MER 312: Dynamics and Kinematics

Schedule:  
MWF  11:45 am – 12:50 pm   NWSE 205 (Lecture)  
Th.  1:55 pm –  4:45 pm   NWSE 205 (Design Lab)  

Instructor:  Abraham Tchako, Ph.D.  
Room 235 Steinmetz Hall  
Tel.: 388-6144  
Email:  tchakoa@union.edu  

Office Hour:  
-MW 10:30 am – 11:30 am    NWSE 235  
-Any other time I am in my office  
-Or by appointment  

Tools  :  Compass, 45- and 30/60 degree triangles, protractor, scale.  
Web Page:  http://antipasto.union.edu/~tchakoa/mer312/  

COURSE DESCRIPTION:  
Introduction to the fundamentals of the kinematics and dynamics of mechanisms and machine elements design. Graphical and analytical techniques are used to analyze, synthesize and design linkages, cam and gears. Machine dynamics, computer aided kinematic design, kinetics and balancing will also be covered.  

COURSE OBJECTIVES:  

- Learn how to synthesize mechanisms that conform to positional and functional requirements.  
- Learn graphical and analytical procedures for determining the time dependent motions (and forces) of complex mechanisms, especially linkages.  
- Gain experience using computer software to facilitate the design and analysis of complex mechanisms.  
- Gain practical working knowledge of some basic machine elements such as motors, gears, belts, bearings, power-screws, cam, and common linkages.  
- Develop the capability of apply the above techniques in systematic fashion to the solution of open-ended problems in design.  
- Gain some familiarity with a wide range of mechanism alternatives.  
- Develop the ability to learn on your own.  
- Improve your ability to communicate your understanding of the topics through preparation of good technical reports.
WHAT IS EXPECTED OF THE STUDENTS?

You are expected to:
- Attend all classes and design project sections
- Check course web page periodically and regularly
- Do all homework on time
- Do all progress reports on time (Report Specifications)
- Do all hw’s, projects and present them in the form prescribed if any.
- Be a good team member (design project)
- Start the project when it is handed out.

GRADING:

Your grade in this course will be based on the exams (3), Lab/Design project, homework assignments, and quizzes.

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<td>Exam 1</td>
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<td>Final Exam</td>
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<td>Design Project</td>
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HOMEWORK:

- Homework will be assigned at end of each class and are due at beginning of the next class
- The assigned homework problems represent a minimum set of exercises for the topics at hand – you should also attempt other problems on your own.
- **The penalty for late homework is a 20% reduction in grade for each day until the solutions are posted. There is no credit after the solutions are posted.**
- Beware of the ME and the School policies on academic integrity.
- After a homework set is due, the solutions will be posted on the web page.

QUIZZES:

- A homework quiz will be given at the start of the class on Thursdays.

EXAMS:

- You will be given 2 sectional exams given during the Thursday lab hours time on the indicated dates (TBA).
- **Final exam** during the time assigned by the Registrar. **NO ADVANCED OR MAKE-UP FINAL EXAM.**
- The exams will be closed-book and closed-note.
- You will need to prepare a "formula card" for each exam.
• Exams will consist of both short-answer qualitative questions and computational quantitative questions.
• If you have question about your score on homework, test, or project, come with your works to my office, preferably during scheduled or arranged office hours.

**TENTATIVE COURSE TOPICS:**

1. **Mechanisms**
   - Machines and Mechanisms
   - Commonly employed Mechanisms
   - Kinematics Chains and kinematics Pairs
   - Mechanism Mobility
   - Generation of alternative mechanisms (by linkage transformation and inversion)
   - Grashof’s Criterion
   - Cognates of mechanism

2. **Linkage Analysis and Design**
   - Limit positions and time ratio of mechanism
   - Transmission angle
   - Instantaneous Center (IC) of velocity. Kennedy Theorem.

3. **Graphical Kinematic Analysis**
   - Velocity analysis using IC.
   - Mechanical advantage using IC

4. **Synthesis of Mechanisms**
   - Function Generation
   - Path Generation
   - Position Generation

5. **Gears and gear-trains design**
   - Estimating the power requirement/ motor selection/ determination of gear ratio
   - Involute gear geometry
   - Design of (spur) gear trains
   - Worm gear sets
   - Bevel gears

6. **Analytical Kinematic Analysis**
   - Loop Closure Equation
   - Complex vector analysis of a planar one-loop mechanism
7. Cams
   - Displacement Diagram
   - Follower Motion

8. Analytical Force Analysis and Balancing
   - Dynamic force balancing

LABORATORY:

Tentative Lab exercises:
   - Rocking Chair (A.1)
   - Flexible-finger Robot Gripper (A.6)
   - Windshield Wiper (A.7)
   - Overhead Garage Door (A.9)