Vidya Pratishthan's

Kamalnayan Bajaj Institute of Engineering and Technology, Baramati.

(An Autonomous Institute)

Faculty of Science and Technology

Board of Studies

Mechanical Engineering

Syllabus

Multidisciplinary Minor

(Pattern 2025)

(w.e.f. AY: 2026-27)

Vidya Pratishthan's

Kamalnayan Bajaj Institute of Engineering and Technology, Baramati.

Vision

To achieve Academic Excellence through Persistent and Synergic Collaborations amongst all Stakeholders.

Mission

1. To ensure holistic development of students as lifelong learners and problem solvers through value-based quality education.
2. To motivate faculty to attain the state-of-the-art knowledge and wisdom in their domain and be a facilitator towards cocreation of knowledge.
3. To frame and deploy conducive and empowering policies for multifaceted growth of students, faculty and staff to make them contributors towards excellence.
4. To partner with industry for mutually beneficial relations to generate employable and deployable workforce.
5. To fulfill the aspirations of alumni, parents, society, region and nation at large by generating technically competent and contributing manpower.

Department of Mechanical Engineering,

VPKBIET Baramati

Vision

To inculcate learning culture in students and faculties to meet the current and future technological challenges of industry and society

Mission

1. To impart the students with fundamental knowledge of mechanical engineering.
2. To provide practical exposure by promoting students for training and internship in related industries.
3. Holistic development of the students by inculcating ethical and moral values towards the society and environment.
4. To develop association with premier educational institutions, industries and alumni for enhancement of faculty skill.

Syllabus: Multidisciplinary Minor Mechanical Engineering (Pattern 2025) w.e.f. AY:2026-2027															
Course Code	Courses Name	Teaching Scheme			Examination Scheme and Marks							Credits			
		TH	PR	TU	CAA	ISE	ESE	TW	PR	OR	Total	TH	PR	TU	Total
ME25051TH	Introduction to 3D Printing Technologies	2	-	-	10	-	60	-	-	-	70	2	-	-	3
ME25051PR	Introduction to 3D Printing Technologies	-	2	-	-	-	-	30	-	-	30	-	1	-	
ME25052TH	Introduction to Robotics & Automation	2	-	-	10	-	60	-	-	-	70	2	-	-	3
ME25052PR	Introduction to Robotics & Automation	-	2	-	-	-	-	30	-	-	30	-	1	-	
ME25053TH	3D Printing	3	-	-	10	30	60	-	-	-	100	3	-	-	4
ME25053PR	3D Printing	-	2	-				30	-	-	30	-	1	-	
ME25054TH	Robotics & Automation	3	-	-	10	30	60	-	-	-	100	3	-	-	4
ME25054PR	Robotics & Automation	-	2	-	-	-	-	30	-	-	30	-	1	-	

Dr. S. C. Mahadik	Dr. M. S. Lande	Dr. S. M. Bhosle	Dr. A. H. Kolekar
Academic Coordinator	**Head of Department**	**Dean Academics**	**Controller of Examination**

Dr. S. B. Lande

Principal

VPKBIET BARAMATI
Affiliated to S.P.P.U. Pune
Id No./PU/PN/Engg./152/2000
PUNE (MS.)

ME25051:- Introduction to 3D Printing Technologies		
Teaching Scheme:	**Credits:03**	**Examination Scheme:**
TH: 02 Hrs/Week	**Theory : 02** **Practical : 01**	**Course Activity: - 10 Marks**
		In-Semester Exam: - NA
		End-Semester Exam: 60 Marks
PR: 02 Hrs/Week		**Term-Work: 30 Marks**

Prerequisites: AutoCAD, Engineering Science Courses.

Objectives:

1. Understanding the principles, methodologies, potentialities, and constraints, along with the environmental risks, inherent in 3D printing technologies.
2. Becoming acquainted with the properties of diverse materials utilized within 3D printing technologies.
3. Investigating the practical applications of 3D printing technologies in various real- world scenarios.

Course Outcomes:

The students will be able to learn:

CO1: Understand the fundamental principles of 3D printing technologies

CO2: Develop skills in using 3D modeling software and printing software

CO3: Learn about different types of 3D printing technologies

CO4: Explore various materials used in 3D printing and their properties

Course Contents

Unit-1: Introduction to 3D Printing	**[07 Hrs.]**
Historical background and evolution of 3D printing technologies, Comparison with traditional subtractive manufacturing methods, advantages and disadvantages 3D printing terminology, 3D printing workflow, calibration in 3D printing : bed leveling, extruder calibration, temperature calibration, flow rate calibration, dimensional accuracy calibration, Significance, and applications of 3D Printing in modern manufacturing.	

Unit-2: Design for 3D Printing	**[08 Hrs.]**
Introduction to the concept of Design for Additive Manufacturing (DFAM), Guidelines for designing parts optimized for 3D printing: Overview of popular CAD software tools and their features, Basics of 3D modeling techniques and design considerations for additive manufacturing, CAD Software and 3D Modeling: Introduction to Computer-Aided Design (CAD) software and its role in 3D printing, re-processing: CAD modeling, file preparation, and slicing, Printing parameters: Layer height, print speed, temperature, etc. Post-processing techniques: Support removal, surface finishing, heat treatment, etc., Quality control and inspection of printed parts.	
Unit-3: 3D Printing Technologies	**[08 Hrs.]**
Extrusion-based Printing: Fused Deposition Modeling (FDM), Vat Polymerization: Stereolithography (SLA), Digital Light Processing (DLP), Powder Bed Fusion: Selective Laser Sintering (SLS), Direct Metal Laser Sintering (DMLS), Electron Beam Melting (EBM), Material Jetting, Binder Jetting, Photopolymerization: Continuous Liquid Interface Production (CLIP).	
Unit-4: Materials for 3D Printing	**[07 Hrs.]**
Thermoplastics: Polylactic Acid (PLA), Acrylonitrile Butadiene Styrene (ABS), Polyethylene Terephthalate Glycol (PETG), Polyvinyl Alcohol (PVA), Metals: stainless steel, titanium, aluminum etc., Photo Polymers: Resin, Flexible Resin, Ceramics, Composites, 4D Printing and Bio active materials, Smart materials, special materials: Food, Textile.	

Text Books:

1. Chua Chee Kai, Leong Kah Fai, "3D Printing and Additive Manufacturing: Principles & Applications", 4th Edition, World Scientific, 2015 2.
2. Amit Bandyopadhyay, Susmita Bose, "Additive manufacturing", CRC Press, Taylor & Francis Group, 2016 3.
3. Ian Gibson, David W. Rosen, Brent Stucker "Additive Manufacturing

Reference Books:

1.L. Lu, J. Y. H. Fuh and Y.S. Wong, "Laser-Induced Materials and Processes for Rapid Prototyping", Springer, 2001

2. Andreas Gebhardt and Jan-Steffen Hötter, "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing" Hanser Publishers, Munich, 2016.

3. Ben Redwood, FilemonSchöffer& Brian Garret, "The 3D Printing Handbook: Technologies, design and applications", 3D Hubs B.V. 2017

4. Ehsan Toyserkani, Amir Khajepour, Stephen F. Corbin, "Laser Cladding", CRC Press, 2004

5. Andreas Gebhardt, "Understanding Additive", Hanser Publishers, Munich, 2011

6. Ben Redwood, Filemon Schöffer & Brian Garret, "The 3D Printing Handbook – Technologies, Design and Applications" Part One:3D Printing Technologies and Materials, 3D Hubs, 2017

7. Chee Kai, Kah Fai, Chu Sing, 'Rapid Prototyping: Principles and Applications", 2nd Ed., 2003

8. D. T. Pham and S.S. Dimov, "Rapid Manufacturing" Springer, 2001

9. Rupinder Singh J. Paulo Davim, "Additive Manufacturing - Applications and Innovations" CRC Press Taylor& Francis Group, 2019

10.I. Gibson, D. W. Rosen, B. Stucker, "Additive Manufacturing Technologies" Springer, 2010

11.L. Jyothish Kumar, Pulak M. Pandey, David Ian Wimpenny, "3D Printing and Additive Manufacturing Technologies" Springer, 2019

Guidelines for Lab /TW Assessment (All Practical's are compulsory)

1) To study different types of 3D printers and materials (filaments) used for the printer.

2) To Familiarize students with basic 3D modeling concepts and software- Introduction to 3D Modeling Software: Creating simple objects using software like Tinkercad or Fusion 360.

3) To understand the preprocessing of 3D printing : File Preparation for 3D Printing: Import designed models into slicing software (e.g., Cura or Flash Print etc), where adjust settings such as layer height, infill density, and support structures.

4) To Demonstrate the practical applications of 3D printing- FDM Printer.

5) To Demonstrate the practical applications of 3D printing- SLA printer.

6) To demonstrate the post processing techniques for 3D printed parts.

7) To understand the 3D model scanning technique using 3D scanner.

8) To construct basic 3D design using 3D pens.

Guidelines for Activity:

1. **Design Challenge - Create a Functional Prototype that has real world application.**

The students must create a project report comprising project proposal, research component, design and modeling, file preparation and slicing, printing and post processing, testing and evaluation, documentation and presentation.

Assessment Criteria:

Creativity and Innovation: Originality and creativity in addressing the chosen problem or improvement area. Design Quality: Quality of the 3D model, including accuracy, detail, and suitability for 3D printing. Functionality and Usability: Effectiveness of the prototype in fulfilling its intended purpose and ease of use. Presentation and Documentation: Clarity and professionalism of the final presentation and documentation.

2. **Industrial/ CoE visit -Report preparation based on the visit.**

ME25052 - Introduction to Robotics & Automation		
Teaching Scheme:	**Credits:03**	**Examination Scheme:**
TH: 02 Hrs/Week	**Theory : 02** **Practical : 01**	**Course Activity: - 10 Marks**
		In-Semester Exam: - NA
		End-Semester Exam: 60 Marks
PR: 02 Hrs/Week		**Term-Work: 30 Marks**

Prerequisites:

Engineering Physics, Engineering Mathematics, Basics of Electrical Engineering, Basics of Electronics Engineering & Engineering Graphics.

Objectives:

1. To introduce the fundamental concepts, classifications, configurations, kinematics, and components of industrial robotic systems.
2. To provide knowledge of robotic drives and sensors and their selection for various industrial robotic applications.
3. To familiarize students with different types of robot end effectors and their selection based on application requirements.
4. To develop fundamental robot programming skills and provide exposure to robot controllers and robotic applications in manufacturing and non-manufacturing environments.

Course Outcomes:

On completion of the course, learner will be able to

CO1: Explain the fundamental concepts, classifications, configurations and components of robotic systems.

CO2: Select appropriate drive & sensors for different Robotic applications.

CO3: Compare different types of robots and end effectors and select suitable combinations for specific industrial applications.

CO4: Develop basic robot programs and demonstrate their applications in manufacturing and non-manufacturing environments.

Course Contents

Unit-1: Fundamentals of Robotics	**[07 Hrs.]**
Historical development of Robotics, Definitions of Industrial Robot, Type and Classification of Robots, Asimov's laws 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.	
Unit-2: Robot Drive Systems & Sensors	**[08 Hrs.]**
Drive Systems :- Pneumatic Drives, Hydraulic Drives, Mechanical Drives, Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors, BLDC-Salient Features, Applications and Comparison of all these Drives, Micro actuators, selection of drive, Power transmission systems for robot, Motion conversion (Gearbox -Planetary, Harmonic, Cycloidal gearbox), VFD. **Sensors:-** Transducers and sensors, Sensors in robotics, Principles and applications of the following types of sensors- Proximity Sensors, Photoelectric Sensors, Position sensors – Piezoelectric Sensor, LVDT, Resolvers, Encoders – Absolute and Incremental: - Optical, Magnetic, Capacitive, pneumatic Position Sensors, Range Sensors- Range Finders, Laser Range Meters, Touch Sensors, Force and torque sensors	
Unit-3: End Effectors	**[07 Hrs.]**
Grippers, Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Advance Grippers- Adaptive grippers, Soft Robotics Grippers, Tactile Sensor Grippers; Various process tools as end effectors; Robot end effectors interface, Active and passive compliance, Selection and Design Considerations.	
Unit-4: Fundamentals of Robot Programming and Applications	**[08 Hrs.]**
Introduction to Robotic Programming, On-line and off-line programming, programming examples. Various Teaching Methods, Survey of Robot Level Programming Languages with manufacture, Various Textual Robot Languages, Typical Programming Examples such as Palletizing, Job Loading & unloading, Welding, Press Work Etc. Robots in manufacturing and non-manufacturing applications, a robot-based manufacturing system, Robot controllers types & specification.	

Text Books:

1. Groover, M.P. Weiss, M. Nagel, R.N. & Odrey, N.G., Ashish Dutta, Industrial Robotics, Technology, Programming & Applications, Tata McGraw Hill Education Pvt. Ltd. New Delhi
2. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill.
3. Groover M.P.-Automation, production systems and computer integrated manufacturing Prentice Hall of India.
4. M.P. Grover, "Automation, Production Systems and Computer Integrated Manufacturing"-Pearson Education.

Reference Books:

1. S B Niku, Introduction to Robotics, Analysis, Control, Applications, 2nd Edition, Wiley Publication, 2015.
2. Mikell P. Groover, Automation, Production Systems & Computer Integrated Manufacturing, PHI Learning Pvt. Ltd. , New Delhi, ISBN:987-81-203-3418-2, 2012.
3. John Craig, Introduction to Robotics, Mechanics and Control, 3rd Edition, Pearson Education, 2009.
4. R K Mittal & I. J. Nagrath, Robotics and Control, McGraw Hill Publication, 2015.
5. Mike Wilson, Implementation of Robotic Systems, ISBN: 978-0-124-04733-4.

E study material: NPTEL Course on Robotics:

1. https://onlinecourses.nptel.ac.in/noc19_me74/preview
2. https://onlinecourses.nptel.ac.in/noc20_de11/preview

Guidelines for Lab /TW Assessment

The student shall perform Practical's from following list:

1. Study on selection of Actuators and related hardware such as DC motor, Servo motor, Stepper Motor, Motor drivers based on application.
2. Study on selection of Sensors such as IR sensors, Proximity Sensor, Ultrasonic Sensor, White line sensor, Temperature Sensor, Touch sensor, Tilt Sensor, Accelerometer, Gyroscopic Sensor etc. based on given application.
3. Simulation / Demonstration of Cartesian / Cylindrical/ Spherical robot. (RoboAnalyzer / RoboDk Software).
4. Simulation / Demonstration of Articulated / SCARA robot. (RoboAnalyzer / RoboDk Software).

5. Simulation & Demonstration of a simple robotic system using Robo DK / RoboAnalyzer software for material handling systems.
6. Case study on selection & simulation of the appropriate robot system for given manufacturing and non- manufacturing applications.

Activity (Any One):-

1. Activity on video based quizzes on unit 1 to 4.
2. One robot programming exercise for any one industrial application.
3. Industrial/ CoE visit - Report preparation based on the visit.

ME25053:- 3D Printing		
Teaching Scheme:	**Credits:04**	**Examination Scheme:**
TH: 03 Hrs/Week	**Theory : 03** **Practical : 01**	**CAA: - 10 Marks**
		In-Semester Exam: 30 Marks
		End-Semester Exam: 60 Marks
PR: 02 Hrs/Week		**Term-Work: 30 Marks**

Prerequisites: AutoCAD, Engineering Science Courses.

Objectives:

1. Understanding the principles, methodologies, potentialities, and constraints, along with the environmental risks, inherent in 3D printing technologies.
2. Becoming acquainted with the properties of diverse materials utilized within 3D printing technologies.
3. Investigating the practical applications of 3D printing technologies in various real- world scenarios.

Course Outcomes:

The students will be able to learn:

CO1: Understand the fundamental principles of 3D printing technologies.

CO2: Develop skills in using 3D modeling software and printing software.

CO3: Learn about different types of 3D printing technologies.

CO4: Explore various materials used in 3D printing and their properties.

CO5: Examine the impact of AI and IoT in additive manufacturing

CO6: Summarize various case studies of AM applications

Course Contents

Unit-1: Introduction to 3D Printing	**[07 Hrs.]**
Historical background and evolution of 3D printing technologies, Comparison with traditional subtractive manufacturing methods, advantages and disadvantages 3D printing terminology, 3D printing workflow, calibration in 3D printing: bed leveling, extruder calibration, temperature calibration, flow rate calibration, dimensional accuracy calibration, Significance,	

and applications of 3D Printing in modern manufacturing.
Unit-2: Design for 3D Printing **[08 Hrs.]**
Introduction to the concept of Design for Additive Manufacturing (DFAM), Guidelines for designing parts optimized for 3D printing: Overview of popular CAD software tools and their features, Basics of 3D modeling techniques and design considerations for additive manufacturing, CAD Software and 3D Modeling: Introduction to Computer-Aided Design (CAD) software and its role in 3D printing, re-processing: CAD modeling, file preparation, and slicing, Printing parameters: Layer height, print speed, temperature, etc. Post-processing techniques: Support removal, surface finishing, heat treatment, etc., Quality control and inspection of printed parts.
Unit-3: 3D Printing Technologies **[08 Hrs.]**
Extrusion-based Printing: Fused Deposition Modeling (FDM), Vat Polymerization: Stereolithography (SLA), Digital Light Processing (DLP), Powder Bed Fusion: Selective Laser Sintering (SLS), Direct Metal Laser Sintering (DMLS), Electron Beam Melting (EBM), Material Jetting, Binder Jetting, Photopolymerization: Continuous Liquid Interface Production (CLIP).
Unit-4: Materials for 3D Printing **[07 Hrs.]**
Thermoplastics: Polylactic Acid (PLA), Acrylonitrile Butadiene Styrene (ABS), Polyethylene Terephthalate Glycol (PETG), Polyvinyl Alcohol (PVA), Metals: stainless steel, titanium, aluminum etc., Photo Polymers: Resin, Flexible Resin, Ceramics, Composites, 4D Printing and Bio active materials, Smart materials, special materials: Food, Textile.
Unit-5: AI and IoT in 3D Printing **[07 Hrs]**
Role of AI in improving print accuracy and defect detection, Comparison of traditional vs. AI-based quality inspection methods, AI-powered image recognition for detecting layer inconsistencies, Real-time monitoring systems in 3D printing, AI-driven pattern recognition for detecting print failures, Introduction to IoT in 3D Printing, Role of Sensors in 3D Printing (Temperature, Humidity, Vibration, Material Flow), Embedded Systems for IoT-Enabled 3D Printing (Arduino, Raspberry Pi)Concept of digital twins in additive manufacturing, Applications of digital twins in industrial 3D printing.

Unit-6: Case Studies and Application of AM	**[07 Hrs]**
3D printing in prominent industries (Aerospace, Electronics, Defense, Automotive, Construction, Architectural, Machine-Tools), Other industrial applications (Health-Care, Personalized Surgery, Bio-medical Applications, Assistive Devices, Food-Processing, Food & Consumer Applications, Art, Fashion, Jewelry, Toys & Other Applications, etc)	

Text Books:

1. Chua Chee Kai, Leong Kah Fai, "3D Printing and Additive Manufacturing: Principles & Applications", 4th Edition, World Scientific, 2015 2.
2. Amit Bandyopadhyay, Susmita Bose, "Additive manufacturing", CRC Press, Taylor & Francis Group, 2016 3.
3. Ian Gibson, David W. Rosen, Brent Stucker "Additive Manufacturing

Reference Books:

1.L. Lu, J. Y. H. Fuh and Y.S. Wong, "Laser-Induced Materials and Processes for Rapid Prototyping", Springer, 2001

2. Andreas Gebhardt and Jan-Steffen Hötter, "Additive Manufacturing: 3D Printing for Prototyping and Manufacturing" Hanser Publishers, Munich, 2016.

3. Ben Redwood, FilemonSchöffer& Brian Garret, "The 3D Printing Handbook: Technologies, design and applications", 3D Hubs B.V. 2017

4. Ehsan Toyserkani, Amir Khajepour, Stephen F. Corbin, "Laser Cladding", CRC Press, 2004

5. Andreas Gebhardt, "Understanding Additive", Hanser Publishers, Munich, 2011

6. Ben Redwood, Filemon Schöffer & Brian Garret, "The 3D Printing Handbook – Technologies, Design and Applications" Part One:3D Printing Technologies and Materials, 3D Hubs, 2017

7. Chee Kai, Kah Fai, Chu Sing, 'Rapid Prototyping: Principles and Applications", 2nd Ed., 2003

8. D. T. Pham and S.S. Dimov, "Rapid Manufacturing" Springer, 2001

9. Rupinder Singh J. Paulo Davim, "Additive Manufacturing - Applications and Innovations" CRC Press Taylor& Francis Group, 2019

10.I. Gibson, D. W. Rosen, B. Stucker, "Additive Manufacturing Technologies" Springer, 2010

11.L. Jyothish Kumar, Pulak M. Pandey, David Ian Wimpenny, "3D Printing and Additive Manufacturing Technologies" Springer, 2019

Guidelines for Lab /TW Assessment (Any 8 Practicals)

1) To Familiarize students with basic 3D modeling concepts and software- Introduction to 3D Modeling Software: Creating simple objects using software like Tinkercad or Fusion 360.

2) To understand the preprocessing of 3D printing: File Preparation for 3D Printing: Import designed models into slicing software (e.g., Cura or Flash Print etc), where adjust settings such as

layer height, infill density, and support structures.

3) To Demonstrate the practical applications of 3D printing- FDM Printer.

4) To Demonstrate the practical applications of 3D printing- SLA printer.

5) To demonstrate the post processing techniques for 3D printed parts.

6) To understand the 3D model scanning technique using 3D scanner.

7) To construct basic 3D design using 3D pens.

8) To make use of machine learning for print failure prediction

9) Setting Up a Remote 3D Printer Monitoring System

10) Implementing a Print Failure Alert System with IoT

Guidelines for Activity:

1. **Design Challenge - Create a Functional Prototype that has real world application.**

The students must create a project report comprising project proposal, research component, design and modeling, file preparation and slicing, printing and post processing, testing and evaluation, documentation and presentation.

Assessment Criteria:

Creativity and Innovation: Originality and creativity in addressing the chosen problem or improvement area. Design Quality: Quality of the 3D model, including accuracy, detail, and suitability for 3D printing. Functionality and Usability: Effectiveness of the prototype in fulfilling its intended purpose and ease of use. Presentation and Documentation: Clarity and professionalism of the final presentation and documentation.

2. **Detecting Print Defects Using AI-powered Image Recognition**
    - Capture images of a 3D printed object using a webcam or smartphone.
    - Use a pre-trained AI model (e.g., Google Teachable Machine) to classify defects like layer shifts, warping, or stringing.
    - Compare AI-detected defects with manual inspection.

<table>
<tr><th colspan="3">ME25054 - Robotics & Automation</th></tr>
<tr><td>Teaching Scheme:</td><td>Credits:04</td><td>Examination Scheme:</td></tr>
<tr><td rowspan="3">TH: 03 Hrs./Week</td><td rowspan="3">Theory : 03
Practical : 01</td><td>CAA: 10 Marks</td></tr>
<tr><td>In-Semester Exam: 30 Marks</td></tr>
<tr><td>End-Semester Exam: 60 Marks</td></tr>
<tr><td>PR: 02 Hrs./Week</td><td>Term-Work: 30 Marks</td></tr>
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Prerequisites:

Engineering Physics, Engineering Mathematics, Basics of Electrical Engineering, Basics of Electronics Engineering & Engineering Graphics.

Objectives:

1. To introduce the fundamental concepts, classifications, configurations, components, and working principles of robotic systems.
2. To provide knowledge of robotic drives and their selection for various industrial robotic applications.
3. To provide knowledge of robotic sensors and their selection for various industrial robotic applications.
4. To familiarize students with different types of robots end effectors, and their selection based on application requirements.
5. To develop basic robot programming skills and provide an understanding of robot controllers and applications in manufacturing and non-manufacturing sectors.
6. To introduce the principles of industrial automation and emerging robotic technologies used in modern automation systems.

Course Outcomes:

On completion of the course, learner will be able to

CO1: Explain the fundamental concepts, classifications, configurations, and components of robotic systems.

CO2: Select appropriate robotic drives for different industrial applications.

CO3: Select appropriate sensors for different robotic applications based on operational requirements.

CO4: Compare different types of robots and end effectors and select suitable combinations for specific applications.

CO5: Develop basic robot programs and demonstrate their applications in manufacturing and non-manufacturing environments.

CO6: Explain the basic concepts and principles of industrial automation.

Course Contents

Unit-1: Fundamentals of Robotics	**[07 Hrs.]**
Historical development of Robotics, Definitions of Industrial Robot, Type and Classification of Robots, Asimov's laws 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.	
Unit-2: Robot Drive Systems	**[07 Hrs.]**
Drive Systems :- Pneumatic Drives, Hydraulic Drives, Mechanical Drives, Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors, BLDC-Salient Features, Applications and Comparison of all these Drives, Micro actuators, selection of drive, Power transmission systems for robot, Motion conversion (Gearbox -Planetary, Harmonic, Cycloidal gearbox), VFD.	
Unit-3: Robot Sensors	**[07 Hrs.]**
Transducers and sensors, Sensors in robotics, Principles and applications of the following types of sensors- Proximity Sensors, Photo Electric Sensors, Laser Scanners, Position sensors – Piezoelectric Sensor, LVDT, Resolvers. **Encoders:** Absolute and Incremental: - Optical, Magnetic, Capacitive, pneumatic Position Sensors **Range Sensors:** Range Finders, Laser Range Meters, Touch Sensors, Force and torque sensors. **Safety Sensor:** Light Curtain, Laser Area Scanner, Safety Switches; Machine vision	
Unit-4: End Effectors	**[07 Hrs.]**

Grippers, Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers, Vacuum Grippers; Two Fingered and Three Fingered Grippers; Internal Grippers and External Grippers; Advance Grippers- Adaptive grippers, Soft Robotics Grippers, Tactile Sensor Grippers; Various process tools as end effectors; Robot end effectors interface, Active and passive compliance, Selection and Design Considerations.

Unit-5: Fundamentals of Robot Programming and Applications	**[07 Hrs.]**

Introduction to Robotic Programming, On-line and off-line programming, programming examples. Various Teaching Methods, Survey of Robot Level Programming Languages with manufacture, Various Textual Robot Languages, Typical Programming Examples such as Palletizing, Job Loading & unloading, Welding, Press Work Etc. Robots in manufacturing and non-manufacturing applications, a robot-based manufacturing system, Robot controllers types & specification.

Unit-6 Introduction to Automation	**[07 Hrs.]**

Introduction: Automation in Production systems, Automated Manufacturing Systems, Reasons for Automation, Automation Principles and Strategies, USA (Use, Simplify & Automate) Principle, Automation Migration Principle, Types of Automation, Classification by Function / Transfer Method, Automation using Hydraulic/Pneumatic Systems, Electrical/Electronic Systems and Automated Assembly Systems - Selection criteria, components, applications

Automated Assembly Systems: Types and Configurations, Part Feeding Devices, Part Orientation Devices, Part Conveying Devices, Feed tracks, Escapements and Part placing mechanism, Parts Delivery at workstations, Single-station and Multi-station Assembly Machines

Text Books:

1. Groover, M.P. Weiss, M. Nagel, R.N. & Odrey, N.G., Ashish Dutta, Industrial Robotics, Technology, Programming & Applications, Tata McGraw Hill Education Pvt. Ltd. New Delhi
2. S. R. Deb, Robotics Technology and Flexible Automation, Tata McGraw Hill.
3. Groover M.P.-Automation, production systems and computer integrated manufacturing Prentice Hall of India.
4. M.P. Grover, "Automation, Production Systems and Computer Integrated Manufacturing"- Pearson Education.

Reference Books:

1. S B Niku, Introduction to Robotics, Analysis, Control, Applications, 2nd Edition, Wiley Publication, 2015.
2. Mikell P. Groover, Automation, Production Systems & Computer Integrated Manufacturing, PHI Learning Pvt. Ltd. , New Delhi, ISBN:987-81-203-3418-2, 2012.
3. John Craig, Introduction to Robotics, Mechanics and Control, 3rd Edition, Pearson Education, 2009.
4. R K Mittal & I. J. Nagrath, Robotics and Control, McGraw Hill Publication, 2015.
5. Mike Wilson, Implementation of Robotic Systems, ISBN: 978-0-124-04733-4.

E study material: NPTEL Course on Robotics:

1. https://onlinecourses.nptel.ac.in/noc19_me74/preview
2. https://onlinecourses.nptel.ac.in/noc20_de11/preview

Guidelines for Lab /TW Assessment

The student shall perform any 8 practical's from following list:

1. Study on selection of Actuators and related hardware such as DC motor, Servo motor, Stepper Motor, Motor drivers based on application.
2. Study on selection of Sensors such as IR sensors, Proximity Sensor, Ultrasonic Sensor, White line sensor, Temperature Sensor, Touch sensor, Tilt Sensor, Accelerometer, Gyroscopic Sensor etc. based on given application.
3. Simulation of target teaching on RoboDk for Scara & Articulated Robot.
4. Simulation of target teaching for curve surface on RoboDk.
5. Simulation of SCARA robot on RoboDk for pick and place application.
6. Demonstration of SCARA robot for pick and place application.
7. Simulation of 6 Axis robot on RoboDk for pick and place application.
8. Demonstration of 6 Axis robot for pick and place application.
9. Simulation of a simple robotic system for material handling systems on RoboDk.
10. Case study on selection & simulation of the appropriate robot system for given manufacturing and non- manufacturing applications.

Activity (Any One):-

1. Activity on video based quizzes on unit 1 to 6.
2. One robot programming exercise for any one industrial application.