



**Swami Keshvanand Institute of Technology, Management
& Gramothan, Jaipur**

Semester III



Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Name of the Programme: Minor Degree in Robotics	Year: II	Semester: III
Course Name: Introduction to Robotics	Course Code: MEUL305	Credit: 3
Max Marks: 100	CIE: 40	SEE: 60
End Term Exam Time: 3 Hrs.	Teaching Scheme: CI (45) + TW & SL (45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite.	1
2	Introduction to robotics : Brief History, Basic Concepts of Robotics such as Definition , Three laws, Elements of Robotic Systems i.e. Robot anatomy, DOF, Misunderstood devices etc., Classification of Robotic systems on the basis of various parameters such as work volume, type of drive, etc., Associated parameters i.e. resolution, accuracy, repeatability, dexterity, compliance, RCC device etc., Introduction to Principles & Strategies of Automation, Types & Levels of Automations, Need of automation, Industrial applications of robot.	10
3	Grippers and Sensors for Robotics: Grippers for Robotics - Types of Grippers, Guidelines for design for robotic gripper, Force analysis for various basic gripper system. Sensors for Robots - Types of Sensors used in Robotics, Classification and applications of sensors, Characteristics of sensing devices, Selections of sensors. Need for sensors and vision system in the working and control of a robot.	10
4	Drives and Control for Robotics: Drive - Types of Drives, Types of transmission systems, Actuators and its selection while designing a robot system. Control Systems: Types of Controllers, Introduction to closed loop control	8
5	Programming and Languages for Robotics: Robot Programming: Methods of robot programming, WAIT, SIGNAL and DELAY commands, subroutines, Programming Languages: Generations of Robotic Languages, Introduction to languages such as Python and ROS etc.	8
6	Related Topics in Robotics: Socio-Economic aspect of robotisation. Economical aspects for robot design, Safety for robot and standards, Introduction to Artificial Intelligence, AI techniques, Need and application of AI, New trends & recent updates in robotics.	8
	TOTAL	45

Text Books:

1. S. K. Saha, Introduction to Robotics 3e, TATA McGraw Hills Education (2024)
2. R. K. Mittal, I. J. Nagrath, Robotics and Control, TATA McGraw Hill Publishing Co Ltd, New Delhi (2003)

Reference Books:

1. S. B. Niku, Introduction to Robotics – Analysis, Control, Applications, 3rd edition, John Wiley & Sons Ltd., (2020)
2. J. Angeles, Fundamentals of Robotic Mechanical Systems Theory Methods and Algorithms, Springer (1997)



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Semester IV



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Name of the Programme: Minor Degree in Robotics	Year: II	Semester: IV
Course Name: Mechanics of Robots	Course Code: MEUL406	Credit: 3
Max Marks: 100	CIE: 40	SEE: 60
End Term Exam Time: 3 Hrs.	Teaching Scheme: CI (45) + TW & SL (45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite.	1
2	Mathematical Preliminaries of Robotics: Spatial Descriptions: positions, orientations, and frame, mappings: changing description from frame to frame, Operators: translations, rotations and transformations, transformation arithmetic, compound Transformations, inverting a transform, transform equations, Euler Angles, Fixed Angles, Euler Parameters.	10
3	Robot Kinematics: Manipulator Kinematics, Link Description, Link to reference frame connections, Denavit-Hartenberg Approach, D-H Parameters, Position Representations, Homogeneous Transformation Matrix, Forward Kinematics. Inverse Kinematics, Geometric and analytical approach.	10
4	Velocities & Statics: Cross Product Operator for kinematics, Jacobians - Direct Differentiation, Basic Jacobian, , Jacobian J_v / J_w , Jacobian in a Frame, Jacobian in Frame {0}, Kinematic Singularity, Kinematics redundancy, Force balance equation, Forces, Velocity/Force Duality, Virtual Work, Force ellipsoid, Jacobian, Kinematic Singularity, Kinematics redundancy, Mechanical Design of robot linkages,	8
5	Robot Dynamics: Introduction to Dynamics, Velocity Kinematics, Acceleration of rigid body, mass distribution Newton's equation, Euler's equation, Iterative Newton -Euler's dynamic formulation, closed dynamic, Lagrangian formulation of manipulator dynamics, dynamic simulation, computational consideration.	8
6	Robot Control: Control schemes used for a robotic manipulator - PID control, computed-torque control, force control, gravity compensation, etc.	8
	TOTAL	45

Text Books:

1. S. K. Saha, Introduction to Robotics 3e, TATA McGraw Hills Education (2024)
2. Dilip Kumar Pratihari, Fundamentals of Robotics, Narosa Publishing House, (2019)

Reference Books:

1. Asitava Ghoshal, Robotics: Fundamental concepts and analysis, Oxford University Press (2006)
2. M. Spong, M. Vidyasagar, S. Hutchinson, Robot Modeling and Control, Wiley & Sons, (2005).



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Semester

V



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Name of the Programme: Minor Degree in Robotics	Year: III	Semester: V
Course Name: Mechatronic Systems	Course Code: MEUL505	Credit: 3
Max Marks: 100	CIE: 40	SEE: 60
End Term Exam Time: 3 Hrs.	Teaching Scheme: CI (45) + TW & SL (45) = 90 hrs. per semester	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite.	1
2	Overview of Mechatronics: Historical perspective, Definition, Applications, Block diagram of Mechatronic system, Functions of Mechatronics Systems, Benefits of mechatronics in manufacturing. Signal Conditioning, Data Acquisition systems.	6
	Sensors and Actuators: Static characteristics of sensors and actuators, Position, Displacement and Proximity Sensors, Force and torque sensors, Pressure sensors, Flow sensors, Temperature sensors, Acceleration sensors, Level sensors, Light sensors, Smart material sensors, Micro and Nano sensors, Selection criteria for sensors, Actuators: Electrical Actuators (Solenoids, Relays, Diodes, Thyristors, Triacs, BJT, FET, DC motor, Servo motor, BLDC motor, AC motor, Stepper motors), Hydraulic and Pneumatic actuators	10
3	Microprocessor: 8086 Microprocessor and its Internal Architecture, Pin Configuration and their functions, Mode of Operation, Introduction to I/O and Memory, Timing Diagrams, Introduction to Interrupts. Introduction to C language, Instruction format, C language programming format, Addressing mode, Instruction Sets, Programming 8086 microprocessor..	8
4	Microcontroller: Introduction to Microcontroller and its families such as 8051, AVR. Criteria for Choosing Microcontroller. Microcontroller Architecture, Programming model, addressing modes, Instruction sets, Assembly and C programming for Microcontroller, I/O interfacing, Timers, Real Time Clock, Serial and parallel Communication protocols.	8
5	Programmable Logic Controllers (PLCs): Architecture, Number Systems Basics of PLC Programming, Logics, Timers and Counters, Application on real time industrial automation systems.	6
6	Case Studies: Design of pick and place robot, Car engine management system, Automated manufacturing system, Automatic camera, Automatic parking system, Safety devices and systems.	6
	TOTAL	45

Text Books:

1. Mikell Groover, Mitchell Weiss, Roger N. Nagel, Nicholas Odrey, Ashish Dutta, Industrial Robotics 2nd edition, SIE, McGraw Hill Education (India) (2012)
2. A Textbook of Mechatronics by RK Rajput, S. Chand Publication, 2007

Reference Books:

1. Microprocessors & Microcontrollers, 1st Edition by Santanu Chattopadhyay McGraw Hill Education (India), 2024.
2. Mechatronics: electronic control systems in mechanical and electrical engineering [6e] William Bolton, Pearson Education Limited.



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Semester VI



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Name of the Programme: Minor Degree in Robotics	Year: III	Semester: VI
Course Name: Robotics Lab	Course Code: MEUP625	Credit: 1
Max Marks: 100	CIE: 60	SEE: 40
End Term Exam Time: 3 Hrs.	Teaching Scheme: CI (0) + TW & SL (0) + L (30) = 30 hrs. per semester	

Module No.	Contents	Hours
1	Introduction: Objective, Scope, Outcome of the Course and Prerequisite.	1
2	Transducers Kit • Characteristics of LVDT • Principle & Characteristics of Strain Gauge	5
3	PLC Programming • Ladder programming on logic gates, timers and counters • Ladder programming for traffic light control, water level control modules	6
4	Mobile Robot • Basics of Arduino, Raspberry pi platforms and its applications • Program for Operating Motion and Direction control • Program for Operating White line follower for the given arena	8
5	Robotics Programming for Applications • Robot programming and simulation for 5-DoF robotic arm • Robot programming for motion control using firebird • Programming of humanoid robot for different movements • Robot programming and simulation for colour identification. • Robot programming and simulation for shape identification / path tracking	10
	TOTAL	30

Text Books:

1. R. K. Mittal, I. J. Nagrath, Robotics and Control, TATA McGraw Hill Publishing Co Ltd, New Delhi (2003)

Reference Books:

1. Mechatronics: electronic control systems in mechanical and electrical engineering [6e] William Bolton, Pearson Education Limited.



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Semester VII



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Name of the Programme: Minor Degree in Robotics	Year: IV	Semester: VII
Course Name: Project Lab	Course Code: MEUD751	Credit: 4
Max Marks: 100	CIE: 60	SEE: 40
End Term Exam Time: 3 Hrs.	Teaching Scheme: CI (15) + TW & SL (15) + L (90) = 120 hrs. per semester	

The plan of conducting project work is given below:

1. Participants will be divided into teams of two/four members within first week of the starting of the course by the course coordinator depending on the number of participants registered in the course.
2. The projects delivered to groups will be of the following types:
 - i. *Algorithm development (AD) type:* Analyse, say, a robot kinematics using RoboAnalyzer or MATLAB/Octave/Freemat/Scilab or similar software or write an algorithm using any programming language (Python, etc.). For example, writing forward kinematics of a robot or image processing in Vision.
 - ii. *Design/synthesis (DS) type:* Proposing a new type of system/device for performing certain task. For example, a mobile robot for Covid-19 isolation wards.
3. The course instructor/coordinator will explain how to do literature survey, how to find the sources of hardware, which software to use for a particular purpose, how to select an electric motor, etc., present case studies, etc.
4. Students must spend about 6 hours in a week to discuss their progress together, study together or individually, write programmes, fabricate circuits, etc.
5. At the end of the course, each team will make a PPT presentation and showcase their project hardware/software/plots, etc. generated during the project with a project report up to 50 pages.



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Annexure-1

List of NPTEL courses (Approved for credits in Minor Degree in Robotics)

Group-1				
S.No.	Name of Course	Offering Institute/University	Duration (weeks)	Credit
1.	Robotics: Basics and Selected Advanced Concepts	Ahmedabad University	12	3
2.	Robotics	IIT Kharagpur	8	2
3.	Mechanics and Control of Robotic Manipulators	IIT Palakkad	8	2
Group-2				
S.No.	Name of Course	Offering Institute/University	Duration (weeks)	Credit
1.	Industrial Robotics and Automation	NITTTR, Chennai	12	3
2.	Advanced Robotics Applications	IIT Kanpur	8	2
3.	Advanced Robotics	IIT Kanpur	12	3
4.	Experimental Robotics	IIT Kharagpur	4	1
Group-3				
S.No.	Name of Course	Offering Institute/University	Duration (weeks)	Credit
1.	Sensors and Actuators	IISc Bangalore	12	3
2.	Foundations of Cognitive Robotics	IIT Kanpur	4	1
3.	Collaborative Robots (COBOTS): Theory and Practice	IIT-ISM Dhanbad	8	2
4.	Intelligent Control of Robotic Systems	IIT Roorkee	4	1

Note:

- It should be noted that a student can take only ONE course from a particular group to complete a total of 6 credits under MOOCs.