UNIVERSITY OF BOLTON

SCHOOL OF ENGINEERING

MSC BIOMEDICAL/ELECTRICAL AND MECHANICAL ENGINEERING

SEMESTER ONE EXAMINATION 2024/25

SMART ENGINEERING SYSTEMS

MODULE NO: MSE 7013

Date: Tuesday 7th January 2025 **Time: 2:00pm – 4:30pm**

INSTRUCTIONS TO CANDIDATES:

There are FIVE questions.

Answer ANY FOUR questions.

All questions carry equal marks.

Marks for parts of questions are shown in brackets.

This examination paper carries a total of 100 marks.

All working must be shown. A numerical solution to a question obtained by programming an electronic calculator will not be accepted.

School of Engineering
MSc Biomedical/Electrical and Mechanical Engineering
Semester 1 Examination 2024/25
Smart Engineering Systems
Module No. MSE7013

Question 1

(a) What distinctions can be drawn between Smart devices and Wireless Sensor Networks (WSNs)? **(7 marks)**

(b) Analyse the security and privacy issues in IoT, especially concerning data management. What methods are currently used to address these issues, and what improvements could be made? **(8 marks)**

(c) What are the main obstacles associated with using app-based IoT smart devices? **(5 marks)**

(d) With the use of an example, briefly explain what the Physical Layer is in the Open Systems Interconnect (OSI) model network system. **(5 marks)**

Total Marks: 25

Question 2:

(a) IoT applications have vast potential in healthcare. Discuss how IoT can be leveraged in healthcare, including specific challenges to implementation. **(6 marks)**

(b) Explain what "Big Stream" means and how it's different from "Big Data". **(5 marks)**

(c) Rationalise the role of configuration in the growth of IOT, state the key benefits of self-configurable IoT systems. **(7 marks)**

(d) With the aid of a diagram, explain the Fog Computing paradigm **(7 marks)**

Total Marks: 25

PLEASE TURN THE PAGE

School of Engineering
MSc Biomedical/Electrical and Mechanical Engineering
Semester 1 Examination 2024/25
Smart Engineering Systems
Module No. MSE7013

Question 3:

(a) Analyse the four pillars of sustainability environmental, social, economic, and technological. Also explain how they influence sustainable manufacturing practices. **(12 marks)**

(b) Explain how the concept of 'sustainable engineering' integrates with Product Lifecycle Management (PLM) to support sustainable product development. **(7 marks)**

(c) Discuss the concept of 'zero emissions' within sustainable manufacturing and how PLM tools can support this goal. **(6 marks)**

Total Marks: 25

PLEASE TURN THE PAGE

School of Engineering
MSc Biomedical/Electrical and Mechanical Engineering
Semester 1 Examination 2024/25
Smart Engineering Systems
Module No. MSE7013

Question 4

(a) Draw a UML Use Case Diagram for the for the Freezer Software System described in Figure Q4 **(10 marks)**

(b) Draw a UML Class Diagram for the Freezer Software System described in Figure Q4. Show classes, and relationships between classes on your diagram. Give attributes and methods for the classes. **(15 marks)**

A temperature controller for a freezer must keep the internal freezer temperature within the range ("User_Set_Temperature" to -18°C), where "User_Set_Temperature" is the user's desired temperature value for the freezer, and -18°C is the highest safe temperature for the freezer.

The "User_Set_Temperature" will be set via a dial, and the dial has a range -30° to -18°C.

The controller will use a temperature sensor to determine the current temperature.

The freezer has a refrigerant pump which, when switched on, cools the inside of the freezer.

If the temperature is above the User_Set_Temperature, the controller will switch the refrigerant pump on.

If the temperature is above -18°C, a red light will be lit as an alarm.

When the red light is on, if the temperature drops back into the desired range, the red light is switched off.

If the temperature is below the User_Set_Temperature, the controller will switch the refrigerant pump off.

When the refrigerant pump is turned on it takes some time to get up to operating speed, and when the refrigerant pump is turned off it takes some time to return to idle.

Figure Q4 **Total (25 marks)**

PLEASE TURN THE PAGE

School of Engineering
MSc Biomedical/Electrical and Mechanical Engineering
Semester 1 Examination 2024/25
Smart Engineering Systems
Module No. MSE7013

Question 5

(a) If the Freezer Temperature Control Software System, described in Figure Q4, were to be used to keep medical samples cool, the reliability of the system would become more important. Assume that if the user's desired temperature cannot be set, or the alarm cannot be sounded, or the current temperature cannot be detected, or the software temperature controller fails, then the system is said to have failed. Assume that greater reliability is designed in by using redundancy for the refrigerant pump, thus creating a design for a modified system. Draw a Reliability Block Diagram (RBD) to show the topology of nodes in the modified system. **(8 marks)**

(b) Explain, in a few sentences, what a functional requirement is and what a non-functional requirement is, and give an example of each, for a passenger plane system. **(6 marks)**

(c) What are the overall aims of standards such as BS ISO/IEC 15288 Systems engineering – System life cycle processes? **(6 marks)**

(d) Considering the six general principles of Design for Reliability: Element/component selection, De-Rating, Environment, Minimum complexity, Redundancy and Diversity. Give an example of a system which should be designed using Diversity, and explain how Diversity could be designed into this system. **(5 Marks)**

Total Marks:25

END OF QUESTIONS

END OF PAPER