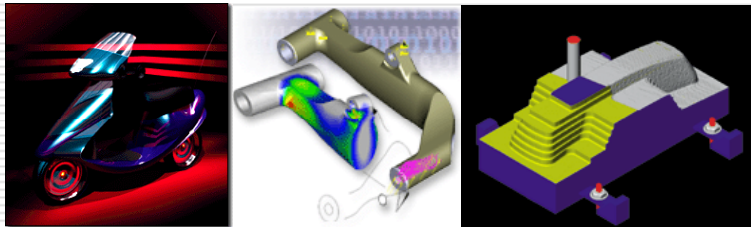


## MECH410/520 Computer Aided Design

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## MECH410/520 Computer Aided Design

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- ❑ Instructors: Armando Tura & Dr. Zuomin Dong
- ❑ Office: ELW B126; Phone: 721-7295;  
E-mail: atura@uvic.ca
- ❑ Course Homepage:  
<http://www.me.uvic.ca/~mech410/>  
Course materials are posted at this web site  
and updated constantly.
- ❑ Lecture: S01,
- ❑ Lab.: LS01 or LS02 (24 hrs open lab)

## Course Contents

- ❑ Computer Graphics Theory (Geometric Representation, Projection, Transformations, Solid and Surface Models of CAD Systems)
- ❑ Advanced CAD/CAE/CAM Systems, Pro/ENGINEER® (Unigraphics NX) and Applications
- ❑ Virtual Prototyping of Mechanical Components and Devices
- ❑ Design Optimization Using Computer Virtual Prototypes
- ❑ Interactive Graphical Programming

### MECH410/520 Computer Aided Design (CAD)

Spring 2010

#### Course Description (see UVic Calendar)

The course consists of the following components:

- 1) Computer Graphics Theory (Geometric Representation, Projection, Transformations, Solid and Surface Models of CAD Systems)
- 2) Advanced CAD/CAE/CAM Systems, Pro/ENGINEER®, and Its Applications
- 3) Virtual Prototyping of Mechanical Components and Devices
- 4) Design Optimization Using Computer Virtual Prototypes
- 5) Interactive Graphical Programming

#### Course Information

Instructors:	Armando Tura Office: ELW B126; Phone: 721-7295; E-mail: <a href="mailto:atura@uvic.ca">atura@uvic.ca</a> Dr. Zuomin Dong Office: EOW 548/551; Phone: 721-8900; E-mail: <a href="mailto:zdong@uvic.ca">zdong@uvic.ca</a> Course Homepage: <a href="http://www.me.uvic.ca/~mech410/">http://www.me.uvic.ca/~mech410/</a>
Section Number:	Lecture: S01, Lab.: LS01 (open lab). Credits: 1 1/2
Lecture Schedule:	Tuesday, Wednesdays and Fridays 11:30 am -12:30 pm
Lecture Place:	CORB 143
Office Hours:	Tuesday: 1:30-3:30 p.m. ELW A254 (or by appointment)
Lab. Schedule:	Computational Design Lab. ELW B228 (Open 7x24, first lab: Jan 13)
Lab. Consultant:	Tuesdays 1:30 - 4:30 p.m. (Mr. Minh Ly, Lab: ELW B228 and Office: ELW A214)
References:	• Lee, K. <i>Principles of CAD/CAM/CAE Systems</i> , Addison Wesley, 1999. • MECH410/520 Web Page at <a href="http://www.me.uvic.ca/~mech410/">http://www.me.uvic.ca/~mech410/</a> • Roger Toogood, <i>Pro/ENGINEER Wildfire 4.0 Tutorial</i> , SDC.

## Laboratory, Project and Quiz

Pro/ENGINEER Laboratory		MECH410 (Group of 2)	MECH520 (Individual)
Laboratory 1 (Start on Jan 15)	Design Modeling - User Interface; 2D Sketching; 3D Modeling; and Engineering Drawing Generation (10 days)	7 %	7 %
Laboratory 2	Mechanical Assembly – Modeling of Assembly and Mechanism; and Motion Animation (10 days)	7 %	7 %
Laboratory 3	Static Structural (and Thermal) Analysis (1 wk)	5 %	5 %
Laboratory 4	Sensitivity Analysis and Design Optimization (1 wk)	5 %	5 %
Laboratory 5	Automated CNC Tool Path Generation & Machining (1wk)	6 %	6 %
Final Project*	Project Presentation (March 30, Tue) and Report (3-4 wks) - An Application of CAD/CAE/CAM System (Your Choice) Using Pro/ENGINEER; or Unigraphics NX; or SolidWorks	35 %	40 %
Assignments	To be assigned in class	0 %	0 %
Quiz 1	(1 lecture time, Sections 1-7) Feb 26	17.5 %	15 %
Quiz 2	(1 lecture time, Sections 8-13) Mar 31	17.5 %	15 %

\* "Satisfactory" work can earn 80 percent of the grade. The rest 20 percent of the grade will be rewarded to creative work.

### Course Outline

1. Introduction to CAD/CAE/CAM and Technology Review
2. Computer Hardware and Software for A CAD System
3. Graphical Coordinate Systems  
Model (or World, Database) Coordinate System (MCS); Working Coordinate System (WCS); Screen Coordinate System (SCS); Viewing Coordinate System (VCS)
4. Reviews on Geometric Transformations and Projections
  - a) 2D and 3D Transformations
  - b) Parallel Projections
5. An Introduction to the Pro/ENGINEER Design Modeling System
  - a) Foundation of the Pro/ENGINEER and Feature-based Solid Modeling CAD Systems
  - b) Function Modules of a CAD/CAE/CAM System
  - c) Pro/E User Interface and Part/Assembly Model Generation
  - d) Engineering Drawings and Documentation, File Conversion
  - e) Motion Simulation
6. An Overview of Unigraphics NX CAD/CAM/CAE System
7. Computer Modeling Techniques
  - a) Wireframe Model
  - b) Solid Model: Boundary Representation; Sweeping; Construction Solid Geometry
  - c) Feature-based Modeling and Parametric Modeling
  - d) Computer Model for Scanned Data and Reverse Engineering
8. An Introduction to Design Optimization
  - a) Formulation of a Design Optimization Problem
  - b) Search Schemes of Commonly Used Optimization Methods
  - c) Important Issues in Design Optimization
  - d) Virtual Prototyping Based Design Optimization

## Course Outline

9. Advanced Applications of Pro/ENGINEER (Integrated CAD/CAE/CAM): Structural/Thermal Analysis, Parameter Design Optimization, Automated CNC Tool Path Generation and Animation, and Freeform Surface Design
10. Representation of Curves
  - a) Parametric Curve Representation
  - b) Cubic spline, Bezier curves, B-spline curves and NURB
11. Representation of Surfaces
  - a) Plane, Bilinear, Ruled, Bezier and NURB Surfaces
  - b) Visualizing Surfaces; Surface Mesh and Surface Machining
  - c) Surface Modeling in Pro/ENGINEER
12. Interactive Computer Graphical Programming
  - a) Introduction and Background Review
  - b) Programming in CAD Systems (Menu, Macro and High-level Programming – AutoCAD & Pro/E)
13. Data Organization in CAD
  - a) Data Structure and Database
  - b) Graphical Standard and CAD/CAM Data Exchange
14. Advanced CAD Systems and Their Industrial Applications
  - a) CAD/CAM Integration and Concurrent Engineering
  - b) Virtual-prototyping in Product Development

(An Overview of SolidWorks and COSMOS Works)



MECH 410 and MECH520

## Computer Aided Design

Course Homepage: <http://www.me.utoronto.ca/~mech410/>

Mr. Armando Tura

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Dr. Zuomin Dong

Office: EOW 548-551, Phone: (250) 721-8900 (or 721-8693), E-mail: [zdong@utoronto.ca](mailto:zdong@utoronto.ca)

Research Interests: <http://www.me.utoronto.ca/~zdong/>

(This website will be continuously updated and activated.)

[Course Outline](#)

[Lab, Project and Time Schedule](#)

**Laboratory Information and Report Formats**

**Lecture Notes**

- [Course Outline and Background Information \(condensed slides\)](#)
- [Introduction to CAD/CAE/CAM and Technology Review \(condensed slides\)](#)
- [Computer Hardware for CAD \(condensed slides\)](#)
- [Technical References on 3D Scanning and Computer Model Generation](#)
- [An Introduction to the Pro/ENGINEER Design Modeling System \(Linked to Pro/E Tutorials and Lecture Notes\)](#)
  - [An Overview of Pro/ENGINEER \(condensed slides\)](#)
  - [About Pro/ENGINEER Tutorials \(condensed slides\)](#)
  - [Assembly Modeling and Motion Animation \(condensed slides\)](#)
- [Graphical Coordinate Systems and Basic Geometric Transformations \(condensed slides\)](#)
- [Rotation about an Arbitrary Axis \(condensed slides\)](#)
- [Geometric Projections \(condensed slides\) \(notes in Word\)](#)
- [Computer Modeling Techniques \(condensed slides\) \(notes in Word\)](#)
- [An Introduction of Design Modeling Using Unigraphics NX \(condensed slide\)](#)
- [Advanced Applications of Pro/ENGINEER](#)
  - [An Over View of Pro/MECHANICA and Applications of Pro/M Structure \(condensed slides\)](#)
  - [A Review of Finite Element Analysis Method \(condensed slides\)](#)
  - [Design of Sculptured Part Using Pro/ENGINEER \(condensed slides\)](#)
  - [CNC Tool Path Generation and Simulation Using Pro/ENGINEER \(condensed slides\) \(5-axis machining video\)](#)

- [Geometric Projections \(condensed slides\) \(notes in Word\)](#)
- [Computer Modeling Techniques \(condensed slides\) \(notes in Word\)](#)
- [An Introduction of Design Modeling Using Unigraphics NX \(condensed slide\)](#)
- [Advanced Applications of Pro/ENGINEER](#)
  - [An Over View of Pro/MECHANICA and Applications of Pro/Model Structure \(condensed slides\)](#)
  - [A Review of Finite Element Analysis Method \(condensed slides\)](#)
  - [Design of Sculptured Part Using Pro/ENGINEER \(condensed slides\)](#)
  - [CNC Tool Path Generation and Simulation Using Pro/ENGINEER \(condensed slides\) \(5-axis machining video\)](#)
- [An Introduction to Design Optimization \(condensed slides\)](#)
  - [An Article on Multiphysics CAD-Based Design Optimization](#)
- [Example Problems for Quiz I](#)
- [Example Quiz I and Solutions](#)
- [Representation of Curves \(condensed slides\)](#)
- [Representation of Surfaces \(condensed slides\)](#)
  - [Generation of Free-form Surface in Pro/ENGINEER \(condensed slides\)](#)
- [Interactive Computer Graphical Programming \(condensed slides\)](#)
- [Data Organization in CAD □ □ \(condensed slides\)](#)
  - [Integrating Pro/E with ANSYS \(ANSYS Connection Users Guide R9 2004\)](#)
- [An Overview of SolidWorks, COSMOSWorks, COSMOSXpress and COSMOSMotion](#)
- [Example Problems for Quiz II](#)
- [Research on Virtual Prototyping, Design Optimization, RP and Fuel Cell Vehicle Systems](#)

#### [Pro/ENGINEER Tutorials and Related Documents](#)

#### [Unigraphics NX Tutorials and Related Documents](#)

#### Laboratory Assignments and Project

- [Laboratory 1 Design Modeling](#) (11 days) Jan 15 □ Jan 26 (First Lab on Jan. 20)
  - [Laboratory 2 Mechanical Assembly](#) (1wk) Jan 26 □ Feb 2
  - [Laboratory 3 Static Structural Analysis](#) (1 wk) Feb 2 □ Feb 9
    - □ □ [Change of Default Unit System in Pro/E](#)
  - [Laboratory 4 Sensitivity Analysis and Design Optimization](#) (1 wk, reading break) Feb 9 □ Feb 23
  - [Laboratory 5a Automated CNC Tool Path Generation & Machining](#) (1wk) Feb 23 □ Mar 5, OR
  - [Laboratory 5b Design Modeling Using Unigraphics NX](#) (1wk) Feb 23 □ Mar 5
  - [Final Project: Application of Integrated CAD/CAE/CAM System for Optimal Design, Design Improvement or Soft-prototyping](#) (3-4 wks) Mar 5 □ Mar 31
- Project Presentation on Tuesday, March 31, 1:30 □ 4:30 pm; Project Report, Due April 3, 2009
- [Example Projects and CAD/CAE/CAM Applications](#)

#### Additional References

- 2D Drawing Generation and 3D Modeling Using AutoCAD (see [Introduction to AutoCAD](#))
- Introduction to C programming (see [A Quick Start on C Programming](#))
- [Introduction to AutoCAD \(Homepage of AutoDesk\)](#)
- [A Quick Start on C Programming](#)
- [Programming in AutoCAD \(ADS Tutorials and Lecture Notes, ARX References\)](#)
- [Other Programming Issues in AutoCAD \(Script File and Menus\)](#)

#### News

The reference books are available at the Reserved Desk in the Library.

Notes: The documents provided here are presented using either the standard HTML or the Adobe Acrobat format. To read these documents in your browser you may need to download the [Adobe Acrobat Reader](#) from the net.  
Last Modified: Jan 14, 2009.

## General Laboratory Information

### Format of the Laboratory Report (Electronic Submission)

- Title of the Assignment
- Names and Student Numbers
- 1. Objective
- 2. Description of the Assignment
- 3. Your Experience and Suggestions
- 4. Illustrations (Images and Drawings from Pro/E)
- 5. New Procedures Developed (if there is any)

Email the following documents to: [mech410@me.uvic.ca](mailto:mech410@me.uvic.ca)

- Lab report in *MS Word* named as: LastName1\_LastName2 (.doc)
- The Pro/E Model File with the same name as above (different extension name).

### Format of the Project Report (Electronic Submission)

- Title of the Project
- Names and Student Numbers
- Abstract (50 – 100 words)
- Table of Contents
- 1. Introduction (Description of the Project, Problem Definition, Theory or Algorithm)
- 2. Implementations
- 3. Technical Challenges
- 4. Special Features and Highlights
- 5. Summary (Experience and Suggestions)
- References
- Appendix
- A. Important figures, drawings, calculations, etc.
- B. Electronic copy of all related and necessary Pro/E files and other source codes.

Email the following documents to: [mech410@me.uvic.ca](mailto:mech410@me.uvic.ca)

- A Microsoft PowerPoint Presentation (4-6 slides)
- Project report in *MS Word* named as: LastName1\_LastName2 (.doc)
- The Pro/E model files with the same name as above (different extension name).

**Laboratory Consultant:**

Mr. Minh Ly (Sen. Sci) Office: ELW A214, Local: 8893, and Email: [mly@me.uvic.ca](mailto:mly@me.uvic.ca)  
TBA (TA) Office: TBA Tel: TBA; Email: [TBA](#)

**Computing Facilities and Software:**

- Department Computational Design Lab (ELW-B228):  
Pro/ENGINEER Wildfire 4.0, ANSYS, MATLAB, SolidWorks, Unigraphics NX  
Autodesk Inventor 10 and Mechanical Desktop 2006 (5 seats)
- Engineering Undergraduate Lab: AutoCAD Lt