CAMOSUN COLLEGE

ELECTRONICS & COMPUTER ENGINEERING DEPARTMENT

COURSE OUTLINE

CALENDAR DESCRIPTION

ELEN 165 Microcontrollers

This course introduces microcontrollers hardware and software to electronics technician students, with emphasizing the PIC16F877A microcontroller and its applications. Topics include microcontrollers architecture, programming basics, hardware interfacing, and troubleshooting.

OFFERED:	Summer Semester
CREDIT:	3
IN-CLASS WORKLOAD:	4 lecture, 3 lab
OUT-OF-CLASS WORKLOAD:	5 hrs/wk
PREREQUISITES:	Reserved for DND MARTECH Program
Instructor:	**John Yang**
Office:	**TEC 268**
Phone:	**(250) 370-4213**
Email:	**yang@camosun.bc.ca**

LEARNING OUTCOMES:

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

- follow prescribed safety procedures appropriate to an electronics laboratory;
- describe the architecture of a microcontroller;
- program a microcontroller using assembly and C programming languages;
- design, compile and debug a microcontroller program in an integrated development environment (IDE);
- create programs to control hardware devices;
- handle exception processing and interrupt service routine;
- use a microcontroller to control hardware peripherals;
- test, troubleshoot and emulate programs for microcontrollers systems.

OUTLINE:

1. **Introduction to Microcomputers**
    - 1.1 History of Computers
    - 1.2 Types of Computers
        - 1.2.1 Mainframe Computers
        - 1.2.2 Mini-computers
        - 1.2.3 Microcomputers
    - 1.3 Elements of a Microprocessor System
        - 1.3.1 Basic Block Diagrams
        - 1.3.2 The CPU
        - 1.3.3 Memory (RAM, ROM, EPROM, EEPROM)
        - 1.3.4 Input/Output (I/O)
        - 1.3.5 Internal Buses/External Buses
        - 1.3.6 Speed
    - 1.4 Differences between Microprocessors, Microcontrollers, and Microcomputers
    - 1.5 Microprocessor Architectures
        - 1.5.1 Harvard Architecture
        - 1.5.2 Von Neumann Architecture
        - 1.5.3 Pipeline Architecture

2. **Number Systems Review**
    - 2.1 Binary, Decimal, Hexadecimal, and Their Conversions
    - 2.2 Decimal and BCD Code Conversion
    - 2.3 The ASCII Character Set (ASCII Code)
    - 2.4 Addition and Subtraction in Binary
    - 2.5 Signed numbers and Two's Complement
    - 2.6 Overview of Parity

3. **Introduction to PIC16F877A Microcontroller**
    - 3.1 PIC16F877A Hardware Overview (Block Diagram)
        - 3.1.1 Processor Architecture
        - 3.1.2 Memory
        - 3.1.3 Buses (Address, Data, Control)
        - 3.1.4 Ports
        - 3.1.5 Timers
        - 3.1.6 Analog to Digital Conversion
        - 3.1.7 Comparators
        - 3.1.8 Pulse Width Modulation
    - 3.2 Microcontroller Software Principles
        - 3.2.1 Instruction Execution and Instruction set
        - 3.2.2 Mnemonic Representation/textual format
        - 3.2.3 Introduction to Addressing Modes
        - 3.2.4 Interpreting the Data Book (Hand Assembly)
    - 3.3 PIC16F877A Assembly language instruction set
        - 3.3.1 Accumulator and registers
        - 3.3.2 Data movement
        - 3.3.3 Bit manipulation
        - 3.3.4 Arithmetic
        - 3.3.5 Conditional branching
    - 3.4 PIC Microcontrollers Applications

4. **MPLAB integrated development environment (IDE)**
    - 4.1 Editor
    - 4.2 Assembler
    - 4.3 Compiler
    - 4.4 Linker
    - 4.5 Programmer
    - 4.6 Simulator

5. **PIC Programming Basics in Assembly Language**
    - 5.1 Assembly Directives
    - 5.2 Data and Storage
    - 5.3 Simple I/O
    - 5.4 Decisions (selection)
    - 5.5 Repetition (loops)
    - 5.6 Simple PIC Programs - fragments with conditional branches, loops, and subroutines

6. **PIC Programming Basics in C Language**
    - 6.1 Preprocessor Directives
    - 6.2 Data and storage
    - 6.3 Simple I/O
    - 6.4 Decisions (Selection)
    - 6.5 Repetition (loops)
    - 6.6 Simple PIC Programs (applications)
        - 6.6.1 Switch debouncing
        - 6.6.2 LED counter
        - 6.6.3 LCD display
        - 6.6.4 Matrix keypads

7. **Introduction to MPLAB C18 compiler**
    - 7.1 Overview
    - 7.2 Installation
    - 7.3 Integrating with MPLAB IDE

8. **PIC Exception Handling**
    - 8.1 Interrupt logic
    - 8.2 Interrupt service routines
    - 8.3 Interrupt constraints

9. **PIC Hardware Peripherals Applications**
    - 9.1 Timers
    - 9.2 Interrupts
    - 9.3 Interfacing LCDs
    - 9.4 Interfacing keypads
    - 9.5 Implementing analog-to-digital converters
    - 9.6 Serial communications and interfacing
        - 9.6.1 RS-232
        - 9.6.2 RS-485
    - 9.7 I^2C embedded serial computer bus

10. **Development and Debugging Tools**
    - 10.1 Development Systems
    - 10.2 in-Circuit Emulation
    - 10.3 Logic Analyzer
    - 10.4 Signature Analysis
    - 10.5 Diagnostics
    - 10.6 Troubleshooting Techniques

EVALUATION (Grading according to College policy):

Marks will be assigned to assignments, laboratory exercises, term tests and the final exam. These marks will be weighted according to the criteria defined in **Table 1: Evaluation Criteria** to obtain a composite percentage mark.

A passing grade must meet following three criteria:

1) Overall lab mark is equal to or greater than 60%;
2) Overall theoretical mark (assignments, tests, final exam) is equal to or greater than 60%;
3) The final exam mark is equal to or greater than 50%.

The percentage mark will be translated to a college standard letter grade according to **Table 2: Percentage to Letter Grade Translation**. Table 2 is applicable in this year and to this course only. The course outline identifies concepts and abilities that will be evaluated in this course.

Table 1: Evaluation Criteria

Quizzes and Assignments	20%
Term test 1	10%
Term test 2	10%
Final Exam	40%
Total theoretical marks	**80%**
Laboratory Evaluation	**20%**
Total	**100%**

Table 2: Percentage to Letter Grade Translation

GRADING (in accordance with College policy):

A+	90 – 100%	**B-**	70 – 72%
A	85 – 89%	**C+**	65 – 69%
A-	80 – 84%	**C**	60 – 64%
B+	77 – 79%	**D**	50 – 59%
B	73 – 76%	**F**	< 50%

TEXT BOOKS AND REFERENCES:

- Course notes and handouts
- Data sheets/manuals
- Internet/Websites