Programme Code: TU856/DT228, TU857/DT211C, TU858/DT282
Module Code: CMPU 4100
CRN:

# TECHNOLOGICAL UNIVERSITY DUBLIN

**CITY CAMPUS**

TU856 – BSc. (Honours) Degree in Computer Science
TU857 – BSc. (Honours) Degree in Computer Science (Infrastructure)
TU858 – BSc. (Honours) Degree in Computer Science (International)

**Year 4**

SEMESTER 1 EXAMINATIONS 2021/22

## Fundamentals of IoT

Dr. Eoin Rogers

Dr. Paul Doyle

Ms. Sanita Tifentale (TU856)
Ms. Pauline Martin (TU857)
Ms. Pamela O'Brien (TU858)
Mr. Charles Markhan (TU857)

*Duration: 2 hours*

***Answer all questions.***

All questions carry equal marks.

1. a) 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)

b) Briefly describe two other architectural patterns commonly used for IoT devices.

(6 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. Resistor
   ii. Light-emitting diode (LED)
   iii. Potentiometer
   iv. System-on-Chip (SoC)

(4 × 2 marks)

c) What is pulse width modulation (PWM)? Why is pulse width modulation useful?

(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 marks)

b) Define *fog computing* in your own words

(6 marks)

c) Many IoT providers utilise *cloud computing services* when implementing their backend systems. Give ***three*** advantages of doing this, as opposed to purchasing and maintaining their own computers.

(3 × 2 marks)

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

(4 × 2 marks)

b) In your own words, explain the difference between *data in motion* and *data at rest*.

(6 marks)

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

(6 marks)

5. A startup company is developing a IoT webcam, which allows users to view a live feed from the camera from a remote device (e.g. a phone or computer), and rewind the camera to see the last 3 hours of footage. In addition, users can permanently store footage from the camera on the company's servers in the cloud, and this footage can be downloaded or deleted at any time.

The camera uses a device-to-cloud (or device-to-gateway) architecture, where video data is streamed from the camera to the company's servers. These servers hold the 3 hours of footage, and it can then be streamed from the servers to the user's device, and be saved or deleted, on demand. The user can use either a web app or smartphone app to access the system.

a) Draw a high-level architectural diagram of the system the company will build. Show the servers, user devices, and camera 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.

(5 marks)

c) Suppose that the camera is successful, and the company wishes to develop a new, updated version. This new version will have a built-in loudspeaker, allowing users to speak with people at home remotely. Making reference to the diagram drawn in part (a), explain what changes will need to be made to the design of the architecture to accommodate this new feature.

(5 marks)