1. Course Title: Robotics and Autonomous Systems

2. **Catalog description:** (3 units) Kinematics, dynamics and control of robot manipulators, robotic vision, sensing, and introduction to autonomy The course will cover forward and inverse kinematics of serial chain manipulators, the manipulator Jacobian, force relations, dynamics, and position/force sensing. Network modeling, stability, and control. Some mobile robot applications.

3. **Prerequisites:** EE 684, AE 607 or ME 659. CS 138, CS 211, AE 227 or ME 325.

4. **Textbooks:**

Roland Siegwart and Illah Nourbakhsh: Introduction to Autonomous Mobile Robots MIT Press 2004

Additional Reading:

Sciavicco, L. and Siciliano, B.: *Modelling and Control of Robot Manipulators*, Springer, 2001

Craig, J. J.: *Introduction to Robotics: Mechanics and Control*, Prentice Hall, 2003

Yoshikawa, T.: *Foundations of Robotics: Analysis and Control*, MIT Press, 1990

5. **Course objectives:** The goal of this course is to provide a unified introduction to the area of robotics for advanced undergraduates and beginning graduate students. This course provides a broad exposure to the subject.

6. **Topics covered:**

Lecture 0: Robotics, its origin and evolution
Lecture 1: General principles of rigid body motion
Lecture 2: Rotation matrices and their properties
Lecture 3: Rigid motion, Homogeneous coordinates
Lecture 4: Geometry of cameras and their motion
Lecture 5: Stereo reconstruction from two views
Lecture 6: Exponential coordinates
Lecture 7: Forces and Wrenches
Lecture 8: Review before midterm
Lecture 9: Midterm Exam 1
Lecture 10: Forward kinematics
Lecture 11: Inverse kinematics
Lecture 12: Inverse kinematics (cont.)
Lecture 13: Jacobian of manipulator
Lecture 14: Jacobian and differential inverse kinematics
Lecture 15: Vision based robotics
Lecture 16: Review before midterm exam
Lecture 17: Midterm Exam 2
Lecture 18: Gyros, Accelerometers
Lecture 19: Applications of body sensors
Lecture 20: Force/Torque sensors
Lecture 21: Range computation

Lecture 22: Robot dynamics, Lagrange equations
Lecture 23: Dynamics, Examples of simple robots
Lecture 24: Dynamics (cont.)
Lecture 25: Elementary feedback control
Lecture 26: Miscellaneous applications of robotic systems
Lecture 27: Project presentations

7. **Homework and Project based on current research in the literature**

8. **Contribution of course meeting the professional component:** This course covers engineering topics. It is approximately 80% science and 20% project and presentation

9. **Relationship of course to program outcomes:** This course requires students to use their fundamental knowledge of mathematics, science, and engineering to configure, apply test conditions, and evaluate outcomes of experimental systems. Laboratory and homework assignments require students to design solutions to robotic kinematics problems. Through laboratory projects, students gain the ability to analyze and interpret data, and to function in teams and communicate their understanding. They learn to apply modern skills, techniques, and engineering tools. Emerging applications are covered throughout the course, giving students acknowledge of contemporary issues and an appreciation for the importance of life-long learning. Through discussions of the role of robotic applications in society, students learn about the impact of engineering solutions in society and their own ethical responsibility.

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