# UTHM
Universiti Tun Hussein Onn Malaysia

# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

## FINAL EXAMINATION
## SEMESTER I
## SESSION 2019/2020

COURSE NAME        :     EMBEDDED SYSTEMS DESIGN

COURSE CODE        :     BEC41703

PROGRAMME          :     BEJ

EXAMINATION DATE   :     DECEMBER 2019 / JANUARY 2020

DURATION            :     3 HOURS

INSTRUCTION         :     ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

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**Q1**    (a)    List **THREE (3)** design metrics for embedded systems.

(3 marks)

(b)    **Table Q1(b)** shows the comparison of embedded hardware platforms. Write suitable answers for items (1) to (9) using the following words – yes or no.

**Table Q1(b)**

| Characteristic | FPGA | ASIC | µCONTROLLER |
|---|---|---|---|
| Support for hardware reconfigurability | (1) | (2) | (3) |
| Support for hardware/software co-design | (4) | (5) | (6) |
| Support for parallel processing in hardware | (7) | (8) | (9) |

(9 marks)

**Q2**    (a)    Write suitable answers for items (1) to (4) in **Table Q2(a)**.

**Table Q2(a)**

| Characteristic | Real Time Operating System (RTOS) | General Purpose Operating System (GPOS) |
|---|---|---|
| Interrupt latency requirement | (1) | (2) |
| Preemptive scheduling support | (3) | (4) |

(4 marks)

(b)    **Figure Q2(b)** provides the specifications for a face recognition system to be used in surveillance system in Batu Pahat. Answer the following questions:

- The system will integrate 100 high definition cameras installed at specific locations around the city
- All cameras will feed to a face recognition system through a high speed dedicated network continuously 24 hours a day
- The face recognition system will detect images of suspected criminals by comparing with police database. Once images of suspected criminals are detected by one or more camera, the system should alert the police in duty within 5 seconds for immediate actions, failure to do so will make the system unreliable

**Figure Q2(b)**

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(i) Decide whether Real Time Operating System (RTOS) should be adopted or not.

(1 mark)

(ii) Give **TWO (2)** reasons for your answer in **Q2(b)(i)**.

(4 marks)

(c) **Figure Q2(c)** shows the design requirements for a large storage room's air conditioning control system to be developed using RTOS. Answer the following questions:

- There are 10 compressor which 2 of them must be turned on every 12 hours period alternately to maintain room temperature at 25 degree Celsius
- In case of any problems such as electrical supply trip or faulty components that affect the operation on the compressor, adjustment will be performed where only 1 compressor will be turned on every 6 hours period alternately and the overall temperature setting will be fixed to 27 degree Celsius until the problem is fixed.

**Figure Q2(c)**

(i) Decide whether the system requires hard real time or soft real time.

(1 mark)

(ii) Give **TWO (2)** reasons for your answer in **Q2(c)(i)**.

(4 marks)

Q3 (a) NAND and NOR type flash memories are used widely as a storage element in embedded systems applications. Elaborate **TWO (2)** advantages of flash memories compared with SRAM and DRAM.

(4 marks)

(b) Summarize **TWO (2)** challenges in embedded memory architecture.

(4 marks)

(c) Discuss the principle to reduce power consumption in Low Power Double Data Rate (LPDDR) memory in terms of clocking architecture.

(2 marks)

Q4 (a) Describe **ONE (1)** advantage and disadvantage of hardcore processors.

(4 marks)

(b) Zynq-7000 FPGA System on Chip (SoC) board contains ARM Cortex-A9 multicore known as Processing System (PS) and also programmable logic (PL). Relate the concept of hardcore and softcore processor to the PS and PL.

(4 marks)

(c) List **THREE (3)** operating modes supported in ARM Cortex-A9 processor.

(3 marks)

(d) It is possible to design multicore embedded systems using Zynq-7000 FPGA SoC by combining ARM Cortex-A9 dual core with additional cores implemented in programming logic.

 (i) Explain the advantages of multicore architecture in embedded systems design.

(2 marks)

 (ii) Suggest **FOUR (4)** embedded applications that will benefit from high number of cores.

(4 marks)

(e) You are asked to design an embedded system device that track glucose level of a person continuously and release accurate amount of insulin when necessary. The system must also send immediate alert to a registered medical doctor over GSM network for emergency responses when the system is malfunction such as when there is over-release of insulin or when the glucose level detected is abnormal. Discuss whether Zynq-7000 FPGA SoC platform is suitable for the application and justify your answer.

(4 marks)

**Q5** (a) Write suitable answers for items (1) to (12) in **Table Q5**, using the following words – low, moderate, high, yes or no.

**Table Q5**

| Characteristic | I2C | SPI | CAN |
|---|---|---|---|
| Design complexity | (1) | (2) | (3) |
| Support for multi-master operation | (4) | (5) | (6) |
| Support for error detection | (7) | (8) | (9) |
| Implementation cost | (10) | (11) | (12) |

(12 marks)

(b) Based on the following components, select a suitable communication interface between I2C, SPI, CAN and LIN protocol to be connected to the main processor or microcontroller in an embedded system and justify your answer.

 (i) Low speed ultrasonic sensor for motion detection in automatic light system

(3 marks)

 (ii) Braking sensors for anti-lock braking system in vehicles

(3 marks)

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(iii)    Multiple Secure Digital (SD) memory cards to log operation data in automatic recycle bin system

(3 marks)

(iv)    Automatic windscreen wiper in vehicle

(3 marks)

(v)    Servo motors for prosthetic leg application

(3 marks)

**Q6**    (a)    Differentiate software and hardware testing methods in embedded systems to conduct testings.

(4 marks)

(b)    Black box and white box testing are two types of software testing methods can be applied to embedded systems designs. An embedded system has been prototyped and software testing must be conducted to ensure it is working as expected. The purpose of the testing requirement is to make sure that the prototype function correctly based on certain input conditions as well as to make sure that the inner structure is written correctly.

(i)    Choose the best testing method.

(2 marks)

(ii)    Justify your answer in **Q6(b)(i)**.

(4 marks)

(c)    Based on the testing processes provided in **Figure Q6(c)**, answer the following questions:

> • A new embedded application has been developed where it is an improvement from existing application with 20% changes in the code
> • Black box and white box testing was conducted on the existing application
> • Black box testing was also conducted on the new embedded application
> • White box testing were not conducted to be able to meet time-to-market target

**Figure Q6(c)**

(i)    Decide whether exploratory testing should be conducted or not.

(1 mark)

(ii)    Give reasons for your answer in **Q6(c)(i)**.

(3 marks)

(d)    List **TWO (2)** primary reasons to do testing in embedded systems.

(2 marks)

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– END OF QUESTIONS –

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