भारतीय सूचना प्रौद्योगिकीअभिकल्पना एवं विनिर्माण संस्थान , कर्नूल

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY DESIGN AND MANUFACTURING KURNOOL

Jagannathagattu, Dinnedevarapadu, Kurnool - 518008, Andhra Pradesh, India
(An Institute of National Importance under MoE, Govt. of India)

Syllabus for

***Minor Specialization* for B.Tech.**

(From AY 2022-23)

DEPARTMENT OF MECHANICAL ENGINEERING

INDIAN INSTITUTE OF INFORMATION TECHNOLOGY,
DESIGN AND MANUFACTURING, KURNOOL
July, 2022

Scheme/Structure for
Minor Specializations for B.Tech.
Offered by the Department of Mechanical Engineering

Minor Specialization in **Robotics and Automation** (open to all Departments students)

	Robotics and Automation					
S. No.	**Course Code**	**Course Name**	**SEM**	**I**	**P**	**C**
1	**MEM101**	Introduction to Robotics and Automation	3	**3**	**0**	**3**
2	**MEM102**	Robot Kinematics and Dynamics	4	**3**	**0**	**3**
3	**NPTEL**	NPTEL course related to Robotics and Automation	5	**3**	**0**	**3**
4	**MEM103**	Robotics: Motion Planning and Control	5	**3**	**0**	**3**
5	**MEM104**	Robotics and Intelligent Automation Lab	6	**1**	**3**	**3**
			Total			**15**

Course Title	Introduction to Robotics and Automation	Course Number	MEM101
Department	Mechanical Engineering	Structure (IPC)	3-0-3
Offered to	**Minor**: Robotics and Automation	Status (Core/ Elective)	NA
Prerequisite	NIL	Effective from	July 2022
Course Objective	To introduce the concepts of robotics and automation along with various types of robotics systems and automation that are in use in the industry like robot arms, mobile robots, wheeled robotics, flying systems etc.		
Course Outcomes	The students will be able to: 1. Understand how the robotics systems works in the real-world 2. Identify various robotics system that exists currently 3. Understand how the automation is important in the modern industrial environments 4. Analyze the given industrial environment identify suitable robotic and automation systems 5. Conceptual Design for various industrial situations		
Contents of the course	1. **Introduction and Overview of Robotics and Automation:** Foundations of Robot and its Control systems, Components of the robotics; Basic Elements of Automation. 2. **Configuration Space:** Degrees of freedom, end effectors: mechanical gripper, magnetic vacuum cup and other types of grippers, general consideration on gripper selection and design; Brief on Motion Analysis and Manipulator kinematics; 3. **Types of Robots**: Classification By Applications, By Coordination System, By Kinematics; Stationary Robots, Legged Robots, Wheeled Robots, Swimming Robots, Flying Robots; Nano Robots; Collaborative Robots; 4. **Introduction to Industrial Automation and Control**: Principles and strategies of automation; Architecture of Industrial Automation Systems; Advanced automation functions, Levels of automations, Automated flow lines and transfer mechanisms, Analysis of transfer lines without storage, Automated flow lines with storage buffers. 5. **Material handling and identification technologies** -Overview of material handling systems, Types of material handling equipment, Design of the system, Conveyor system, Automated guided vehicle system, Automated storage systems, Interfacing handling and storage with manufacturing, OPC-UA for Machine-to-Machine Communication. 6. **Robotics and Automation in Industry**: Applications of Robotics and Automation in various Industries like Manufacturing, Medical, Healthcare, Domestic, Defense, Food industry etc. 7. **Overview on Artificial Intelligence and Computer Vision in Robotics and Automation**		
Textbooks	1. S. B. Niku, "Introduction to Robotics: Analysis, Control, Applications," John Wiley & Sons, Inc., 2011. 2. John J. Craig, "Introduction to Robotics Mechanics and Control," Pearson Education, Inc., 2005.		
References	1. K. S. Fu, R. C. Gonzalez and C. S. G. Lee, "Robotics: Control, Sensing, Vision and Intelligence," McGraw-Hill, 1987.		

Course Title	Robot Kinematics and Dynamics	Course Number	MEM102
Department	Mechanical Engineering	Structure (IPC)	3-0-3
Offered to	**Minor**: Robotics and Automation	Status (Core/ Elective)	NA
Prerequisite	NIL	Effective from	July 2022
Course Objective	1. To study the mechanisms and kinematics of robot manipulators. 2. To study the dynamics of robots of various forms like robot arms, mobile robots etc.		
Course Outcomes	The students will be able to: 1. Understand the motion and dynamics of rigid bodies. 2. Understand the forward and inverse kinematics of robot manipulators. 3. Understand the forward and inverse dynamics of robot manipulators. 4. Analyze the joint velocities/accelerations and forces/torques.		
Contents of the course	1. Rigid-body motions and twists. • Rotations and angular velocities • Homogenous transformation matrices • Twists 2. Formulation of forward and inverse kinematics. • Forward kinematics in space frame and end-effector frame • Analytical and numerical inverse kinematics 3. Velocity kinematics and statics. • Manipulator Jacobian • Relationship between space and body Jacobian • Statics of open chains • Singularity analysis 4. Dynamics of open chain robot manipulators. • Lagrangian formulation • Dynamics of single rigid body • Newton-Euler inverse dynamics • Dynamic of open chains • Constrained dynamics 5. Robot dynamics. • Numerical algorithms for forward and inverse dynamics 6. Robot trajectory generation under dynamic constraints. 7. Kinematics and Dynamics of Wheeled Robots, Drones and Swimming Robots.		
Textbooks	1. John J. Craig, "Introduction to Robotics Mechanics and Control," Pearson Education, Inc., 2005. 2. K. M. Lynch and F. C. Park, "Modern Robotics: Mechanics, Planning and Control," Cambridge U. Press, 2017.		
References	1. K.S. Fu, R. C. Gonzalez and C. S. G. Lee, "Robotics: Control, Sensing, Vision and Intelligence," McGraw-Hill, 1987. 2. S. B. Niku, "Introduction to Robotics: Analysis, Control, Applications," John Wiley & Sons, Inc., 2011.		

Course Title	Robotics: Motion Planning and Control	Course Number	MEM103
Department	Mechanical Engineering	Structure (IPC)	3-0-3
Offered to	**Minor**: Robotics and Automation	Status (Core/ Elective)	NA
Prerequisite	NIL	Effective from	July 2022
Course Objective	To plan robot motion and feedback control in presence of obstacles.		
Course Outcomes	The students will be able to: 1. Analyse and control the robot motion. 2. Understand trajectory planning. 3. Analyse robot grasping and other manipulation tasks. 4. Understand feedback control of wheeled mobile robots. 5. Do robot programming for trajectory planning and feedback control.		
Contents of the course	1. Classical and modern motion planning techniques. • Grid methods • Sampling methods • Virtual potential fields 2. Robot motion and force control. • Control system overview • Motion control with velocity, torque or force inputs • Force control • Hybrid motion-force control 3. Grasping and Manipulation • Contact kinematics • Contact forces and friction • Manipulation 4. Nonholonomic wheeled mobile robots. • Modeling • Motion planning • Feedback control 5. Feedback control of omnidirectional wheeled mobile robots. • Modeling • Motion planning • Feedback control		
Textbooks	1. K. M. Lynch and F. C. Park, "Modern Robotics: Mechanics, Planning and Control," Cambridge U. Press, 2017. 2. John J. Craig, "Introduction to Robotics Mechanics and Control," Pearson Education, Inc., 2005.		
References	1. S. B. Niku, "Introduction to Robotics: Analysis, Control, Applications," John Wiley & Sons, Inc., 2011. 2. K.S. Fu, R. C. Gonzalez and C. S. G. Lee, "Robotics: Control, Sensing, Vision and Intelligence," McGraw-Hill, 1987.		

Course Title	**Robotics and Intelligent Automation Lab**	Course Number	MEM104
Department	Mechanical Engineering	Structure (IPC)	1-3-3
Offered to	**Minor**: Robotics and Automation	Status (Core/ Elective)	NA
Prerequisite	NIL	Effective from	July 2022
Course Objective	To inculcate specialized knowledge and skill in robotics and automation using the principles and methods of engineering analysis and design.		
Course Outcomes	The students will be able to: 1. Identify the suitable Controller for a given Robot types. 2. Perform analysis of mobility and DoF. 3. Select the best suitable combination of actuator and sensors for a given requirements. 4. Understand requirements to model or build a robotic manipulator.		
Contents of the course	1. Advantages, functions, components, operation and applications of industrial robots and end effectors; the function, operation, storage and retrieval of robot programs and position points; the use, function and operation of on-line programming, off-line programming, Teach pendants, operator stations, and digital inputs and outputs for industrial robots. Use a PC and robot programming software for various operations. 2. Use the Cartesian coordinate system to command robot position and program with World Coordinates and Tool Coordinates. 3. Connect, configure, program and operate a robot in conjunction with both servo-driven and non-servo-driven conveyors. 4. Use robot simulation software to design a work-cell. 5. Use PLC Open motion function blocks to implement a synchronized multi-axis motion application. 6. Troubleshoot a multi-axis motion system. 7. Robot Simulation using Gazebo and ROS.		
Textbooks	1. John J. Craig, "Introduction to Robotics Mechanics and Control," Pearson Education, Inc., 2005. 2. K. M. Lynch and F. C. Park, "Modern Robotics: Mechanics, Planning and Control," Cambridge U. Press, 2017.		
References	1. Editor: Maki K. Habib, Advanced Robotics and Intelligent Automation in Manufacturing. United States: IGI Global, 2019. 2. Altman, Roy. Intelligent Automation: Rules, Relationships and Robots. N.p.: FUTURE STRATEGIES Incorporated, 2019. 3. Robotics Technology and Flexible Automation. India: McGraw-Hill Education (India) Pvt Limited, 2010. 4. https://www.ros.org/ 5. http://www.roboanalyzer.com/ (developed by IIT Delhi)		