TECHNOLOGICAL UNIVERSITY DUBLIN

Grangegorman

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TU856 – Computer Science
TU857 – Computer Science (Infrastructure)
TU858 – Computer Science (International)

Year 4

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SEMESTER 1 EXAMINATIONS 2022/23

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CMPU4100 – Fundamentals of IoT

Internal Examiner(s):
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External Examiner(s):
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Instructions To Candidates: Answer **ALL** Questions. All questions worth equal marks.

Exam Duration: 2 hours

1. **(a)** In your own words, describe *three* challenges associated with the rapid growth of IoT.

   (2 × 3 = 6 marks)

   (b) A commonly used architectural pattern in IoT systems is the *device-to-cloud architecture*. Describe this architecture in your own words, using a diagram to illustrate your answer.

   (8 marks)

   (c) List *three advantages* and *three disadvantages* of the device-to-cloud architecture.

   (6 marks)

2. **(a)** An *Arduino sketch* is written in a dialect of C++, and requires *two* functions to be present. *Name* these functions, and *describe* their purpose in your own words.

   (6 marks)

   (b) Explain the purpose of the following electronic components:

       i.   Capacitor
       ii. Transformer
       iii. System-on-Chip (SoC)
       iv. Potentiometer

   (2 × 4 = 8 marks)

   (c) Unlike an Arduino, a Raspberry Pi does not provide analogue input pins. Given this restriction, how can a Raspberry Pi be made accept input from a analogue device?

   (6 marks)

3. **(a)** In your own words, *describe* the following network layers from the OSI model. Give an *example* of a protocol or technology that would be implemented at each layer in a real IoT device.

       i.   Physical layer
       ii. Network layer
       iii. Transport layer
       iv. Application layer

   (2 × 4 = 8 marks)

   (b) With respect to the *MQTT protocol*, briefly define the following terms in your own words:

       i.   Broker
       ii. Publisher
       iii. Subscriber
       iv. Topic

   (2 × 4 = 8 marks)

(c) Define *fog computing* in your own words.

(4 marks)

4. (a) Name and briefly define each of the *four Big Vs of Big Data*.

(2 × 4 = 8 marks)

(b) Define *dimensionality reduction* and explain why it might be useful in your own words.

(6 marks)

(c) Name *three* dimensionality reduction algorithms.

(3 × 2 = 6 marks)

5. A startup company is developing an IoT smartspeaker, similar to the Amazon Echo or Google Nest. Users can speak to the device, and it will respond by playing audio. The audio may be synthesised speech (for example, if the user asks the speaker the time or weather) or an audio stream provided by a third party (for example, if the user asks for a song to be played from a music streaming service).

The speaker uses a device-to-cloud architecture: when a wake word is detected, the users speech is recorded and sent to a remote server, which interprets it and creates a response to be sent back to the server. The speaker can also be controlled via a smartphone app that connects to the company's servers also.

(a) Draw a high-level *architectural diagram* of the system the company will build. Show the servers, user devices and the speaker connected to the user's home network in your answer.

(10 marks)

(b) Security is often poorly implemented in many existing IoT devices. One obvious way to ensure this system is secure is to encrypt the video stream so only authorised users can access it. Suggest and briefly describe an algorithm that could be used to do this.

(6 marks)

(c) The company has decided to use a cloud computing service for their servers, rather than purchasing their own servers. Give *two advantages* and *two disadvantages* to this approach.

(1 × 4 marks)