%</b>	<b>15%</b>	<b>10%</b>	<b>10%</b>	<b>15%</b>

**Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom’s Taxonomy)**

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

**Bachelor of Technology (B. Tech.)  
Instrumentation and Control**

**Reference Books:**

Sr no	Title of book /article	Author(s)	Publisher and details like ISBN	Year of publication	Publication Edition
1.	Introduction to Robotics: Analysis, Control, Applications,	Saeed B.Niku	Wiley. 978-8126533121	2007	First edition
2.	Robotics	Fu, Lee and Gonzalez,	McGraw Hill 978-0070265103	2017	First edition
3.	Industrial Robotics	Groover M.P	McGraw Hil	2001	First edition
4.	Introduction to Robotics Mechanics and Control	JohnJ.Craig	Pearson Education	2009	Third edition

**Course Outcomes:**

Sr. No.	CO statement At the end of the course the student will be able to:	Marks % weightage
CO-1	define fundamentals of robotics and its components.	15%
CO-2	recognize the mathematics of rigid motions as forward kinematics, inverse kinematics	25%
CO-3	demonstrate different robot actuators and trajectory planning	20%
CO-4	discuss about the dynamics and control in robotics industries	15%
CO-5	Describe basic of Image processing & Vision System.	25%

**Mapping with POs:**

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO8	PO 9	PO 10	PO 11	PO 12	PSO1	PSO2	PSO3
CO1							1		1						
CO2	3	2					1		1				2	2	
CO3	3	2					1		1				2	2	
CO4	3	2					1		1				2	2	
CO5	3	3					1		1				2	2	

**Rationale\* : Explaining why it is matching this particular program outcome**

**BSC: basic science course /ESC: Engineering Science Course /HSM: Humanities and management  
/PCC: Professional Core course /PEC: professional Elective course /OEC: Open Elective course/  
TOE: Transdisciplinary open elective/ MD: mandatory non-credit course**

**List of Open learning website:** NPTEL course on Introduction to Robotics

**List of Open Source Software:** Roboanalyzer

**FOR LAB SESSIONS:**

**List of Experiments:**

1. To study different Robot Configuration
2. To study Firebird V Robot (e-yantra IITB P89v51RD2)
3. Perform direction control of motor of P89v51RD2 based Firebird V robot.
4. Perform Position control of the robot using Timer1 as counter
5. Write a code for Robot to follow white line using three white line sensors
6. To perform intensity transformation operations like histogram equalization, power law and piecewise linear transformation with gray scale images.
7. To perform arithmetic operations on gray scale images like averaging, smoothing and sharpening for grayscale images
8. To identify specific color in the given RGB image
9. Perform edge detection on a given image.
10. Study of Robotic Arm(Dexter Robot)

**Major Equipment Needed:**

Firebird five Robots, PC