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 2023**
	Exam Duration:	**60 Minutes**	**Total Marks:**	**35**
	Paper Date:	**28-Feb-2023**	**Weight**	**12%**
	Section:	**ALL**	**Page(s):**	**4**
	Exam Type:	**Mid-1**		

Name:_____ **Roll No.**_____ **Section:**_____

Instruction/Notes: • Answer all the question on separately provided answer book.

Question 1: Write the correct option(s) for following multiple-choice questions on your answer book. You are not required to rewrite the question statement. **[1+1+1+1+1+1 = 6 Marks]**

I. Arduino IDE uses ----------programming language.
   A. C/C++ B. Java
   C. Python D. Javascript

II. If the second byte of MQTT CONNECT packet is 4A (in hex), then total number of bytes (in decimal) in the CONNECT packet will be ----------.
   A. 75 B. 76 C. 64 D. 74

III. With respect to MQTT protocol, ------- is the correct combination of true and false for following statements (i) MQTT is appropriate for resource-constrained devices used in high bandwidth link., (ii) MQTT is based on TCP instead of UDP.
   A. true, true B. true, false C. false, false D. false, true

IV. If the second and third bytes of MQTT CONNECT packet are 50 and 00 respectively (in hex), then total number of bytes (in decimal) in the CONNECT packet will be ----------.
   A. 282 B. 82 C. 128 D. 80

V. Multi-level wildcards "#" must appear ---------- of the string.
   A. at the start B. at the end C. middle D. none of these

VI. In publish subscriber model, subscribing to topic office/# covers
   A. Office/room1/temperature B. home/room1/main-light
   C. office/room1/alarm D. home/office/room1/alarm

Question 2: In publish subscriber model, subscriber makes the following subscription:
myHome/+/tvroom/temp
Write whether the results given below are correct or not correct. Moreover, state the rational behind your answer as well. **[1+1+1+1+1+1 = 6 Marks]**

(A) myHome/groundfloor/tvroom/temp

(B) myHome/firstfloor/drawingroom/temp

(C) myhome/groundfloor/tvroom/temp

(D) myHome/groundfloor/tvroom/brightness

(E) myHome/groundfloor/tvroom/fridge/temp

(F) myHome/firstfloor/TVroom/temp

Answer:

(A) Correct, groundfloor replaces single entry wild card +.

(B) not correct, topic is not the same (drawingroom instead of tvroom)

(C) not correct, myhome and myHome don't represent the same topic as topics are case sensitive.

(D) not correct, topic is not the same (brightness instead of temp)

(E) not correct, change in hierarchy level due to inclusion of fridge

(D) not correct, at third level, TVroom instead of tvroom

Question 3: Answer the following questions? Avoid unnecessary details. **[2+2+2+2 = 8 Marks]**

(A) What is the purpose of DUP flag in MQTT message format?
(B). Diversity of applications is one of the major challenges of IoT in the light of IP architecture. Elaborate this statement.
(C) Describe single level and multilevel wildcard with the help of appropriate example in the context of publish subscribe model?
(D). Miniaturization is one of the major enablers of IoT. Describe it with the help of a related example.

Answer:

(A) The DUP flag indicates that the massage is duplicated and that the receiver may have received it before.

(B) 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

(C) 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/#

(D) 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.

Question 4: Answer the following questions in the context of MQTT protocol for IoT: **[3+6=9 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?
II. How many bytes belong to variable length header?
III. How many bytes belong to payload?

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

(II) 17 bytes

(III) 9 bytes

(B) Suppose packet length (i.e., remaining length) field of MQTT packet indicates that there are 20000 bytes in variable header and payload part. You are required to answer the following keeping in view the encoding algorithm. X represents the length i.e., X = 20000.

I. How many bytes are required for packet length field including extension bytes?
II. For each byte of the packet length, write down the encoded data either in binary or in hexadecimal. Support your answer by providing each step of encoding algorithm for the first byte only.

Answer:

(I) 3 bytes are required

(II)

First byte: 1010000,
Second byte: 10011100, and
Third byte: 000000001

Question 5: Write a simple Arduino program (sketch) to demonstrate automation of room light. It should turn on lights in the room automatically upon detection of human motion and turn it off when there is no motion. Your program must contain at least one LED (connect to pin 4 of Arduino) and a motion sensor. You can connect Data Out Pin of motion sensor to pin 3 of Arduino. LED indicates either on or off state. Your program should not only follow the following instructions but also make use of correct syntax and keywords where required. **[6 Marks]**

- set the motion sensor pin as an input while led pin as an output pin in the setup() function.
- In the loop() function, read the input of motion sensor.
- If motion is detected, turn on the light (led) for 20 seconds before sensing the motion again and if no motion is detected turn off the light for 5 seconds before sensing it again.

Answer:

```
int sensorPin = 3;
int ledPin = 4;

void setup()
{
  Serial.begin(9600);

  pinMode(sensorPin, INPUT);
  pinMode(ledPin, OUTPUT);

  digitalWrite(ledPin,LOW);
```

```
}

void loop()
{
  digitalWrite(ledPin,LOW);
  int motion = digitalRead(sensorPin);
  if(motion == HIGH)
  {
        digitalWrite(ledPin,HIGH);
      delay(20000);

  }
  else
  {
       digitalWrite(ledPin,LOW);
      delay(5000);
  }

}
```