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UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
(ONLINE ASSESSMENT)
SEMESTER II
SESSION 2019/2020**

COURSE NAME : ADVANCED MICROCONTROLLER
COURSE CODE : BEC 41103
PROGRAMME CODE : BEJ
EXAMINATION DATE : JULY 2020
DURATION : 3 HOURS
INSTRUCTION : THIS PAPER CONTAINS PART A, PART B
AND PART C. ANSWER **ALL** QUESTIONS.
OPEN BOOK EXAMINATION.

THIS QUESTION PAPER CONSISTS OF **THIRTEEN (13)** PAGES.

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**PART A: TRUE OR FALSE QUESTIONS. EACH QUESTION CARRIES ONE (1) MARK.
(10 QUESTIONS x 1 MARK = 10%)**

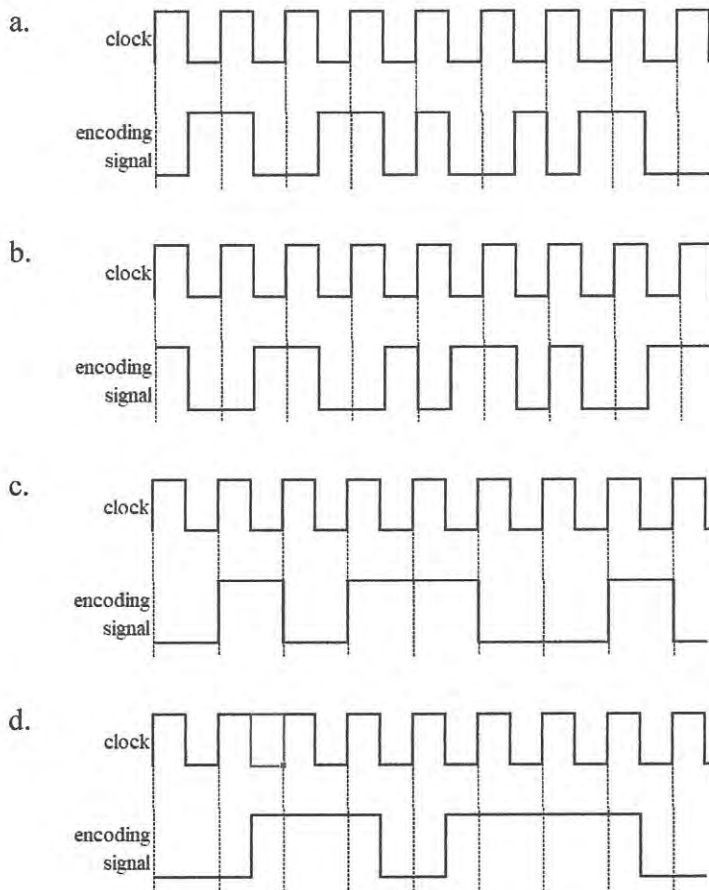
- Q1.** ARM is the provider of CISC based microprocessor solutions and other semiconductor IPs.
- Q2.** An ARM microcontroller is a load store architecture means the core cannot directly operate with the data in the memory.
- Q3.** When ARM processor exits from reset, it typically fetches initial address value for PSP and reset vector address.
- Q4.** The ARM processor implements concept subset of the instruction set and features provided by an Cortex-M profile architecture is binary compatible with the instruction sets and features implemented in other Cortex-M profile processors.
- Q5.** Semaphore access a shared resource using token and return token while releasing the shared resource.
- Q6.** In OS environment, both Main Stack Pointer (MSP) and Process Stack Pointer (PSP) can be used at the same time.
- Q7.** A common practice for nowadays local network and internet is to facilitate advanced interactive applications.
- Q8.** Closed loop control system improve performance of the system by feedback a portion of the output signal to the input.
- Q9.** CAN bus nodes uses address to determine data on the bus.
- Q10.** Cortex-M processor is a dedicated DSP processor to perform many DSP operations.

PART B: MULTIPLE CHOICE QUESTIONS. EACH QUESTION CARRIES ONE (1) MARK. (20 QUESTIONS x 1 MARK = 20%)

- Q11.** Some instruction in ARM machines is encoded into _____ Word.
- 2 byte
 - 3 byte
 - 4 byte
 - 8 byte
- Q12.** Memory can be accessed in ARM systems by _____ instructions.
- Store
 - MOVE
 - Load
 - Arithmetic
 - Logical
- i, ii, iii
 - i, iii
 - i, iv, v
 - iii, iv, v
- Q13.** The system timer SysTick of an ARM cortex-M3 processor is _____.
- 8-bit count-down timer
 - 16-bit count-down timer
 - 24-bit count-down timer
 - 32-bit count-down timer
- Q14.** When an ARM Cortex-M processor is processing an interrupt service routine.
- The processor operates in thread mode.
 - The processor operates in handler mode.
 - The processor operates in either thread mode or handler mode depending on the type of interrupts.
 - None of above.
- Q15.** In an ARM Cortex-M processor,
- exceptions include system reset, system wakeup events, system faults, and interrupts.
 - exceptions are interrupts.
 - exceptions are special type of interrupts.
 - all of above.

- Q16.** WFI stands for _____.
- Wait For Interval
 - Wait For Interrupt
 - Word Fetch Instruction
 - Word Forward Instruction
- Q17.** The transfer rate, when the USB is operating in low speed of operation is _____.
- 5 Mbps
 - 12 Mbps
 - 2.5 Mbps
 - 1.5 Mbps
- Q18.** The type/s of packets send by the USB is/are _____.
- Data
 - Address
 - Control
 - Both data and control
- Q19.** How many bits are there in the Ethernet address?
- 24 bits
 - 36 bits
 - 42 bits
 - 48 bits
- Q20.** In _____ transmission, bits are transmitted simultaneously, each across its own wire.
- Asynchronous serial
 - Synchronous serial
 - Parallel
 - a. and b.
- Q21.** Which of the following is not true about bluetooth?
- Bluetooth has a range of about 30 feet.
 - Bluetooth has a bandwidth of 720 kbps.
 - Bluetooth is considered to be low bandwidth wireless technology.
 - Bluetooth is considered to be a long-distance wireless technology.

Q22. Which of the following is Manchester encoding signal for bit sequence 01011001?



Q23. Figure Q23 shows sequence of codes to define Ethernet network interface. What is IP address of gateway for the eth Ethernet network interface?

```

EthernetNeflf eth(
    IpAddr(192, 168, 1, 22),
    IpAddr(225, 255, 255, 0),
    IpAddr(192, 168, 0, 0),
    IpAddr(192, 168, 0, 1)
);
    
```

Figure Q23

- a. 192.168.1.22
- b. 225.255.255.0
- c. 192.168.0.0
- d. 192.168.0.1

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- Q24.** Which of the following is not a disadvantage of wireless LAN?
- Interference of transmissions from different computer.
 - Slower data transmission.
 - Higher error rate.
 - All of the above.
- Q25.** In an open loop control system, _____.
- output is independent of control input.
 - output is dependent on control input.
 - only system parameters have effect on the control output.
 - none of the above.
- Q26.** A closed loop system is distinguished from open loop system by which of the following?
- Servo mechanism
 - Feedback
 - Output pattern
 - Input pattern
- Q27.** Which of the following is an example of a closed loop system.
- auto-pilot for an aircraft
 - direct current generator
 - car starter
 - electric switch
- Q28.** A _____ filter significantly passes all frequencies below f_c and attenuates all frequencies above f_c .
- Low-pass
 - High-pass
 - Band-pass
 - Band-stop
- Q29.** The interface between an analog signal and a digital processor is _____.
- Digital-to-analog converter
 - Analog-to-digital converter
 - Analog reconstruction filter
 - Biassing circuit

- Q30.** Analog reconstruction filter could be realized with _____ with f_c at around 20 KHz.
- low-pass filter
 - high-pass filter
 - band-pass filter
 - none of above

PART C: SUBJECTIVE QUESTIONS. THE TOTAL MARK FOR PART C IS 70%.

- Q31.** Listing Q31 gives sequence of C code. Analyze the code given and answer the following questions. Compute the output of APSR flags after the execution of the sequence of code in Listing Q31.

```
R1 = 0x00000004;  
R2 = 0x00000005;  
R3 = 0xFFFFFFFF;  
R0 = R2 - R1;  
R4 = R0 + R3;
```

Listing Q31

- Compute the R0 value. Clearly show step of calculations. (2 marks)
 - Compute the R4 value. The determine APSR flags. Justify your answer. (4 marks)
- Q32.** Determine right register in ARM processor for the following operation.
- To hold address to indicate where an execution is in its program sequence. (1 mark)
 - Temporary hold either data or address. Have capability of storing 32-bit, 16-bit or 8-bit binary number. (1 mark)
 - Record various pieces of information regarding the state of the program being executed by the processor and the state of the processor. This information is recorded by setting or clearing specific bits in the register. (1 mark)

(d) Reserve area of memory used to keep track of a program’s internal operations, including functions, return addresses, and passed parameters. It usually maintained as a ‘last in, first out’ (LIFO) data structure, so that the last item added to the structure is the first item used.

(1 mark)

(e) A special-purpose register which holds the address to return to when a function call completes.

(1 mark)

Q33. Figure Q33 shows program image of program memory. Determine the initial value of program counter (PC) and start address of stack pointer (SP) when the processor exits reset.

(3 marks)

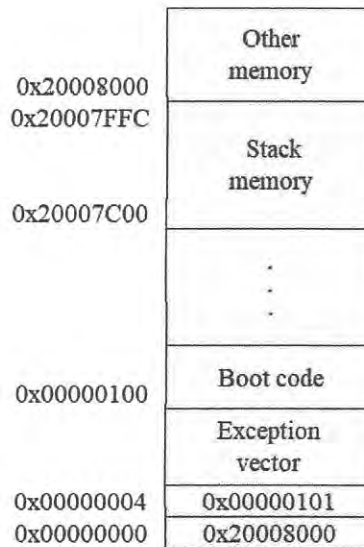


Figure Q33

Q34. Specify suitable stack pointer based on situation as given below.

(a) The processor is executing thread mode and bit 1 of CONTROL register is cleared.

(1 mark)

(b) The processor is executing normal code and bit 1 of CONTROL register is set.

(1 mark)

(c) The processor is executing exception handler and bit 1 of CONTROL register is cleared.

(1 mark)



- Q35.** Write sequence of instructions to create a task event called blinky. The task identifier for blinky task is `t_blinky`. The blinky task is initiated with priority level 1. (4 marks)
- Q36.** Discuss why interrupt driven based embedded systems are preferable nowadays. Justify your answer. (3 marks)
- Q37.** What are typical architectural features of Cortex-M processor that make it low power device. Justify your answer. (4 marks)
- Q38.** Complete **Table Q38**. Describe the purpose of the statements given in the table. (5 marks)

Table Q38

Statement	Purpose
<code>#include "mbed.h"</code>	
<code>char data[]={0xB9, 0x46};</code>	
<code>serial pc(Tx, Rx);</code>	
<code>USBMouse mouse;</code>	

- Q39.** **Figure Q39** shows Ethernet data formed with Manchester encoding. Determine the associated bit sequence for the Ethernet data. (2 marks)

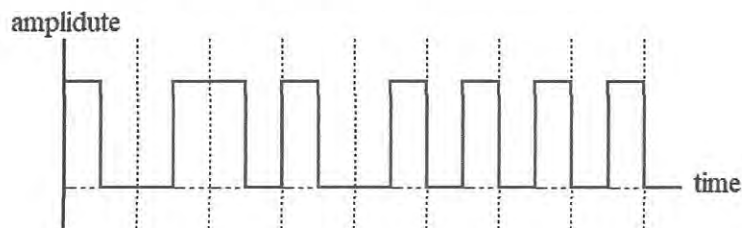


Figure Q39

Q40. Figure Q40 illustrates a serial Ethernet data packet. Determine the Ethernet data packet size, and the actual data size receives by Ethernet reader, in bytes.

(4 marks)

Preamble	Start of frame delimiter	Destination MAC address	Source MAC address	Length	Data	Frame check sequence	Interframe gap
7 bytes of 10101010	1 byte of 10101011	6 bytes	6 bytes	2 bytes	60 bytes	4 bytes	

Figure Q40

Q41. The process trend in Figure Q41 showing the process value, input and output of a loop controller. Based on what you see on the figure, determine whether this is an open-loop or closed-loop response. Justify your answer.

(2 marks)

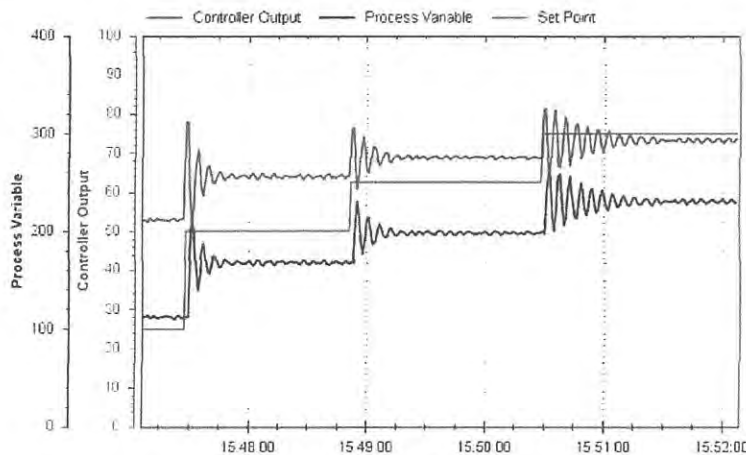


Figure Q41

Q42. Sunseeker solar system is an automatic tracker which uses LDR to sense the sunlight. A microcontroller reads the LDR voltage and signals the connected motor which rotates the panel towards the sun. Based on statement given, determine element of sunseeker solar system that associated with the terminology of control system as given in Table Q42.

(4 marks)

Table Q42

Terminology	Technical element
Input	
Plant	
Controller	
Output	

Q43. Figure Q43 indicates a schematic circuit for the mbed-to-mbed CAN communication.

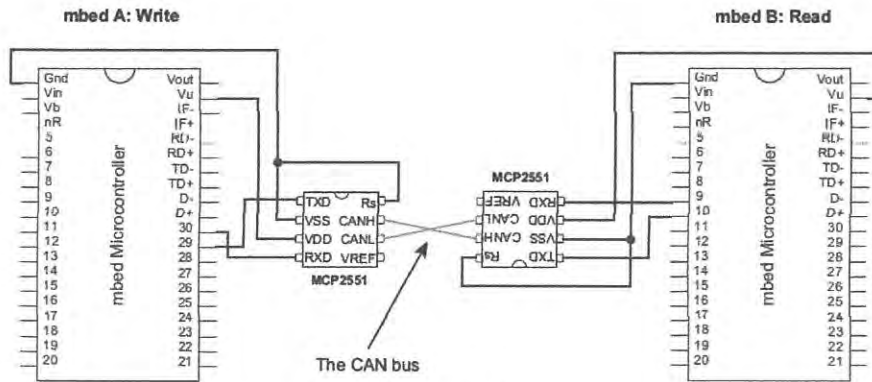


Figure Q43

- (a) Explain the purpose of differential CAN bus architecture in the communication. (2 marks)

- (b) Write a program to configure the mbed A for continuously sending an incrementing count value to the CAN bus every 5 seconds. Assume the message ID is 2, and the data size is two bytes. Increment the count value and toggle LED2 when the CAN message is sent successfully. (7 marks)

Q44. The program in **Figure Q44** configures mbed for digital signal processing (DSP) application. Analyze the program and answer the following questions.

```
#include "mbed.h"
AnalogIn Ain(p15);
AnalogOut Aout(p18);
Ticker sampled_tick;
void sampled_task(void);
float data_in, data_out;
int main() {
    sampled_tick.attach_us(&sampled_task, 40);
}
void sampled_task(void){
    data_in=Ain;
    data_out=data_in;
    Aout=data_out;
}
```

Figure Q44

- (a) Specify type of input and output signals. Justify your answer. (2 mark)

- (b) Describe the purpose of line ‘void sampled_task(void);’. (1 mark)

- (c) Explain why data type float is selected to define variable. (2 marks)

- (d) Differential between sampled_tick and sampled_task. (2 marks)

- (e) Predict the output for the program. (2 marks)

- (f) Calculate frequency for function sampled_task. (2 marks)



Q45. Figure Q45 illustrates schematic circuit of an audio DSP system that is implemented using mbed microcontroller to receive a 1000 Hz input audio signal. After DSP process, the mbed microcontroller outputs analog signal through pin 18.

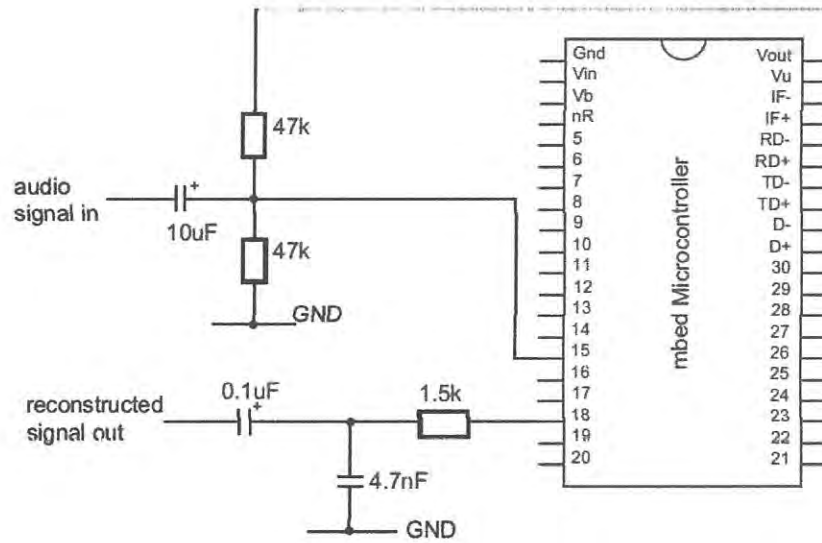


Figure Q45

- (a) Is that possible to directly enter audio signal into analog input pin 15 of mbed microcontroller? Justify your answer. (3 marks)

- (b) Explain why reconstructed circuit is attached to output analog signal. (2 marks)

- END OF QUESTIONS -

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