University of Guelph
School of Engineering
ENGG*2340, Kinematics and Dynamics
Winter 2011 Course Outline

Instructor

Name:	Fantahun M. Defersha, PhD
Email:	fantahun.defersha@uoguelph.ca
Telephone:	(519) 824-4120 Ext. 56512
Office Hours:	Friday; 1:30 PM - 4:30 PM (and by appointment); Room THRN 226

Teaching Assistants

Name:	Email:	Office hours:
Bray-Miners, J.	jbraymin@uoguelph.ca	Tuesday 3:00pm-4:00pm; THRN Room 301
Song, Q.	qsong@uoguelph.ca	Tuesday 3:00pm-4:00pm; THRN Room 317

Schedules

Lecture: Monday, Wednesday, Friday; 10:30 AM - 11:20 AM; THRN, Room 1307

Lab 1 (Section 102): Tuesday; 08:30 AM - 11:20 AM; THRN, Rooms 2313 and 1007

Lab 2 (Section 103): Wednesday; 11:30 AM - 02:20 PM; THRN, Rooms 2313 and 1007

Lab 3 (Section 104): Monday; 02:30 PM - 05:20 PM; THRN, Rooms 2313 and 1007

Calendar Description

The course will cover kinematics and dynamic analysis including graphical and analytical methods for kinematics analysis of mechanisms and elementary body motion, static and dynamic force analyses of mechanisms, gyroscopic forces, dynamics of reciprocating and rotating machinery, cam and gear mechanisms and specifications. Vibration analysis will deal with free and forced vibration of underdamped lumped systems with multidegrees of freedom, analytical and numerical techniques of solution, viscous damping, vibration isolation, vibration measurement and control. *Prerequisite(s):* ENGG*2160

Text Book

John J. Uicker, JR., Gordon R. Pennock, and Joseph E., Shigley (2010). Theory of machines and mechanisms, 4ed, OXFORD University Press, New York.

Note: The lecture is the primary source of information for the course and discussions will me more elaborated than presented in the text book. Examples that may not be available from the text book may also be presented during the lecture time to further help you understand the subject matter of the topics discussed. As such it is highly recommended that you attend the lectures.

Required Book

Dan B. Marghitu, (2009). Mechanism and Robots Analysis with MATLAB, Springer

Course Learning Outcomes:

Upon successful completion, students will be able to:

1. Understand motion generated by different types mechanisms
2. Construct displacement, velocity and acceleration vector diagrams and solve them graphically and analytically
3. Apply the concepts of displacement, velocity, and acceleration to solve mechanical problems
4. Analyse both static and dynamic forces on machine components
5. Analyze the Design of cams
6. Understand the fundamentals of gears and gear trains
7. Understand the dynamics of vibration and its isolation
8. Use MATLAB and Working Model 2D for kinematics and dynamics analysis of mechanisms

Detail Course Outline

General Outline	Topics	Section	Tentative Schedule
1. Introduction	Revision of kinematics of rigid bodies from ENGG*1210		Week 1

2. Velocity Analysis	Velocity difference equation	3.1-3.3	Week 2 and 3 5 lectures
	Velocity polygons (Graphical Solution)	3.4	
	Apparent velocity equation	3.5, 3.6, 3.8	
	Direct and Rolling contact velocity	3.7	
	Instantaneous center of velocity	3.13	
	Aronhold-Kennedy therorem of three center	3.14, 3.15	
	Use of instantaneous centers to find velocity	3.16, 3.17	
3. Acceleration Analysis	Acceleration difference equation	4.1-4.3	Week 3 and 4 4 lectures
	Acceleration polygon (Graphical Solution)	4.4	
	Apparent acceleration equation and Coriolis component of acceleration	4.5, 4.6	
	Direct and rolling contact acceleration	4.7, 4.8	
4. Static Force Analysis	Introduction	13-1-13.6	Week 5 and 6 6 lectures
	Two-, three-, and four-force members	13.7, 13.8	
	Force Polygons	13.7-13.8	
5. Dynamic Force Analysis	D'Alembert's Principle	14.1-14.4	
	Dynamic forces in machine members	14.4, 14.6	
6. Vibration Analysis	Differential equations of motion	15.1	Week 7 6 lectures
	A vertical model	15.2	
	Solution of the differential equation	15.3	
	Step input forcing	15.4	
	Phase-plane analysis	15.5, 15.6	
	Free vibration with viscous damping	15.8	
	Damping obtained by experiment	15.9	
	Phase-plane representation of damped vibration	15.10	
	Response to periodic forcing	15.11	
	Harmonic forcing	15.12	
	Forcing caused by unbalance	15.13	

	Relative motion	15.14	
	Isolation	15.15	
	Rayleigh's method	15.16	
7. Cam Design	Introduction to cam design	6-1	
	Classification of cams and followers	6.2	Week 8
	Displacement Diagram	6.3	3 lectures
	Graphical layout of cam profile	6.4	
8. Gear Design	Spur Gear Terminology and definition	7.1	
	Fundamental law of Toothed Gearing	7.2	
	Involutes property	7.3	
	Fundamentals of Gear-Tooth action	7.5	
	The manufacturing of gear teeth	7.6	Week 9 and 10
	Interface and undercutting	7.7	5 lectures
	Contact ratio	7.8	
	Varying the center distance	7.9	
	Involutomery		
	Introduction to helical, bevel and worm gears	From chapter 8 of the text book	
9. Gear Trains	Parallel-axis gear trains	9.1	
	Example of gear trains	9.2	
	Determining tooth numbers	9.3	Week 11 and 12
	Analysis of epicyclic gear trains	9.4, 9.6, 9.7	
	Bevel gear epicyclic train	9.5	

Laboratory Sessions

Week	Dates	Theme
2	January 17 – January 21	Graphical Position and Velocity Analysis using AutoCAD
3	January 24 – January 28	Position Analysis Using MATLAB
4	January 31 – February 4	Velocity Analysis Using MATLAB

5	February 7 – February 11	Complete Motion Analysis Using MATLAB
6	February 14 – February 18	Introduction to Working Model 2D
7	February 28 – March 4	More Exercise on Working Model 2D
8	March 7 – March 11	Vibration Analysis Using Working Model 2D
9	March 14 – March 25	Experimental Vibration Analysis
10 & 11	March 28 – April 1	Experimental Cam Analysis
12	April 4 – April 9	Experimental Gear Analysis

Assignments

Type 1 --- Assignments that are based on Graphical Solutions using AutoCAD and Manual Calculation for Analytical Solution (15%)

Type 2 ---- Kinematics Analysis of Mechanisms using MATLAB and Working Model 2D (10%)

Assignment No.	Type	Worth	Theme	Due Date
1	1	4%	Analytical and Graphical Position and Velocity Analysis	January 31
2	2	3%	Position and Velocity Analysis using MATLAB	February 14
3	1	3%	Analytical and Graphical Acceleration Analysis	February 28
4	2	4%	Complete Motion Analysis using MATLAB	March 7
5	1	2%	Static and Dynamic Force Analysis	March 14
6	2	3%	Kinematic Analysis using Working Model 2D	March 21
7	1	4%	Vibration Analysis	March 28
8	1	2%	Graphical Cam Profile Generation	April 4

Instructional Methods

Instructional methods include lectures and problem solving and laboratory periods. For the first several weeks, the labs are mainly in a computer room (Room 2313) and involve the use of MATLAB and Working Model 2D for kinematics and dynamics analysis of mechanisms. We will also use AutoCAD for graphical position, velocity and acceleration analysis. In the last few weeks, the labs will involve experimentation on cams, gears and vibration analysis. Problems will be assigned for homework and solving these assignment problems is highly essential to reach the learning objective if carried out under your own steam. MATLAB and Working Model 2D assignments and projects should be carried out in group of size 4 or 5 students. *Groups should be formed no latter than the second week of class* and the members of a group should be from the same Section of the LAB.

Attendance

The best leaning experience will be achieved if you ***attend lecture and lab regularly***. Scientific studies have proven that a student success rate is strongly related to his/her class attendance. Those who attend classes and tutorials have higher success rates than those who do not.

Class Participation

Students are encouraged and expected to actively participate in class. You can use laptop or tablets in class, but only for following along with the class notes — please, no web surfing, e-mailing, instant-messaging, etc., as such is very distracting to those around you, and obviously to you. Turn-off all cell phones, phones, blackberries, etc. during class ... putting on vibrate may not be enough. Out of respect to your classmates please keep your private discussions outside the classroom.

Grading Scheme:

- Assignments (Graphical Solutions using AutoCAD and Analytical Solutions using Hand Calculation) 15%
- MATLAB and Working Model 2D Assignments and Project 10%
- LAB Exercises 10
- Mid-term Exam 25%

- Final Exam 40%

Late Assignment/Missed Test Policy:

Generally, when you find yourself unable to meet a course requirement such as an assignment, LAB or a test as a result of compassionate, illness or physiological reasons, a formal explanation must be made in writing to the instructor and (where possible) proper documentation must be provided. This should be done prior to an exam or assignment or LAB period (if possible) or as soon as possible but definitely within a week after the exam or assignment due date or the Lab is conducted. If no explanations are provided, exams receive a grade of zero and assignments/lab reports are subject to the following deductions:

- 25% will be deducted if the assignment is up to 24 hours late,
- 50% will be deducted if the assignment is 24 to 48 hours late,
- No assignments will be accepted after that.

Assignments will be collected during lecture time at their due dates and will be returned to you during LAB periods. Assignment marks will be posted on CourseLink. It is your responsibility to continually check your mark records on the CourseLink and you may appeal any mark for an assignment within one week after the marked assignments are returned to the class. Solutions of assignment problems will be posted on CourseLink.

Exam Dates:

- Mid-term exam will be outside the regular lecture hours; **Saturday, 10:00AM – 12:00PM, March 5, 2011** (Room - TBA).
- Final Exam will be on Friday 08:30AM - 10:30AM (2011/04/15), Room TBA

University Policy on Academic Misconduct:

Academic misconduct, such as plagiarism, is a serious offence at the University of Guelph. Please consult the Undergraduate Calendar 2010-2011 and School of Engineering programs guide, for offences, penalties and procedures relating to academic misconduct.

http://www.uoguelph.ca/registrar/calendars/undergraduate/current/pdffiles/calendar.pdf

Disclaimer:

The instructor reserves the right to change any or all of the above in the event circumstances, subject to the University of Guelph Academic Regulations.