UNIVERSITY OF JOHANNESBURG

PROGRAM	:	NATIONAL DIPLOMA *ENGINEERING: ELECTRICAL* *ENGINEERING: COMPUTER SYSTEMS* *ENGINEERING: MECHANICAL*
SUBJECT	:	**MICRPROCESSORS**
MODULE CODE	:	**CMP311**
DATE	:	SUMMER EXAMINATION 2017 11 NOVEMBER 2017
DURATION	:	(SESSION 1) 08:30 - 11:30
TOTAL MARKS	:	100

EXAMINER	:	Mr. S.B.K. Ntsaluba
MODERATOR	:	Ms. M. Michael
NUMBER OF PAGES	:	16 Pages

STUDENT SURNAME: _____

STUDENT INITIALS: _____

STUDENT NUMBER: _____

INSTRUCTIONS

1. Ensure that you include your calculations and clearly indicate your answers in the script, which is to be submitted at the end of the test period
2. This is a closed book test. No other material is permitted during test session accept writing material and a pocket calculator.
3. It is advised that all questions be attempted.
4. Ensure that for all answers provided, where applicable, units are indicated, otherwise marks will be lost.
5. Ensure that all answers are written in pen as no answers in pencil will be marked.
6. All written work to be discarded should be crossed out, no tipp-ex is to be used.

QUESTION 1 (TRUE/FALSE) [15]

Read and answer the questions below on the answer sheet (table 1).

1.1. Microcontrollers are generally more expensive then Microcontrollers [1].

1.2. When comparing a system board based on a microcontroller and a general-purpose microprocessor, the microcontroller would be cheaper [1].

1.3. An embedded system is also referred to as a dedicated system as it is dedicated to doing more than one type of job [1].

1.4. A microprocessor generally needs RAM, ROM and I/O ports to be externally connected to it [1].

1.5. A microcontroller generally has RAM, ROM and I/O ports embedded [1].

1.6. The MOVLW instruction takes two instruction cycles [1].

1.7. The GOTO instruction takes one instruction cycle [1].

1.8. The return instruction takes two instruction cycles [1].

1.9. The GOTO instruction and the BNZ instruction are interchangeable [1].

1.10. The default oscillation frequency of the pic18F45K20 onboard oscillator is 16 MHz [1]

1.11. The PIC18F45K20 has two dedicated built in ADCs [1].

1.12. When considering an ADC, the resolution of the ADC will not impact the step size of the input voltage being sampled [1].

1.13. The PIC18F45K20 has an 8bit ADC [1].

1.14. When the input voltage sampled exceeds the maximum voltage of the microprocessor, the voltage should not be normalized [1].

1.15. When the input voltage sampled exceeds the maximum voltage of the microprocessor, the voltage should only be normalized once it is sampled by the ADC [1].

ANSWER SHEET (Mark answer with an X)		
1.1	T	F
1.2	T	F
1.3	T	F
1.4	T	F
1.5	T	F
1.6	T	F
1.7	T	F
1.8	T	F
1.9	T	F
1.10	T	F
1.11	T	F
1.12	T	F
1.13	T	F
1.14	T	F
1.15	T	F

Table 1: True/False answer table.

QUESTION 2 [10] Multiple Choice

Select one option in table 2 for each of these questions below.

2.1. Determine the binary value loaded in the working register after the following set of instructions [2.5].

```
ORG     0H
MOVLW   D'500'
```

a) 00101100 b) 11100000 c) 11110100 d) None

2.2. Determine the hexadecimal value loaded in the working register after the following set of instructions [2.5].

```
ORG     0H
MOVLW   D'200'
MOVWF   PORTD
ADDLW   D'55'
```

a) 0H b) FFH c) FCH d) None

2.3. Determine the binary value loaded in Port A after the following set of instructions [2.5].

```
ORG     0H
MOVLW   40H
MOVWF   PORTA
MOVLW   7H
ADDWF   PORTA, F
```

a) 00101100 b) 01000111 c) 101000000 d) 00101111

2.4. Determine the delay for the following set of instructions if the oscillation frequency is 4MHz [2.5].

```
Begin   MOVLW   40H
        MOVWF   PORTA
        DECFSZ  PORTA
        GOTO    Begin
        RETURN
```

b) $500\mu S$ b) $321\mu S$ c) $200\mu S$ d) None of the above

Answer Sheet (Mark with X)				
2.1	A	B	C	D
2.2	A	B	C	D
2.3	A	B	C	D
2.4	A	B	C	D

Table 2: Multiple Choice Answer Table.

QUESTION 3 [15]

3.1. What are the three file types that we work with in assembly language [3]?

3.3. Determine the total number of instruction cycles for the code below. Show your calculations [5]:

```
Start   MOVLW   D'65'
        MOVWF   PORTD
        NOP
Begin   MOVLW   D'50'
        MOVWF   PORTA
        DECFSZ  PORTA
        GOTO    Begin
        NOP
        DECFSZ  PORTD
        GOTO    Start
        NOP
        RETURN
```

Answer: _____

3.3. If it is given that the oscillation frequency is 16 MHz, what procedure/steps would you follow to determine the delay using simulation mode of MPLAB [5]:

3.3. After simulation, you discover that the delay you have calculated is 10% outside of its designed value. What steps will you undertake to correct this [2]?

QUESTION 4 [20]

As part of a practical project, you are requested to design a system that consists of microcontrollers and is used to control residential lights. The operating schedule is as follows.

Time Duration (seconds)	**State**	**Action (Lights)**	**Duration**
$0:00 < t < 6:00$ (Night time)	1	Lights on (all pins of port D)	Simulate as: $0s < t < 6s$
$6:00 < t < 18:00$ (Day time)	2	Lights off (all pins of port D)	Simulate as: $6s < t < 18s$
$18:00 < t < 24:00$ (Night time)	3	Lights on (all pins of port D)	Simulate as: $18s < t < 24s$
Operation repeats			

4.1. Provide the initial part of your program code (directives, setting of ports as input/output, additional registers) [4].

4.2. Using the default operating frequency of the microprocessor, provide the assembly code (with loaded values) that you would construct to realise the 6s delay and the 12s delay [10].

6s delay:

12s delay:

4.3. Provide the main programme code that would realise this operation [6].

QUESTION 5 [30]

As part of an industrial project, you are requested to design a system that consists of microcontrollers and is used to control residential lights. The system switches LEDs on based on the light output level sampled from a Light sensor and connected to the ADC pin of the microcontroller. The system should sample when an external interrupt is triggered, and the output action of the sample must remain until the next interrupt trigger. The criteria is shown below.

Sampled voltage range	**Input action**	**Output action**
$0 < V < 2$	Interrupt Triggered	All LEDs connected to port D on
$2 < V < 3$	Interrupt Triggered	Four LEDs connected to port D must be on while the other four are off.
$3 < V < 5$	Interrupt Triggered	All LEDs connected to port D off

5.1. Provide the initial part of your program code (directives, setting of ports as input/output, additional registers) [5].

5.2. Provide the initial part of your program code that will allow you to use interrupts [5].

5.3. Provide the initial part of your program code that will allow you to use the ADC [5].

5.4. Provide the main programme code that would realise this operation [5].

5.5. Provide the main code inside your ISR [10]

QUESTION 6 [10]

As part of a practical project, you are requested to design a system that consists of a microprocessor and three LEDs. The operation of the LEDs is shown in the table below. Provide complete **code in C** that will realise this system. Include all instructions, directives, delay calculations, delay subroutines and other commented lines of code that you feel are necessary. The default oscillation frequency of the microprocessor should be used.

Time Duration (seconds)	**State**	**Action**
$0 < t < 1$	1	LED 1 on, LED 2 and 3 off
$1 < t < 2$	2	LED 2 on, LED 1 and 3 off
$2 < t < 3$	3	LED 3 on, LED 1 and 2 off
$3 < t < 4$	4	LED 2 on, LED 1 and 3 off
$4 < t < 5$	5	LED 1 on, LED 2 and 3 off
$5 < t < 6$	6	LED 1, LED 2 and 3 off
$t > 6$	States repeat from 1 onwards