Course Number: ME 452 **Approval: 10th senate meeting**
Course Name: Robotics and Control
Credits: 2-1-0-3
Prerequisites: ME309 Theory of Machine or consent of faculty.

Intended for: B-Tech final year/pre-final, MS.
Distribution: Elective
Semester: Odd/Even

Preamble: The course on robotics is intended to provide a reasonable understanding of robotics, how they function, the mathematics behind position, motion and dynamics of robot. It also involves controlling the robot using motors, controllers etc. It is also expected that students will get a hands on experience through the use of Matlab and simulink to simulate robots or to build simple mobile robots or arms using simple motors and sensors.

Course Outline: The course starts with key definitions and concepts in robotics, different components that go into making a robot. Then the mechanical part of robotics is discussed which involves kinematics, motion planning, and dynamics of robot. The dynamics model is used for developing the controller of robot. Different types of sensors, actuators and control law are discussed for designing a robot.

Modules:
1. **Introduction to Robotics:** Basic definitions, mechanism, degree of freedom, classification and specifications of Robots, Industrial Robots, sensors, controller, actuator. (4 hrs)
2. **Robot Kinematics:** Position and orientation of links, Coordinate transformation, d-h parameters, joint variable and position of end effectors, forward and inverse kinematic analysis. Velocity analysis – Jacobian and singularity. Static force analysis. (10 hrs)
3. **Trajectory Planning:** joint space trajectory planning, cubic polynomial path generation, obstacle avoidance (5 hrs)
4. **Robot Dynamics:** Derivation of dynamics equation based on Newton Eulers formulation and Lagrangian formulation. (9 hrs)
5. **Robot Control:** Actuators - hydraulic, pneumatic, electric motors, Sensors – position, velocity, proximity, force and pressure, Position control- Proportional-Integral-Derivative control, servo compensation. Force control – Impedance control, hybrid control (force + position control), introduction to nonlinear control of manipulators. (14 hrs)

Text Books:

1. Craig John J., "Introduction to robotics: Mechanics & Control", 3rd Ed., Pearson. 2008.
2. Tsuneo Yoshikawa, "Foundations of Robotics – Analysis and Control", 1990.

Reference:

1. 1. Niku Saeed B., "Introduction to Robotics: Analysis, Systems, Applications", Second edition, 2011 Wiley.
2. Robotics Engineering : Richard Klafter, T. Chmiewski, M. Nigin: PHI India
3. Industrial Robotics : Michel P Grover, et al, McGraw Hill
4. Introduction to robotics : Subir Kumar Saha, Mc Graw Hill