COURSE TITLE	**ROBOTICS & FMS**
COURSE CODE	**01ME0743**
COURSE CREDITS	**4**

Objective:

1 This course provides a detailed study of robotics and flexible manufacturing systems (FMS), focusing on design, analysis, and implementation. Topics include robot kinematics, dynamics, control, programming, sensors, end- effectors, FMS components, integration, and applications. Students gain practical skills for designing and optimizing systems in modern manufacturing environments.

Course Outcomes: After completion of this course, student will be able to:

1 Apply the fundamental principles of robotics and flexible manufacturing systems (FMS) to industrial problems.

2 Analyze robotic manipulators and FMS layouts to optimize efficiency and sustainability.

3 Develop robot programs and trajectory planning techniques for automated applications.

4 Evaluate the integration of robots, CNC machines, sensors, and end-effectors in FMS for productivity and sustainability.

5 Assess the performance, safety, and productivity of FMS with collaborative robots (cobots) in industrial environments.

Pre-requisite of course: Basic knowledge of Theory of machines

Teaching and Examination Scheme

Theory Hours	Tutorial Hours	Practical Hours	ESE	IA	CSE	Viva	Term Work
3	0	2	50	30	20	25	25

Contents : Unit	Topics	Contact Hours
1	**Fundamentals of Robotics:** Introduction,, Fundamentals of robot technology - anatomy, work volume, drives system, types of end effectors, robot sensor., Robot and its peripherals; Basic control systems, Controllers & sensors.	8
2	**Kinematics of Robotic Manipulators:** Introduction to manipulator kinematics, homogeneous transformations and robot kinematics,, Matrix Representation point, vector, frame and rigid body,, Representation of Transformations of pure translation, rotation and combined,, Denavit-Hartenberg (D-H) representation, concept of forward and inverse kinematics., Robot programming & languages, Trajectory planning of robot motion.	12

Contents : Unit	Topics	Contact Hours
3	**Application Engineering for Manufacturing:** Robot cell design, Robot cell layout,, multiple robots & machine interference, work cell control,, robot cycle time analysis; Material transfer, Machine loading / unloading;, Process applications, Robot implementation & integration into manufacturing.	6
4	**Robot Vision System** Vision sensors and their operation, image acquisition and processing,, object recognition and interpretation.	4
5	**Computer Integrated Manufacturing and automation:** Elements of CIM, Different modules and information flow,, Design aspects of CIM, CIM planning & implementation process,, requirements of CIM, Computerized production activities,, Computerized integrated quality	6
6	**Flexibility In Manufacturing:** Definition & concept, flexible automation & productivity, components of FMS,, Different types of FMS, Design problem of FMS, Technology required for FMS system., Robots - their function & programming in FMS. Bottleneck Model and related formula	6
7	**Group Technology:** Part family, Part classification and coding, production flow analysis– OPITZ classification system,, cellular manufacturing, quantitative analysis in cellular manufacturing., Rank Order Clustering Technique (ROC), Holier Method –I, II, Single Linkage Cluster Analysis Technique (SLCA).	6
Total Hours		**48**

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
1	**Understand the forward and inverse kinematics to analyze various robot configurations.** Understand the forward and inverse kinematics to analyze various robot configurations.	2
2	**Build a basic robot arm and apply mathematical models to comprehend its dynamics.** Build a basic robot arm and apply mathematical models to comprehend its dynamics.	2
3	**Investigate the impact of different loads and velocities on robot motion, applying theoretical concepts to practical scenarios.** Investigate the impact of different loads and velocities on robot motion, applying theoretical concepts to practical scenarios.	2
4	**Develop and apply a control system for a robot, enabling it to execute specific tasks like pick and place operations.** Develop and apply a control system for a robot, enabling it to execute specific tasks like pick and place operations.	2

Suggested List of Experiments:

Contents : Unit	Topics	Contact Hours
5	**Program a robot to autonomously navigate a maze or follow a predefined path, demonstrating practical programming skills.** Program a robot to autonomously navigate a maze or follow a predefined path, demonstrating practical programming skills.	2
6	**Examine various sensors used in robotics and learn how to integrate them into a robot system for enhanced functionality.** Examine various sensors used in robotics and learn how to integrate them into a robot system for enhanced functionality.	2
7	**Assess different end-effectors for specific tasks, analyzing their suitability and performance.** Assess different end-effectors for specific tasks, analyzing their suitability and performance.	2
8	**Design and simulate a flexible manufacturing system using software, showcasing the ability to create complex manufacturing systems.** Design and simulate a flexible manufacturing system using software, showcasing the ability to create complex manufacturing systems.	2
9	**Evaluate the integration of robots, CNC machines, and other components into a flexible manufacturing system layout for efficiency and effectiveness.** Evaluate the integration of robots, CNC machines, and other components into a flexible manufacturing system layout for efficiency and effectiveness.	2
10	**Develop a robotic system or flexible manufacturing system tailored to a specific application, demonstrating creativity and problem-solving skills.** Develop a robotic system or flexible manufacturing system tailored to a specific application, demonstrating creativity and problem-solving skills.	2
11	**Assess the implementation of collaborative robots (COBOTS) for human-robot collaboration, evaluating their effectiveness and safety.** Assess the implementation of collaborative robots (COBOTS) for human-robot collaboration, evaluating their effectiveness and safety.	2
12	**Analyze the layout, programming, and integration of robots in an industrial facility, evaluating their impact on production processes.** Analyze the layout, programming, and integration of robots in an industrial facility, evaluating their impact on production processes.	2
Total Hours		**24**

Textbook :

1 Industrial Robotics: Technology Programming & Applications, Mitchell Weiss, Roger N. Nogel,, McGraw Hill International, 2011

Textbook :

2 Automation, Production Systems, and Computer-Integrated Manufacturing, Mikell P. Groover , Pearson , 2016

References:

1 A Robot Engineering Textbook, A Robot Engineering Textbook, Mohsen Shahinpoor, Harpercollins College Div , 1987

2 Introduction to Robotics: Analysis, Systems, Applications , Introduction to Robotics: Analysis, Systems, Applications , Saeed B. Niku , Pearson, 2001

3 Robotics Technology and Flexible Automation, Robotics Technology and Flexible Automation, S. R. Deb (Author), Sankha Deb (Author), McGraw Hill Education, 2017

4 Robotics and Control, Robotics and Control, R. K. Mittal, Tata-Mcgraw, 2003

5 Robot Technology Fundamentals, Robot Technology Fundamentals, James Keramas, Delmar Cengage Learning, 1998

Suggested Theory Distribution:

The suggested theory distribution as per Bloom's taxonomy is as follows. This distribution serves as guidelines for teachers and students to achieve effective teaching-learning process

Distribution of Theory for course delivery and evaluation					
Remember / Knowledge	**Understand**	**Apply**	**Analyze**	**Evaluate**	**Higher order Thinking / Creative**
10.00	25.00	20.00	20.00	15.00	10.00

Instructional Method:

1 Lecture and Animation Video

Supplementary Resources:

1 https://nptel.ac.in/