

Pimpri Chinchwad Education Trust's
**PIMPRI CHINCHWAD COLLEGE OF
ENGINEERING**

SECTOR NO. 26, PRADHIKARAN, NIGDI, PUNE 411044

An Autonomous Institute Approved by AICTE and Affiliated to SPPU, Pune

**DEPARTMENT OF ELECTRONICS AND
TELECOMMUNICATION ENGINEERING**



Curriculum Structure and Syllabus

Minors in

ROBOTICS

(Regulations 2023)



Effective from Academic Year 2025-26

(Updated with Minor Changes)

Institute Vision

To be one of the top 100 Engineering Institutes of India in coming five years by offering exemplarily Ethical, Sustainable and Value Added Quality Education through a matching ecosystem for building successful careers.

Institute Mission

1. Serving the needs of the society at large through establishment of a state-of-art Engineering Institute.
2. Imparting right Attitude, Skills, Knowledge for self-sustenance through Quality Education.
3. Creating globally competent and Sensible engineers, researchers and entrepreneurs with an ability to think and act independently in demanding situations.

EOMS Policy

“We at PCCOE are committed to offer exemplarily Ethical, Sustainable and Value Added Quality Education to satisfy the applicable requirements, needs and expectations of the Students and Stakeholders.

"Knowledge Brings Freedom"


We shall strive for technical development of students by creating globally competent and sensible engineers, researchers and entrepreneurs through Quality Education.

We are committed for Institute’s social responsibilities and managing Intellectual property.

We shall achieve this by establishing and strengthening state-of-the-art Engineering Institute through continual improvement in effective implementation of Educational Organizations Management Systems (EOMS).”

Course Approval Summary

Board of Studies - Department of E&TC Engineering

Sr. No.	Name of the Course	Course Code	Page number	Signature and stamp of BoS chairman
1	Fundamental of Robotics	BET25MN01/ BET25MN01	10	 Chairman BoS, Electronics & Telecommunication Engineering PCET's, Pimpri Chinchwad College of Engineering Sector No. 26, Pradhikaran, Nigdi, Pune-44
2	Fundamentals of Robotics Lab	BET25MN02/ BET25MN02	12	
3	Robot Programming	BET26MN01/ BET26MN01	13	
4	Robot Programming Lab	BET26MN02/ BET26MN02	15	
5	Sensors and Actuators in Robotics	BET27MN01/ BET28MN02	16	
6	Seminar	BET27MN02/ BET28MN03	18	
7	Project /Industry Driven Course	BET28MN01/ BET27MN03	19	

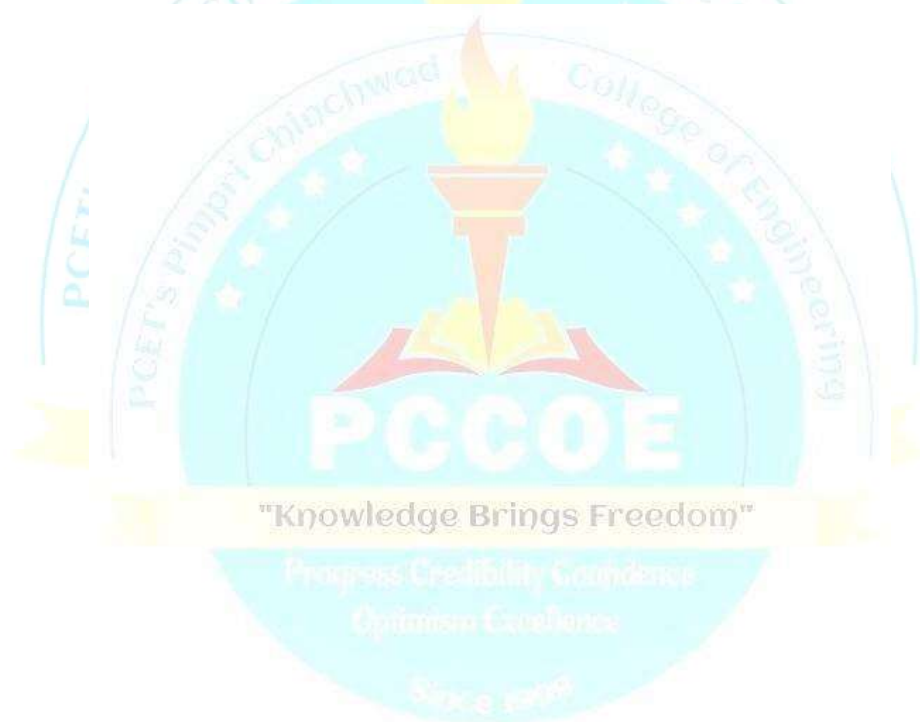
Approved by Academic Council:


Chairman
Academic Council
PCET's, Pimpri Chinchwad College of Engineering
Sector No. 26, Pradhikaran, Nigdi, Pune-44

Chairman, Academic Council
Pimpri Chinchwad College of Engineering, Pune

INDEX

Sr. No.	Content	Page No.
1	Preface	5
2	Robotics Course Introduction	6
3	Curriculum Structure – Honors In Data Informatics	7
4	Course Syllabus	9-19
7	Vision Mission of E&TC Department	20



Preface

Looking at Global Scenario to enhance the employability skills and impart deep knowledge in emerging/ multidisciplinary areas, an additional avenue is provided to passionate learners through the Minors and Honors Degree Scheme in academic structure.

For **Minors degree** program, student has to earn additional 20 credits in multidisciplinary areas of other domains.

Objectives of Minors Degree

- To impart knowledge in multidisciplinary areas.
- To provide effective yet flexible options for students to achieve basic to intermediate level competence in the multidisciplinary area.
- To enhance the employability skills through different combinations in the diverse fields of engineering.
- To provide an academic mechanism for fulfilling multidisciplinary demands of industries.
- To provide a strong foundation to students aiming to pursue research/ higher studies in an interdisciplinary field of study.



Robotics

The robotics minor covers the fundamentals of designing, building and programming robots, and provides a concentrated experience in the multidisciplinary field of robotics. Robotics graduates are in high demand in the many industries dealing with following application like Aerospace, Automotive, Construction, Defence, Electronics, IT industry, Manufacturing and fast-moving consumer goods, Marine.

Objectives of Minor program:

1. To familiarize the students with the significance of robotic system in agile and automated manufacturing processes.
2. To prepare the students to be conversant with robotic elements/ peripherals, their selection and interface with manufacturing equipment.
3. To familiarize the students with the basics of robot kinematics.

Outcomes of Minor program:

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

1. Acquire the skills in understanding robot language and programming.
2. Acquire the skill in robot task planning for problem solving.
3. Develop skills in understanding various sensors, robot peripherals and their use.
4. Develop skills in identifying areas in manufacturing, where robotics can be deployed for enhancing productivity



Curriculum Structure

Progress Credibility Confidence
Optimism Excellence

Since 1999

Since 1999

Curriculum structure - Scheme-A

Sem-ester	Course Code	Course Name	Teaching Scheme					Evaluation Scheme						
			L	P	T	Hrs	CR	FA1	FA2	SA	TW	PR	OR	Total
V	BET25MN01	Fundamental of Robotics	4	-	-	4	4	20	20	60	-	-	-	100
	BET25MN02	Fundamentals of Robotics Lab	-	2	-	2	1	-	-	-	25	-	25	50
VI	BET26MN01	Robot Programming	4	-	-	4	4	20	20	60	-	-	-	100
	BET26MN02	Robot Programming Lab	-	2	-	2	1	-	-	-	25	-	25	50
VII	BET27MN01	Sensors and Actuators in Robotics	4	-	-	4	4	20	20	60	-	-	-	100
	BET27MN02	Seminar	-	4	-	4	2	-	-	-	-	-	50	50
VIII	BET28MN01	Project /Industry Driven Course	-	8	-	8	4	-	-	-	100	-	50	150
Total			12	16		28	20	-	-	-	-	-	-	600

Curriculum structure - Scheme-B

Sem-ester	Course Code	Course Name	Teaching Scheme					Evaluation Scheme						
			L	P	T	Hrs	CR	FA1	FA2	SA	TW	PR	OR	Total
V	BET25MN01	Fundamental of Robotics	4	-	-	4	4	20	20	60	-	-	-	100
	BET25MN02	Fundamentals of Robotics Lab	-	2	-	2	1	-	-	-	25	-	25	50
VI	BET26MN01	Robot Programming	4	-	-	4	4	20	20	60	-	-	-	100
	BET26MN02	Robot Programming Lab	-	2	-	2	1	-	-	-	25	-	25	50
VII	BET27MN03	Project /Industry Driven Course	-	8	-	8	4	-	-	-	100	-	50	150
VIII	BET28MN02	Sensors and Actuators in Robotics	4	-	-	4	4	20	20	60	-	-	-	100
	BET28MN03	Seminar	-	4	-	4	2	-	-	-	-	-	50	50
Total			12	16		28	20	-	-	-	-	-	-	600

Abbreviations:L-Lecture, P- Practical, T-Tutorial, H- Hours, FA-Formative Assessment , SA- Summative Assessment, TW–Termwork, OR – Oral, CR- Credits



Course Syllabus



Program of Quality Education
Optimism Excellence
Since 1999

Program: B. Tech. (E&TC)-Minors in Robotics					Semester: V					
Course Name : Fundamentals of Robotics				Course Code : BET25MN01						
Teaching Scheme (Hrs./Week)				Evaluation Scheme and Marks						
Credit	Lecture	Practical	Tutorial	FA		SA	TW	OR	PR	Total
				FA1	FA2					
5	4	2	-	20	20	60	-	-	-	100
Prior Knowledge of										
<ul style="list-style-type: none"> ● Basic Electronics Engineering ● Mechanics is essential. 										
Course Objectives:										
<ol style="list-style-type: none"> 1. To familiarize the students with the basic principles of robotics 2. To introduce the Various Parts of Robots and Fields of Robotics. 3. To acquaint the students with the knowledge of applications of robotics. 4. To prepare the students for understanding Planning and control in Robotics. 										
Course Outcomes:										
<p>On the completion of the course, students will be able to,</p> <ol style="list-style-type: none"> 1. Understand basics of robotics, types, classification and methodology. 2. Acquire the skills in understanding principles of robotics. 3. Acquire the skills in understanding robotics in inspection. 4. Develop skills in understanding industrial robotics. 5. Identifying opportunities for robotics to enhance productivity in manufacturing. 6. Learn Socio-economic aspects of Robotics. 										
Detailed Syllabus:										
Unit	Description									Duration (Hrs.)
1.	Introduction of Robotics Historical development of Robotics, Definitions of Industrial Robot, Type and Classification of Robots, Asimov's laws of robotics, Methodology of robotics									10
2.	Principles of Robotics Robot configurations, Robot Components, Robot Degrees of Freedom, Work volume and work envelope, Robot Joints and symbols, Robot Coordinates, Robot Reference Frames, Resolution, accuracy and precision of Robot, Work cell control									10
3.	Robotics in Inspection Robots for Inspection: Robotic vision systems, image representation, object recognition and categorization, depth measurement.									10
4.	Industrial Applications of Robotics Introduction of processes like Coating, Deburring, cleaning, Die Casting, Molding, Material handling, Picking, Palletizing, Packaging, hospitals and patient care, sports and recreation, defense and surveillance industry, home automation, mining industry.									10
5.	Planning and control in Robotics Trajectory planning, position control, force control, Robot programming methods, hybrid control, Industrial and medical robotics: application in manufacturing processes									10
6.	Socio-economic aspects of Robotics									10
	A robot-based manufacturing system, robot cell design considerations and selection of robot, Robot Economics, Functional Safety in Robotic Application									
	Total Hrs.									60

Textbooks:

1. M.P. Groover, "Automation, Production Systems & Computer Integrated Manufacturing", PHI, 3rd Edition, 2018.
2. M.P. Groover, M.Naegel, "Industrial Robotics, Technology, Programming & Applications", TMH, 2nd Edition, 2016.

Reference Books:

1. J.G. Keramas, "Robotics Technology Fundamentals", Thompson Learning, 2nd Edition, 2016.
2. J.J.Craig "Introduction to Robotics Mechanics & Control", Pearson Education, 3rd Edition, 2014.
3. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill Book, 2015.



Program: B. Tech. (E&TC)-Minors in Robotics				Semester:V			
Course: Fundamentals of Robotics Lab				Code:BET25MN02			
Teaching Scheme (Hrs./Week)				Evaluation Scheme and Marks			
Credit	Theory	Practical	Tutorial	TW	OR	PR	Total
1	-	2		25	25	-	50
Prior knowledge of: Sensors, Control Systems and basic of programming is essential							
Objectives:							
The main objective of this course is to							
<ol style="list-style-type: none"> 1. To learn and understand the basics of fundamentals of robotics systems. 2. To be acquainted with different configuration of robotics system 3. To design MATLAB program for robotic configuration 							
Outcomes:							
At the end of Laboratory work, the students will be able to:							
<ol style="list-style-type: none"> 1. Identify and understand the unique characteristics and components of robotics systems 2. Compare and understand various types of robotics systems 3. Design, simulate and test kinematic equations for robotic systems in MATALAB 4. Compare and understand various industrial application of robotics systems 							
General Guidelines: Any Six Experiments is to be performed.							
Detailed Syllabus:							
Expt. No.	List of Experiments						
1	Study and analysis of robot grippers (includes the problems based on gripper force)						
2	Demonstration of various robotic configurations using industrial robot						
3	MATLAB program for simple kinematics of simple robot configuration						
4	MATLAB program for inverse kinematics of simple robot configuration						
5	To demonstrate simple robotic system using Matlab/ MscAdam / RoboAnalyser software						
6	Study of configuration of robots and motion of robot manipulator						
7	Study of pick and place industrial robot						
8	One Industrial visit for Industrial robotic application						
Virtual Lab Links							
Mechanisms & Robotics Lab							
http://vlabs.iitkgp.ernet.in/mr/							
Robotics Application							
Lab https://vlab.amrita.edu/?sub=3&brch=271&sim=1642&cn=3525							
Bio Inspired Robotics Virtual Lab							
https://vlab.amrita.edu/?sub=3&brch=257							

Program: B. Tech. (E&TC)-Minors in Robotics					Semester: VI					
Course Name: Robot Programming					Course code :BET26MN01					
Teaching Scheme (Hrs./Week)				Evaluation Scheme and Marks						
Credit	Lecture	Practical	Tutorial	FA		SA	TW	OR	PR	Total
				FA1	FA2					
4	4	-	-	20	20	60	-	-	-	100
Pre-requisites:										
<ul style="list-style-type: none"> ● Fundamentals of Robotics ● System Programming and Operating Systems 										
Course Objectives:										
<ol style="list-style-type: none"> 1. To introduce students with framework used for robot programming. 2. To impart the knowledge of robot programming language. 3. To explain the Virtual Robot Systems and their applications. 										
Course Outcomes:										
<p>On the completion of the course, students will be able to,</p> <ol style="list-style-type: none"> 1. Understand the significance of Robot operating system (ROS) and various ROS frameworks. 2. Learn the fundamentals robot programming language. 3. Design of Robotic system using VAL Language. 4. Design of Robotic system using VAL -II Language. 5. Acquire knowledge of RAPID Language. 6. Design practical robotics systems. 										
Detailed Syllabus:										
Unit	Description									Duration (Hrs.)
1.	Introduction to ROS The ROS Equation, History, Distributions & difference from other meta-operating systems. ROS framework: Operating system and its various releases.									10
2.	Basics of Robot Programming . Method, Robot Programming as a path in space, Motion interpolation, motion & task level Languages, Robot languages, Programming in suitable languages, characteristics of robot									10
3.	Robot Language: VAL Language: Part 1 Classifications, Structures, VAL language commands, motion control, hand control, program control, pick and place applications, palletizing applications using VAL, Robot welding application using VAL program-WAIT, SIGNAL and DELAY command for communications using simple applications									10
4.	Robot Language: VAL Language: Part 2 VAL-II programming-basic commands, Simple problem using conditional statements, Simple pick and place applications, Production rate calculations using robot.									10
5.	Robot Language: RAPID Language Motion Instructions-Pick and place operation using Industrial robot- manual mode, automatic mode, and subroutine command-based programming. Move master command language- Introduction, syntax, simple problems. AML Language, elements and functions, Statements, constants and variables-Program control statements, Motion, Sensor commands, Data processing									10
6.	Virtual Robot Systems Introduction to soft robotics; Robotic Process Automation (RPA); Computer Vision, AR & VR in Robotics. Multiple robot and machine Interference-Process chart-Simple problems-Virtual robotics, Robot									10

	studioonline software- Introduction, Jogging, components, work planning, program modules, input and output signals, Singularities, Collision detection, Repeatability measurement of robot, Robot economics.	
	Total Hrs.	60
Textbooks:		
1. Kumar Bipin, "Robot Operating System Cookbook", Packet Publishing, 2018.		
2. Lentin Joseph, "Robot Operating Systems (ROS) for Absolute Beginners, A press, 2018.		
Reference Books:		
1. Jason M O'Kane, "A Gentle Introduction to ROS", CreateSpace, 2016.		
2. Anis Koubaa, "Robot Operating System (ROS) – The Complete Reference (Vol.3), Springer, 2018.		



Program: B. Tech. (E&TC)-Minors in Robotics				Semester :VI			
Course: Robot Programming Lab				Code :BET26MN02			
Teaching Scheme (Hrs./Week)				Evaluation Scheme and Marks			
Lecture	Practical	Tutorial	Credit	TW	OR	PR	Total
	2		1	25	25		50
Prior knowledge of Sensors Technology, Robot Drive Systems is essential							
Objectives:							
1. To understand robot programming methods							
2. To compare and understand different types of languages used for robot programming							
3. To understand rules to design robot application using robot programming languages							
Outcomes:							
At the end of Laboratory work, the students will be able to:							
1. Explain the components of robot programming							
2. Develop simple program to simulate robot movements							
3. Develop robot program for specific application							
4. Describe the safety rules in robot handling.							
General Guidelines: Any Six Experiments is to be performed.							
Detailed Syllabus:							
Expt. No.	List of Experiments						
1	Programming on VAL Language						
2	Programming on VAL-II Language						
3	Programming on RAPID Language						
4	Programming on AML Language						
5	Demonstrate Industrial Robot programming using VAL II or equivalent.						
6	Programming the robot for pick and place operation using any robot						
7	Robot Programming for Colour identification/shape identification/path tracking						
8	Industrial visit and its report on industrial applications of robots						
References:							
1. S. R. Deb, "Robotics technology and flexible automation", Tata McGraw Hill publishing company limited, 1994.							
2. Mikell. P. Groover, "Industrial Robotics Technology", Programming and Applications, McGraw Hill Co, 1995. Robotcs Lab manual, 2007.							
3. Klafter. R.D, Chmielewski.T.A. and Noggin's., "Robot Engineering : An Integrated Approach", Prentice Hall of India Pvt.							
4. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "Robotics control, sensing, vision and intelligence", McGraw Hill Book co, 1987.							
Craig. J. J. "Introduction to Robotics mechanics and control", Addison-Wesley, 1999..							

Program: B. Tech. (E&TC)-Minors in Robotics				Semester : VII			
Course Name Sensors and Actuators in Robotics				Course code : BET27MN01/ BET28MN02			
Teaching Scheme (Hrs./Week)				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	FA		SA	Total
				FA1	FA2		
4	4	-	-	20	20	60	100
Prior Knowledge of							
<ul style="list-style-type: none"> Basic Electronics Engineering, Basic Electrical Engineering Image Processing, Fundamentals of Robotics, Sensors and Automation is essential 							
Course Objectives:							
<ol style="list-style-type: none"> To introduce the various parts of electronics in the field of Robotics. To explain students the need of embedded system technology for robot building. To familiarize with the selection of appropriate sensors and actuators in robotic applications. To help students understand about the smart real-time robot system technologies 							
Course Outcomes: On the completion of the course, students will be able to,							
<ol style="list-style-type: none"> Selection of suitable embedded boards for robots. Understanding the concepts of robotics & automation and working of Robot. Analyze the function of sensors and actuators in the Robot. Write program to use a Robot for a typical application. Develop machine vision-based algorithm for robotic tasks. Apply the knowledge of sensors, embedded systems and actuators for industrial robot development. 							
Detailed Syllabus:							
Unit	Description						Duration (Hrs.)
1.	Review of Electronics in Robotics Fundamentals of electronic blocks in robotics, Traditional and Mechatronics approach, Data conversion devices, sensors, microsensors, transducers, signal processing devices, relays, contactors and timers. Microprocessors controllers and PLCs						10
2.	Sensors in Robotics: Part 1 Transducers and sensors, Sensors in robotics, Principles and applications of the following types of sensors- Proximity Sensors, Photo Electric Sensors, Laser Scanners, Position sensors – Piezo Electric Sensor, LVDT, Resolvers. Encoders: Absolute and Incremental: - Optical, Magnetic, Capacitive, pneumatic Position Sensors						10
3.	Sensors in Robotics: Part 2 Range Sensors: Range Finders, Laser Range Meters, Touch Sensors, Force and torque sensors. Safety Sensor: Light Curtain, Laser Area Scanner, Safety Switches;						10
4.	Actuators in Robotics Mechanical Actuation Systems, Electrical Actuation Systems, A.C. Motor, D.C. Motor, Stepper Motor, Hydraulic & Pneumatic Actuation Systems. Design of hydraulic circuits.						10
5.	Machine vision in Robotics: Part 1 Introduction, Low level & High-level Vision, Sensing & Digitizing, Image Processing & analysis, Segmentation, Edge detection, Machine vision algorithms , Applications						10
6.	Machine vision in Robotics: Part 2						10
	Object Description & recognition, interpretation, Imaging based automatic sorting and inspection, image processing, imaging-based robot guidance, Application						
	Total Hrs.						60

Textbooks:

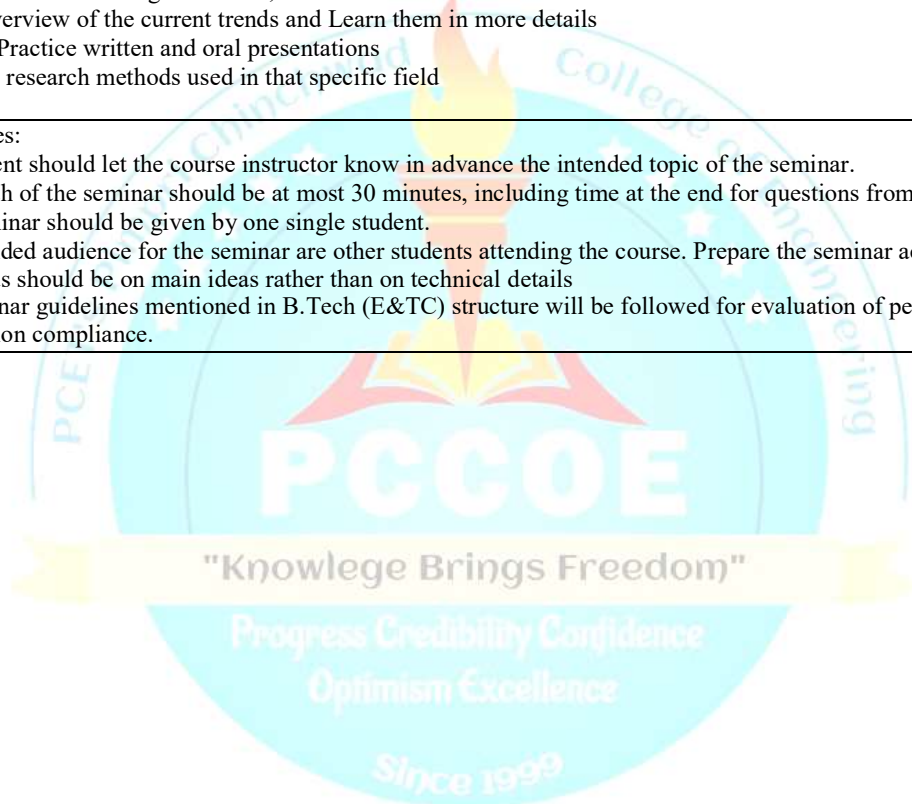
1. M.P. Groover, "Automation, Production Systems & Computer Integrated Manufacturing", PHI, 3rd Edition, 2012.
2. M.P. Groover, M.Naegel, "Industrial Robotics, Technology, Programming & Applications", TMH, 2nd Edition, 2012.

Reference books:

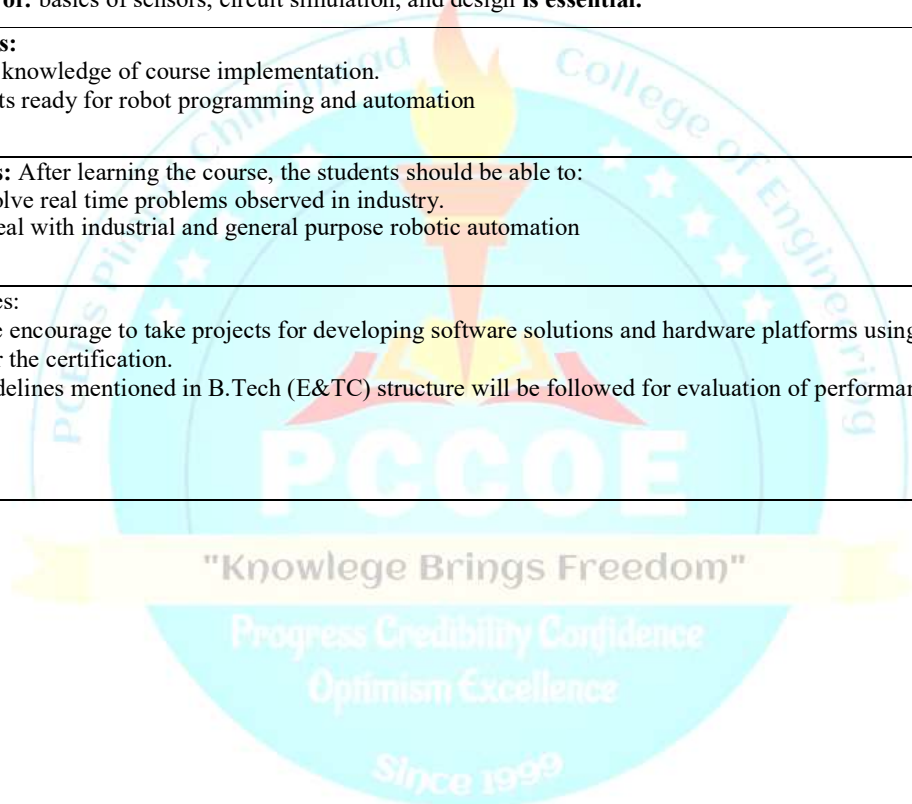
1. Mike Wilson, "Implementation of Robotic Systems", 2014
2. Fu. K. S., Gonzalez. R. C. & Lee C.S.G., "Robotics Control, Sensing, Vision and Intelligence", McGraw Hill Book co, 2015.
3. S.R. Deb, "Robotics Technology and Flexible Automation", TMH, 2nd Edition, 2018.



Program:	B. Tech. (E&TC)-Minors in Robotics			Semester:	VII /VIII		
Course:	Seminar			Code:	BET27MN02/ BET28MN03		
Teaching Scheme (Hrs./Week)				Evaluation Scheme and Marks			
Credit	Theory	Practical	Tutorial	TW	OR	PR	Total
2	-	4	-	-	50	-	50
Prior Knowledge of: -- is essential.							
Course Objectives:							
<ol style="list-style-type: none"> To identify practical learning skills and concepts and learn to communicate it to society. To encourage personal growth of students and development of effective communication skills 							
Course Outcomes: After learning the course, the students should be able to:							
<ol style="list-style-type: none"> Get an overview of the current trends and Learn them in more details Improve Practice written and oral presentations Learn the research methods used in that specific field 							
Detailed Guidelines:							
<ol style="list-style-type: none"> The student should let the course instructor know in advance the intended topic of the seminar. The length of the seminar should be at most 30 minutes, including time at the end for questions from the audience. Each seminar should be given by one single student. The intended audience for the seminar are other students attending the course. Prepare the seminar accordingly. The focus should be on main ideas rather than on technical details The seminar guidelines mentioned in B.Tech (E&TC) structure will be followed for evaluation of performance and certification compliance. 							



Program:	B. Tech. (E&TC)-Minors in Robotics			Semester:	VII /VIII		
Course:	Project /Industry Driven Course			Code:	BET28MN01/ BET27MN03		
Teaching Scheme (Hrs./Week)				Evaluation Scheme and Marks			
Credit	Lecture	Practical	Tutorial	TW	OR	PR	Total
4	-	8	-	100	50	-	150
Prior Knowledge of: basics of sensors, circuit simulation, and design is essential.							
Course Objectives: 1. To test students knowledge of course implementation. 2. To make students ready for robot programming and automation							
Course Outcomes: After learning the course, the students should be able to: 1. Solve real time problems observed in industry. 2. Deal with industrial and general purpose robotic automation							
Detailed Guidelines: 1. The students are encourage to take projects for developing software solutions and hardware platforms using the concept of course taken under the certification. 2. The project guidelines mentioned in B.Tech (E&TC) structure will be followed for evaluation of performance and certification compliance.							



Department Vision and Mission

VISION:

To serve the society by creating competent Electronics and Telecommunication engineers with value added quality education.

MISSION:

To produce competent and cultured Electronics and Telecommunication engineers through quality education by imparting attitude, knowledge, skills, project-based learning using well defined teaching learning process and excellent learning facilities to serve the needs of society.

PROGRAM EDUCATIONAL OBJECTIVES (PEOS)

1. To provide sound foundation in mathematics, basic science and fundamentals of E&TC engineering to the students.
2. To provide students with good Electronics and Telecommunication Engineering breadth so as to enable them to comprehend, analyze, design, and create novel products and solutions for the real- life problem
3. To inculcate effective communication skills, teamwork spirit and professional ethics in students to meet employers need at large and prepare them for higher studies.
4. To create awareness among students about social commitment and responsibilities.

PROGRAM SPECIFIC OUTCOMES

1. Ability to comprehend and exhibit the competency in the areas of Electronics & Communication Engineering including Signal processing and Communication, VLSI and Embedded System, Computing and programming and Automation.
2. Ability to design and analyze the systems of Electronics & Telecommunication Engineering using state of the art hardware and software tools to address the needs of industry and society.
3. Ability to demonstrate proficiency to build research attitude, imbibe ethical values and strengthen/enhance professional competency for holistic development and build problem solving attitude to address the societal, environmental, health & safety issues.