National University of Computer and Emerging Sciences, Lahore Campus

Course Name:	Introduction to the Internet of Things	Course Code:	IO4041
Degree Program:	BS (CS)	Semester:	Spring 2022
Exam Duration:	60 Minutes	Total Marks:	36
Paper Date:	22-Mar-2022	Weight	12%
Section:	ALL	Page(s):	5 + 1 (Rough Page)
Exam Type:	Mid-1		

Name:_____ Roll No._____ Section:_____

Instruction/Notes:
- Attempt all questions on the provided question paper.
- Space for rough work is provided at the end of the paper.
- Even if you do use rough sheets, they should NOT be attached with final paper.

Question 1: Answer the following multiple-choice questions by filling the following table.   **[1+1+1+1+1+1 = 6 Marks]**

Any answers outside the table will NOT be marked.

1	C
2	C
3	D
4	A
5	D
6	A

1.1. A real time operating system (RTOS) is specially designed to run applications with very precise ---------------------- and a high amount of ------------------------.

 A. timing, delay   B. reliability, delay

 C. timing, reliability   D. energy, delay

1.2. In order to make a well-informed routing choice, a node typically requires information about ----------------------.

 A. the network as a whole   B. its nearest neighbors

 C. Both A & B   D. None of these

1.3. IoT devices in the house help in which of the following?

 A. safety and security   B. automation

 C. energy conservation   D. all of these

1.4. Arduino IDE uses --------------------programming language.

 A. C/C++   B. Java

 C. Python   D. Javascript

1.5. -------------------- is/are the MQTT method(s).

 A. connect, disconnect   B. publish

 C. subscribe, unsubscribe   D. all of these

1.6. Which of the following is not true with respect to MQTT?

 A. MQTT is appropriate for resource-constrained devices used in high bandwidth link

 B. MQTT is based on TCP instead of UDP.

 C. MQTT is a many-to-many communication protocol.

 D. 1883 is the default MQTT port.

Question 2: Answer the following questions in the context of MQTT protocol for IoT:

[3+3+6=12 Marks]

(A) Assume that A publisher wants to publish a message "WELCOME" to the topic "UNIVERSITY/CS" with QoS1 (Quality of service level 1 i.e., 01 in binary) and DUP flag and RETAIN are not set. Suppose that the Message ID is 20. Then,

    (i) What value (in decimal) is represented by remaining length (packet length) field of this publish packet?

Answers: Value in remaining length field: 26 (15 bytes for topic name, 2 bytes for message ID, 9 bytes for message in payload)

    (ii) How many bytes belong to variable length header?

    Answers: 17 bytes

    (iii) How many bytes belong to payload?

    Answers: 9 bytes

(B) Now, assume that A publisher wants to publish a message "HELLO" to the topic "LAHORE" with QoS0 (Quality of service level 0 i.e., 00 in binary) and DUP flag and RETAIN are not set. Then,

    (i) What value (in decimal) is represented by remaining length (packet length) field of this publish packet?

    Answers: Value in remaining length field: 15 (8 bytes for topic name, 7 bytes for message in payload)

    (ii) How many bytes belong to variable length header?

    Answers: 8 bytes

    (iii) How many bytes belong to payload?

    Answers: 7 bytes

(C) Suppose a TCP/IP socket connection is established from a client to a server and a protocol level session is created using a CONNECT flow. The table below provides hexadecimal values present in each byte of a CONNECT packet which comprises of 20 bytes including fixed length header bytes.

Note B stands for Byte and B 1 means Byte 1 (which is most significant byte). Moreover, hexadecimal codes from 41 to 5A represent Capital alphabets from 'A' to 'Z'.

B 1	B 2	B 3	B 4	B 5	B 6	B 7	B 8	B 9	B 10	B 11	B 12	B 13	B 14	B 15	B 16	B 17	B 18	B 19	B 20
10	12	00	04	4D	51	54	54	03	00	01	2C	00	06	50	55	4E	4A	41	42

    (i) How many bytes belong to variable length header?

    Answers: 10 bytes

(ii) How many bytes are there in payload?

Answers: 8 bytes

(iii) What is the value of keep alive time in seconds?

Answers: 300 seconds

(iv) Write the name of application protocol mentioned in variable length header.

Answers: MQTT

(v) Which version of the protocol is mentioned in variable length header?

Answers: version 3

(vi) What type of information payload field provides?

Answers: payload provides client id

Question 3: Answer the following questions? Avoid unnecessary details.   **[2+2+2+2+2+2 = 12 Marks]**

(a) Write the names of functions which are used to read analog and digital data from a sensor in Arduino?

Answers:

Function namely, analogRead() is used to read analog while

digitalRead() function is used to read digital data from a sensor in Arduino.

(b) Describe single level and multilevel wildcard with the help of appropriate example in the context of publish subscribe model?

Answers: A subscriber can subscribe by using single level wild card. Single-level wildcards "+" can appear anywhere in the topic string. For example, let the topic be "Temperature of various places", then it can be mentioned with single level wildcard as home/+/temperature. Arbitrary values are allowed in place of + (hall, kitchen, bed room etc).

With multilevel wildcards, a subscriber can subscribe to any topic starting with main topic. For example, let the topic be "various aspects of home", then it can be mentioned with multilevel wild card as home/#

(c) What is the main difference between sensors and actuators? Explain your answer with suitable example(s).

Answers:

A sensor monitors conditions and signals when changes occur. For example, Light, smoke, temperature, soil moisture, Object sensor, cameras.

Whereas an actuator receives a signal and performs an action accordingly, mostly in terms of movement in a mechanical machine. For example, Window blinders, water control motor, washing machines, ovens, door locks, air conditioner

(d). Miniaturization is one of the major enablers of IoT. Describe it with the help of a related example.

Answers:

It involves creation of new and significantly smaller mobile form factors that allow the use of personal mobile devices while on the move. For example, small size microprocessor chips.

(e). Define embedded systems. Write down the names of three major applications areas of embedded systems.

Answers:

An embedded system is a special-purpose computer system designed to perform one or a few dedicated functions, often with real-time computing constraints. It is usually embedded as part of a complete device including hardware and mechanical parts.

zMajor application areas: Consumer Electronics, High technology cars, Industrial automation, security, finance etc

(f). Diversity of applications is one of the major challenges of IoT in the light of IP architecture. Elaborate this statement.

Answers:

The number of IoT applications is huge, and so is the number of differences in each application. A home automation application does not share all of the properties of an industrial automation application. So, IoT technology tailored to one specific application therefore may not work for other applications.

Question 4: The code given below (developed by using Arduino IDE) demonstrates a simple traffic light management system using LEDs. Based on this code, you are required to answer the questions given after the code. Remember that **HIGH** indicates **ON** state while **LOW** represents **OFF** state.   **[2+2+2 = 6 Marks]**

```
int RED = 7;
int YELLOW = 8;
int GREEN = 9;
void setup()
{
  pinMode(RED, OUTPUT);
  pinMode(YELLOW, OUTPUT);
  pinMode(GREEN, OUTPUT);
}
void loop()
{
      changeLights();
      delay(3500);
}
void changeLights()
{
  digitalWrite(GREEN, LOW);
  digitalWrite (YELLOW, HIGH);
  delay(3000);

  digitalWrite(YELLOW, LOW);
  digitalWrite (RED, HIGH);
  delay(3500);

  digitalWrite(YELLOW, HIGH);
  delay(1500);
  digitalWrite(RED, LOW);
  digitalWrite(YELLOW, LOW);
  digitalWrite (GREEN, HIGH);
  delay(3500);
}
```

(A) Whenever RED light is put in ON, for how many seconds it remains in ON state?

Answers: 5 Seconds

(B) Whenever GREEN light is put in ON state, for how many seconds it remains in ON state?

Answers:7 seconds

(C) For how many seconds, RED and YELLOW lights remain in ON state together?

Answers: one and half seconds

---BEST OF LUCK---

Rough Work: