Ryerson University
Department of Aerospace Engineering

COURSE OUTLINE

ME8138

COMPUTATIONAL DYNAMICS

Winter 2006

Course Objective:

The objective of this course is to study the basic modeling and computational methods for rigid and flexible multi-body systems. Computational dynamics provides a fundamental tool for analyzing and computing the motions and forces for large complex mechanical systems, such as robots, mechanisms, machines, automobiles and space systems. Applications of computational dynamics include analysis, design and control. Analysis is to study system behaviors for given inputs through modeling and simulation. Design is to determine the prescribed functions through synthesis and optimization. Control is to control mechanical systems based on the dynamic models.

Topics:

Topics covered in this course can be classified into three parts. The first part is on kinematics, covering joint classifications, mobility analysis, coordinates transformation, forward and inverse kinematics. The second is on dynamics covering energy and vector methods. The third part is on numeric methods, mainly on recursive methods.

References:

"Dynamics of Multibody Systems" by A.A. Shabana, published by John Wiley & Sons, Inc. 1989.

"Computational Dynamics" by A.A. Shabana, published by John Wiley & Sons, Inc. 2001.

Course Evaluation:

Assignments	20%
Project	30%
Final	50%

Week	Topic	Assignment
1	Introduction to machine systems *Terminologies and definitions* *Kinematic pairs*	Program of kinematic pair DOF
2	Mobility analysis *Degrees-of-freedom* *Mobility criteria* *Movability and redundancy*	Program of mobility analysis
3	Position and orientation *Coordinates* *Position vector and rotation matrix* *Angle representations*	Program of rotation matrix
4	Translation and rotation *Pure rotation* *General motion - single body* *General motion - multiple bodies*	Program of recursive method for translation and rotation
5,6	Serial/parallel robot kinematics	
7,8	Velocity analysis *Angular velocity* *General motion* *Twist mapping matrix and Jacobian matrix*	Program of recursive method for velocity analysis
9,10	Acceleration analysis *Angular acceleration* *General motion* *Hessian matrix*	Program of recursive method for acceleration analysis
11,12,13	Dynamics *Lagrange's formulation* *Newton-Euler formulation* *Recursive method*	Program of recursive method for dynamics analysis