EGR/CS333 Digital Design & Interfacing ("Digital Design II, Assembly Language, and Interfacing")
SPRING 2019 FINAL EXAM
JT Wunderlich PhD

This final exam is worth 30% of your course grade; 2/3 of it is based on your customized individual problem; the other 1/3 of the grade is based on your answer to your choice of 10 of the attached **"Questions"** that you believe are most relevant to your design; the grade on those questions will be based on both the quality of your answers and whether or not you picked the 10 most relevant questions to your project.
Everything is due **BY MIDNIGHT ON SUNDAY MAY 12 OF FINALS WEEK; EMAIL ALL OF IT TO ME**, or if the file is too big to attach to an email, put it somewhere where I can get it and tell me where it is; **IT MUST BE IN FULLY EDITABLE FORMATTING.**

CUSTOMIZED INDIVIDUAL PROBLEM:

Lacie:
Since you did an internship with Phoenix Contact last summer and have displayed some of the very best understanding of our advanced Phoenix Contact Axioline PLC controllers and PCWorkx software, solicit input from everybody in the class about their experience with these PLC's in addition to all of the information gathered by our teaching assistant Clay. Also, contact Josh Krug at Phoenix contact and get access to the training material for PC Workx 6 (see below -- sharepoint link expired).

REF: Email form Josh Krug:
"I would be happy assist your students in creating a connection to Axioline controller. They are more than welcome to contact me via email or phone with their questions.
In regards to the manual, I have a few helpful tools I can offer.
PC Worx 6: https://bit.ly/2S8eIJX
-In the downloads tab you will have access quick start guides, application notes, software updates, and libraries
AXC 1050 manual: https://bit.ly/2Niez0k
-Also available in downloads tab
Training material for PC Worx 6: https://phoenixcontact-my.sharepoint.com/:f:/p/jkrug_americas/EsW9wP96lrhEqVnOBQGzi7wBw7SY2UQNp8zJrwh1g5YmNq?e=Vo7kWM
-This material is available via shared link which will expire in one day. Please download before it expires and distribute as needed.
The training material will be the most helpful for the students for getting started with connecting to the PLC and using PC Worx 6. Let me know if you have any questions!
Regards, Joshua R. Krug Associate Solutions Engineer Phoenix Contact USA, Inc. | Industry Management & Automation
800-888-7388 ext 3975 (717) 395-6961"

Then do these things:

1) Learn how Control the PLC using structured text
2) Using our standard format for 333 lab project assignments, create a new lab assignment asking students to compare the use of structured text to the function block layout technique we have been using.
3) Update our custom manual with all of the above (doc version located in 333 folder): http://users.etown.edu/w/wunderjt/AXC%20Manual%20v0.0.5.pdf

Lindsey:
Solicit input from everybody in the class about their experience with Phoenix Contact NanoLC PLC's in addition to all of the information gathered by Clay, our teaching assistant. Also ask everybody about what they observed while mentoring the visiting Teams of students at the Northeastern Regional Competiton we hosted for Phoenix Contact on a Saturday in February. Then update our custom NanoLC PLC manual with all of the above (doc version located in 333 folder) http://users.etown.edu/w/wunderjt/NanoLC%20Manual.pdf

Hameedah:
Solicit input from everybody in the class about their experience with Phoenix Contact Relays in addition to all of the information gathered by Clay, our teaching assistant. Then create a new custom lab manual including at least two downloaded data sheet specifications for both a solid state and an electromechanical relay, and fully explain every part of each data sheet.

Lauren:
Since I observed in your lab 5_6, the best implementation and demonstration of a raspberry pi, I want you to solicit input from everybody in the class about their experience with Raspberry Pi's in addition to all of the information gathered by Clay, our teaching assistant. Then update our Raspberry Pi and ARM Assembly language custom manual with all the above (doc version located in 333 folder). http://users.etown.edu/w/wunderjt/Raspberry%20Pi%20MANUAL%20and%20Labs.pdf Include screenshots like you displayed to me when demonstrating lab 5_6, and photographs of your circuit set-ups including the special design of your own, with a description.

Scott:
Create a full set of drawings and specifications for somebody to build the competition robot like you built in high school; include mechanical diagrams and narrative, electrical circuit schematics and narrative, and software engineering flow charts, code, and narrative. Add a section about how you would possibly use any of the technologies you have learned this semester in 333 to enhance that Robot. We may very likely use this as our first case study in CS/EGR434 Green Robotics & Automation in the Fall. Write everything in a way that high school students can understand, because you may be asked to complete a special community-service outreach mission in the fall using your case-study.

Derek:
Create a complete design document of the robot you built for Lab 4, plus your work for lab 7 such that someone could easily follow your work and completely rebuild what you made, and add to it. Include mechanical, electrical, software, and navigation details, as well as costs and where to get parts. Include many photos. Also, at your discretion, add details of any project completed by you or others this semester in EGR/CS33 that you believe could enhance this project. Then also create a poster of all this that we can show to ABET in Fall 2020 after you graduate in Spring 2020. I will likely put both of these things in the 2020 ABET Computer Engineering Self-study and/or other ABET documentation.

Kevin:
You did an outstanding job cleaning and organizing the giant mess of parts and equipment that accumulated over the past 20 years in my lab. Discuss with me the 2014 computer engineering self study, and write a new sub-section for the 2020 self-study within the Lab Facilities chapter which includes a complete inventory of working parts and equipment in E273, with estimated values next to each (use brand new market replacement values) and title it "Inventory and Dollar Values of all equipment and parts in the Robotics and Machine Intelligence Lab by Kevin Carman" -- also include a list of what you see as things that need to be repaired or replaced so that future offerings of EGR/CS333, 433, and 434 can fully function.

Jonathan:
Create a new lab manual for assembly language simulations including both the Intel 8051 microcontroller simulator that we used, and your own assembly language simulator. Compare and contrast the two including the GUI and HCI aspects as well as the power and beauty of the assembly language for each; include screenshots and sample code segments as well as the assembly language instruction set for each, with register transfer notation. Reflect on our most recent custom lab manual for microcontrollers as well our past manuals, and selectively bring some of that content forward into your new manual

http://users.etown.edu/w/wunderjt/8051%20manual_Amir_Buxton_Combined%20v1.0.pdf
http://users.etown.edu/w/wunderjt/8051%20Manual%20v%201.0%20Kelly%20and%20Cain.pdf
http://users.etown.edu/w/wunderjt/Instructions%20on%2080251%20Microcontroller%20Board%20and%20Software%20-%20SP11WEB2.htm

Ethan:
In preparation for the EGR/CS434 Green Robotics and Machine Intelligence course that you are registered for in the Fall, research all available student robotics competitions (IGVC, NASA, etc) and read related past publications and online web content of students from past Elizabethtown College robotics projects (located all over my website), then create a schedule and outline specification (mechanical, electrical, software, and navigation & obstacle avoidance plan), with some conceptual estimates of dollar values, for a autonomous mobile robot design that you believe is feasible to mostly implement by the 12 computer science and computer engineering students in the fall in that course, with follow-up work to be done in other computer engineering and senior project courses in the spring. Also include discussion of all of the hardware and software used in EGR/CS333 and how each of these may or may not be applicable to this robotics project. Begin by reading these previous "Wunderbot" documents (click on all links):

http://users.etown.edu/w/wunderjt/Wunderbot User Manual.docx
http://www2.etown.edu/wunderbotvi/
http://users.etown.edu/w/wunderjt/home_researchMINE.html

Conor:
Read all of my publications related to simulations and real time control including the assembly language code and high-level language code for the 1991 bottling plant real time control and simulation projects here: http://users.etown.edu/w/wunderjt/home_Lab_Manuals_HiTech.html , then research what happened at three Mile Island, Chernobyl, and Fukushima, and write a report as if you were writing it as an official report to both the U.S. Nuclear Regulatory Commission (NRC) and the United Nations, with technical terminology to be reviewed by their staff, stating specifically what SCADA, and real time control circuitry, operating system, and human computer interaction should be specified to prevent international environmental disasters. Also create an annotated bibliography of all of your citations for government leaders and their staff around the world to find High quality information and standards. Make sure you emphasize the strengths of running concurrent simulations with real time code as well as using simulations before initial design, and for quality testing before these critical systems are ever implemented.

Eric:
Read all of my publications related to simulations and real time control including the assembly language code and high-level language code for the 1991 bottling plant real time control and simulation projects here: http://users.etown.edu/w/wunderjt/home_Lab_Manuals_HiTech.html , then research what happened in as many aircraft related malfunctioning of technology as you can find, including the Boeing Max 737, the Boeing V-22 Osprey disasters, and the completely fly-by-wire Boeing 787, and then write an official report as if you were writing to the US Military High Command about the risks in proposing multi billion dollar contracts with Boeing if your recommendations for quality control and software engineering are not implemented; followed by a detailed outline specification including flow charts and testing methodology of your plan.

Baihzhong:
Write a report that you intend to give to your uncle in China demonstrating your complete knowledge of controlling the electrical power system, and negotiating pricing for the electrical power requirements, of the Data Mining operation you helped supervise last summer. Clearly demonstrate your understanding of Real and Reactive Power, Power Factor, and how these things are dealt with differently in the United States versus in China including variations in pricing and standards. Include real data from the Chinese operation that you worked on as well as phasor diagrams and dollar values. Begin by re-reading my lecture on AC Power:

http://users.etown.edu/w/wunderjt/333%20PURDUE%20EET231%20lecture2,3,4A,4B%20AC%20POWER,%20single%20and%20three%20phase,%20PowerFactor.pdf

TEACHING ASSISTANT CLAY:
In addition to all of the intensive work and updating of manuals that you have done for the students and I over the semester, please implement with the most recent FPGAs, interfacing examples using at least a couple of the sensors we bought intentionally for this purpose when we purchased the FPGA's. In addition to sending me this document separately, incorporate it into your custom user manual, with a comprehensive write up, and a listing of all the code that you create, plus photographs of the working electronics, timing traces, etc. And as you finish up our most recent FPGA manual, please read through old manuals and bring some of those ideas forward (in updated ways of course), like FPGA Cells and LookUp Tables, Xilinx Software packaged with FPGA instead of Logisim done separately, Register-Transfer-Level (RTL) schematics in recent FPGA vs logic circuits in Logisim and Xilinx and why the "Synthesis" logic circuits look so different than both of these (i.e., talk about optimization vs standardization, as well as differences in energy efficient "Low Power" design – by what is energized or not for different functionality at any given time), etc:
http://users.etown.edu/w/wunderjt/333%202018B%20FPGA%20Manual.pdf
http://users.etown.edu/w/wunderjt/FPGA%20DRAFT%203_12_18%20manual%20update%20ise%2032bit.pdf
http://users.etown.edu/w/wunderjt/Xilinx%20instructions.pdf
http://users.etown.edu/w/wunderjt/Instructions%20on%20FPGA%20Board%20and%20Xilinx%20softwareWEBupdated_s06.htm

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QUESTIONS:

OVERARCHING CONCEPTS

1. **(This one question is worth SEVEN questions in weight)** From a your own problem defined in words, draw
    a. the needed ladder logic
    b. the nanoLC flowchart,
    c. a sketch of how the circuit would look on the axioline PLC
    d. a breadboarded chip implementation with SSI parts (including full wiring schematic showing all pinout connections)
    e. an FPGA simulation including any special input and output designations
    f. a logisim simulation using the unique symbols of that software
    g. an Intel 8051 microcontroller assembly language program,
2. Rank each of digital design and interfacing apparatus that you used in the course from most favorite to least favorite and describe precisely why you would recommend this ranking order to a future employer or client.
3. Which one of the technologies in this course would you hope would be behind the technology keeping you alive under critical conditions in a hospital when you're years old; assuming you of healthy mind and body and wish to survive.
4. Describe precisely what the team that you mentored during the 2019 Northeastern regional nanoLC competition did; including their hardware, software and construction of an apparatus; and their team cooperation, division of labor, and team presentation & demonstration impact, professionalism, demonstrated knowledge of complexity, and creative thought.
5. What is the main intent of EGR/CS332 Computer Organization (Digital Design I and Intro to Assembly Language) and why is it a mandatory prerq for EGR/CS333 Digital Design (II) and Interfacing and EGR/CS433 Advanced Computer Engineering
6. ~~Where is the company our guest speakers are from?~~
7. ~~Approximately how many billions of dollars of revenue and how many employees work at our guest speakers company?~~
8. ~~Approximately how many of our computer engineers have been employed at this company?~~
9. Name one aspect of our guest speakers technology that could be very sensitive to cyber attack?
10. Name one application of our guest speakers technology that requires extremely high precision temperature control?
11. Name one application of our guest speakers technology that is most dangerous if not controlled careful?

12. ~~Write a paragraph about what our guest speakers talked about.~~
13. Describe how a design-build turnkey company works
14. ~~What manufacture of PLCs does our guest speakers company use?~~
15. ~~Describe at least one component of a thermodynamic circuit in a refrigerator.~~
16. Write a paragraph about what you would hope to see and learn on a field trip to our guest speakers' work.
17. Give an example of when you may have given up too soon on trying to solve a problem.
18. ~~Why is the penalty for an unexcused absence in this type of class so harsh?~~
19. Why are teams often better than individuals working solo even if the net productivity is less?
20. If you were to handpick a team of six people to work together under the most extreme of circumstances, define your selection criteria including what your role would be.
21. Describe your favorite team moment where everybody in your group was equally happy about solving some problem together. Describe the problem, why it was so puzzling initially, and what made the solution so happy.
22. What are the advantages of working with random potentially-broken equipment with potentially no solution?
23. Research what happened on Apollo 13 and how they survived.
24. Give one example where are you designed a test of a circuit in 333 that you're most proud of.
25. Give one example where are you designed a test of software in 333 that you're most proud of.
26. Rank each of digital design and interfacing apparatus that you used in the course from most favorite to least favorite and describe precisely why you would recommend this ranking order to a future employer or client.
27. Which one of the technologies in this course would you hope would be behind the technology keeping you alive under critical conditions in a hospital when you're years old; assuming you of healthy mind and body and wish to survive.
28. How could exercising on a secret military base compromise security? https://www.theguardian.com/world/2018/jan/28/fitness-tracking-app-gives-away-location-of-secret-us-army-bases
29. Imagine and define a peacetime sustainability application of any of the technologies you have learned in this course.
30. Imagine and define a military application of any of the technologies you have learned in this course.
31. Imagine a new technology that you might create based on what you have learned in this course.

DIGITAL DESIGN II

31. ~~Solve this two's complement problem~~
32. ~~Simplify this combination digital circuit function using a simplification map~~
33. ~~Convert this circuit to all NAND gates~~
34. ~~Design this combinational digital circuit...~~
35. ~~Design this sequential synchronous digital circuit...~~
36. ~~Analyze the unused states of this sequential digital circuit.~~
37. ~~Design this counter given this count in binary.~~
38. What are the advantages of learning HDL Hardware Descriptive Language for programming FPGA's?
39. What would be the downside of only learning HDL Hardware Descriptive Language to design digital circuits?
40. Write in HDL Hardware Descriptive Language routine to implement a given digital logic design problem
41. Describe the use of timing diagrams using an FPGA
42. Compare and contrast why you would use and FPGA versus Logisim for a given application
43. What is your favorite digital design tool and why?
44. What is the difference between the final "Synthisized" (not "optimized"!) schematic created by the 2019 FPGA and the RTL Register Transfer Level schematic that you can generate, and how does this possibly relate to schematics made with Logisim. Describe how FPGA's in general, are more about the power and flexibility of implementing sophisticated digital design than about low-power circuit design, or optimized logic
45. Describe precisely what you would need to do to make a Logisim circuit that you create work on the 2019 FPGA. Compare and contrast digital design using the FPGA versus Logisim
46. State one thing that you believe definitely needs to be clarified in our 2019 FPGA manual.
47. What did your group add to the FPGA PLC manual
48. Define precisely what an "FPGA" Cell and LookUp table (LUT) are

INTERFACING

49. What does it mean to have a floating input or pin, and why is it a bad thing?
50. Describe how a pull-up resistor works?
51. Describe how a current-limiting resistor works with an LED?
52. Describe how to debounce a toggle switch using logic gates
53. Describe how to debounce a pushbutton using an analog circuit
54. Why can't you just splice in toggle switch or push button switch into an input line of any kind of device to presumably create logic zero and logic one?
55. Why does every pin on an integrated circuit chip need to be connected to some voltage level if it is part of a logic circuit implementation?
56. Why do integrated circuit chips need to have a power and ground, but your simulated circuits do not?
57. How do you get 24V from two 12V batteries?
58. How do you make a voltage divider?
59. What is the difference between a single phase and a three phase AC motor? Describe using applications.
60. What are the different types of AC motors?
61. What are the different types of DC motors, and how do you control them?
62. When can you use pulse width modulation to control a motor?
63. What is an optical encoder, and when would you use one?
64. Describe what a motor's stator, rotor, and commutator are?
65. What is the purpose of brushes in some motors?
66. How is a DC stepper motor similar to a three phase AC motor?
67. Describe in words and draw an internal electrical schematic of how a DC stepper motor works.
68. Describe an application for when a DC stepper motor would be the best choice.
69. Why are AC motors often a better choice for industrial applications?
70. Draw an H bridge, describe how it works, and state an alternative way to create directional control for a DC motor.
71. What is the difference between open loop and close loop control?
72. Why exactly did we burn out three relays in a row? One group had the likely answer.
73. What is the difference between a stepper motor and a servo?
74. Draw a closed loop circuit showing 120 V DC power source, 0.8 ohm transmission line, and a 100 amp load, then calculate the voltage delivered to the load and state why it may not be acceptable. Also calculate the input power created by the source.
75. Calculate the transmission line Power loss if we were to generate 120 V DC and deliver it to a 100 amp load over a transmission line with a 0.8 ohm resistance.
76. List the three advantages of AC power over DC power
77. Draw a two line diagram showing 120 V AC generator and a 1:10 step-up transformer

78. Draw a single line diagram showing 120 V AC generator, a 1:10 step-up transformer, a 1200 V AC transmission line, a 10:1 step-down transformer, and a 100 amp load. Then calculate the voltage delivered to the load and make a statement about its appropriateness in magnitude.
79. Describe what Power Factor (PF) is in an AC circuit
80. Describe what reactive power is in an AC circuit
81. Describe how to use a bank of capacitors in a factory to correct a Power Factor
82. Why is understanding how our power generation and distribution works critical to understanding our vulnerability to cyber attack? And what degree of security do you believe our nanoLC and advanced PLCs provide in preventing cybersecurity attack if they were to be networked and connected over the Internet?
83. In the United States we have three separate power grids, list three reasons that we connect them together, and then list one reason concerning cyber security that they should stay separate.
84. What is a Phasor in reference to AC circuits; give an example starting with an AC sine wave.
85. Describe in words the difference between real power, reactive power, apparent power an AC circuit power distribution.
86. Describing in words the difference between electrical inductance and capacitance.
87. Draw the power triangle showing Real, reactive, and apparent power, and then state what a lagging and leading power factor is and how it is effected by an inductive or capacitive load
88. What is the difference between kVA and kVAR?
89. Why do you believe the power company penalizes customers financially for poor power factor?
90. Why do you believe factories typically have poor Power Factors?
91. If you were hired as a consulting engineer to improve the Power Factor of a factory, what would you recommend?
92. Describe in words what three phase power is, and also draw the three phases with voltage sine waves.
93. Draw a picture and describe in words what a harmonic is when discussing AC power, or anything having to do with waves including music, mechanical vibration control, or architectural acoustics.

B) Computer Engineering & Science

94. What are the hazards to the function of electronics in an industrial setting?
95. Convert some ladder logic to a flow chart.
96. What voltage can you input or output into the Axioline PLC?
97. What is the advantage of having sinking outputs on the nanoLLC?
98. Why is it a good idea to use relays to control outputs instead of trying to source the voltage and current directly out of the base unit?
99. What is SCADA?
100. What is the advantage of running a simulation concurrent to a real-time control system in industrial applications?
101. Why does the problem of system stability and close loop control only apply to PLCs and not SCADA?
102. How do you connect relays to the inputs and outputs of an axiolineline PLC?
103. Compare and contrast simulation versus real time control, including the strengths and weaknesses of both, and why you may want them to be working concurrently together.
104. What exactly happened at three Mile Island in 1979 and how did the people combined with their control systems fail?
105. What kind of real world scenarios require the most adaptability in real time?
106. Why do you think assembly language is used for embedded applications?
107. What did your group add to the Axioline PLC manual
108. Describe every part of a given Phoenix Contact data sheet for a relay
109. Describe polls and throws in a DPDT switch
110. Draw both the United States and international symbol for DPDT
111. Draw and describe in words exactly how you would connect wires to both the primary and secondary sides of a relay
112. Describe how to debounce a pushbutton using an assembly language routine
113. Describe in words how backpropagation neural network learning works
114. Describe the mobile robot real time and simulation assignments discussed in the Wunderlich publication ***simulation versus real time control with applications to robotics and neural networks***
115. Describe the robotic arm real time and simulation example discussed in the Wunderlich publication ***simulation versus real time control with applications to robotics and neural networks***
116. Describe the Neural Network real time and simulation example discussed in the Wunderlich publication ***simulation versus real time control with applications to robotics and neural networks***
~~117. Compare and contrast a raspberry pi to an Arduino~~
118. Compare and contrast why you would use a PLC versus a standard computer for a given application
~~119. Compare and contrast the Intel 8051 microcontroller to the ARM microcontroller, including both hardware and assembly language aspects~~
120. Compare and contrast PLC ladder logic to flowchart-driven software implementation.
121. State one thing that you believe definitely needs to be clarified in our advanced PLC manual.
122. State one thing that you believe definitely needs to be clarified in our nanoLC PLC manual
123. Describe two distinctly different aspects of Dr. Wunderlich's real time vs simulation of a bottling plant.
124. Describe two distinctly different ways that a simulation can be used in reference to developing a real-time system (not two different applications, but rather two different purposes for one application)
125. Name one present day mission critical application where the coordination between real-time code and simulation code is critical.
126. Precisely describe one situation where an airplane pilot desperately needs the help of a simulation.
127. Precisely describe one situation when an airplane pilot needs to easily be able to override a simulation to take control of real-time actuation's of aerodynamic control surfaces.
128. Precisely describe one situation when a fighter pilot makes the best use of concurrent interactive simulation and real time code.
129. Precisely describe what happened at three Mile Island and how the mix of simulation, real-time code, and human screwup, led to what almost was the biggest environmental disaster in United States history. And describe how Chernobyl was different. And describe how Fukushima was different.
130. Why do you believe that the advanced PLC, unlike the nanoLC, does not seem to obviously have a way to simulate before implementation?
131. What is your favorite interfacing device and why?
132. How could a cyber attack on water supply controls, including PLCs, of California, specifically effect southern California the most?
133. How could a cyber attack on the supply chain in the United States, including PLC controls of automated packing and distribution, affect the health of United States citizens (worst case)?
134. How could a cyber attack on a nuclear power facility, including PLCs, cause a disaster?
135. How could a cyber attack on an oil and gas facility, including PLC's, create the most damage?
136. How could a cyber attack on the United States electrical grid, including PLCs, cause the most damage?
137. What exactly happened with "Stuxnet"?
138. What manufacture of PLCs did our guest lectures tell us they use at GEA Systems?
139. What technology did our guest lectures from GEA systems demonstrate for us?
140. What was the most mission-critical application of PLCs that our guest lecturers from GEA systems told us about?
141. Describe the difference between an op code and an operand

142. ~~Do this assembly language problem using Dr. Wunderlich's instruction set creation for the purely REGISTER-reference instruction shown here, including showing the changing of register and memory contents, register transfer notation, and any necessary calculations show. (this is exactly like what you learned in the pre-requisite EGR/CS332 course.)~~
143. ~~Do this assembly language problem using Dr. Wunderlich's instruction set creation for the purely MEMORY-reference instruction shown here, including showing the changing of register and memory contents, register transfer notation, and any necessary calculations show. (this is exactly like what you learned in the pre-requisite EGR/CS332 course.)~~
144. ~~Do this assembly language problem using Dr. Wunderlich's instruction set creation for the MIXED REGISTER/MEMORY-reference instruction shown here, including showing the changing of register and memory contents, register transfer notation, and any necessary calculations show. (this is exactly like what you learned in the pre-requisite EGR/CS332 course.)~~
145. List the four basic stages of instruction pipeline (machine instruction cycle) and how they differ for register reference versus memory reference instructions in most microprocessors and large scale systems.
146. List the four reasons stated in lecture as advantages of knowing how to program in assembly language.
147. Why are memory reference machine instructions slower than register reference machine instructions most of the time for microprocessor applications, and why can this sometimes not be true for microcontroller applications.
148. How is the PSW in the 8051 microcontroller not just a status register?
149. What is an Accumulator and how is it different from a typical general purpose register; and how is it sometimes the same?
150. How does the 8051 microcontroller assembly language sometimes use the accumulator?
151. Describe in words the difference in the how a register is used for register reference versus memory reference instructions
152. State register transfer notation for four instructions of your choosing to demonstrate your knowledge of the four different addressing modes of 8051 microcontroller assembly language.
153. Describe what an assembler directive is?
154. Describe the exact purpose of these four Intel 8051 assembler directives: "org" "equ" "db" "dw"
155. Why are register-reference instructions typically faster than memory reference instructions?
156. Why are register-reference instructions not typically faster than memory reference instructions in microcontrollers?
157. What is the difference between a Princeton architecture and a Harvard architecture in microprocessor and microcontroller design?
158. What is the function of a program counter?
159. How is a stack used in assembly language for program calls and interrupt service routines in assembly language?
160. Draw and precisely describe the pinouts of the 8051 microcontroller for one of the ports
161. Draw the memory map of the 8051 microcontroller
162. Describe the multiplexing of pins in the 8051 microcontroller
163. Describe the different addressing modes in the 8051 microcontroller
164. Compare and contrast the long, short, and absolute jumps in the 8051 microcontroller
165. Describe how the two control bits in the 8051 microcontroller status register are used to reconfigure the default register bank in the memory map.
166. Draw and describe all of the contents of the 8051 microcontroller status register.
167. ~~Describe in words and register transfer notation each of the following 8051 microcontroller arithmetic instructions~~
168. ~~Describe in words and register transfer notation each of the following 8051 microcontroller logic instructions~~
169. ~~Describe in words and register transfer notation each of the following 8051 microcontroller bit manipulation instructions~~
170. ~~Describe in words and register transfer notation each of the following 8051 microcontroller jump instructions~~
171. ~~Describe in words and register transfer notation each of the following 8051 microcontroller subroutine instructions~~
172. Why does the NOP instruction exist in 8051 microcontroller assembly language
173. Compare and contrast in precise detail why you would use a microcontroller versus a microprocessor for a given application