Biomedical Engineering Department **Time Allowed: 1 ½ Hours**
Cairo University **Open-Book/Open-Notes**

Medical Electronics III I Term Exam
January 25, 2009

Solve as Much as You Can – Maximum Grade: 37½ Points

Part I. Answer the following questions by marking the best answer among the choices given [1 ½ points each]:

1. Relative addressing mode is useful in …
a) Jump or branching instructions (*)
b) Data transfer instructions
c) Arithmetic instuctions.

2. For a microcontroller application in which timing accuracy is not important, a system clock based on … is used.
a) RC oscillator
b) Crystal oscillator
c) The microcontroller's own internal oscillator (*)

3. Microcontroller watchdog timer can be used to …
a) Schedule periodic check on the status of a process
b) Reset the microcontroller when runs out of control (*)
c) Measure the number of particular events of interest

4. Using a 3.3V microcontroller, a GPIO pin can provide high current output using …
a) A push-pull output mode
b) An open-drain output mode with internal weak pull-ups
c) An open-drain output mode with external pull-ups. (*)

5. The following assembly code requires … clock cycles to execute.

```
mov   WDTCN, #0ADh        (3)
mov   XBR2, #40h          (3)
orl   P1MDIN, #40h        (3)
clr   P1.6                (2)
```

a) 12
b) 11 (*)
c) 10

6. We can toggle bit 4 of P4 by the following C instruction …
a) P4= P4 ^ 008H (*)
b) P4= P4 & 0F7H
c) P4.4= ~P4.4

7. Timer 0 is turned on (i.e., starts to count) when …
a) TL0 and TH0 are loaded
b) Timer interrupt is enabled
c) TR0 in TCON is set (*)

8. The selection of timer or counter operation is made by correct programming of …
a) TMOD register (*)
b) CKCON register
c) TCON register

9. It is very important that while configuring a timer one should make sure …
a) Not to disturb the mode of other timers (*)
b) To keep a copy of the old configuration before you make a change
c) To disable all interrupts

10. When the microcontroller starts and finds out that its external clock source is invalid, …
a) It switches automatically to internal oscillator (*)
b) It can be configured to reset
c) It causes a flag to be raised for the program to repair the problem

Part II. Mark the following statement as either True (T) or False (F) (½ point each):

11. Microcontroller clock configuration must perform a check on the external clock validity (T)
12. Indirect addressing is not useful in C8051F020 assembly language programming (F)
13. **sbit** variable can only declare global variables (T)
14. One can declare an array of bits in C language programming for microcontrollers (F)
15. It is possible to have a 16-bit timer with auto-reload using Timer 0 (F)
16. It is possible to have two 8-bit counter/timers using Timer 1 (F)
17. It is not necessary to have the output of timers in the form of interrupt (T)
18. Not all GPIO ports are bit addressable (T)
19. For external crystal oscillators, only certain values are can be used with C8051F020 (T)
20. Microcontrollers can be programmed using either assembly or C languages (T)

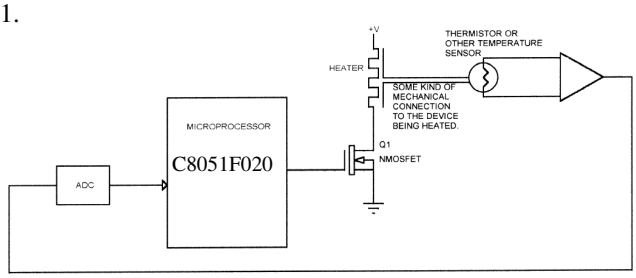
Q3. Denote the following C8051F020 microcontroller instructions as either being true (T) or false (F) assembly instructions. [½ point each]

21.	`CLR`	`P4.2`	(F)
22.	`CPL`	`C`	(T)
23.	`JZ`	`@R7`	(F)
24.	`DIV`	`A,B`	(F)
25.	`SUBB`	`R2, F0H`	(F)
26.	`ANL`	`C, /P1.0`	(T)
27.	`XCH`	`A, 040H`	(T)
28.	`INC`	`@R0`	(T)
29.	`CPL`	`A`	(T)
30.	`DJNZ`	`R6, 70H`	(T)

Q4. Compute the output of the following operations in a C Language program for a C8051F020 device [½ point each]

31.	`!(00100100b && 00000001b)`	(ans: FALSE)
32.	`(0F0H - 080H) != 0`	(ans: TRUE)
33.	`0FFH % 04H`	(ans: 3)
34.	`018H<<2`	(ans: 060H)
35.	`(0FE20H | 080H)`	(ans: 0FEA0H)
36.	`01000100b & 10100001b`	(ans: 0)
37.	`(0F0H ^ 00AH) || 011H`	(ans: TRUE)
38.	`!(0AAH)`	(ans: FALSE)
39.	`~(0F0H & 0A0H)`	(ans: 05FH)
40.	`0FFH ^ 10101010b`	(ans: 01010101b)

Q5. [5 points] Consider a microcontroller-controlled heater shown below. Design a C8051F020 project that would enable the ON/OFF control of the heater to adjust the temperature to within a predefined range T_{min} and T_{max}. The desired control is such that the heater is turned on whenever the temperature drops below T_{min} and turned off when the temperature is above T_{max}. Assume that the ADC used is of 8-bit FLASH type connected to GPIO port P0 (i.e., requires no clock and its digital reading corresponds to the temperature value whenever it is read). Assume also that the control of the heater is such that when the microcontroller pin is 1 the heater is ON and when it is 0 the heater is OFF. Let the ADC reading port be the entire P0 and the output pin be P1.1.



Solution:

An assembly language or C code that does the following:

1. **Turns on the heater by setting P1.1=1**
2. **Reads in P0**
3. **Checks if the value of P0 is > Tmax to turn off the heater (P1.1=0)**
4. **Checks if the value of P0 is < Tmin to turn on the heater (P1.1=1)**

5. **Loop on the steps from 2 to 4**

Q6. [5 points] In a microcontroller application, it is desired to have a periodic control signal of period 1 minute and duty cycle of 50% from pin P1.6. Provide the programming sequence of a microcontroller timer to generate such periodic signal. Make sure to include all parts of the code including the initialization.

Use the internal clock with lowest frequency (2 MHz) or assume whatever external clock you want to use
Calculate the number of clock cycles needed to do the required delay
Choose a timer and see if the number of bits available are sufficient
Use a software variable inside the timer interrupt to reach the period you need if the timer max period is still short

Best of Luck!