NIRMA UNIVERSITY
INSTITUTE OF TECHNOLOGY, SCHOOL OF ENGINEERING
B Tech in Mechanical Engineering

(Department Elective)

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Course Code	**2MEDE52**
Course Title	**Robotic Engineering**

Course Outcomes (CO):

At the end of the course, students will be able to –

1. select the suitable manipulator for the given application,
2. apply concept of coordinate transformation to analyze relative motions,
3. formulate the mathematical relations for kinematic analysis of robotic manipulator,
4. integrate the structural design, actuator selections, drive system, sensor and control system necessary to implement a robot in a specific job task,
5. build the robotic model and tasks using industrial robots, simulations tools and components.

Syllabus **Teaching Hours: 30**

UNIT I **Robot technology** **02 hours**

Fundamentals of Robots Introduction, fundamentals of robot technology, classification, applications, Systems overview of a robot, basic components, control system and components, economical and societal aspects related to robotics, cost and energy optimization of robots

UNIT II **Robot position analysis** **10 hours**

Concept of transformation matrices, homogeneous transformation matrix and its applications to robotics, Co-ordinate transformation, transform arithmetic, inverse o transformation matrix, Denavit-Hartenber (DH) parameters, derivation of joint transformation matrix for robot manipulator, Forward kinematics, solutions for joint variables, need of inverse kinematics solutions for robot arm and its methodology, inverse kinematics for industrial robots.

UNIT III **Robot trajectory, velocity and dynamics** **09 hours**

Linear and angular velocities of robot links and joint, mathematical concepts for calculations of velocities, jacobian matrix for link and joint velocities, singularities for industrial robots, robot motion consideration, trajectory generation for criteria, joint interpolation for calculation of position of a joint, different interpolations for joint of a

robot, Lagrange-Euler formulation, calculation of kinetic and potential energy, dynamic model of robotic arm.

UNIT III **Actuators, sensors and programming in Robot** **05 hours**

Inertia calculation for robotic application, motor and load torque, selection of electric motor, other type of actuators. Robot programming methods and languages.

Internal state and External state sensors for robotic application, software related to robotics

UNIT IV **Types of End Effectors and Design** **04 hours**

End effectors, Classification, Force analysis and Gripper design.

Self - Study The self-study contents will be declared at the commencement of semester. Around 10% of the questions will be asked from self-study contents.

Laboratory Work:

Laboratory work will be based on above syllabus with minimum 10 experiments/exercise to be incorporated.

Suggested Readings:

1. Klafter R. D., Thomas A Chmielewski and Michael Negin, Robotics Engineering An integrated approach, Prentice Hall
2. Mittal and Nagrath , Robotics and Control , Tata McGraw-Hill Publishing Company Ltd.
3. Craig John, Introduction to Robotics, mechanics and control, Pearson Education
4. Groover M.P., Mitchell Weiss, Roger N. Nagel and Nicholas Godfrey, Industrial Robotics. Tata McGraw Hill Education Pvt. Ltd
5. Ghoshal Ashitava, Robotics Fundamental Concepts and Analysis, Oxford University Press.

L=Lecture T= Tutorial P=Practical, C=Credit