SYLLABUS

MAE 342 - DYNAMICS OF MACHINES (CRN: 83327)
FALL 2018

MEETING TIME: MWF 9:00 – 9:50 AM, G102 ESB
INSTRUCTOR: Dr. Sam Mukdadi, Office 927 ESB
Ph. (304) 293-3110, e-mail: sam.mukdadi@mail.wvu.edu
OFFICE HOURS: MWF 11:00 - 12:00, or by appointment.
TEXTBOOK: DESIGN OF MACHINERY: An Introduction to the Synthesis and Analysis of Machines and Mechanisms. 4th or 5th Ed. McGraw Hill Book Co.* (* It comes with a DVD that may be used for assignments)
SUPPLIES: Drafting kit will be needed, access to the Internet on a PC or laptop, Matlab (or similar) programming skills will be needed.

OBJECTIVES OF THE COURSE:
The objective of this course is to provide students with the necessary knowledge on the methods needed to formulate analytical models and to analyze and synthesize machines and mechanisms to perform specific engineering functions. The methods involve analytical, numerical, graphical and computational approaches to establish the relationships between link dimensions, motion characteristics and forces with associated power and work delivery. Basic vibration characteristics of machines and mechanisms will also be addressed. Specifically the objectives are:
1. To model various types of mechanisms.
2. To analyze kinematics and dynamic characteristics of machines and mechanisms.
3. To synthesize closed loop mechanisms to satisfy specific performance requirements.

COURSE LEARNING OBJECTIVES MAPPING:

<table>
<thead>
<tr>
<th>Course Learning Objectives</th>
<th>ABET Outcomes*</th>
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<tbody>
<tr>
<td>1. Mathematical models of mechanisms and machines for kinematic analyses.</td>
<td>E</td>
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<tr>
<td>2. Conduct Force analysis of mechanisms under static and dynamic loads.</td>
<td>E</td>
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<tr>
<td>3. Synthesis of mechanisms for specific kinematics and dynamic requirements.</td>
<td>E</td>
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<tr>
<td>4. Use of graphical, analytical and computational approaches for the representation of realistic machines and mechanisms for meaningful analysis and design purposes.</td>
<td>E</td>
</tr>
<tr>
<td>5. Understand physical, professional and ethical consequences of mechanism failures.</td>
<td>F</td>
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</table>

This course effectively supports more ABET Outcomes than those shown in this table, but will provide evidence to support the assessment of ABET outcomes E and F.
TOPICS FOR THE COURSE:

I. INTRODUCTION TO KINEMATICS
Basic definitions and descriptive nature of mechanisms and issues related to the kinematic and dynamic modeling and study of mechanisms. Emphasis will be given to the “four-bar mechanism”, the “slider crank mechanism”, and the concept of degree of freedom. Concepts of professional responsibility and ethics of mechanism failures will be presented through a case study assignment.

II. MECHANISM DESIGN PROCESS
The stages of the general design process for mechanisms. Emphasis will be placed on mechanism classification, and types of mechanisms with graphic representation of joints for 2D and 3D mechanisms. Introduction to Working Model Software.

III. GRAPHICAL SYNTHESIS OF MECHANISMS
Dimensioning of planar (2D) linkages for function, path and motion generation with practical applications. Illustrations with Working Model Software.

IV. DISPLACEMENT AND VELOCITY
Analytical approaches for the position, displacement and velocity vector analysis of mechanisms. Emphasis will be placed on the relative motion concepts (linear and rotational) applied to the “four-bar mechanism”, the “slider crank mechanisms” and their combination. Review of “Grashoff’s Law” for the four-bar mechanisms and extreme positions. Use of graphical, analytical, numerical and computational approaches for position and velocity analysis of general mechanisms. Instantaneous centers of rotation and Kennedy’s Theorem. Review of the concept of “mechanical advantage”.

V. ACCELERATION ANALYSIS
Graphical, analytical and computational methods for the acceleration analysis of four-bar, slider crank and combined mechanisms. Acceleration polygon and vector representation of acceleration of mechanisms.

VI. DYNAMICS OF MECHANISMS

VII. CAM DESIGN
Basic cam-follower mechanisms, motion characteristics for flat face and radial roller followers. Graphical and analytical approaches for cam profile synthesis.

VIII. GEARs AND GEAR TRAINs
Gear tooth shape, gear standard parameters and gear contact kinematics. Planetary and differential gear train systems. Power flow in branching of gear trains.

IX. INTRODUCTION TO MECHANICAL VIBRATIONS
One degree of freedom damped and undamped, free and forced vibrations, two degrees of freedom and multidegree of freedom systems. Lagrangian approach to derive the equations of motion for multidegree of freedom systems.
TERM PROJECT:
Students will develop a project in teams of two (2). The project will be assigned during the second or third week of the course. The project will require students to make use of design and computational tools such as SOLIDWORKS, MATLAB, EXCEL, etc. A progress report and a final report of professional quality (word processor narrative, computer sketches, engineering calculations, etc.) will be required at the end of the course. The project will be due the last day of classes.

CLASS RULES:
1. Professional attitude in class is expected from all students.
2. No cell phones or MP3Players allowed in class or exams,
3. Disruptive behavior in class will not be allowed (that includes reading newspaper, falling asleep, using music players and talking).
4. Assignments must be submitted IN CLASS at the time they are due. (NOT responsible for assignments submitted in mailbox, in the halls or under my office door)
5. Late assignments will be heavily penalized at instructor’s discretion.
6. Late assignments will not be accepted after solutions are discussed in class or after one week past due.
7. All assignment problems must be presented on individual pages on plain white paper or engineering pad paper.
8. Missing an exam with no reasonable justification will result in a Zero grade for that exam.
9. Completeness, neatness and legibility in assignments, exams and projects are mandatory. Sloppiness on the other hand will be penalized at instructor’s discretion.

COURSE GRADING:

<table>
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<tr>
<th>Component</th>
<th>Percentage</th>
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<tbody>
<tr>
<td>Class Participation and Attendance</td>
<td>5%</td>
</tr>
<tr>
<td>Homework</td>
<td>15%</td>
</tr>
<tr>
<td>Project</td>
<td>20%</td>
</tr>
<tr>
<td>Exams (2)</td>
<td>40%</td>
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<tr>
<td>Final Exam</td>
<td>20%</td>
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Grade is assigned based on performance, NOT on “effort”. Project is assessed based on overall quality of document and engineering considerations as well as on relative comparison with the rest of the class. Typically, grades will be assigned according to the following scale: A (90-100); B (80-89); C (70-79); D (60-69); F (less than 60).

IMPORTANT DATES:

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
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<tbody>
<tr>
<td>August 15</td>
<td>First Day of Classes</td>
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<tr>
<td>August 21</td>
<td>Last day to add/drop courses</td>
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<tr>
<td>September 3</td>
<td>Labor Day Recess (University Closed)</td>
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<tr>
<td>September 26</td>
<td>Exam I, Time: 7:00-9:00 PM, Room: SAS-E 1021</td>
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<tr>
<td>October 4</td>
<td>Mid Semester Reports Due</td>
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<tr>
<td>October 12</td>
<td>Fall Break Recess</td>
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<tr>
<td>October 23</td>
<td>Last day to drop a class</td>
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<tr>
<td>October 31</td>
<td>Exam II, Time: 7:00-9:00 PM, Room: SAS-E 1021</td>
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November 6   General Election Recess
November 19-23  Thanksgiving Recess
December 5  Last Day to withdraw from the University
December 6  Last day of class
December 11  Final Exam, Time: 2:00-4:00 PM, Room: TBA

STATEMENT ON ACADEMIC INTEGRITY:
The integrity of the classes offered by any academic institution solidifies the foundation of its mission and cannot be sacrificed to expediency, ignorance, or blatant fraud. Therefore, I will enforce rigorous standards of academic integrity in all aspects and assignments of this course. For the detailed policy of West Virginia University regarding the definitions of acts considered to fall under academic dishonesty and possible ensuing sanctions, please see the Student Conduct Code at http://www.arc.wvu.edu/rightsc.html. Should you have any questions about possibly improper research citations or references, or any other activity that may be interpreted as an attempt at academic dishonesty, please see me before the assignment is due to discuss the matter.

INCLUSIVITY STATEMENT:
The West Virginia University community is committed to creating and fostering a positive learning and working environment based on open communication, mutual respect, and inclusion. If you are a person with a disability and anticipate needing any type of accommodation in order to participate in this class, please advise me and make appropriate arrangements with the Office of Accessibility Services (293-6700). For more information on West Virginia University's Diversity, Equity, and Inclusion initiatives, please see http://diversity.wvu.edu