ME 581 Simulation of Mechanical Systems - Spring 2008 - 1:25-2:15 MWF, 67 Willard

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Text: *Computer-Aided Kinematics and Dynamics of Mechanical Systems*, Haug
Grading: 4 homeworks (40pts), 5 computer programs (100pts), semester project (50pts)

Day	Date	Chap	Notes	Topic	Assign
1	Jan 14	1.1-1.2	01_01	administration, topology	H0, H1
2	Jan 16	no class		HJS not available	
3	Jan 18	1.3-1.4	01_01, 03_01	mobility, geometric kinematics	
4	Jan 21	no class		MLK Day	
5	Jan 23		03_02	complex number kinematics	H2
6	Jan 25	4.5	03_03	Newton-Raphson solution	
7	Jan 28		05_01, 05_02	experimental kinematics	
8	Jan 30		06_01	Newtonian mechanics for inverse dynamics	H3
9	Feb 1		06_03	virtual work	
10	Feb 4		08_06	philosophy of DAE versus reduced DOF dynamics	
11	Feb 6	2.1-2.6		matrix notation, velocity, acceleration	
12	Feb 8	3.1		generalized coordinates, constraint equations	
13	Feb 11	3.2-3.3.1		revolute, double revolute	C1
14	Feb 13	3.3.2		prismatic, pin-in-slot	
15	Feb 15	3.3.3-3.4, 3.5		composite joints, gears, driving constraints	
16	Feb 18	3.6.1, 4.2		position analysis	
17	Feb 20	3.6.2-3.6.3		velocity and acceleration analysis	C2
18	Feb 22	3.7, 4 - 5		singularities, alternate modeling approaches	
19	Feb 25	6.1.1-6.1.3	07_01, 07_02	centroidal polar moment of inertia	
20	Feb 27	6.1.4-6.1.5	07_03	centroidal polar moment of inertia	C3
21	Feb 29	6.2		generalized forces	
22	Mar 3	6.3.1		2D dynamic equations of motion	
23	Mar 5	6.3.2-6.3.3		Lagrange multipliers, differential-algebraic equations	
24	Mar 7	6.4-6.5		forward versus inverse dynamics, equilibrium	
25	Mar 17	6.6		constraint reaction forces	C4
26	Mar 19	7.1-7.2		forward dynamics, time integration	
27	Mar 21	7.3		constraint stabilization	
28	Mar 24	7.4-7.5	10_02	numerical integration	
29	Mar 26	9.1	11_01	3D matrix kinematics, rotation matrix	
30	Mar 28	9.2	11_02	Chasles angle, Euler parameters	
31	Mar 31	9.3		velocity, acceleration	
32	Apr 2	9.4.1-9.4.3	11_02	Euler parameters	H4
33	Apr 4	9.4.4	11_03	basic constraints	
34	Apr 7	9.4.4		spherical/universal/revolute constraints	
35	Apr 9			cylindrical/prismatic/screw constraints	
36	Apr 11	9.4.5-9.6		composite constraints, driving constraints	
37	Apr 14	9.7		position analysis	C5
38	Apr 16	9.8		velocity and acceleration analysis	
39	Apr 18	11.2		moments and products of inertia	
40	Apr 21	11.1, 11.3		3D dynamic equations of motion	
41	Apr 23	11.4-11.6		actuator and constraint forces	
42	Apr 25	12		forward versus inverse dynamics	
43	Apr 28		03_05	instant centers	
44	Apr 30			instant screws	
45	May 2			second order screws	
				Project presentations (date and time subject to negotiation)	

Course Objectives

After completing ME 581, all students should be able to:

1) diagram topology and detemine mobility of 2D and 3D mechanisms
2) compute kinematics and dynamics of 2D mechanisms using generalized coordinates, constraint vectors and differential-algebraic equations
3) measure mass moment of inertia
4) compute kinematics and dynamics of 3D mechanisms using Euler parameters, constraint vectors and differential-algebraic equations
5) describe 2D and 3D kinematics using finite and instantaneous screw axes
6) communicate well using verbal, written and electronic methods

Course Policy

1) Attendance at lectures is mandatory.
2) Homework problems are individual assignments but scholarly collaboration is permitted.
3) Students should know and understand these course policies in regard to College of Engineering policy on academic integrity available at http://www.engr.psu.edu/www/ug/acad_int/students/default.htm .

Project Information

The latter half of the semester will be devoted to a project utilizing the concepts learned in this course. Project topics are your choice and may be drawn from your research/teaching interests, industrial experience, hobbies or intriguing devices. ***Be creative.*** Your mechanisms may be planar or 3D, open loop or closed loop, static or moving. The projects may range from design of novel mechanisms, to analysis of existing devices, to exemplar use of analysis packages (e.g. Working Model, ADAMS), to modeling of biological motion, to construction of working prototypes (passive, motorized or instrumented), to literature review and a written report on theoretical kinematics or dynamics (e.g. screw theory, Kane's equations). A list of ideas is appended below.

The intent of this project is to provide some personal insight into kinematics and dynamics outside the content of the class. It is not intended as a burdensome requirement, rather as an opportunity for you to gain some practical experience on a topic of your choice. You may work in groups or individually on this project.

Project Requirements

1) A short, one page proposal detailing your project concept and project team. The proposal should contain WHO comprises your project team, WHAT you wish to accomplish, WHY this topic is pertinent or interesting or valuable, and HOW you plan to complete this project (e.g. time plan, requisite resources).
2) A self-explanatory, high quality final report.
3) An eight minute oral presentation during final exam week.

Possible Project Concepts

Passive physical models (that work)
    RUGR, CRSP, Stewart Platform, Solid Strut Platform (SSP), Grood/Suntay knee model
Motorized/instrumented physical models
    RUGR, SSP, 6DOF Ascension Bird
Computer models (analysis and/or animation)
    RUGR, CRSP