0907333 Embedded Systems (Spring 2009)
Midterm Exam

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Instructions: Time **90** minutes. Closed books and notes. No calculators or mobile phones. **No questions are allowed**. Complete and sign the pledge below before you start answering the questions of this exam. Show your work clearly and write your final answer in the underlined space. Every problem has 2 points.

عهد والتزام

أنا الطالب:..... رقمي الجامعي:..... رقم شعبتي:.....

أقسم بالله العظيم أنني سألتزم الصدق والأمانة أثناء أدائي **لامتحان نصف الفصل لمادة الأنظمة المضمنة**، وأنني لن أغش أو أحاول الغش، ولن أقدم المساعدة لأي شخص أو أتلقاها من أي شخص، طيلة فترة الامتحان . وأن إجابتي على كامل الأسئلة ستكون نتاج جهدي الشخصي وحدي. وأنني أتعهد بتحمل كافة المسؤوليات والعقوبات القانونية، المنصوص عليها في أنظمة وتعليمات الجامعة، في حال عدم التزامي بذلك.

التاريخ: توقيع الطالب:

Q1. The main difference between a lab-top computer system and an embedded system is

A lab-top computer is a standalone general purpose computer and its principle function is computational. While an embedded system is a computer incorporated within a product to undertake control.

Q2. The main difference between an assembler directive and an assembly instruction is

Directives are used to aid the process of writing and transferring the program instructions (codes) to the target microcontroller/microprocessor. They only pass info to the assembler telling it what to do. In contrast, the instructions perform the real task of the program and deal directly with the microcontroller/microprocessor hardware.

Q3. The side effect of using the **`retfie`** to return from a normal subroutine in a PIC program is

The **retfie** instruction enables the GIE/GIEH bit in the flag register and this would enable all unmasked interrupts. Consequently, the system will be subject to unexpected interrupts if this issue is not taken into consideration during the program development.

Q4. List the four sources of interrupts in the PIC16F84A microcontroller.

1) Timer-0 overflow
2) A change in the upper nibble of Port B.
3) External interrupt via PB0
4) EEPROM write completion.

Q5. What happens inside the microcontroller hardware when the instruction **`goto 0x34`** is executed?

1- Flush the current PC.

2- Load PC with 0x34.

Q6. The PIC 16F84A instructions that are related to the literal and control operations can be represented by either an OPCODE and 8-bit literal or an OPCODE and 11-bit literal. What are purposes of the literal bits in each case?

8-bit literal: Data

11-bit literal: Address

Q7. Why does a PIC 16F84A's branch instruction take an effective of two instruction execution cycles?

1- One cycle to flush current PC and execute dummy cycle.

2- One cycle to fetch a new address where the branch starts.

Q8. Assume that the following code has just been executed.

```
movlw  20
sublw 10
```

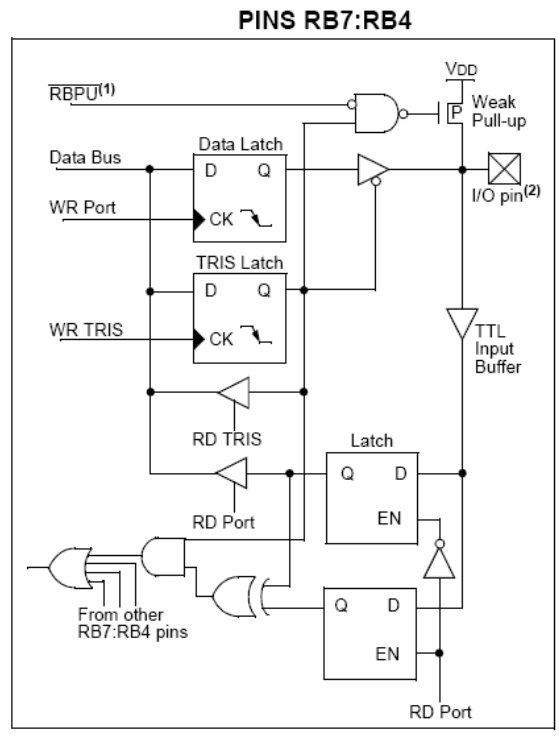
a) Specify the condition of the following three status flags:

C:	0	DC:	1	Z:	0

b) The binary content of the working register is 11110000

Q9. For the I/O port to the right, what is the purpose of the circuit producing the signal at the output of the 4-input OR gate?

To detect an interrupt on PORTB pins 4-7 when any change form 0 to 1 or 1 to 0 happen.



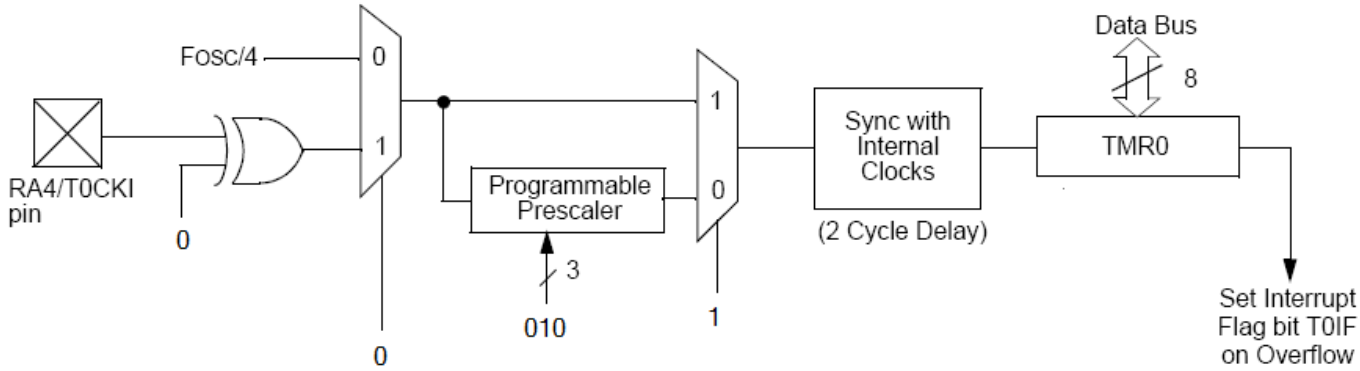
Q10. How long does it take to execute the following instructions on a PIC 16F84A running at a clock of 400 kHz?

```
movlw 0ff          1T
movwf var1         1T
btfss var1,0       2T
sublw 10           skipped

focs/4 = 400 kHz /4 = 100 kHz
T = 1/100,000 = 10 µsec
Time = 10 * (1+1+2) = 40 µsec
```

The answer is __40___ µsec

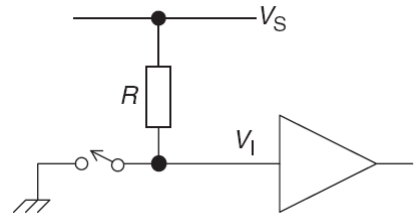
Q11. Every how many instruction cycles the following circuit generate an interrupt signal? __256_____



Q12. For the following circuit, find the maximum value of resistance *R* given that V_s = 5V, Min. V_{IH} = 2.4V, and I_{IL} =1µA.

$V_s = I_{IL} * R + V_{IH}$

$R <= (V_s - V_{IH}) / I_{IL} = (5-2.4)/ 1\mu A = 2.6\ M\ \Omega$

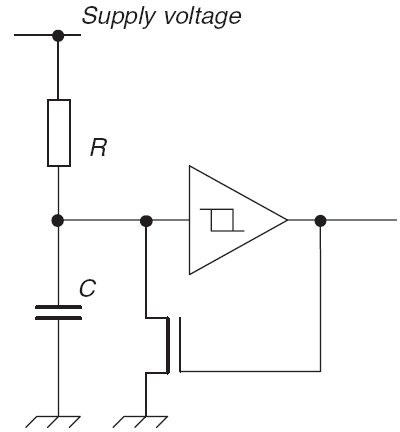


The answer is *R* =____2.6M___ Ω

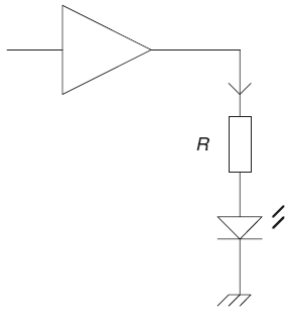
Q13. For the circuit to the right, what is the purpose of the Schmitt trigger buffer and MOSFET transistor?

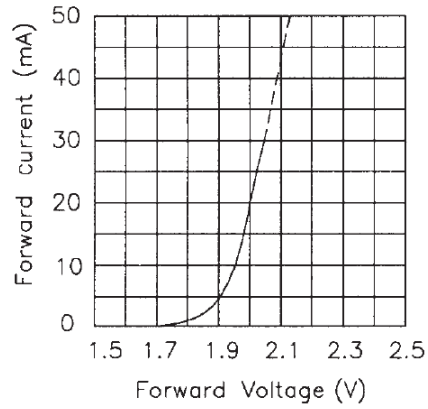
The buffer ensures that the transistor is open for enough time to discharge the capacitor and produces a rectangular waveform.

The transistor discharges the capacitor when it is open.



Q14. For the following circuit and LED voltage-current characteristics, find the resistance *R* given that the LED requires 20mA when "ON", V_s = 5V, and the microcontroller's output resistance R_S = 100 Ω.





$V_s = I * (R_s + R) + V_D$

$R = (V_s - V_D) / I - R_s$

$R = (5 - 2) / 2mA - 100 = 3/0.02 - 100 = 50\ \Omega$

The answer is *R* =____50___ Ω

Q15. For the following DC characteristics of PIC 16LF84A, how long does a battery of capacity 1000 mAh lasts?

Param No.	Symbol	Characteristic	Min	Typ†	Max	Units	Conditions
	IDD	**Supply Current (Note 2)**					
D010		16LF84A	—	1	4	mA	RC and XT osc configuration **(Note 4)** FOSC = 2.0 MHz, VDD = 5.5V
D010		16F84A	—	1.8	4.5	mA	RC and XT osc configuration **(Note 4)** FOSC = 4.0 MHz, VDD = 5.5V
D010A			—	3	10	mA	RC and XT osc configuration **(Note 4)** FOSC = 4.0 MHz, VDD = 5.5V (During FLASH programming)
D013			—	10	20	mA	HS osc configuration (PIC16F84A-20) FOSC = 20 MHz, VDD = 5.5V
D014		16LF84A	—	15	45	µA	LP osc configuration FOSC = 32 kHz, VDD = 2.0V, WDT disabled

For Fosc = 2 MHz => Time = 1000 mAh / 1 mA = 1000 hr

For Fosc = 32 kHz => Time = 1000 mAh / 15 µA = 66,667 hr

The answer is _____ hours

<Good Luck>