MECH 4710 Introduction to Robotics

Spring 2024

Course Description:

Introduce the mechanical structure of industrial robots as well as the spatial description and transformations of the robot, forward kinematic and inverse kinematic equations for different robotic structures, and dynamic of the robot manipulator.

Prerequisite: MECH 2030
Instructor: Lilong Cai (Room 2549, Tel 2358-7209, Email melcai@ust.hk)
TA: TBD

Grading Policy: Homework and Computer Assignment 15%
Midterm Exam: 40%
Final Exam: 45%

Textbook: *Introduction to Robotics,* by John J. Craig 3 Edition

Supplementary Texts: *Introduction to Robotics,* by Phillip John McKerrow.

Contents in the lecture

1. Introduction to robotics (1 weeks Chapter 1)
   * Background
   * The mechanics and control mechanical manipulator
   * Notation

2. Spatial Descriptions and Transformations (2 weeks Chapter 2)
   * Object location, frame, and transformation

3. Manipulator Kinematics and Static Force (4 weeks Chapter 3-4)

   * Manipulator position, forward and inverse kinematics
   * Manipulator motion, velocity
   * Manipulator Jacobian, singularities, and static force

4. Manipulator Jacobian and Dynamics (5 weeks Chapter 5-6)
   * Manipulator motion, velocity, and acceleration
   * Manipulator Jacobian, singularities, and static force
   * Dynamics of robots Newton-Euler formulation
   * Lagrange formulation.

MECH4710 Introduction to Robotics

Course Code: MECH 4710	**Course Title:** Introduction to Robotics
Required Course or Elective Course: elective	**Terms Offered (Credits):** Spring, 3 credits
Faculty In Charge: Lilong Cai	**Pre-Requisites:** MECH2030
Course Structure: Lecture 2 hours, Lab 1hur per week	
Textbook/Required Material: John J. Craig, Introduction to Robotics: Mechanics and Control, 3rd Ed., Prentice-Hall, 2005. Supplementary Texts: Introduction to Robotics, by Phillip John McKerrow.	
Course Description: This is an elective course for the BEng in Mechanical Engineering with Option in Design and manufacturing. In this course, it will introduce the mechanical structure of industrial robots as well as the spatial description and transforms of the robot, forward kinematic and inverse kinematic equations for different robotic structures, and dynamic of the robot manipulator.	
Course Topics: 1. 1. Introduction to Robotics 2. 2. Spatial Transformations 3. 3. Orientation Matrices 4. 4. Forward Kinematics 5. 5. Inverse Kinematics 6. 6. Jacobian and Singularities 7. 7. Manipulator Dynamics	
Course Objectives: (correlated program objectives)	1. The goal of the course is to familiarize the students with the concepts and techniques in design and analysis of robot manipulator and its application. (P-O1, P-O3) 2. To introduce basic and entry level theories and terminology for students to develop the skill to description and transform of the robot in forward and inverse kinematic and dynamic equations for different robotic structures. (P-O3) 3. To provide students with hands on experience in laboratory practice to learn simple robot programming and control. (P-O1, P-O3)
Course Outcomes: (correlated course objectives and program outcomes)	A. The student will have a thorough understanding of the fundamental kinematics and dynamics of industrial robots. [2] (POC1, POC2, POC3) B. The student will be able to analysis and establish kinematic and dynamic equations for different robot manipulators. [1] (POC1, POC2, POC3, POC4) C. Students will know enough about different applications of robotic systems and be able to evaluate, choose, and incorporate robots in engineering systems according to

	the kinematic and dynamic features of the robots. [1,2,3] (POC1, POC2, POC3, POC4)
Assessment Tools: (Correlated course outcomes)	Regular homework problems - 15 % [B] Mid-term and Final exams - 85% [B]

BEng in Mechanical Engineering (4-year program)

Program Objectives:

P-O1 Be able to communicate and perform as an effective engineering professional in both individual and team-based project environments,

P-O2 Have an international outlook with clear perspectives on the Pearl river Delta and Greater China,

P-O3 Be able to research, design, develop, test, evaluate and implement engineering solutions to problems that are of complexity encountered in professional practice and leadership,

P-O4 Clearly consider the ethical implications and societal impacts of engineering solutions,

P-O5 Continuously improve through lifelong learning.

Program Outcomes:

POC1 ability to identify and formulate problems in multidisciplinary environment with an understanding of engineering issues and constraints;

POC2 ability to design and conduct experiments as well as analyze and interpret data;

POC3 ability to apply knowledge of mathematics, science, and engineering for problem solving in mechanical engineering and related sectors or for further education in a research career;

POC4 ability to develop specification and to design system, component, or process to meet needs;

POC5 ability to understand the manufacturability, maintainability, and recyclability of engineering system and components;

POC6 ability to use modern engineering tools, techniques, and skills in engineering practice;

POC7 ability to communicate effectively;

POC8 ability to function in multi-disciplinary teams and provide leadership;

POC9 broadly educated with an understanding of the impact of engineering solutions on issues such as economics, business, politics, environment, health and safety, sustainability, and societal context;

POC10 clear understanding of professional and ethical responsibilities;

POC11 recognition of the need for life-long learning and continuing education;

POC12 international outlook with knowledge of contemporary issues.