# CpE-310 Introduction to Microprocessor-Based Design

[August 7, 2019 …rsn]

Semester : Fall 2019
Home page: at https://ecampus.wvu.edu Location : 135 AER
Time 12:00-12:50 MWF

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

Instructor : Roy S Nutter
Office: 257 AEB
Tel: 304-293-9131
e-mail: RNUTTER@wvu.edu
Office Hours : 1:00 MWF is usually a good time. For other times, feel free to stop by or by appointment (please call or e-mail to be sure I will be in my office when you come. I am many times there and available at other times not scheduled as well. If you are outside the building, call first to be sure I will be in and available when you arrive.)
***[All e-mail should start the subject line with "CpE-310" so that I see it.]***

Required Texts: Two books are required.

1. The INTEL Microprocessor Family By James L.Antonakos

- Third Edition is better if you can find it (in fact I prefer this one. It is sometimes on Amazon and other on-line sources.) ISBN-10: **0138934398** | ISBN-13: **978-0138934392** | Publication Date: **June 3, 1998**

OR

- Latest edition: Publisher is Thomson, ISBN 1-418-03845-8

2. Upgrading and Repairing PC's, by Scott Mueller, Que Publishing, Get the **latest Edition**. (no earlier than 22nd Edition.) ISBN-10: 0789750007
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.

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

[*Recommended* PR: 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.]

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 Objectives :
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 Extentions 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

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

| | |
|---|---|
| Homework and quizzes: | 21% |
| (A few HW and mostly daily quizzes) | |
| Portfolio (See last pg of syllabus) | 5% |
| Attendance | 5% |
| Examinations | |
| Test #1 (at mid-term) | 22% |
| Test #2 (at end of semester) | 22 |
| Final (COMPREHENSIVE) | 25% |
| | 100 % |

Grade Assignment : A= 90-100
B= 80-89

C= 70-79
D= 60-69
F= 59 and below

Grading Policy :

1. Late Homework: Late homework is not acceptable. Homework is due **on e-Campus** only and at the time it is due. Late homework will be worth zero. HW turned in on paper will not be graded.

2. 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.

3. Makeup Exams: No make-up exams (except by prior arrangement with the instructor.)

**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 regarding the definitions of acts considered to fall under academic dishonesty and possible ensuing sanctions, please see the West Virginia University Academic Catalog at http://catalog.wvu.edu/undergraduate/coursecreditstermsclassification/#academicintegritytext. Should you have any questions about possibly improper research citations or references, or any other activity that may be interpreted as an attempt at academic dishonesty, please see me before the assignment is due to discuss the matter.

- I consider it academic dishonesty if you share final assignments, work, solutions, etc with other students.
- Changing variable names and/or output messages on code does not make original work!
- If code is "reused," you must cite the source and should cite it in the comments for that code or routine.
- Allowing others to view your work by leaving permissions set incorrectly or leaving files on hard drives or other storage accessible by others will be considered academic dishonesty (not to mention poor security practice on your part.)
- 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 indisputable mistake in grading.
- Use of cell phones, smart wearable devices, 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 Catalog: http://bit.ly/2hDAeUa.
- Students have the right to appeal final grades. The appeal process is outlined in the WVU Catalog: http://bit.ly/2uiMM9E.

- Incidents of student misconduct or academic dishonesty will be handled promptly and appropriately in accordance with the WVU Student Conduct Code and Discipline Procedure. The case will be referred to the Office of Student Conduct. Violations may lead to dismissal from the Statler College and expulsion from the University.

HW Assignments: Homework assignments will be given aperiodically. 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 worth 21 % of the final grade as 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 !

Attendance Policy: **Attendance at all class sessions is REQUIRED**. Attendance will be taken at most class sessions and will count 5% of the final grade as shown above. Consistent with WVU guidelines, students absent from regularly scheduled examinations because of authorized University activities will have the opportunity to take them at an alternate time provided that

arrangements are made before the test; homework for such activities shall be submitted before the absence occurs. Make-up exams for absences due to any other reason will be at the discretion of the instructor and will not generally be granted.

Class distractions: Cell phones, iPods, etc must be turned OFF during class. These are distracting for all.

Lap Tops in Class: You are expected to take notes ON PAPER. You may NOT use your laptop or tablet in class unless I have received information from the disabilities office. (My belief is that you will learn more by digesting what I say and hearing and writing what I put on the blackboard. Typing of verbatim notes in class has been shown not to work well for students in class.)

Course Schedule

| | TOPICS | Approx. # of lectures |
|---|---|---|
| A) | Computer Architectures | |
| 1) | Basic physical architecture of microprocessor (notes). | 2 |
| | Overall Architecture types (Harvard Vs Von Neumann) | |
| | Overall Architecture Diagrams | |
| | Single bus vs Multiple bus architectures | |
| | **Chap 1** | |
| [You must be able to draw a general architecture diagram.] | | |
| 2) | Registers (8086 16 bit-example), Why use | |
| | Address & Data Registers | |
| 3) | Special Purpose Registers, Why do we need | |
| | Program Counter | |
| | Status Register | |
| 4) | Memory, Introduction to | |
| | RAM, how addressing works, Post Office example | |
| 5) | Simple Instruction examples (for the 8086) | |
| | MOVE, ADD, NOP, JMP | 1 |
| 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….. | 8 |

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) 2
   4) Addressing
      - Byte Addressing
      - Word Addressing
      - Long Word Addressing 2
10) Instruction formats
    - Program Control hardware
    - Program Counter
    - Instruction Format options
    - Multiple word instructions
    - Assembly language Vs machine code 2
    - 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** **2**

B) Microprocessor Hardware
   2) Pin Definitions
   3) Clock rates 1

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 3

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 Address Decoding]
5) Asynchronous Vs synchronous Bus
6) PC buses
ISA (8Mhz)
EISA
VESA
PCI (33 MHz)
AGP
USB
7) North Bridge, South Bridge. 3
[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
1

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 2
[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.] 3
[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 2

[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 3

[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
2) Cache memory techniques . 1
3) Basics of math coprocessors 1
4) CRT Displays 1
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.

Academic Policies:
By default, all WVU recommended Academic policies and syllabus statements located at 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. Note: Violations may lead to dismissal from the Statler College and expulsion from the University.

  Makeup Exams: No make-up exams (except by prior arrangement with the instructor.)

**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 of these materials may result in disciplinary sanctions under the Campus Student Code.**

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# ACADEMIC DISHONESTY POLICY

As a student in the Lane Department of Computer Science and Electrical Engineering, you are expected to behave ethically and professionally. In addition to the WVU policies on cheating in the WVU student Handbook, **https://tlcommons.wvu.edu/syllabus-policies-and-statements** the Lane Department and your instructor add the following.

In particular, academic dishonesty, including plagiarism and cheating, will not be tolerated.

If you submit any assignment -- report, project, homework, portfolio, exam, etc. -- under your name that has been reproduced in any part or in whole from the work (paper or electronic ) of others without specifically citing the source, you are being academically dishonest. You are also being dishonest if you knowingly allow your work to be submitted by someone else without acknowledgement that it is yours.

If you are found to be academically dishonest, in addition to WVU sanctions that can lead to expulsion from the program, and/or from WVU, the Lane Department and the Professor will take the following action:

Per the Student Handbook, the instructor may choose any of the following:

- -- you may receive a zero score for the applicable assignment. A notation will be placed in your student file (if you are a Lane Department major) AND sent to your advisor, the Department Chair, and the University.
- – you may receive an "unforgivable F" in the applicable course.
- – you may be dismissed from the class and prevented from taking any Lane Department class in the future.
- -- you may be dismissed from WVU.
- These actions may be appealed following the process outlined in the WVU Student Code of Rights and Responsibilities. In all cases a formal report will be sent to WVU as per WVU procedures.

You should know that such actions may affect future internship, work, or job opportunities.

# Portfolio Guidelines

## CpE-310: Introduction to Microprocessor-Based Design

last update 1/6/2018 by rsn

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 with**
    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.**