TECHNOLOGICAL UNIVERSITY DUBLIN
CITY CAMPUS - GRANGEGORMAN

—————

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

Year 4

—————

SEMESTER 1
EXAMINATIONS 2023/24

—————

Fundamentals of IoT

Dr. Eoin Rogers
Dr. Paul Doyle

Ms. Sanita Tifentale
Dr. Charles Markham

Exam Duration: 2 hours

Instructions: Answer ALL questions

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

(8 marks)

b)   Briefly name and describe **two** other architectural patterns commonly used for IoT devices

(2 × 3 = 6 marks)

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

(3 × 2 = 6 marks)

2.   a)   In your own words, list **three** advantages of the Arduino, and **three** advantages of the Raspberry Pi, when used as IoT platforms

(6 × 1 = 6 marks)

b)   Explain the purpose of the following electronic components:
   i.   System-on-Chip (SoC)
   ii.   Capacitor
   iii.   Inductor
   iv.   Motor controller

(4 × 2 = 8 marks)

c)   The Raspberry Pi and Arduino do not have analogue output pins, instead relying on a trick called *pulse-width modulation* (*PWM*). Explain how PWM works in your own words, making reference to the terms *frequency* and *duty cycle*.

(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

(4 × 2 = 8 marks)

b)   Define *fog computing* in your own words. In your answer, contrast fog computing with cloud computing.

(6 marks)

c)   MQTT is a common protocol in IoT systems and applications. Briefly define the meaning of the following terms in an MQTT setup:
   i.   Broker
   ii.   Publisher
   iii.   Subscriber

(3 × 2 = 6 marks)

4. a) In your own words, define the terms *data in motion, data in use* and *data at rest*.

                         (3 × 2 = 6 marks)

    b) Name ***three*** dimensionality reduction algorithms.

                         (3 × 3 = 6 marks)

    c) Define *statistical correlation analysis* and explain why it might be useful in your own words.

                         (5 marks)

5. A startup company is developing a wearable IoT device to allow users to track their heart rate. The system consists of a small heart rate monitor that the user wears, which records the user's heart rate and uploads the information to a centralised server. Users can access the information through a phone or web application, and see a graph of their heart rate over the last week. The company also feeds the data into a third party cloud service, which uses machine learning to identify health problems the users may be suffering from, and alert the user if a problem is found.

    a) Draw a high-level architectural diagram of the system. Show the heart rate monitors, servers, the user's gateway device, and the third party machine learning service in your answer

                         (8 marks)

    b) Because the system is dealing with data which relates to the user's medical state, it is essential that it is kept secure and private. To do this, the company decides to encrypt the data using AES. Briefly describe the operation of the AES algorithm.

                         (4 marks)

    c) As mentioned above, the company is depending on a third party cloud service to identify health issues. Give ***two*** advantages and ***two*** disadvantages of using such a service compared to hosting their own servers

                        (4 × 2 = 8 marks)