Kinematic Analysis and Synthesis of Mechanisms
(MEC 567)- Spring 2020
COURSE OUTLINE

Instructor: J. Rastegar
Office: H. E. 108
Office Hours: Online by appointment
Lectures: Wed 4:25 – 7:15 pm **Location:** Zoom

Reference:

1. *Mechanism Design – Analysis and Synthesis – Volume I* – By A. Erdman and G. Sandor, 3rd Edition, Prentice Hall.
2. *Mechanism Design – Analysis and Synthesis – Volume II*, By A. Erdman and G. Sandor,
3. Prentice Hall.
4. *Introduction to Robotics, Mechanics and Control* - By J. Craig, 2nd Ed., Addison-Wesley, 1989 (or another similar robotics text).
5. Instructor provided material and lecture.

Course Description: This course will cover fundamental concepts in kinematics of open-loop and closed-loop mechanisms and manipulators, and dynamics and control of robotic systems useful for applications ranging from traditional manipulators in industrial robotics to unmanned aerial robots. We will cover basic concepts, including direct and inverse position kinematics, workspace and differential kinematics, dynamics, mechanical design of robot manipulators, vibration and feedback and feedforward control. This course is intended for graduate students with interests in mechanisms and robotics and related topics such as Artificial Intelligence (AI). Advanced undergraduates with a demonstrated interest in mechanisms and robotics are also welcome. Prerequisites include a foundation in Linear Algebra and Calculus, and the ability to program in Matlab.

The following topics will be covered from the above text and references:

Topics to be covered:

1. History of mechanisms and robotic manipulators.
2. Kinematic diagram, review of kinematic analysis of mechanisms, branching, force/motion transmission.
3. Closed-loop and open-loop mechanisms, mechanism types and classifications: degrees-of-freedom, redundancy, branching and number of configurations, service/approach angle, path and trajectory.
4. Spatial open-loop and closed-loop mechanisms, Denavit-Hartenberg parameters, homogeneous transformation matrices.

First Midterm

5. Kinematic analysis of closed-loop and open-loop spatial mechanisms.
6. Direct kinematics and inverse kinematics concepts in serial and parallel manipulators.
7. Workspace/reachable space in serial linkage manipulators and movability concept in closed-loop mechanisms and parallel manipulators. Effects of joint motion constraints.
8. Geometrical and analytical approaches workspace analysis – singularity, local and global motion and force transmissibility.

Second Midterm

9. Mechanical design of closed-loop mechanisms and open-loop and parallel manipulators; Structural design issues, speed and precision issues, joints and actuation selection, vibration issues and considerations.
10. Dynamics of Manipulators; Lagrangian Formulation.
11. Basics of feedback and feed-forward control of robotic manipulators.

During the semester, each student will select a mechanism or manipulator analysis and synthesis project. A short statement of the project is due following the first midterm exam. Each student is expected to discuss the project with the instructor for approval before the due date. The projects will involve the identification of the function(s) that the mechanism or manipulator is intended to perform, formulation of appropriate method(s) to estimate the level of performance of the device and solution method(s), followed

by the formulation of an appropriate method to synthesize the device to achieve a prescribed or optimal performance. A final ppt presentation as well as a written report is due by the last day of classes. Oral presentation will be required during the last day of classes.

No late homework will be accepted.

GRADING

1- Homework (15 points).

2- Two midterms (15 points each).

3- Final exam (40 points).

4- Project (proposal, presentation and final report) - (15 points).

DISABILITY SUPPORT SERVICES (DSS) STATEMENT (must be the following language)
If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, ECC (Educational Communications Center) Building, room128, (631) 632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential.

[*In addition, this statement on emergency evacuation is often included, but not required:*
Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services. For procedures and information go to the following website: http://www.stonybrook.edu/ehs/fire/disabilities]

ACADEMIC INTEGRITY STATEMENT (must be the following language as approved by the undergrad council):
Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Technology & Management, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at http://www.stonybrook.edu/uaa/academicjudiciary/

CRITICAL INCIDENT MANAGEMENT (must be the following language as approved by the undergrad council):
Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures.
#