Objectives
In this course, three fundamental disciplines of modern robotics are introduced: mechanics, control, and computing. These components are integrated to analysis, design, and control of mobile robots and manipulators to serve engineering or scientific needs. Students will learn: (1) how to use mathematical methods to model mobile robots and manipulators and to plan their motion; (2) how to process sensor information to form a perception of the environment; and (3) how to implement algorithms through computer systems to achieve autonomy. As class projects, students will be encouraged to perform simulations using MATLAB and open source robotics operating systems such as ROS and to carry unsupervised experiments on mobile robots.

Class Information in Catalog
Credits (3-0-3): 3 hour lecture, 3 credits earned.
No Pre-requisite

Assessment
There will be a total of 4 homework sets and 1 class project. Homeworks should be performed independently and late homework is not acceptable. 3 highest homework scores will be used towards the final score.

There will be one mid-term exam and one final exam. The exam will be open book and open notes. However, only the books in the "Textbooks" section can be consulted. There should be no discussions.

The class project assignments will be determined by the student and the instructor before the midterm exam and should demonstrate master of knowledge of the class. Class project can be performed by student individually or by a small team of students. It can be simulation based or working with real robots, depend on accessibility of the robots. For distance learning students the project topic can be work related or based on discussions with the instructor. A project report should be prepared. The results should be submitted to the instructors and the code should be turned in and ready to run by the instructor. The project score depends on the quality of the report and the performance of the simulation or experiments. In the case of a team project, each student will be given a score individually to reflect actual contribution to the team based on mutual evaluation forms filled by each team member.

The final score of the course will be distributed as follows: One Midterm 25%, Homeworks 30%, Class project 15%, and one final 30%

Textbooks
1. Class Notes by the Instructor. (Available for Free.)

In addition, there will be assigned readings from the internet regarding the technology advancements for robotics.

Outline of the Course
1. Introduction: Anatomy of a Robot: Classification of Robots; Robot Configurations; Robot Components; Performance Characteristics.
3. Kinematics: Modeling kinematic chains, Forward kinematics, Inverse kinematics
4. Perception: Simple pinhole camera model, Basics in camera calibration, Triangular active sensing, Color space, Image filtering algorithms to reduce noise, Edge detection, Hough transform for lines and circles
5. Localization: Odometry, Range based localization relative to landmarks. Vision based localization relative to colored blobs and landmarks. Localization based on Kalman filters.
7. Motion and Path Planning: Optimal control, the A* algorithm, the Fast Marching method, Potential field based method.
8. Manipulator Dynamics and Force Control (if time permit).