Robotics and Automation
23MTOE321

(COURSE HANDBOOK)

B.E - MECHATRONICS

COURSE FACULTY:

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1. GENERAL INFORMATION

Welcome to Robotics and Automation, an Open Elective course offered to undergraduate engineering students.

This course provides students with a comprehensive understanding of robotics and automation systems widely used in modern manufacturing and industrial environments. It introduces the fundamentals of robotics, robot anatomy, motion analysis, sensors, drive systems, end effectors, industrial automation principles and material handling technologies. The course emphasizes both theoretical foundations and practical relevance preparing students for careers in automation, robotics and smart manufacturing.

The curriculum is structured into five well-defined modules, beginning with an introduction to robotics and its societal and industrial impact. Subsequent modules focus on robot configurations, motion and sensors, robot drives and end effectors, automation systems, and material handling and identification technologies. Each module is designed to progressively build student competence and application skills.

1.1.Course Objectives

This course is designed to:

1. Familiarize with the fundamentals of robotics, its impact, applications and future prospects
2. Impart knowledge of robot anatomy, configurations, movements and sensor technologies
3. Provide an understanding of robot drives, end effectors, gripper design, degrees of freedom and control types
4. Impart knowledge of automation, its principles, system elements and production economics
5. Familiarize with material handling systems, types of equipment, system design identification methods

1.2.Course Outcomes

At the end of the course, the student will be able to:

1. Understand the fundamentals of robotics and its future prospects
2. Understand robot anatomy, configurations, degrees of freedom, and sensor technologies in robotic systems
3. Apply knowledge of robot drive systems, end effectors, gripper design, degrees of freedom, and various robot control types
4. Apply knowledge of automation concepts, functions, levels, and production economics in manufacturing processes
5. Apply knowledge of material handling systems and identification methods in automation

1.3. Textbooks and Suggested Sources

Text Books:

1. Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey and Ashish Dutta, "Industrial Robotics: Technology, Programming and Applications", 2nd Edition, Tata McGraw Hill, 2012
2. Srinivas Medida, "Pocket Guide on Industrial Automation: For Engineers and Technicians", 1st Edition, IDC Technologies, 2007

Reference Books:

1. Ghosh, "Control in Robotics and Automation: Sensor Based Integration", 1st Edition, Allied Publishers, Chennai, 1998
2. Asfahl C.R., "Robots and manufacturing Automation", 1st Edition, John Wiley, 1992

2. THE COURSE

2.1.Course Description

Robotics and Automation			
Semester	**VI**	CIE Marks	**50**
Course Code	**23MTOE321**	SEE Marks	**50**
Teaching Hours/Week (L:T:P)	**3:0:0**	Exam Hrs	**03**
Total Hours	**42**	Credits	**03**

The Robotics and Automation course is designed to provide students with fundamental knowledge of robotics systems and industrial automation practices relevant to modern manufacturing environments. The course is offered during Semester VI and consists of five modules covering essential topics such as robotics fundamentals, robot anatomy and sensors, drive systems and end effectors, industrial automation principles, and material handling technologies. The course is delivered over a span of 14 weeks, with 3 lectures per week, amounting to a total of 42 contact hours. This 3-credit course is evaluated through Continuous Internal Evaluation (CIE) for 50 marks and a Semester-End Examination (SEE) for 50 marks, conducted over a 3-hour duration. This course structure emphasizes strong theoretical foundations aligned with the requirements of automation oriented engineering applications.

2.2. Initiating Contact with Staff and Other Students

Students are encouraged to raise their queries during class hours and may visit the faculty office for additional support. However, considering the large class size email may also be used as an effective mode of communication. Additionally, we encourage you to engage with your peers for discussions and collaborative learning, as this will enhance your understanding of the course material and foster a supportive academic community.

2.3.Resources

Resources include dynamic tools such as digital libraries, e-learning platforms which provide students with anytime, anywhere access to academic materials and interactive courses through a variety of resources available on the college website, including the VTU Consortium, open-access repositories, and government portals (e.g., NPTEL, NDLI). .

E-learning and digital library can be accessed via the college website https://mite.ac.in/ (Campus Life section > Library > VTU Consortium/e-learning platforms/additional sources)

2.4.Staff

Course Faculty: Mrs. Rajeshwari
Cabin: 2nd floor, Mechanical Block
Email: rajeshwari@mite.ac.in

2.5.Topics and Reading materials for each module

Module 1 *No. of Hours: 08*

Topic: Introduction to Robotics

Definition and Origin of Robotics, Evolution of robotics, Different Types of Robots, Generations of Robots, Degrees of Freedom, Asimov's Laws of Robotics, Basic Components of a Robot, Robot Specifications, Classification of Robots, Human–Robot Interaction, Safety Measures in Robotics, Social Impact of Robotics, Robotics Market and Future Prospects, Advantages and Disadvantages of Robots.

Activities:

Classroom discussion on the evolution and applications of robotics, focusing on human-robot interaction, safety considerations, societal impact and future trends in the robotics industry.

Essential Readings:

Mikell P. Groover, "Industrial Robotics: Technology, Programming, and Applications", McGraw Hill, 2nd Edition (Chapter 1)

Additional Reading:

John J. Craig, "Introduction to Robotics: Mechanics and Control", Pearson Education, 3rd Edition

Module 2 *No. of Hours: 08*

Topic: Robot Anatomy, Motion Analysis and Sensors

Anatomy of a Robot, Robot Configurations: Polar, Cylindrical, Cartesian, and Jointed Arm Configurations; Robot Links and Joints; Degrees of Freedom – Types of Movements: Vertical, Radial, and Rotational Traverse; Roll, Pitch, and Yaw; Work Volume / Work Envelope; Machine Vision; Ranging Sensors – Laser, Acoustic, Magnetic, Fiber Optic, and Tactile Sensors.

Activities:

Classroom discussion on various robot configurations and their work envelopes, with emphasis on degrees of freedom, sensing technologies and applications in industrial automation.

Essential Readings:

Mikell P. Groover, *"Industrial Robotics: Technology, Programming, and Applications*, McGraw Hill, 2nd Edition (Chapter 2 & 6)

Additional Reading:

John J. Craig, *"Introduction to Robotics: Mechanics and Control"*, Pearson Education, 3rd Edition (Sections on robot kinematics and sensors)

Module 3 *No. of Hours: 08*

Topic: Robot Drives and End Effectors

Robot Drive Systems: Hydraulic, Pneumatic, and Electric Drive Systems; Classification of End Effectors; Mechanical Grippers, Vacuum Grippers, Magnetic Grippers, Adhesive Grippers; Gripper Force Analysis and Gripper Design; Degrees of Freedom – 1 DoF, 2 DoF, and Multiple Degrees of Freedom; Robot Control Types – Limited Sequence Control, Point-to-Point Control, Playback with Continuous Path Control, and Intelligent Control.

Activities:

Case-based classroom discussion on the selection of robot drive systems, end effectors and control strategies for different industrial applications.

Essential Readings:

Mikell P. Groover, *"Industrial Robotics: Technology, Programming, and Applications"*, McGraw Hill, 2nd Edition (Chapter 2 & 5)

Additional Reading:

John J. Craig, *"Introduction to Robotics: Mechanics and Control"*, Pearson Education, 3rd Edition (Relevant sections on robot actuators and control systems)

Module 4 *No. of Hours: 09*

Topic: Industrial Automation

Automation in Production Systems, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automation; Production Economics – Methods of Evaluating Investment Alternatives, Costs in Manufacturing, Break-Even Analysis, Unit Cost of Production, Cost of Manufacturing Lead Time, and Work-in-Process (WIP).

Activities:

Case-based classroom discussion on automation strategies and production economics, focusing on cost analysis, break-even evaluation and decision-making in automated manufacturing systems.

Essential Readings:

Mikell P. Groover, *"Automation, Production Systems, and Computer-Integrated Manufacturing"*, Pearson Education, 4th Edition (Relevant chapters on automation and production economics) (Chapter 4)

Additional Reading:

Groover, M. P., *"Fundamentals of Modern Manufacturing"*, Wiley, 6th Edition (Sections on production economics and automation levels)

Module 5 *No. of Hours: 09*

Topic: Material Handling Systems and Automation

Overview of Material Handling Systems, Types of Material Handling Equipment, Design of Material Handling Systems, Conveyor Systems, Automated Guided Vehicle (AGV) Systems, Automated Storage Systems, Interfacing Handling and Storage with Manufacturing Systems, and Overview of Automatic Identification Methods.

Activities:

Team-based presentation on the design and application of material handling and automation systems used in modern manufacturing and logistics environments.

Essential Readings:

Mikell P. Groover, *"Automation, Production Systems, and Computer-Integrated Manufacturing"*, Pearson Education, 4th Edition (Relevant chapters on material handling and automated systems) (Chapter 10 & 12)

Additional Reading:

R. P. Stephens and R. L. Meyers, *"Manufacturing Facilities Design and Material Handling"*, Pearson Education, 3rd Edition (Relevant sections on material handling equipment and system design)

3. ASSESSMENT

The assessment for the Robotics and Automation is divided into two components: Continuous Internal Evaluation (CIE) and Semester End Examination (SEE), each accounting for 50% of the total marks.

Continuous Internal Evaluation (CIE) comprises two internal tests, scheduled for the 8th and 14th week, which together contribute 30% of the total marks. Additionally, students can earn 20% through the completion of assignments.

Semester End Examination (SEE) constitutes the remaining 50% of the total marks.

Rubrics for Other Assessment

1. **Students (in teams) shall select one industrial automation system and study its basic elements and advanced functions. (10 Marks)**					
Criteria	**10-9 Marks (Excellent)**	**8-7Marks (Very Good)**	**6-5 Marks (Good)**	**4-3 Marks (Fair)**	**2-1 Marks (Poor)**
Presentation Quality and Engagement	Exceptionally engaging presentation with original insights	Clear and engaging presentation with minor shortcomings	Adequate presentation with limited originality	Poorly organized with low engagement	No effective contribution
Conceptual Clarity and Application	Thorough understanding with strong linkage of concepts	Sound understanding of key concepts	Partial understanding with basic explanations	Limited grasp of concepts	No evidence of understanding

2. Students (in teams) shall select one automated industrial service system and analyze its operational workflow and efficiency. (10 Marks).					
Criteria	**10-9 Marks (Excellent)**	**8-7Marks (Good)**	**6-5 Marks (Fair)**	**4-2 Marks (Poor)**	**2–1 Marks (Poor)**
Analysis and System Representation	Comprehensive analysis with clear and accurate system representation	Well-structured analysis with minor gaps	Basic analysis with limited system clarity	Superficial analysis with unclear representation	No meaningful analysis
Application of Concepts	Concepts applied effectively to real airport operations	Appropriate application of most concepts	Limited application of concepts	Minimal application of concepts	No application of concepts