ME296M Course Syllabus

CALIFORNIA STATE UNIVERSITY SACRAMENTO
The Department of Mechanical Engineering

ME296M – MULTIBODY DYNAMICS OF RIGID AND FLEXIBLE SYSTEMS

SYLLABUS

DESIGNATION: Mechanical Design and Mechatronic Systems

CATALOG DESCRIPTION:

ME296K MULTIBODY DYNAMICS, RIGID AND FLEXIBLE SYSTEMS. Analysis and Design of Rigid and flexible multi-body assemblies in two and three dimensions. Kinematic and Kinetic analysis in two and three dimensions. Multibody systems with applications to mechanisms, machinery, ground and space vehicles. Study of impulsive and impact forces. Use of solid modeling, dynamic analysis and Finite Element Analysis methods for the design of rigid and flexible multibody systems. Study of modes of vibration and their application in design and control of multibody systems. Lecture three hours. Prerequisite: Eng110. Graded: Graded Student. Units 3.0

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

OFFICE HOURS: 2:00 – 3:00 pm or by appointment

TIME: 5:30 p.m. 6:45 p.m.

PLACE: ARC 1014

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

PREREQUISITES: E110

- Fundamentals of Multibody Dynamics: Theory and Applications Farid M. L. Amirouche
- Multibody system simulation: numerical methods, algorithms, and software Reinhold von Schwerin
- Methods of Analytical Dynamics Leonard Meirovitch
- Theory of Machines and Mechanisms Uiker, Pennck, Shiegley , Oxford Press
REFERENCES: Working Model 2D Manual
NASTRAN4D Manual

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.

COURSE OBJECTIVES: The objectives of this course are to provide the student with analytical and computer skills that will allow students to:
1) Design Multibody systems in two and three dimensions starting from scratch using sound theoretical principles and state of the art software.
2) Design of rigid body systems with applications to mechanisms and working assemblies in two and three dimensions.
3) Dynamic analysis models for kinematic (position, velocities accelerations) and kinetics (forces and moments).
4) Perform simulations of rigid and flexible multi-body assemblies to determine loads, dynamic forces, energy and momentum and control. Finite Element Analysis under dynamic loads.
5) Analyze forces and moments in two and three dimensions under impulsive impact forces and collisions.
6) Apply these techniques to, ground, space vehicles and machinery.

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 drafting would be useful for development of Solid Models.

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:
ME296M Course Syllabus

Quizzes/Exams .......... 40%
Homework Assignments .... 10%
Lab assignments .......... 30%
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.

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
**ME296K MULTIBODY DYNAMICS OF RIGID AND FLEXIBLE SYSTEMS**

**COURSE CONTENTS**

<table>
<thead>
<tr>
<th>WEEK</th>
<th>TOPICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fundamentals of Particle Mechanics, equations of motion.</td>
</tr>
<tr>
<td>2</td>
<td>Kinematics of Rigid Bodies Position Analysis, velocity and accelerations</td>
</tr>
<tr>
<td>3</td>
<td>Rigid Bodies, Plane Motion, Linkages, and mechanisms in two dimensions</td>
</tr>
<tr>
<td>4</td>
<td>Three dimensional models for dynamic analysis. (Software, SOLIDWORKS, NASTRAN4D)</td>
</tr>
<tr>
<td>5</td>
<td>Dynamic analysis of Rigid Multi-Body systems. Forces and moments in two and three-dimensional Mechanisms</td>
</tr>
<tr>
<td>6</td>
<td>Mechanics of deformable bodies.</td>
</tr>
<tr>
<td>7</td>
<td>Mutibody dynamic applications to ground and space vehicles.</td>
</tr>
<tr>
<td>8</td>
<td>Dynamic Force Analysis in three dimensions (ADAMS software)</td>
</tr>
<tr>
<td>9</td>
<td>Multibody Energy and momentum methods</td>
</tr>
<tr>
<td>10</td>
<td>Multibody Impact forces and collisions.</td>
</tr>
<tr>
<td>11</td>
<td>Flexible multibody systems</td>
</tr>
<tr>
<td>12</td>
<td>Dynamic Finite Element Analysis for dynamic deformations and loads</td>
</tr>
<tr>
<td>13</td>
<td>The large deformations problem in Rigid and Flexible multi-body systems</td>
</tr>
<tr>
<td>14</td>
<td>Modes of vibration</td>
</tr>
<tr>
<td>15</td>
<td>How to Control of multibody systems</td>
</tr>
<tr>
<td>16</td>
<td>Final Exams</td>
</tr>
</tbody>
</table>