CALIFORNIA STATE UNIVERSITY SACRAMENTO
The Department of Mechanical Engineering

ME115 – DYNAMICS OF MACHINERY
Spring 2009

SYLLABUS

DESIGNATION: Mechanical Design and Mechatronic Systems

CATALOG DESCRIPTION:

ME115 Dynamics of Machinery. Kinematic and Kinetic analysis of mechanisms. Rigid and flexible multi-body assembly models in two and three dimensions. Use of solid modeling, dynamic analysis and finite element methods. Study of loads on linkages, cams, gears as integral functioning components of machines, ground and space vehicles. Study of forces and moments in machinery under impulsive and impact forces, balancing, and elements of vibration. Lecture three hours. Prerequisite: Eng 6, Eng110. Graded: Graded Student. Units 3.0

INSTRUCTOR: Prof. José J. Granda
Riverside 5002, 916- 278-5711
Email: grandajj@ecs.csus.edu

OFFICE HOURS: 12:00 – 1:00 pm or by appointment

TIME: 10:30 am – 11:45 am.

PLACE: ARC 1014

WEB PAGE: Course documents will be posted on Web CT or on the instructor’s web site.

OBJECTIVES: The objective of this course is to provide the student with analytical and computer skills that will allow students to:

1) Use analysis and techniques learned in solid modeling and basic dynamics to develop computer models of linkages and complete working assemblies in two and three dimensions.

2) Transform solid models into dynamic analysis models to analyze kinematics, (velocities and accelerations), kinetics (forces and moments).

3) Perform simulations of rigid multi-body assemblies and calculation of loads, dynamic forces, energy and momentum.

4) Analyze forces and moments in two and three dimensions under impulsive impact forces and collisions.

5) Understand basic concepts of vibrations and balancing principles.

6) Perform simulations to obtain Finite Element Analysis under dynamic loads.
7) Apply these techniques to machinery, vehicles, cranes, engines, and any device or assembly that has moving parts in two and three dimensions.

PREREQUISITES: Eng 6, E110  UNITS: 3.0


Theory of Machines and Mechanisms Uiker, Pennck, Shiegley, Oxford Press

REFERENCES: Working Model 2D Manual
NASTRAN4D Manual

Machines and Mechanisms. Myska, Prentice Hall
McGraw Hill.

KNOWLEDGE, SKILLS, AND ABILITIES STUDENTS SHOULD HAVE BEFORE ENTERING THIS COURSE: Communicate technical information accurately and concisely – both orally and in writing, use analysis, computer software, word processors, etc., to define and develop solutions to technical problems. The skills learned in E110, basic dynamics and in Eng 6 for Solid Modeling are required of every student taking this class. The student will be expected to study the assigned reading assignments and homework following the schedule. Students are responsible for ALL material presented in class. This includes any announcements, due dates, changes or clarifications made in class. The instructor and the materials available to you will be your guidance, but the real learning process takes place on your own going over examples in class and in communication with the instructor.

KNOWLEDGE, SKILLS, AND ABILITIES STUDENTS GAIN FROM THIS COURSE:
The objective of this course is to provide the student with analytical and computer skills that will allow students to analyze and design two and three dimensional components and entire working assemblies. Provide students with the ability to perform kinematic and kinetic dynamic analysis and apply the techniques cited in the objective to machinery, vehicles, cranes, engines, and any device or assembly that has moving parts in two and three dimensions.

IMPACT ON SUBSEQUENT COURSES IN CURRICULUM: For those enrolled students, who have not yet participated in the capstone design course, provides a foundation for analysis and computer tools to be used in their senior projects of ME190, ME191. It will also facilitate the understanding of modeling, simulation of rigid and flexible multi-body systems. It will assist also to generate “plant” models for students taking a control course like ME114.
ABET CRITERIA 2000 OUTCOMES ACHIEVED: This course contributes to the following EC2000 Criterion 3 outcomes and those specific to the EAC accredited program.

<table>
<thead>
<tr>
<th>Outcome</th>
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<tbody>
<tr>
<td>a. An ability to apply knowledge of mathematics, science, and engineering</td>
<td>g. An ability to communicate effectively</td>
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<td>b. An ability to design and conduct experiments, as well as to analyze and interpret data</td>
<td>h. The broad education necessary to understand the impact of engineering solutions in a global/societal context</td>
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<td>c. An ability to design a system, component, or process to meet desired needs</td>
<td>i. A recognition of the need for and an ability to engage in life-long learning</td>
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<td>d. An ability to function on multi-disciplinary teams</td>
<td>j. A knowledge of contemporary issues</td>
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<tr>
<td>e. An ability to identify, formulate, and solve engineering problems</td>
<td>k. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice</td>
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<tr>
<td>f. An understanding of professional and ethical responsibility</td>
<td>l. Begin list of any other outcomes unique to the program.</td>
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ABET PROGRAM CRITERIA OUTCOMES ACHIEVED: Program criteria outcomes are unique to each degree program and are to be compiled from the program criteria given for each degree program and listed in bullet format below.

a. Demonstrate a knowledge of the science, mathematics, and engineering principles that are fundamental to thermal and mechanical systems design and manufacturing;

b. Identify, analyze, and solve technical problems in the areas of machine design, including solid mechanics and control systems; fluid mechanics, thermodynamics, and heat transfer, materials properties and selection; and manufacturing, using the principles of multivariate calculus and differential equations, including the appropriate use of computer technology;

c. Apply creativity in design of systems, components, or processes to meet desired needs.

d. Function effectively as part of a team

e. Communicate effectively through speaking, writing and graphics, including appropriate use of computer technology.

f. Show understanding of professional, ethical, and social responsibilities and the need for a commitment to life-long learning and participation in professional societies.

COMPUTER USAGE: Computers are used for writing reports (WORD) and presentations (PowerPoint). Spreadsheets are used as appropriate in doing multiple trade studies. Computational tools such as WORKING MODEL 2D, NASTRAN4D AND ADAMS are used as these are the current state of the art tools.

CLASS FORMAT: This course follows a lecture format. Assignments will be both individual and group. Groups will be approximately 4 people, and pre-assigned by the instructor. Students are responsible for reading the assigned material prior to the scheduled class. Class participation is required and part of the course grading. Students are encouraged to actively participate and to ask questions freely. Students will be expected to present their work periodically.

COURSE GRADING:
Quizzes/Exams ............ 50%
Homework Assignments ..... 10%
Lab assignments .......... 20%
Individual Project ........ 10%
Final Exam .............. 10%

100%

Exams and assignments will be graded balancing the procedure used and the correctness of your answer on an equal basis. Presentation and organization of your assignments will also be considered in grading. There will be Quizzes approximately one to two weeks apart, including the last week of class. Quizzes and final exam will be closed book exams. If there is a discrepancy in grading, you have two weeks from the date you received it to bring up for discussion. After that period grades are final. Projects are due on the last day of class. Work turned in after the deadlines will not be computed in your final grade.

HOMEWORK, COMPUTER ASSIGNMENTS POLICY:
Assignments are issued each week and students work is due in one week unless otherwise noted in the accompanying class schedule. Assignments are due at the start of class on the due date. Late assignments may be accepted, but at a loss of 20% of the grade per 24 hours late. Homework assignments will be returned to students post grading. There will be reading homework and computer assignments. Students are responsible for ALL material presented in class. This includes any announcements, changes, clarifications on assignments, or due dates. It is expected that the assignments will be completed and turned in before or on the specified deadlines. There will be no make up tests except in cases of confirmed and documented illness or emergency.

As the semester goes on and you realize "things" are not going well for you in this class or you become frustrated with the computer, be aware of the policy on drops and incomplete. To drop the class you must meet deadlines and an incomplete is rarely granted and can not be used to "bail out" of the class.

EXAMINATIONS:
There will be quizzes and exams. These will be announced to cover specific modules of the course. The final exam will be administered in accordance with the University scheduled time. Make-up exams require the permission of the instructor prior to the day of the exam.

ATTENDANCE:
Regular attendance is expected. Note that a portion of your grade is based on class participation and self-initiative. Professional contribution is a goal of this course.

SCHEDULE / CRITICAL DATES:
- Last Day of Official Adds/Drops
- Holidays
- Last Drop Day for Possible Refund
• Mid-Term Exam
• Spring Break
• Last Drop Day (with Approval)
• Final Book Reports Due
• Final Exam

Other important dates are available from the University Academic Calendar web site.

SPECIAL NOTES:

Students with Disabilities: The California State University provides upon request appropriate academic adjustments for qualified students with disabilities. For more information, contact the Office of the Dean of Students or the College of Engineering Director of Students with Disabilities.

Class Web Sites and Student Privacy: Web-based, password-protected class sites are associated with all academic courses taught at The University. Syllabi, handouts, assignments and other resources are types of information that may be available within these sites. Site activities could include exchanging e-mail, engaging in class discussions and chats, and exchanging files. In addition, electronic class rosters will be a component of the sites. Students who do not want their names included in these electronic class rosters must restrict their directory information in the Office of the Registrar.

EVALUATION:
The Measurement and Evaluation Center forms for the College of Engineering will be used during the last week of class to evaluate the course and the instructor.

UNIVERSITY POLICY ON INDIVIDUAL WORK
CSUS is a high level educational institution and therefore a professional environment should exist. However discipline problems or attempts to disrupt any aspect of the course, or influence other students to do the same.

The assignments are supposed to be individual unless assigned as a group. Copying assignments or exams will at the very least, result in zeroes assigned to ALL involved. It is the Mechanical Engineering Department's policy to remove from the major students who copy an exam or to expel them from the university. Copying or deleting unauthorized disk files will have the same effect. Logging onto somebody else's account is not permitted. Students are expected to answer questions on any of the work they hand-in.

Students are encouraged to make constructive suggestions to the instructor about any aspect of the course. Please feel welcome to come and see me. Students are encouraged also to suggest projects, particular engineering problems or research topics of interest to the whole class.

INSTRUCTOR RESERVES THE RIGHT TO REVISE SCHEDULE AS NECESSARY COURSE CONTENTS
# ME115 COURSE CONTENTS

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<th>TOPICS</th>
<th>READINGS</th>
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<td>Kinematics of Rigid Bodies</td>
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<td>2</td>
<td>Position Analysis, velocity and accelerations</td>
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<td>3</td>
<td>Introduction to Working Model 2D</td>
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<td>4</td>
<td>Plane Motion, Linkages, and mechanisms</td>
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<td>5</td>
<td>Three dimensional kinematic analysis.</td>
<td>Review of solid modeling using SOLIDWORKS.</td>
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<td>6</td>
<td>Introduction to NASTRAN4D</td>
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<td>6</td>
<td>Forces and moments in Mechanisms, Gear Trains</td>
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<td>7</td>
<td>Dynamic analysis of Rigid Multi-Body systems.</td>
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<td>8</td>
<td>Kinetics of machines and vehicle components.</td>
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<td>9</td>
<td>Dynamic Force Analysis in three dimensions</td>
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<td>10</td>
<td>Energy and momentum methods in dynamics of machinery</td>
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<td>11</td>
<td>Impact forces and collisions.</td>
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<td>12</td>
<td>Cam Dynamics. Engine valve cam system</td>
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<td>13</td>
<td>Introduction to Finite Element Analysis for dynamic conditions</td>
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<td>14</td>
<td>Combination of Rigid and Flexible multi-body systems</td>
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<td>15</td>
<td>Vibration elements. Modes of vibration.</td>
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<td>16</td>
<td>Final Exams</td>
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