Score_____/_____

Instructions: Please review each question prior to responding, there is probably multiple sections to it. Fully explain, describe, and as needed draw a picture that will assist as necessary. If there is math and logic to accomplish please show all your steps. Good luck!

1. What are the four commands that set up the stack segment? Explain each line of code.

    LDI R16, HIGH (Ramend)   Loads the High end of Ram into R16
    out SPH, R16   Sends that value to SPH
    LDI R16, LOW (Ramend)   Loads the Low end of Ram into R16
    out SPL, R16   Sends that value to SPL

2. What location has been used for the top of the stack in our programs? What physical address location? Where can you find this information?

    $085F
    In the book and datasheet.

3. With each RET instruction, the SP is (**incremented**, decremented, unchanged). Circle the correct answer.

4. There are a total of ___4___ ports in the Atmega32.

5. True or (**False**). Upon power-up, the I/O pins are configured as output ports.

6. Explain the purpose of the 74LS244 in the interface circuitry? Draw how the device is connected for proper operation? The 74LS244 used to prevent current coming Back into the microcontroller.

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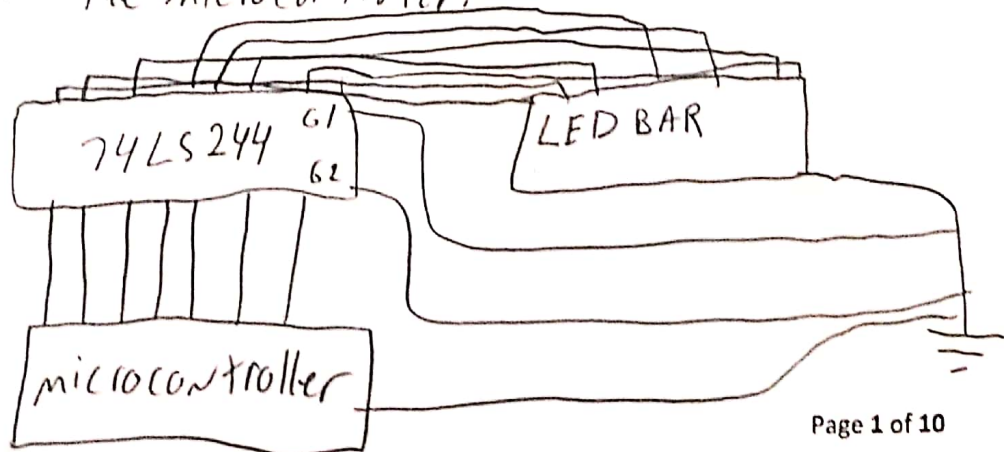
7. Explain the role of DDRx and Portx in I/O operations. Describe both Input and Output Function. You must load 0x00 DDRx to configure Portx for input and 0xff for output. Portx can be used to assign a value to the pins of the port.

8. Describe the purpose of the flag bits C, V, N, H, and Z and how are they interpreted. Where are the flag bits stored?

C- Carry Flag   - This flag is set whenever there is a carry out from the D7 Bit

V - Overflow flag - This flag is set whenever the result of a signed number operation is too large

N - Negative flag - The D7 Bit is used to designate a value as negative

H - Half carry - If there is a carry from D3 to D4 during an ADD or SUB operation this Bit is set

Z - Zero flag - It means the arithmetic result was zero.

9. The AVR system uses primarily 1 machine cycle or period to execute a command. If the microcontroller system is using a 16 MHz crystal, how much time is elapsed per command? 10 commands?

$$\frac{1}{16 \times 10^6} = 16 \, us$$

$$\frac{1}{16 \times 10^6} \times 10 = 160 \, us$$

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10. Which address is pushed into the stack when a call instruction is executed?

The address of the instruction being called.

11. The command BRNE uses which flag bit to exit out of a loop? Write an example of the use of a BRNE command for a loop and describe the commands and what they do.

BRNE uses the Z Flag.

```
LDI R16, 10          ; load 10 into R16
LDI R20, 0           ; load 0 into R20
LDI R21, 3           ; load 3 into R21
Again: ADD R20, R21  ; R20 + R21 → R20
   Dec R16           ; reduce R16 by 1
   BRNE Again        ; Branch Back to Again if R16 is not 0
   out PortB, R20    ; Send sum to PortB
```

12. What are the four commands used to manipulate a bit from an I/O register? Describe how each line of command would be interpreted by the assembler by providing an example.

```
SBI, CBI, SBIS, SBIC
   SBI PortB, 2    ; set Bit at PortB 2
   CBI PortB, 2    ; clear Bit at PortB 2
   SBIS PinB, 2    ; Skip Bit if PB2 is High
   SBIC PinB, 2    ; skip Bit if PB2 is Low
```

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13. Write the instruction to make R23 have a label of counter.

.equ counter = R23

14. Write the instructions to add the values 0x16 and 0xCD. Place the results in the R19 register and copy the results to memory location 0x0200

LdI r18, 0x16
LdI r19, 0xCD
ADD r19, r18
StS 0x200, r19

15. True or (False:) No value can be moved directly into the I/O registers.

16. Below are several lines of assembly language instructions. Treat each assembly code line as an individual event. Therefore, the previous instruction does not impact the next line of code. Describe what each line of assembly code is accomplishing. State the contents and locations affected by the opcode.

    a. SER temp   Loads the value 0xFF directly into temp

    b. LDI numb1, $FE Loads the value $FE into numb1

    c. ADC num1, num2 Adds num1+num2 with the carry flag and stores it in num1

    d. RJMP LEDoff relative jump to Label LEDoff

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17. Below are several lines of assembly language instructions. Describe if the instruction is a valid instruction for the location and value being manipulated.
    a. LDI R14, 45 ; Valid

    b. SER R0 ;   Valid

    c. MUL R23, R24 ; Valid

    d. ADI R16, 34   Invalid

    e. STS R16, 0x0200 Valid

    f. LDI R20, 500   Invalid

    g. LDS PortB, R0 Invalid

18. Describe how to write the following types of numbers using assembly language:
    a. Binary numbers   0b 0001

    b. Hexadecimal numbers   0x00 , $FF

    c. Decimal numbers   10

    d. Octal numbers   o 10

19. Describe the purpose of the assembly directives used to this point in the course:
    a. .org   Set at an address
    b. .def   Create a label for something
    c. .equ   Define a constant value or address
    d. .include   It includes a specific library

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20. What is the result of the following code along with the impact on the SREG for each command?

What are the initial and final values in all registers?

LDI R16, 0x38 ; Loads immediately the value 0x38 into r16 , none

LDI R17, 0x2F ; Loads immediately the value 0x2F into r17, none

ADD R16, R17 ; R16 + R17 → R16 "A" Bit

STS 0x0200, R16 ; Store r16 at address 0x0200

STS 0x0201, R17 ; Store r17 at address 0x0261

21. What command and/or process is used to divide an unsigned number using the AVR?

multiple subtraction

22. How many general purpose and special function registers are there in the Atmega32 device?

32 GPR

23. What is the capacity of the internal SRAM of the Atmega32 device?

2 Kb

24. What is the capacity of the EEPROM of theAtmega32 device?

1KB

25. Using the program on the next page. Write in the first four addresses of the stack in the first column. In the subsequent columns show where the SP register is pointing and what data has been pushed unto the Stack or off of the stack. Use the examples from class and in the book to assist you.

Stack Addresses	Before the first call	After the first call	After RET	After the second call	After RET
0x0000	0X065F	0X065D	0X065F	0X065D	0X065F
0x0001	0X065F	0X065D	0X085F	0X085D	0X085F
0X0800	0X065F	0X086D	0X065F	0X0860	0X065F
0X065F	0X065F	0X045D	0X065F	0X065D	0X065F

The 0x0000: values are address in program flash for each of the commands in the code.

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26. Write either the command or comment for what the code is doing.

```
.include "m8515def.inc"

.org 0

        ldi r16, high(ramend)
        out SPH, r16              ;send value to stack pointer register high byte
        ldi r16, Low(ramend)      ;load immediately the value for the low byte address of SRAM
        out spl, r16

start:
        ldi r17, $CC             ; load immediately the value $CC into r17

                                 ;send value to portb

        rcall delay              ;relative call to delay
        ldi r17, $FF             ;load immediately the value $FF into GPR r17
        out portb, r17           ; send value in r17 out to portB
        call delay               ; call delay function
        jump start               ;forever loop to the main code

.org 0x100

wait:
        ldi r20, 250             ; load immediately the value 250 into GPR r20

again:
        NoP                      ;no operation command
        NoP                      ;no operation command
        dec r20                  ; decrement R20
        BRNE again               ;if not equal branch to again


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```

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27. What three registers are used to access the EEPROM memory location? What are their purposes?

Address, Data, and Control Registers.

Address specifies the address in the EEPROM Space

data register contains the data to be read/written to/from the EEPROM

Control Registers contain the Reserved bits the EERIE and EEMWE

28. What are the three primary step sequences for running the stepper motor and what are they called? What type of interface circuit is required to run the uni-polar stepper motor? Explain the purpose of using both the logic analyzer and oscilloscope to monitor the operation of the stepper motor circuitry.

Full step 1100, 0110, 0011, 1001

half step 1000, 1100, 0100, 0110,0010, 0011, 0001, 1001,

wave step 1000, 0100, 0010, 0001

LM7805CT Power Supply Circuit

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29. Which activities did you find most challenging in this class? Which activities surprised you and why? Which activities would you change and why?

Stepper motor lab but that was mostly because of my own hardware issues. I was surprised how well the LCD lab went for me since many other students had troubles with it.

30. What would you do differently as a student if you could now that you have been through the class? If you could leave a note for your classmates next year about the class what would you say to them?

Stay on top of the class more I fell behind and it made it difficult to move forward in the class. Make sure you have a good understanding of this week or you will struggle next week.

31. What do I need to do differently or keep the same or develop to make this class better?

The only problem I had was with the covid restrictions.