EMISY 19L, questions for mid-term test 28.03.2019

This list contains theoretical questions that may appear during mid-term test.

The test will consist of two parts: theoretical questions (5 to 10 questions for 10 points total) and one design task for 15 points total. Maximum number of points to score is 25.

The primary requirement for passing the course is to score minimum 25 points from both lecture tests (and optional make-up test).

Questions (requiring answers as short as possible):

1.) What is the difference between microcontroller and microprocessor?
2.) Name three different microcontroller manufacturers.
3.) Name three different microcontroller families.
4.) Draw the symbol of logic 2 input NAND gate. What will be the output state of NAND driven with inputs equal to 0,0 ?
5.) Draw the symbol of logic 2 input XOR gate. What will be the output state of XOR driven with inputs equal to 1,1?
6.) Shortly describe what a tristate gate is. Where is it used?
7.) Is it always possible to connect logic gates from different types, for instance CMOS and TTL?
8.) What is a minimum input voltage level considered as logic '1' by TTL inverter? What is a maximum input voltage level considered as logic '0' by TTL inverter?
9.) Draw a simple block diagram of a microcontroller.
10.) What do a control unit and execution unit do?
11.) What does ALU do?
12.) Describe a concept of three bus microcontroller architecture, using block diagram.
13.) Describe von Neumann architecture.
14.) Describe Harvard architecture.
15.) What are the differences between von Neumann and Harvard architectures?
16.) What is the difference between CISC and RISC architectures?
17.) Name three different packages for microcontrollers.
18.) Draw a schematic of serial input parallel output register.
19.) Draw a schematic of parallel input parallel output register.
20.) What will be the binary representation of 89 DEC in natural binary system?
21.) What will be the binary representation of 107 DEC in U2 coding system?
22.) What will be the binary representation of 66 DEC in BCD coding system?
23.) What will be the binary representation of 33 DEC in BCD coding system?
24.) What is memory map and why is it helpful? What is the maximum internal program memory size of 8051 microcontroller?
25.) What are the general purpose registers? How many of them are in 8051 microcontroller? How are they arranged?
26.) What are SFR registers? Name minimum 3 SFR registers in 8051 microcontroller.
27.) What is the accumulator? Describe its function How many accumulators are in 8051 microcontroller? How many of them are in AVR microcontroller?
28.) What is the stack? Describe its function.
29.) Describe immediate addressing.
30.) Describe register addressing.
31.) Describe direct addressing.
32.) Describe indirect addressing with offset. When may it be useful?
33.) Draw a simple block diagram of typical microprocessor system?
34.) What types of power supplies do you know? What type of power supply would you use for a device available worldwide and why?

35.) What are typical voltage levels required to supply microcontrollers and digital logic?
36.) Why don't we still use 5V digital logic in most applications? Where is it still used and why?
37.) What is the function of reset in microcontroller? Draw a simple reset circuit for STM32 microcontroller.
38.) What is the function of clock signal in microcontroller?
39.) Why the square wave clock signal can be a source of EMI?
40.) Draw a schematic of simple Schmitt inverter RC generator.
41.) Draw a schematic showing how to connect crystal resonator to microcontroller.
42.) How would you divide clock signal frequency of 1 MHz by 2?
43.) How would you divide clock signal frequency of 1 MHz by 10?
44.) How would you divide clock signal frequency of 500 MHz by 20?
45.) Draw a schematic of simple PLL frequency multiplier and describe how it works.
46.) Draw a schematic of simplified bi-directional GPIO pin, without alternate functions.
47.) How much current can the load draw from 8051 microcontroller pin? How much current in total can the loads draw from 8051 port?
48.) How would you connect 100mA LED to the microcontroller? Draw schematic of the circuit.
49.) How would you connect 4V violet LED diode to 3.3V microcontroller?
50.) Why do LEDs are driven with current sources or resistors?
51.) What are the values of voltage drop for different color LEDs?
52.) How does a RGB diode work? Draw a schematic of common anode RGB LED.
53.) Describe 3 different types of switches.
54.) How would you connect SPDT switch to microcontroller?
55.) What is debouncing and why is it needed in microprocessor systems?
56.) Describe how hysteresis loop work in Schmitt trigger buffers.
57.) Describe how matrix keyboard works.
58.) Describe how interrupt based keyboard works.
59.) List 3 different types of displays.
60.) Describe static driving method for LED display.
61.) Describe multiplexing for LED display. What should be the switching frequency?
62.) What is DDRAM in alphanumeric text LCD displays based on HD44780 driver or its clone?
63.) What is CGROM in alphanumeric text LCD displays based on HD44780 driver or its clone?
64.) What is the function of RS and R/W pins in HD44780 driver based LCD display?
65.) Describe 4 bit interface and 8 bit interface connection diagram for HD44780 driver based LCD display.
66.) What is the purpose of using potentiometer connected to pin 3 (VO) of HD44780 driver based LCD display?
67.) Describe the initialization procedure of HD44780 driver based LCD display.
68.) List 3 different types of LCD graphical displays.
69.) How to drive a single NIXIE tube with a microcontroller? What voltage does it require?
70.) What is assembler and its function?
71.) List 3 assembler program elements.
72.) Describe 3 assembler directives and their functions.
73.) What is the function of MOV instruction?
74.) What is the function of MOVX instruction?
75.) What is the function of DJNZ instruction?
76.) What is the difference between SJMP, AJMP and LJMP instructions?
77.) How many clock cycles does a typical instruction of 8051 require?
78.) How many clock cycles do MUL and DIV instruction require?
79.) How would you write value stored at address 30H to the accumulator? Write one assembler instruction and describe addressing mode you want to use.
80.) How would you write value stored in the accumulator at the address given in R0 register? Write one assembler instruction and describe addressing mode you want to use.

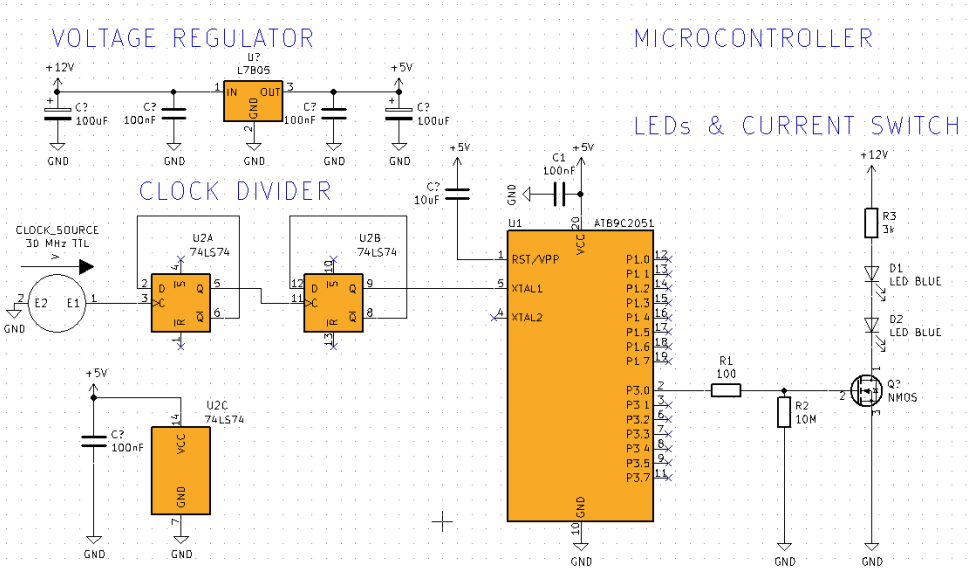
Example of design task:

Design a simple microprocessor system based on 8051 microcontroller that will light two blue LEDs connected in series. Draw a full schematic, describe component selection and calculate what needs to be calculated. Do not forget about the power supply and the assembler code.

- Available power supply is 12V.
- Available LEDs have voltage drop of 3V when forward-biased by 2mA current.
- Available microcontroller is AT89C2051:
  - Power supply range from 3 to 5V (safe operation)
  - Reset circuit – 10uF capacitor connected to VCC
  - Max. GPIO current – 1mA source, 10mA sink
  - External clock signal should be connected to XTAL1, XTAL2 left floating
  - No MOVX function (too small internal memory, no external memory)
  - Clock frequency up to 12 MHz
  - Do not add programming interface or communication peripherals.
- Available clock source is 30 MHz external TTL square wave signal (0-5V)
- Available NMOS and PMOS transistors – V_{TH} = 4V, I_{DSMAX} = 5A.
  - Gate polarization resistor should be 10 MOhm to ground.
  - Gate should be connected with microcontroller pin via 100 Ohm series resistor.
  - When ON the U_{DS} voltage is equal 0V.
- Available flip flops: 74LS74
  - Supply voltage 4.5 to 5.5V
  - Max. input frequency greater than 50 MHz
- Available voltage regulators: 7805, LD1117-33
  - Output voltage 5V or 3.3V
  - Output current – max. 1A
  - Power dissipation – max 1W
  - Use 100uF and 100nF capacitors
- We can assume that overall current will not be greater than 100mA.

Solution:

1.) Two blue LEDs in series will have voltage drop equal to 6V. This makes it impossible to drive them directly from the microcontroller pin.
   a. A current switch is needed, based on available NMOS switch.
      i. It needs 10 MOhm resistor to bias the gate and 100 Ohm series resistor (according to task remarks).
      ii. It is NMOS switch – it is turned on with logic one
      iii. The V_{TH} voltage is 4V, so it fits the 89C2051, supplied with 5.0V
   b. LEDs are current driven devices – I need a resistor that will limit the current flowing through the LEDs.
      i. I will use the available 12V power supply for the LEDs. When switch is turned ON there is no voltage drop on it, so the only voltage drop is on the resistor and the LEDs. The drop on the resistor is 12V-6V = 6V, so to have the 2mA current I need R = 6V/2mA = 3kOhm.
2.) Reset circuit is given in remarks – capacitor to VCC, nothing more.
3.) Clock circuit – I have external TTL 30 MHz square wave signal. I need to divide it's frequency by 4 so it fits the 89C2051 requirement (12MHz max). For this I need two D-type flip flops, acting as frequency dividers, connected in series. This will give the frequency of 30:4 = 7.5 MHz.
4.) Power supply:
   a. LEDs need 12V
   b. 89C2051 needs 5V, because of clock signal and NMOS V_{TH} voltage.
   c. 74LS74 needs 5V,
   d. Current consumption should not exceed 100mA – I can use a standard 7805 linear voltage regulator. It will dissipate power equal to (12V-5V)*100mA = 700mW. The 7805 will require small heatsink, but it meets the requirements
5.) Schematic



6.) Assembler code:
   a. LED is connected to P3.0
   b. One line is needed: MOV P3, #01H
      i. It uses immediate addressing to write 01H (00000001B) to P3 port – set P3.0
      ii. NMOS is ON when gate is driven logic '1' – LEDs are ON.