

Kolhapur Institute of Technology's College of Engineering, Kolhapur



Curriculum (Structure) for B.TECH Robotics (Hons.) Programme (Under Graduate Programme) From Academic Year 2021-2022

**Kolhapur Institute of Technology's College of Engineering,(Autonomous)
Kolhapur.**

Department of Mechanical Engineering

Teaching and Credit scheme for

Propose B.Tech. Robotics (Hons.) Programme in Mechanical Engineering

Course No.	Course Name	Semester	No. of Hours /Week			
			L	T	P	Credits
UMEH0301	FUNDAMENTALS OF ROBOTICS	III	3	1	--	4
UMEH0401	FUNDAMENTALS OF MICROCONTROLLERS	IV	3	1	--	4
UMEH0501	PROGRAMMING & SIMULATIONS FOR ROBOTICS	V	3	1	--	4
UMEH0601	ROBOT KINEMATICS AND DYNAMICS	VI	3	1	----	4
UMEH0701	MINI PROJECT	VII	-	-	4	2
			12	4	4	18

Total Credits - 18, Total Contact hours – 20

Title of the Course: Fundamentals of Robotics												L	T	P	Credit
Course Code: UMEH0301												3	1	--	4
Course Pre-Requisite: Basics of Electrical and Electronics															
Course Description: This course introduces the stream of robotics. The course is designed to clear the fundamentals of the students related to robot anatomy, grippers, basic concepts along with number systems, and control systems which are essential for learning computations and advanced concepts in robotics.															
Course Objectives															
1. To provide graduates of mechanical engineering with fundamental knowledge in the field of robotics for advanced graduate studies in the area of Automation and Robotics.															
2. To prepare graduates of mechanical engineering with comprehensive knowledge of Robotics to enable them to apply the relevant knowledge for the learning upcoming advanced subjects in robotics.															
3. To introduce graduates of mechanical engineering with anatomy, grippers, control systems, and applications of robotic systems.															
Course Learning Outcomes:															
CO	After the completion of the course, the student should be able to												Bloom's Cognitive		
													level	Descriptor	
CO1	Demonstrate the fundamentals concepts and knowledge of digital circuits, robotics, grippers, tools used in industrial robots, and control systems.												II	Cognitive (Understand)	
CO2	Illustrate the robot anatomy, configurations, and applications of the robotic systems.												II	Cognitive (Understand)	
CO3	Explain the concepts related to the system, system types, system examples, transfer functions and analysis methods, and control elements of the systems.												II	Cognitive (Understand)	
CO-PO Mapping:															
CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	3	3	3			2				2		2	3	2	
CO2	2	2	2			2						2		3	
CO3	2	2	2											3	2
Assessments:															
Teacher Assessment:															
Assessment												Marks			
ESE												100			
No ISE 1 and ISE II and MSE:															
ESE: Fianl ESE Assessment is based on 100% course content for 100 marks.															

Course Contents:	
Unit 1:- Introduction to Robotics: Industrial Automation and Computers, Industrial Robots, The Laws of Robotics, Robot Population and Application, Misunderstanding about robotization (Unemployment, Uncontrolled operations, etc.) Economics of Robotics.	(06) Hrs.
Unit 2:- Robot Anatomy Introduction, Anatomy of Robots, Classifications of Robots, Robot Configurations & types of Work Volume, Technical specifications of Industrial Robot, Spatial Resolution, Accuracy, Repeatability, Degrees of Freedom, Static and Dynamic properties of Robots.	(08) Hrs.
Unit 3:- Grippers and Tools of Industrial Robots Gripper Designs, Different types of grippers and End effector, Selection of grippers, Degrees of Freedom, End Effectors: Grippers, Tools. Force Analysis of Grippers, Innovative Robotic Grippers.	(06) Hrs.
Unit 4:- Fundamentals of Sensors and Transducers Performance terminology, static and dynamic characteristics of transducers, classification of sensors and transducers, Need of sensors in Robotics.	(04) Hrs.
Unit 5:- Sensors in Robotics Contact and non-contact type switches and proximity sensors- inductive, capacitive, optical, pneumatic, potentiometric, incremental and absolute encoders, tachogenerator; Applications in position, displacement, velocity, force, torque and temperature measurement.	(06) Hrs.
Unit 6:- Miscellaneous Sensors in Robotics Contour sensors, 2D code readers, Profile sensors, Vision sensors, Safety sensors, Image Sensor	(06) Hrs.
Textbooks: 1. Introduction to Industrial Robotics by Ramachandran Nagarajan Pearson Education India (2016) 2. Fundamentals of Robotics_ Linking Perception to Action (Machine Perception and Artificial Intelligence, 54)-Ming Xie, World Scientific Publishing Company (2003) 3. Fundamentals of robotics _ analysis & control-Robert J. Schilling, Asoke K.Ghosh, Prentice-Hall of India (2003) 4. Fundamentals of Robotics Engineering-Harry H. Poole, Springer Netherlands (1989) 5. Mikell P. Groover, Mitchell Weiss, Roger N. Nagel, Nicholas G. Odrey, Industrial Robotics : Technology, Programming & Applications, McGraw–Hill International, 2011. 6. Richard D. Klafter , Thomas A. Chmielowski, Michael Negin, Robotic Engineering : An Integrated Approach , Prentice Hall India, 2002. 7. Saha S K, Introduction to Robotics, McGraw Hill Education (India) Private Limited, 2014.	
References: 1. Introduction to Robotics_ Analysis, Control, Applications- Saeed B. Niku ,Wiley (2010) 2. Introduction to Robotics Mechanics and Control- John J.Craig, 3rd edition-Pearson Education, Inc. (2005) 3. Fundamentals of Robotics- David Ardayfio, CRC Press (1987)	

Title of the Course: Fundamentals of Microcontrollers													L	T	P	Credit
													3	1	-	4
Course Code: UMEH0401																
Course Pre-Requisite: Basics of electronics, fundamentals of programming,																
Course Description: This course gives knowledge about the fundamentals of microcontrollers and types and some of the recent advances in microcontroller programming																
Course Objectives																
1. To understand basic terminologies and concepts associated with microcontrollers.																
2. To study fundamentals of 8051/AVR microcontroller architectures.																
3. To study the peripheral devices when connected to microcontrollers.																
4. Experiment with microcontrollers for simple applications.																
Course Learning Outcomes:																
CO	After the completion of the course the student should be able to												Bloom's Cognitive			
													level	Descriptor		
CO1	Describe the microcontrollers architectures and various registers associated with it												I	Cognitive (Knowledge)		
CO2	Interpret the results using IDE programming tools												II	Cognitive (Understand)		
CO3	Use the knowledge for interfacing external peripherals												III	Cognitive (Apply)		
CO4	Contrast the various architecture for various microcontrollers												IV	Psychomotor (Analyze)		
CO-PO Mapping:																
CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3	
CO1	2	2			3			2	2			2	3	2		
CO2	2	3	3	3	3				3			2		3		
CO3	2	3	3	3	3				2			2		3	3	
CO4	2	2			2				2			2		2	3	
Assessments:																
Teacher Assessment:																
Assessment									Marks							
ESE									100							
No ISE 1 and ISE II and MSE:																
ESE: Fianl ESE Assessment is based on 100% course content for 100 marks.																
Course Contents:																
Unit 1:- Microcontroller Basics														(07)Hrs.		
Difference between microprocessor and microcontroller, CISC Vs RISC design philosophy, Von Neumann vs Harvard architecture.8-bit and 16-bit microcontroller. Architecture of microcontroller. I/O ports, stack and use of stack pointer, priority. Memory structure, Data Memory, Program Memory and execution of programs, different registers (SFR's), addressing modes, timing diagram.																
Unit 2:-Integrated Development Environment (IDE) for Microcontrollers														(07)Hrs.		
Editor, linker, loader, debugger, simulator, emulator. Instruction set, instruction formats, concept of assembler directives and various addressing modes of AVR microcontroller. Basic programming using AVR assembly instructions. Introduction to embedded- C, Integrated Development Environment (IDE), cross																

compiler, ISP, simple program for delay generation	
Unit 3:- Peripheral Interfaces-1 I/O programming, interfacing with simple switch, LED. 8bit and 16 bit Timers, various modes of operations of timers, counters, PWM programming. Interrupt structure, Interrupt priority, Interrupt programming. Analog to Digital Converter, UART programming, RS232, RS 485 transceivers, I/O expansion techniques, Memory expansion, Communications Protocols	(08)Hrs.
Unit 4:-External Interfaces: LCD, Keyboard interfacing, Digital to Analog Converters, Stepper Motor interfacing, DC motor interfacing. Introduction to CAN Protocol and its interfacing. Introduction to Bluetooth and USB protocols.	(06) Hrs.
Unit 5:- Introduction to Other Advanced Microcontrollers Introduction to ARM and PIC processors of MSP 430 microcontroller, 16 bit Micro-controllers overview; features, architecture, addressing modes. Low power feature of MSP 430.	(06) Hrs.
Unit 6:- Fundamentals of Arduino and Raspberry Pi. Introduction to Arduino, Prototyping environment, Arduino Environment development, setting up Arduino board, creating sketches, Basic functionality of Raspberry Pi board and its processor ,setting and configuring board.	(06) Hrs.
Textbooks: 8. The 8051 Microcontroller: A System Approach by Muhammad A. Mazidi, 1st Ed., PHI,• 2012. 9. The AVR Microcontroller and Embedded Systems: A System Approach by Muhammad A.●Mazidi, 1st Ed., PHI, 2013.	
References: 1. Arm System Developer's Guide: Designing and Optimizing System Software - Andrew N. Sloss, Elsevier Publication, 2005 2. Embedded System - Raj Kamal, 2nd Ed.,TATA McGraw Hill, 2009. 3. Embedded C Programming and the ATMEL AVR by R H Barnett 2nd Ed., Cengage Learning Publication, 2006 4. Designing Embedded System with PIC microcontroller, Tim Wilmshurst, 2nd Ed., NewnesPublication, 2009	
Unit wise Measurable students Learning Outcomes: U01.1: Understand the architecture of AVR/8051 microcontrollers U02.1Understand and apply the basics fundamentals of IDE for microcontrollers UO 3.1 Understand and apply the basics fundamentals of timers of 8 bit and16bit U04.1: Students can study the different interrupts and interrupts programming. U05.1: Understand and apply the programming of stepper motors. U06.1: Students can study of various aspects advance microcontrollers.	

Title of the Course: Programming and Simulations for Robotics											L	T	P	Credit	
											3	1	-	4	
Course Code:UMEH0501															
Course Pre-Requisite: Basics of programming, Basic electronics & electrical, Basic Sciences,sensors															
Course Description: This course gives knowledge about the Robotics programming. It also describes the emerging trends in robotics programming in different languages															
Course Objectives															
1. To understand basic terminologies and concepts associated with Robotics and its programming.															
2. To study various peripheral devices and interfacing them with robots.															
3. To study motor control using PWM and communication between two robots.															
4. To study the various different platforms for robot programming.															
Course Learning Outcomes:															
CO	After the completion of the course the student should be able to										Bloom's Cognitive				
											level		Descriptor		
CO1	To Apply knowledge of automation tools and otherequipment's by taking into account the fundamental principles robot programming										I		Cognitive (Knowledge)		
CO2	To identify various task related to robot programming										I		Cognitive (Knowledge)		
CO3	To Acquire knowledge various new tool usage for robot programming										I		Cognitive (Knowledge)		
CO4	To Analyzing the problem logically and Demonstrate,& apply knowledge for robot programming.										II		Psychomotor (Skill)		
CO-PO Mapping:															
CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO1	2								2						
CO2	2			3					2				2	2	
CO3		3			3				2					2	
CO4		2			3				2				2		
Assessments:															
Teacher Assessment:															
Assessment									Marks						
ESE									100						
No ISE 1 and ISE II and MSE:															
ESE: Fianl ESE Assessment is based on 100% course content for 100 marks.															
Course Contents:															
Unit 1:- Introduction to Robot Programming													(05)Hrs.		
Robot programming-Introduction-Types- Flex Pendant- Lead through programming, Coordinate systems of Robot, Robot controller- major components, functions-Wrist Mechanism-Interpolation-Interlock commands Operating mode of robot, Jogging-Types, Robot specifications- Motion commands, end effectors and sensors commands.															
Unit 2:-Robot Programming Languages													(07)Hrs.		
Robot Languages-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. VAL-II programming-basic commands, applications-Simple problem using conditional statements-Simple pick and place applications-Production rate calculations using robot.	
Unit 3:-Introduction to Firebird V and ROS Introduction to Firebird V, Avatars of Fire Bird V Robot, Block diagram, Pin Connections. Introduction to an architectural overview of the Robot Operating System Framework and setup with ROS environment using suitable Workspace	(05)Hrs.
Unit 4:-Motion Control & Robot communication Basic movements of Robots ,Understanding L293DIC, Motion interfacing with Firebird-V, Pin Connections, Logic tables, writing c code. Serial Communication using UART, Registers involved in the serial communication, Interrupts, Sources of Interrupts, Position encoder,	(05) Hrs.
Unit 5:-Velocity control using PWM&LCD Interfacing Introduction, PWM, Duty cycle, PWM generation in AVR, Timers in AVR, Timers in Firebird V, Servo motor control using PWM.LCD definition, Pin configuration, control pins, Data pin, LCD Interfacing, LCD Commands.	(05) Hrs.
Unit6:-Artificial Intelligence:- Foundations of AI, AI techniques, Need and application of AI, Turing test, acting and thinking humanly, acting and thinking rationally. History of AI. Intelligent Agents of AI.	(05) Hrs.
Textbooks: • John J. Craig, Introduction to Robotics (Mechanics and Control), Addison-Wesley, 2nd Edition, 2004 • Mikell P. Groover et. Al., Industrial Robotics: Technology, Programming and Applications, McGraw – Hill International, 1986. • Automation, Production Systems and Computer Integrated Manufacturing, M.P. Groover, Pearson Education. • Industrial Automation: W.P. David, John Wiley and Sons. Programming Robots with ROS: A Practical Introduction to the Robot Operating System 1st Edition, by Morgan Quigley (Author), Brian Gerkey (Author), William D. Smart, O'Reilly Media; 1st edition (16 November 2015)	
References: • Robot Programming A Guide to Controlling Autonomous Robots by Cameron Hughes, Tracey Hughes, Que Publishing. • Robot Operating System (ROS) for Absolute Beginners: Robotics Programming Made Easy by Lentin Joseph ISBN 1484234049, 978-1484234044	
Unit wise Measurable students Learning Outcomes: UO1.1: Understand the problem and Apply knowledge of robot programming. UO2.1 Understand and apply the basics fundamentals of VAL Programming UO 3.1 Understand and apply the basics fundamentals of Firebird V robot UO4.1: Understand and apply the basics fundamentals of Motion Commands. UO5.1: Understand and apply the PWM concept for motion control UO6.1: Students can study of various aspects robot communication.	

Title of the Course: Robot Kinematics and Dynamics												L	T	P	Credit	
Course Code: UMEH0601												3	1		4	
Course Pre-Requisite: Basic electronics & electrical, Basic Sciences,																
Course Description: This course gives knowledge about Robotics and its kinematics and dynamics. It also describes the fundamentals of Artificial Intelligence.																
Course Objectives																
1. To understand basic terminologies and concepts associated with Robotics.																
2. To study various Robotic kinematics, forward and backward or inverse.																
3. To study kinematics and dynamics to understand exact working pattern of robots.																
4. To study the associated recent updates in Artificial Intelligence.																
Course Learning Outcomes:																
CO	After the completion of the course the student should be able to											Bloom's Cognitive				
												level	Descriptor			
CO1	Define various robot structures and their workspace.											I	Cognitive (Knowledge)			
CO2	Interpret spatial transformations associated with rigid body motions											II	Cognitive (Knowledge)			
CO3	Acquire knowledge of fundamentals of Artificial Intelligence											III	Cognitive (Knowledge)			
CO4	Relate the problem logically and demonstrate problem solving with Artificial Intelligence technique											III	Psychomotor (Skill)			
CO-PO Mapping:																
CO	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3	
CO1	2															
CO2	2			3				2					2	2		
CO3		3			3	2			2					2		
CO4		2			3								2			
Assessments:																
Teacher Assessment:																
Assessment									Marks							
ESE									100							
No ISE 1 and ISE II and MSE:																
ESE: Final ESE Assessment is based on 100% course content for 100 marks.																
Course Contents:																
Unit 1:- Introduction														(05)Hrs.		
The mechanics and control of manipulators :-The description of position and orientation, Concept of Forward kinematics of manipulators, Inverse kinematics of manipulators, Velocities, static forces, singularities, Robot joints and work volume																
Unit 2:- Forward Kinematics :-														(05)Hrs.		
Description Position, orientation and frames. Transformation matrices and																

their arithmetic, link and joint description, Mapping : Changing descriptions to frame to frame, Operations: Translation, Rotation and transformation Denavit-Hartenberg parameters, frame assignment to links, direct kinematics,	
Unit 3:-Manipulator Kinematics:- Link Description, Link connection description, convention for affixing Frames to links, Actuator Space, Joint space, Cartesian space, Frames with standard names.	(06)Hrs.
Unit 4:- Inverse kinematics:- Kinematics redundancy, kinematics calibration, inverse kinematics, solvability, algebraic and geometrical methods. Velocities and Static forces in manipulators:- Jacobians, singularities, static forces, Jacobian in force domain. Dynamics:- Introduction to Dynamics , Trajectory generations.(Theoretical Treatment Only)	(05) Hrs.
Unit5:- Dynamics :- Introduction to Dynamics, Trajectory generations, Forward Dynamics and Inverse Dynamics – Importance – Spatial description and transformations – Different types of dynamic formulation schemes – Lagrangian formulation for equation of motion for robots and manipulators.	(07) Hrs.
Unit6:-Trajectory Planning Trajectory planning, Geometric Jacobian / Analytical Jacobian, Singularities and redundancy, Inverse kinematics algorithms, Statics and manipulability, Kinematic solutions and trajectory planning,	(07) Hrs.
Textbooks: • John J. Craig, Introduction to Robotics (Mechanics and Control), Addison-Wesley, 2nd Edition, 2004 • Mikell P. Groover et. Al., Industrial Robotics: Technology, Programming and Applications, McGraw – Hill International, 1986. • Shimon Y. Nof , Handbook of Industrial Robotics , John Wiley Co, 2001. • Artificial Intelligence A modern approach by Stuart Russell 2nd edition • Artificial Intelligence by Saroj Kaushik	
References: • Richard D. Klafter , Thomas A. Chmielowski, Michael Negin, Robotic Engineering : An Integrated Approach , Prentice Hall India, 2002. • Handbook of design, manufacturing & Automation: R.C. Dorf, John Wiley and Sons.	
Unit wise Measurable students Learning Outcomes: U01.1: Understand the fundamentals of The mechanics and control of manipulators. U02.1 Understand and apply the basics fundamentals of forward kinematics. U0 3.1 Understand and apply the basics fundamentals of manipulator kinematics. U04.1: Understand and apply the basics fundamentals of Inverse kinematics. U05.1: Understand and apply the fundamentals Robot dynamics. U06.1: Understand and apply the fundamentals of trajectory Planning	

Title of the Course: Mini project											L	T	P	Credit		
Course Code:UMEH0701											-	-	2	1		
Course Pre-Requisite: Fundamentals of Robotics, Sensors, Motors, and Design, Basic fundamentals of Thermal &Manufacturing Processes.																
Course Description: Mini project aims to give exposure to the students to practical knowledge and real life problems																
Course Objectives: To understand the working of industry To apply the theoretical knowledge to real life problems To learn to prepare and present the report																
Course Learning Outcomes:																
CO	After the completion of the course the student should be able to											Bloom's Cognitive level		Descriptor		
C01	Explain the need of various Sensors, actuators, Controllers and End effectors for the robots											II	Understand			
C02	Use the sensors, actuators Controllers and end effectors for the robot under considerations											III	Apply			
C03	Compare the results for the various actuator, sensors and controllers for the robot under considerations											IV	Analyze			
C04	Classify the various results of the robot under considerations											V	Evaluate			
C05	Design and Develop the Robotics systems for the problem under consideration											VI	Create			
CO-PO Mapping:																
CO	PO1	PO2	PO3	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
C01	3													2		2
C02	3	2								3	3			2		2
C03	2								3	3	3					2
C04					3	3										2
C05				3		3				3		3	3			
Assessments :																
Teacher Assessment:																
ESE are based on practical performed/ Quiz/ Mini-Project assigned/ Presentation/ Group Discussion/ Internal oral etc.																
ESE(O.E) : a) Submission of dissertation report b) Viva-voce of project																
Assessment											Marks					
ESE(O.E)											100					

Course Contents:

1. Students can preferably identify a problem
2. Fabrication of product/ testing setup of an experimentation unit/ apparatus/ small equipment, in a group.
3. Experimental verification of principles used in Mechanical Engineering Applications.
4. Critical analysis of any design or process for optimizing the same.
5. Software development for particular applications. The subject content of the mini project shall be from emerging/ thrust areas, topics of current relevance. The completion of work, the submission of the report and assessment should be done at the end of Part-I (Semester I only).
6. Mini project diary shall be maintained by each group. Students shall be evaluated for the Mini project at the end of VIIth semester.
7. Students are expected to use any programming language for coding.

Report Format:

Report should be of 30 to 50 pages (typed on A4 size sheets).

- a) For standardization of the Project reports the following format should be strictly followed.
- b) Page Size: Trimmed A4
- c) Top Margin: 1.00 Inch
- d) Bottom Margin: 1.32 Inches
- e) Left Margin: 1.5 Inches
- f) Right Margin: 1.0 Inch
- g) Para Text: Times New Roman 12 Point. Font
- h) Line Spacing: 1.5 Lines
- i) Page Numbers: Right Aligned at Footer. Font 12 Point. Times New Roman
- j) Headings: Times New Roman, 14 Point, Bold Face

Certificate: All students should attach standard format of Certificate as Described by the department. Certificate should be awarded to batch and not to individual student.

Index of Report:

- I. Certificate should have signatures of Guide, Head of Department and Principal/Director
- II. Title Sheet
- III. Certificate
- IV. Acknowledgement
- V. Table of Contents.
- VI. List of Figures
- VII. List of Tables
- VIII. References: References should have the following format For Books:
"Title of Book", Authors, Publisher, and Edition