CpE-310 Introduction to Microprocessor-Based Design

Semester: Fall 2020 (On-Line)

Course Format and Credit Hours: 3 hr Lecture, 3 hr Credit

Pre-requisites: CpE-271/272
Co-requisites: CpE-311

[Recommended PreReq: EE-251, and EE-252, (and by default Physics, and Math 156. If you are an EE or a CpE, you should have completed EE-251 and EE-252, BEFORE taking this course. CS students get a waiver on this because they have taken Physics. In addition, some programming experience in C would be extremely helpful.)]

Instructor: Dr. Roy S Nutter, (Office: 257 AEB This semester, I am working remote.)

Tel: 293-9131 (I do answer my office phone occasionally so you may call this number and leave a message. I do check messages at least daily.)

e-mail: RNutter@wvu.edu

PLEASE use **Subject: CpE-310** in all e-mail to me

Schedule: MWF 12-12:50 We will start this semester synchronous mode (ie 12:00 MWF) and see how it goes. ie, we WILL meet at this time. I will attempt to record and post all sessions in case you are not able to make it.

Location: On-line = Zoom.com

Office Hours: By appointment (I am NOT in my office this semester, best to e-mail me so I can set up a Zoom session for you at a mutually agreeable time so we can talk.)
Course Objectives: To present the theory and design of microprocessor systems; organization and architecture of modern processors; integration of microprocessors with RAM, ROM, and I/O devices; machine language, assembly language, and software development.

Expected Learning Outcomes:
Upon successful completion of this course:

1. Architecture: the student shall be able to:
   a) draw an overall computer architecture diagram
   b) draw a detailed architecture diagram of the INTEL-8086.
   c) design an address decoder
   d) draw block address decoder
   e) describe two major types of memory
   f) describe the three major types of input output
   g) draw disk drive, tracks, sectors, and cylinders
   h) draw the Interrupt process flow
   i) draw a PC diagram using north bridge, south bridge and all attached busses.

2. Assembly Language: the student shall be able to:
   a) write a program in assembly language for the INTEL 80x86
   b) hand assemble assembly code to machine code.
   c) use all addressing modes in assembly language.

3. I/O Interfacing: the student shall be able to:
   a) draw a design for an output port I/F to light an LED
   b) draw a design for input port I/F to read a switch position

4. Optional Extensions if time permits:
   Digital Communications: The student shall be able to:
   a) draw an Asynchronous data transmission timing diagram
   b) interface an RS-232 device
   c) draw and explain a typical TCP/IP packet
   d) draw a time and/or frequency domain diagram for standard modems

Required Texts: Two books are required BOOK(s)

1. The INTEL Microprocessor Family By James L. Antonakos
   OR
   - Latest edition: Publisher is Thomson, ISBN 1-418-03845-8

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You WILL want to keep this one so you may NOT want an electronic version!!

3. We will be using on-line sources for the INTEL chip and for software that are all free and available. I will provide links as we need them during the semester.

**Grading :** Semester grades for CpE 310 will be computed as follows:

PRE-Covid-19

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>HW Assignments and quizzes</td>
<td>30%</td>
</tr>
<tr>
<td>Participation</td>
<td>5%</td>
</tr>
<tr>
<td>Test #1 (at mid-term)</td>
<td>22%</td>
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<tr>
<td>Test #2 (at end of semester)</td>
<td>22%</td>
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<tr>
<td>Portfolio (See last pg of syllabus)</td>
<td>5%</td>
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<tr>
<td>Final (COMPREHENSIVE)</td>
<td>25%</td>
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**TOTAL =** 100%

**Grade Assignment :**

- A= 90-100
- B= 80-89
- C= 70-79
- D= 60-69
- F= 59 and below

**Grading Policy :**

1. Late Assignments: Late assignments are not acceptable. Assignments are due **on e-Campus at the time it is due**. Late assignments will be worth zero. No paper assignments will be accepted.
2. Joint work: Students are encouraged to discuss assignments but **must submit their own individually prepared work**. Jointly prepared and/or copied assignments **WILL** be severely penalized.
3. Grades assigned during the semester on exams, quizzes, reports, or homework assignments are considered final and are not subject to negotiation for any reason other than an indisputable mistake in grading.

**The Statler College Smart Device Policy:** “The use of programmable calculators or smart devices (including smart-phones, smart watches, tablets, cameras, wearable devices, etc.) on exams and quizzes is prohibited unless specifically indicated by the instructor.”
HW Assignments: Assignments or quizzes may be expected EVERY class. Note once again, they MUST be turned in on e-Campus (no paper will be accepted). Each assignment will be worth approximately the same amount of credit. Each will be counted equally with quizzes. The total of HW and Quizzes is noted above. Assignments are due at the time and date assigned submitted on e-campus. No late HW or other assignments will be accepted.

e-Campus: All class communications (i.e. HW, assignments, announcements, etc) will be via ecampus.wvu.edu. Assignments will be posted on e-Campus. ALL ASSIGNMENTS will be turned in on e-campus. No paper copies or e-mail copies will be accepted. (Note: Be sure to run the “browser check” before you login and check your system for up to date software.)

QUIZES: Quizzes may be given daily based generally on the previous class. BE prepared!

Participation Policy: Participation at all sessions is REQUIRED.

Notes: I recommend that you take notes ON PAPER while participating in class even though I will provide a recording of the class when possible. It has been shown by educators that the act of actually writing down notes and copying graphics from the lecture are a major assist in learning the material. This means writing, not typing on a keyboard. (My belief is that you will learn more by digesting what I say and hearing and writing what I present. Typing of verbatim notes during class has been shown not to work well for students in class.)

Course Schedule

<table>
<thead>
<tr>
<th>TOPICS</th>
<th>Approx. # of lectures</th>
</tr>
</thead>
<tbody>
<tr>
<td>A) Computer Architectures</td>
<td>2</td>
</tr>
<tr>
<td>1) Basic physical architecture of microprocessor (notes).</td>
<td></td>
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<tr>
<td>Overall Architecture types (Harvard Vs Von Neumann)</td>
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<tr>
<td>Overall Architecture Diagrams</td>
<td></td>
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<tr>
<td>Single bus vs Multiple bus architectures</td>
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<tr>
<td>Chap 1</td>
<td></td>
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<tr>
<td>[You must be able to draw a general architecture diagram.]</td>
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<tr>
<td>2) Registers (8086 16 bit-example), Why use Address &amp; Data Registers</td>
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<tr>
<td>3) Special Purpose Registers, Why do we need Program Counter Status Register</td>
<td></td>
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4) Memory, Introduction to
   RAM, how addressing works, Post Office example
5) Simple Instruction examples (for the 8086)
   MOVE, ADD, NOP, JMP
6) Addressing modes (example 80x86)
   Immediate  MOVE.W  #$8123, D3
   Absolute   MOVE.L  D3, $1234
   Register
   Direct     MOVE.L  D0, D3
   Indirect   MOVE.L  (A0), D3
   PC-relative
   more…..
7) Branching
   JMP unconditional
   Jump conditional
   Loop
   Stack Pointer and Stack allocation
8) Jump subroutine (JSR)
9) Memory
   1) RAM, ROM, PROM, EPROM, UVEPROM, EEPROM
   2) Static random access memory (SRAM)
   3) Dynamic random access memory (DRAM)
   4) Addressing
      Byte Addressing
      Word Addressing
      Long Word Addressing
10) Instruction formats
    Program Control hardware
    Program Counter
    Instruction Format options
    Multiple word instructions
    Assembly language Vs machine code
    Flag Register
    Segment Registers
    Real Mode
    Protected Mode

   [You must be able to draw an 8086 architecture diagram including detail of all registers and data paths]

   1

   [You MUST be able to:
    1. Write a program in Assembly Language
    2. Hand assemble to machine code
    3. Use all addressing modes]
[4. Hand operate the machine cycle by cycle ]

Review and TEST #1

B) Microprocessor Hardware
2) Pin Definitions
3) Clock rates

C) Parallel Input/Output
1) General Parallel I/O
2) Address decoding (Page 407)
[You must be able to design an address decoder]
3) Parallel Interface/Timer Chips,
   Modes of operation
   Double Buffering
   Output register
   Output port Registers and addressing

D) Microprocessor Bus
1) Internal Vs External Buses
2) Addressing
3) Memory maps (example lab board)
4) Full Address Decode Vs Block Address Decode
[You must be able to draw Block (Partial) Address Decoding]
5) Asynchronous Vs synchronous Bus
6) PC buses
   ISA (8Mhz)
   EISA
   VESA
   PCI (33 MHz)
   AGP
   USB
7) North Bridge, South Bridge.
[You must be able to draw a PC diagram showing all buses, bridges and speeds.]

E) Secondary Memories
1) Disk Drives
   Track, sector, cylinder,
   Disk Drives, Hard drive, CD Drive, DVD
[You must be able to draw disk drive, tracks, sectors, and cylinders]
2) Cache memory
   L1 and L2

F) Peripheral Interfacing
1) Drivers (Review of EE-56, Totem Pole, Open collector, Tri-state)
2) Driving LED's, How to
3) Reading Switches, How to
4) A/D and D/A converters

[You must be able to draw a design for an output port I/F to light an LED.]
[You must be able to draw a design for input port I/F to read a switch position.]

G) I/O Programming
1) Programmed I/O
2) Interrupts and interrupt programming
   Interrupt request, Interrupt Priority, Interrupt Mask
3) DMA, Direct Memory Access
[You must know the three major types of I/O.]
[You must be able to draw the Interrupt process flow.]

H) Serial Input/Output
1) RS-232 serial ports
2) UARTs and DUARTs
4) RS-422, RS-423
[You must be able to draw an Asynchronous RS-232 data transmission timing diagram.]
[You must know how to interface an RS-232 device.]

I) Digital Communications
1) Modems
   ASK, FSK, PSK, QSK, Cable modem, ADSL, POTS
2) OSI/ISO levels
3) Physical Layer
   Ethernet, 10-base-T, 100-base-T, ATM
4) TCP/IP Addressing
   Class A, B, C, D,
   Subnets and Subnet masks
   Hub, Bridge, Switch, Router
[You must be able to draw a time and/or frequency domain diagram for STD modems.]  
[You must be able to draw and explain a typical TCP/IP packet.]
[You must be able to calculate the value of a subnet mask.]

J) Advanced Topics: (Time permitting, basic concepts, less heavily treated
   than in textbooks. Topics may differ from those listed below.)
1) Basics of memory management and virtual memory (parts of
   sections 7.2 and notes).
2) Cache memory techniques
3) Basics of math coprocessors
4) CRT Displays
5) Multiprocessing
Course Goals:

In CpE-310, the student will develop a working understanding of contemporary 16/32/64-bit microprocessors (using the INTEL 80x86 family of microprocessors as examples) and their expanding role as software-controlled elements of digital systems (embedded computers) and large scale systems. The companion laboratory (CpE-311) will use an INTEL QUARK commercial 80x86 based single board computer (SBC.) This is in the form of an INTEL D2000 development board and will be provided for you in lab. This experience assist the student gain practical experience with both programming (assembly language) and interfacing applications.

Lectures in CpE-310 will emphasize the underlying principles associated with microprocessors, starting with the programmer’s model and the general internal architecture of microprocessors. Assembly language programming, providing an understanding of the fundamental microprocessor instruction sets and addressing modes, will be presented, providing the student with an appreciation of the low-level structure of executable programs supported by lab projects using the laboratory single board computer. Lectures will then extend to other hardware issues, including execution times, microprocessor buses, memory hardware, I/O functions such as serial and parallel ports and an introduction to modem communications and TCP/IP protocols. Interfacing of special purpose peripherals to a microprocessor is discussed, leading to a final project in the laboratory, CpE-311. Advanced topics including digital communications, cache memory, memory management, while such things as floating point coprocessors will be discussed if time permits.

Class policies include all policies and statements located at the following link:
https://tlcommons.wvu.edu/syllabus-policies-and-statements

Class Communications:

All class communications will be via ecampus.wvu.edu
Lecture notes and assignments will be posted there as well.

Participation Policy: This class will be impossible to pass without participating.

Class Cancellations: If a class is cancelled, notice will be posted on e-campus and mailed to your MIX ACCOUNT. Generally, assignments will be posted as well to replace the missed lecture time. Students are responsible for getting cancellation information and assignments. In all emergency situations, however, we rely on individuals to make the best decision for themselves about their safety.

Notice of Class Recording Policy: Meetings of a course at West Virginia University (WVU),

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whether online or in-person, may be recorded. Recordings are not guaranteed, and are intended to supplement the planned class session. Recordings will be made available to class participants, which may include students, assistants, guest lecturers, and co-facilitators. Recordings may be shared by the instructor or institution in accordance with WVU Rules and policies. The Recordings are owned by and contain intellectual property of WVU. The Recordings may not be shared, copied, reproduced, redistributed, transferred, or disseminated in any form or by any means without the prior written consent of authorized officials of WVU.

**Covid-19**: If a student becomes sick or is required to quarantine during the semester, they should notify the instructor. The student should work with the instructor to develop a plan to receive the necessary course content, activities, and assessments to complete the course learning outcomes.

**Sale of Course Material**: All course materials, including lectures, class notes, quizzes, exams, handouts, presentations, and other course materials provided to students for their courses are protected intellectual property. As such, the unauthorized purchase or sale of these materials may result in disciplinary sanctions under the WVU Student Conduct Code.

**In addition:**

**Academic Integrity**

The integrity of the classes offered by any academic institution solidifies the foundation of its mission and cannot be sacrificed to expediency, ignorance, or blatant fraud. Therefore, I will enforce rigorous standards of academic integrity in all aspects and assignments of this course.

For the detailed policy of West Virginia University and Statler College regarding the definitions of acts considered to fall under academic dishonesty and possible ensuing sanctions, please see **Sanction Policy for Academic Integrity Offenses that is linked below**: [http://catalog.wvu.edu/undergraduate/collegeofengineeringandmineralresources/#policiestext](http://catalog.wvu.edu/undergraduate/collegeofengineeringandmineralresources/#policiestext)

By default, all WVU recommended Academic policies and syllabus statements located at [https://tlcommons.wvu.edu/syllabus-policies-and-statements#10](https://tlcommons.wvu.edu/syllabus-policies-and-statements#10) are hereby included in this syllabus.

In addition:

- Homework joint work: Students are encouraged to discuss homework assignments
but **must** submit their own individually prepared assignments. Jointly prepared
and/or copied assignments **WILL** be severely penalized.

- **Other notes on academic dishonesty**
  - I consider it academic dishonesty if you share final assignments, work, solutions,
etc with other students.
  - Changing variable names and/or output messages does not make it original work!
  - If ANYTHING, including code, is “reused,” you must cite the source (code
source can be cited in the comments for that code or routine. This includes your
own previous work!)
  - Allowing others to view your work by leaving permissions set incorrectly or
leaving files on hard drives or other disks accessible by others will be considered
academic dishonesty and will result in an F in the course.
  - If a student does discuss and share work with another, thinking that the person who
is receiving that information will not copy it, both people will be held responsible
for academic dishonesty if identical work is submitted and both claim that it is
original.
  - Grades assigned during the semester on exams, quizzes, reports, or homework
assignments are considered final and are not subject to negotiation for any reason
other than an clear mistake in grading as determined by me.
  - Use of cell phones, smart wearable devices such as Apple watches etc, or possession
of other external communication devices are strictly prohibited during exams, tests,
or quizzes administered inside the classroom.
  - Common standards of academic integrity prohibit not only cheating or
plagiarizing,
but also the unethical conduct of trying to obtain grades that the student has not
earned. Violations of academic integrity are described in the WVU statements
referenced above.
  - All incidents of student misconduct or academic dishonesty will be handled
promptly and appropriately in accordance with the WVU Student Conduct Code and
Discipline Procedure. ALL cases will be referred to the Office of Student Conduct.
  - **NOTICE:** Violations may lead to dismissal from the Statler College and expulsion from
the University.

**NOTICE:**

All course materials, including lectures, class notes, quizzes, exams, handouts,
presentations, and other materials provided to students for this course are protected
intellectual property. As such, the unauthorized purchase or sale or distribution of these
materials may result in disciplinary sanctions under the Campus Student Code and US
Federal Law.

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Portfolio Guidelines

CpE-310: Introduction to Microprocessor-Based Design

Portfolios are used as an assessment tool. The learning objectives for the course are specific and are enumerated in the course syllabus. The portfolio then serves to document your progress toward the learning objectives of this course. You will turn in your portfolio at the final exam. It is best if you collect your material as the semester progresses.

ESSENTIAL ELEMENTS OF THE PORTFOLIO

It is important to include all of the following:

1. **Title page**: Should include name and class. This should appear as the cover AND as an internal title sheet.

2. **Cover Letter** “About the author” (tell me about yourself and your background) and “What my portfolio shows about my progress in this class.” The cover letter informs about your background and summarizes the evidence of a student’s learning and progress. This MUST be a cover letter. i.e. write a letter!

3. **Self-Evaluation**: Your overall class self-evaluation, written at the end of the semester. You should include in this, a well-supported argument for the course grade you think you deserve.

4. **Table of Contents**
   1. Numbered pages,
   2. If paper form, index tabs for each “learning objective” to help with the organization.
   3. Dates on all entries, to facilitate proof of growth over time.
   4. Organized by “Learning Objective.”

5. **Entries** –
   **Required**
   - Organized by “learning objectives” from the syllabus, you should provide a complete and well organized record of How you learned each learning objective. I would suggest that you use your homework, quizzes, personal reading of the text or other material, internet sites, and/or lab reports to show how each objective has been learned. (In fact, you may wish to refer back to this material in the future.) How did you progress in this “learning objective” over the semester?

   **Optional**:
   These items allow the folder to represent the uniqueness of each student.
   - You may choose to include “best work” or your “favorite pieces of work.”
   - You may include also a piece of work which gave trouble or one that was less successful, and
give reasons why.

- **Reflections** can appear at different stages in the learning
  1. For each item - a brief rationale for choosing the item should be included. This can relate to students’ performance, to their feelings regarding their progress and/or themselves as learners.
  
  Students can choose to reflect upon some or all of the following:
  2. What did you learn from it?
  3. What did you do well?
  4. Why did you choose this item?
  5. What do you want to improve in the item?
  6. What were the problem areas?
  7. How did I perform on this?

REMEMBER: Do NOT put extra items into the portfolio just for volume. It is **quality** that counts, not quantity, and the main point of portfolio assessment is the thoughtful selection of **evidence of learning**.

**Make it look professional.**