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 2026-27

(Updated with Minor Changes)

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	
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	Project	BET28MN01/ BET27MN03	18	

Approved by Academic Council:

Chairman, Academic Council
Pimpri Chinchwad College of Engineering,Pune

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.

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)."

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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

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
VIII	BET28MN01	Project	-	8		8	4	-	-	-	100		50	150
Total			**12**	**12**		**24**	**18**	**-**	**-**	**-**	**-**	**-**	**-**	**550**

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	-	8		8	4	-	-	-	100		50	150
VIII	BET28MN02	Sensors and Actuators in Robotics	4	-	-	4	4	20	20	60	-	-	-	100
Total			**12**	**12**		**24**	**18**	**-**	**-**	**-**	**-**	**-**	**-**	**550**

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

Course Syllabus

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

- Basic Electronics Engineering
- Mechanics is essential.

Course Objectives:

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:

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

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, objectrecognition 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 programing 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

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:

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
Labhttps://vlab.amrita.edu/?sub=3&brch=271&sim=1642&cnt=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:

- Fundamentals of Robotics
- System Programming and Operating Systems

Course Objectives:

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:

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

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 andvariables-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

- Basic Electronics Engineering, Basic Electrical Engineering
- Image Processing, Fundamentals of Robotics, Sensors and Automation is essential

Course Objectives:

1. To introduce the various parts of electronics in the field of Robotics.
2. To explain students the need of embedded system technology for robot building.
3. To familiarize with the selection of appropriate sensors and actuators in robotic applications.
4. 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,

1. Selection of suitable embedded boards for robots.
2. Understanding the concepts of robotics & automation and working of Robot.
3. Analyze the function of sensors and actuators in the Robot.
4. Write program to use a Robot for a typical application.
5. Develop machine vision-based algorithm for robotic tasks.
6. 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:	Project					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.

Vision and Mission of E&TC Department

VISION : To be recognized as a distinguished department in the field of electronics and telecommunication transforming students into competent technocrats by providing an Ethical, Sustainable and Value-Added Quality Education.

MISSION :

1. To create competent Electronics and Tele-communication engineers with Knowledge, Skill and Attitude by establishing a conducive learning environment.
2. To nurture technical competency, entrepreneurship skills and promote higher studies through the state-of-art facilities for building successful careers.
3. To facilitate research by engaging in projects of industrial requirement and national importance.
4. To impart Life skills, Ethical and Social values for self-sustainability.

Programme Educational Objectives (PEO's)

1. Establish a strong base in mathematics, basic sciences, and the fundamental principles of Electronics and Telecommunication Engineering for the students.
2. Equip students with a comprehensive understanding of Electronics and Telecommunication Engineering, enabling them to effectively comprehend, analyse, design, and to innovate practical solutions for real-world challenges.
3. Foster the development of effective communication skills, teamwork, and professional ethics among students, in order to meet the demands of employers and prepare them for higher studies and successful careers.
4. Promote social consciousness and a sense of responsibility among students, creating awareness about their commitment and obligations to society.

Program Outcomes (PO's)

Engineering Graduates will be able to:

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics,natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply thesssse to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Outcomes (PSOs)

1. **PSO1:** Ability to exhibit the competency to solve the problems related to Electronics & Telecommunications Engineering by applying advanced knowledge in the fields of VLSI, Embedded Systems, Signal Processing, Communication, Computing and Automation.
2. **PSO2:** Ability to design and analyse Electronics & Telecommunications systems using state of the art hardware and software tools to address the needs of the industry and society.
3. **PSO3:** Ability to build research and problem-solving attitude through Project based learning to address the societal, environmental, health and safety issues.