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Time taken	1 hour
Grade	**7.88** out of 10.75 (**73.26**%)

Question 1

Correct

Mark 0.25 out of 0.25

In MQTT quality of service

○ a.   is not supported

○ b.   it is determined by the broker only

◉ c.   determines the reliability of the communication among brokers and subscribers ✔

○ d.   determines the priority of the topics in the brokers

Your answer is correct.

The correct answer is:
determines the reliability of the communication among brokers and subscribers

Consider an IoT system for monitoring an industrial environment. The system is composed of different elements distributed over an area of 5000m^2. These elements monitor different parameters related to safety (e.g., presence of various dangerous gases in the air) as well as conditions of the building (e.g., presence of people, temperature). Furthermore, the system might be used to rise alarms and/or act on different parts of the production plant (e.g., close security valves on parts of the plant).

Which is the best type of communication protocol (wired/wireless) to use for connecting the different elements? In the selected category, is there any specific protocol that you can mention? Explain your choices.

For such an extense area i would first think of CANBus, but due to the different locations of the devices, a mesh of two protocols would be best, the wired CANBus for certain important nodes such as servers, and control terminals, and for the sensors and alarms which are spread trough the building and may be difficult to install, a wireless protocol such as BL or WiFi would be best.

As for the communication, a messaging protocol would be good, the one which we've seen in class is MQTT, which has an architecture of publisher / subscriber, so using this protocol we can define different topics for each type of data which we want to manipulate.

Comment:

Question 3

Incorrect

Mark 0.00 out of 0.25

When an application includes tasks with different data rates, the best option is

- a. Rely on an operating system and write a single-thread task
- b. Rely on an operating system and write a multi-thread task
- c. Running the application on bare metal
- d. Rely on a real-time operating system ✖

Your answer is incorrect.

The correct answer is:
Rely on an operating system and write a multi-thread task

Explain the difference between continouos dynamics and discrete dynamics systems.

Continuous dynamics are the systems which are continuous in time, IE: helicopter movements, water boiler, etc, and due to this it has infinite precision, it can be modeleded in a mathematical way, but it requires a discrete controller. For the system, a open or closed loop (or PID) can be used. Usually PIDs are far better since they compute the current error, the weighted past errros, and predicts the future errors given the data.

Discrete dynamics are the systems which are discrete, so its precision is limited. And they can be modeled with state machines. We've seen two state machines, Moore, and Mealy. Moore machines take the decisions based on their current status (status = output), and Mealy machiens take the decision based on the transtion given an input (status + input = output). Both kinds of state machines can be transformed to each other. There is also hybrid machines.

Comment:

Question 5

Correct

Mark 0.25 out of 0.25

Semaphores

- ○ a. Are not available in mBedOS
- ○ b. Can be used to deal with exceptions
- ○ c. Are used to decide real-time processes can start
- ◉ d. Are used to guard critical sections ✔

Your answer is correct.

The correct answer is: Are used to guard critical sections

Suppose there are three processes with the following execution times and periods:

- P1 – exec. time 1 – period 4
- P2 – exec. time 2 – period 6
- P3 – exec. time 1 – period 2

All processes are ready at the same time (24).

What is the execution order of the three processes when an SJF scheduling algorithm is adopted? Consider a full hyperperiod.

Will the order change if FCFS was adopted instead?

Hyperperiod = 12

Feasible? = 1/4 + 1/3 + 1/2 > 1: Schedule not feasible.

Schedule with SJF: Shortest Job First. IE: Low exec. time = higher priority.

P3: exec 1 – Priority 1.
P1: exec 1 – Priority 2.
P2: exec 2 – Priority 3.

X: Running process
_: Stopped / Waiting / Sleeping.
|: End of current period.

P1		X	_	_|		X	_	_|		X	_	_|
P2				*X*	_	_/		X	_			X|
P3	X	_|	X	_|	X	_|	X	_|	X	_|	X	_|
T	24	25	26	27	28	29	30	31	32	33	34	35

P2 Is not scheduleable with SJF, it misses the second execution time on the first period (shown with italics).

FCFS: First come first served.

They all arrive at the same time (T24), so another sheduling process should be selected, and in the case where we prioritize the deadline or execution time for this case they will end up having the same outcome.

Comment:

Question 7

Correct

Mark 0.25 out of 0.25

Precision of a sensor

○ a. describes repeatability of measures

○ b. is the same as the the dynamic range

◉ c. is the smallest absolute difference between two values of a physical quantity whose sensor readings are distinguishable ✔

○ d. corresponds to the higher threshold on measured values

Your answer is correct.

The correct answer is:
is the smallest absolute difference between two values of a physical quantity whose sensor readings are distinguishable

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Question 8

Complete

Mark 0.75 out of 1.00

Consider a home smart device (e.g., a smart lightbulb). Should a watchdog be used in the firmware of the device? Explain the reasons of your answer.

A watchdog CAN be used on smart devices.

In the case of the lightbulb, the watchdog will be running on a separate chip from the one which is running the main process, the process of the light bulb will reset the watchdog's counter from time to time notifying the watchdog that the system is still alive and not frozen, in the case that the counter is not reseted, the watchdog can trigger a different process to mitigate the issue, or even restart the lightbulb.

Now, if a watchdog should be used on smart home devices... i feel it all depends on the complexity of the smart device and its utility, IE: personally i dont think a lightbulb should *need* a watchdog, but for example a thermostat, or a solar pannel system absolutely yes.

Comment:
What if the light bulb is installed in a location that is not easy to reach?

What if the software crashes goes into an infinite loop and the lamp does not switch on or off anymore?

Question 9

Correct

Mark 0.25 out of 0.25

The PID controller is

- ⦿ a. A closed-loop controller that consider three components: the error, the derivative of the error, the integral of the error ✔
- ○ b. An open-loop controller that consider three components: the error, the logaritm of the error, the integral of the error
- ○ c. A closed-loop controller that consider three components: the error, the logaritm of the error, the integral of the error
- ○ d. An open-loop controller that consider three components: the error, the derivative of the error, the integral of the error

Your answer is correct.

The correct answer is: A closed-loop controller that consider three components: the error, the derivative of the error, the integral of the error

Question 10

Incorrect

Mark 0.00 out of 0.25

The temperature of a certain chip must never exceed 95°C. If the chip gets too hot, it must be switched off. From the shutdown signal to the actual switch-off, the chip takes 0.01s. For safety reasons, the chip is switched-off when it reaches 94°C. Temperature in the chip changes at the maximum rate of 20°C/s.

What is the best sampling rate to be adopted for temperature sensor?

- ○ a. at least 10Hz
- ○ b. 2Hz
- ○ c. at least 40Hz
- ⦿ d. at least 20Hz ✖

Your answer is incorrect.

The correct answer is:
at least 40Hz

Question 11

Incorrect

Mark 0.00 out of 0.25

In NMR

- ○ a. n voters are used to decide if a component is faulty
- ◉ b. There are n voters that decide if the output of a certain critical component is correct ✖
- ○ c. There are n copies of a critical component and the output is decided by of a voter
- ○ d. The computation is repeated n times and the correct results is selected by a voter

Your answer is incorrect.

The correct answer is:
There are n copies of a critical component and the output is decided by of a voter

Question 12

Correct

Mark 0.25 out of 0.25

I2C

- ◉ a. Is a serial bus and every device has its own address ✔
- ○ b. Is a point-to-point serial communication protocol
- ○ c. Is a parallel bus and every device has its own address
- ○ d. Is a serial bus where data are broadcast in turn by connected devices

Your answer is correct.

The correct answer is: Is a serial bus and every device has its own address

Question 13

Correct

Mark 0.25 out of 0.25

Interrupts

- ⦿ a. Provide the ability to handle asynchronous events ✔
- ○ b. Can deal only with synchronous events
- ○ c. Are not suitable for embedded devices
- ○ d. Are required in the polling technique

Your answer is correct.

The correct answer is:
Provide the ability to handle asynchronous events

Question 14

Incorrect

Mark 0.00 out of 0.25

Interrupts in real-time systems

- ○ a. Cannot be used
- ⦿ b. They are needed, otherwise supporting real-time tasks would be impossible ✘
- ○ c. They can be used, but they might introduce additional uncertainty
- ○ d. They are masked when real-time tasks are executed

Your answer is incorrect.

The correct answer is:
They can be used, but they might introduce additional uncertainty

Question 15

Correct

Mark 0.25 out of 0.25

Continous dynamics systems

- ⦿ a. Are physical systems that can be described by means of a mathematical model ✔
- ○ b. They require analog sensors
- ○ c. Are physical systems that cannot be described by a mathematical model
- ○ d. Cannot be controlled by using a microprocessor

Your answer is correct.

The correct answer is:
Are physical systems that can be described by means of a mathematical model

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Question 16

Correct

Mark 0.25 out of 0.25

Priority inversion is

- ○ a. A technique adopted in the BLE communication protocol for handling quality of service
- ○ b. A problem that is never present in real-time operating systems
- ○ c. A technique for dealing with low-priority processes that are not assigned the CPU for a very long time
- ⦿ d. A problem that cause high-priority processes to wait for lower-priority processes to obtain a shared resource ✔

Your answer is correct.

The correct answer is: A problem that cause high-priority processes to wait for lower-priority processes to obtain a shared resource

A surveilance system makes use of machine learning to spot and track people in images captured by cameras. Each node is connected to a local network and it includes a camera and computational resources; a local server completes the system. Among other things, an ML model is used to follow the subjects identified in images: the camera can move along two axes by using electric motors.

Discuss the parameters that should be considered in deciding wether the ML model should be run on the nodes or on the server and describe two different configurations, one in which the on-server computation would be more suitable, and one in which a computation on edge devices would be instead.

It all dependes on the burden of the system, with this i mean for example how many pictures are captured and processed per second, if the camera takes pictures at 1FPS, then we can argue that the model can be ran on the cameras themselves, which will make the network traffic lighter, the issue for this approach is the difficulty on updating the models.

In another case where the cameras have a high FPS, the pictrues are better processed on a separate server, where updating this model is far easier than in the nodes, and would also leverate the burder from the cameras, still this may clog the network depending on how big is the ammout of data transfered between the cameras and the server, and also shows a primary point of failure (if the server crashes, the system crashes).

Still, for most scenarios, a server-side processing is more advasible for image processing.

Comment:

Question 18

Complete

Mark 0.50 out of 1.00

What are the steps involved in converting an analog signal into a digital one?

Two steps:
- Sampling: gathering the analog singnals, usually recommented at twice the sampling rate of the device we want to transform from.
- Quantization: the process of transforming / representing the signals into digital data (bytes).

Comment:
description of the steps not precise

Question 19

Correct

Mark 0.25 out of 0.25

Quantization

- ○ a.   Is used, along with sampling, in DACs
- ○ b.   Either sampling or quantization are used in converting analog values into digital numbers
- ● c.   Is used, along with sampling, in analog to digital conversion ✔
- ○ d.   Is involved in converting digital numbers into analog values

Your answer is correct.

The correct answers are:
Is used, along with sampling, in analog to digital conversion,

Is used, along with sampling, in DACs

Question 20

Correct

Mark 0.25 out of 0.25

Supporting security requires suitable resources (computational resources, energy, memory). Which of the following options is best?

- ○ a. Disregard security during the design of the device and add it when the customers start complaining.
- ○ b. Design systems without security, but overprovision resources for later integration of security mechanisms
- ◉ c. Design system security from the beginning, planning system resources with security included ✔
- ○ d. Do not use any security mechanism, as they cannot be integrated into embedded devices

Your answer is correct.

The correct answer is:
Design system security from the beginning, planning system resources with security included

Question 21

Correct

Mark 0.25 out of 0.25

In modern Arduino devices (e.g., Portenta H7), when the Arduino IDE is used

- ○ a. The IDE runs over mBedOS, applications run on bare metal
- ○ b. Applications run on bare metal
- ○ c. One core runs the mBedOS operating system, the other core runs applications on bare metal
- ◉ d. Applications run over the mBedOS operating system ✔

Your answer is correct.

The correct answer is:
Applications run over the mBedOS operating system

Question 22

Correct

Mark 0.25 out of 0.25

CANBus is

- ○ a. a point-to-point wired protocol
- ○ b. unsuitable for communications that exceed a 2m distance
- ○ c. an obsolete wireless network protocol
- ● d. a wired network protocol that supports quality of service ✔

Your answer is correct.

The correct answer is: a wired network protocol that supports quality of service

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Question 23

Correct

Mark 0.25 out of 0.25

When programming an embedded device based on a specific abstract achiteture (e.g., ARM v8), limited resources, and no screen and keyboard, the following steps are adopted:

- ○ a.   1. Write the code on a PC
          2. Build the code on the PC by using a standard compiler
          3. Upload the machine code to the device

- ○ b.   1. Write the code on the device
          2. Build the code on the device

- ● c.   1. Write the code on a PC   ✔
          2. Build the code on the PC by using a cross-compiler
          3. Upload the machine code to the device

- ○ d.   1. Write the code on a PC
          2. Upload the code to the device
          3. Build the code on the device

Your answer is correct.

The correct answer is:
   1. Write the code on a PC
   2. Build the code on the PC by using a cross-compiler
   3. Upload the machine code to the device

Quantization to integer weights for machine learning models might provide an improvement in performance (intended as computation speed) and/or used energy because...

- ○ a.   only quantized models can be used in real-time systems
- ○ b.   models become bigger in size
- ○ c.   floating point units are faster than integer ones
- ⦿ d.   it limits the use of floating point computational units ✔

Your answer is correct.

The correct answer is:
it limits the use of floating point computational units