



## ***ECET 292: Design for Manufacturing***

### ***Description***

Students will study material that emphasizes the relationship of electronic design and manufacturing, including an introduction to CAD/CAM, Resource Management, Thermal Management and various standards. They will also examine design methodology for the various materials and equipment used in the manufacture of electronic products.

### ***Contact Information***

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### ***Pre-requisites***

*One of:*

- C in English 12
- C in English First Peoples 12
- C in ENGL 092
- C in ENGL 103
- C in ENGL 130
- C in ENGL 142
- C in ELD 092
- C in ELD 097
- C in ELD 103
- C in ECET 190

*And one of:*

- C in Pre-calculus 12
- C in Principles of Math 12
- C in MATH 107
- C in MATH 115

*And one of:*

- C in Physics 11
- C in Physics 101

### ***Course Type***

- *Face-to-face fixed-pace instruction generally on campus*
- *Lecture:* 4 Hours per Week
- *Lab:* 2.5 Hours per Week
- *Out of Class Work:* 4 to 8 Hours per Week

***Credits: 4.0***

## Intended Learning Outcomes

*Upon successful completion of this course a student will be able to:*

- communicate appropriate design documentation
- compare prototype vs. medium vs. large scale manufacturing
- describe the implementation of compliance and safety standards
- demonstrate CAD/CAM techniques using industry standard software
- construct a physical object from a 3D design
- employ strategies for thermal/power/electromagnetic management
- demonstrate the effective use of basic measurement tools
- describe Enterprise Resource Planning principles as they apply to product development and manufacture
- explain the criteria for quality management systems, principles and standards
- demonstrate familiarity with manufacturing processes and equipment
- describe and compare manufacturing materials and their applications
- interpret and apply safety codes and risk management principles

### 11. Grading System:

- Letter Grades as per Camosun College Policies

### IMPORTANT NOTES:

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**Course completion requires:**

- *Lab attendance is **mandatory***
- *All course material must be submitted by the last day of classes*
- *To write the final exam a passing grade ( $\geq 60\%$ ) on all course material must be achieved prior to the final exam*

**A Note on Late Material:**

- *All late course material is reduced in mark by 40% and then an additional 5% per day*

### COURSE EVALUATION:

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Labs	30%	Lab Attendance & Punctuality	5%
Assignments	5%	Equipment Stewardship	5%
Tests	15%	Final Exam	40%

### TEXT BOOKS AND REFERENCES:

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- ◆ Text: None
- ◆ D2L
- ◆ In Class Handouts
- ◆ Web Resources

## Course Outline:

### Design Documentation

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- Product Lifecycle
  - Life Cycle Stages
  - Life Cycle Costs
- Manufacturing
  - PCB fabrication documents
  - Test documents
  - Enclosure Fabrication
- Design Documentation
  - Design Reviews
  - Handover to Manufacturing
    - Over the wall vs Concurrent Design
  - Version Control

### Compliance and Safety Standards

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- Standards
  - E-Waste
  - CSA, UL, FCC
  - CE (Europe), EU
- Electromagnetic Compatibility - EMC
  - EMC
  - Mutual Recognition Agreements (MRAs)
  - Test Methods
  - Design

### CAD/CAM Techniques

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- Drawing standards and techniques
  - Review of ECET 190
- Fusion 360
  - Solid Modeling
  - Constraint Driven
  - Tutorials
  - File Formats
- 3D modelling Integration using Altium and Fusion 360 (**Optional Topic**)
  - MCAD <-> ECAD, Mechanical CAD <-> Electrical CAD <-> 3D Printer
  - Supported Data Exchange File Formats
  - Clearance and Tolerance

### Measurement Tools (Optional)

- Review measuring tape and callipers
- 3D Scanning Overview
  - File Types
  - Importing to Fusion 360
- CMM

### 3D Printing

- STL (Standard Triangle Language) and 3MF (3D Manufacturing Format) file formats
- 3D printing approach
- Student drawn parts

## Thermal and Power Management

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- Thermal Management and Enclosure Design
  - Environmental Testing
  - Thermal Analysis (Optional)
- Power Budget
  - Overall concept
  - Linear vs switching power supplies
- Software tools for analysis: Fusion 360
- Fail-Safe (Optional)
  - General concept
  - Hardware examples
  - Software Examples

## Enterprise Resource Planning – The Supply Chain

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- Time management in manufacturing
  - Timesheets
  - Labour and product Progress tracking
  - Part Procurement and Inventory
- JIT Manufacturing
- Lean manufacturing principles
  - Toyota Production System
  - Bottlenecks and obstacles
- Project Management
  - Serial and Parallel Processes

## Quality Management Systems, Principles and Standards

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- ISO
  - Quality management standard basic concepts and language
  - Requirements of a quality management system
  - Environmental management standards

## Manufacturing Processes and Equipment

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- Electronics Manufacturing
  - Production Fixturing and Tooling
  - PCB Manufacturing
  - Final Assembly
  - Product Acceptance Sampling
- Enclosure Design
  - CNC Machining
  - Human Machine Interface
  - Application
  - Cost
  - Weight
  - Thermal
  - Material
  - Strength
  - Environment
  - IP Ratings (Ingress Protection Markings), Europe
  - NEMA (National Electrical Manufacturers Association), North America
  - Finish

## Manufacturing Materials and their Applications

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- Metals
  - Steel
  - Stainless
  - Aluminium
  - Titanium
  - Copper
- Plastics and composites
  - Thermoplastic
  - Thermosetting plastic
  - Plastic injection molding
  - Plastic Blow molding
  - Two shot (multi shot) molding
  - Ultrasonic welding
- Fasteners for materials
  - Cost
  - Material dependant
  - Installation
  - Special Tools
  - Self-Clinching Fasteners
  - Metal fasteners for plastic
  - Disassembly
  - Finishing
- Adhesives

## Safety Codes

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- Electrical Safety Code

## Prototype vs. Medium vs. Large Scale Manufacturing

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- Principles of Risk Management
- Job vs Batch vs Mass Production
- Design Cautions for Manufacturing:
- Reliability
- Electrical Connectors
- Differences due to location of manufacturer
- Cost reduction
- Time to market
- Part Selection
- Early vendor involvement
- Cultural differences due to location of manufacturer
- Hand loaded Components and Wiring:
- Yield rate
- Offshore Manufacturing Issues
- Quoting Implications
- Design for testing
- Design for Assembly