UNIVERSITY EXAMINATIONS: 2022/2023 EXAMINATION FOR THE

DEGREES OF BACHELOR OF SCIENCE IN

SOFTWARE DEVELOPMENT

BAC 3203/BSD 3205 : EMBEDDED SYSTEMS

FULLTIME/PART TIME
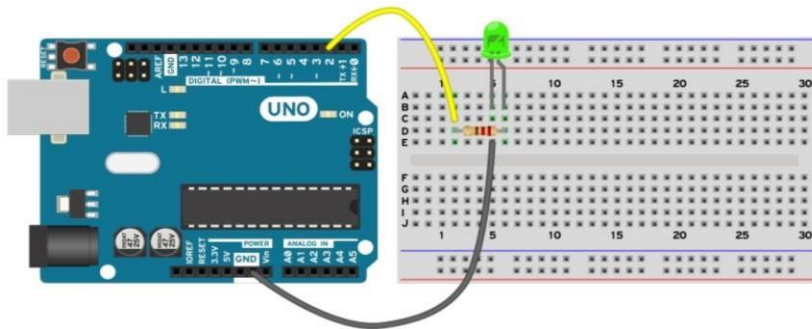
ORDINARY EXAMINATION

DATE: JULY/AUGUST, 2022   **TIME: 2 HOURS**

INSTRUCTIONS: Question One Is Compulsory, Choose Two Other Questions

QUESTION ONE (20 marks) Compulsory

a). Consider the following connection of an external LED to an Arduino board.

   Write code to make the external LED blink   [6 marks]

b). Distinguish between Von Neumann Architecture and the Harvard Architecture as used in Classification of Microcontroller.   [4marks]

c). We can get LEDs in a variety of colors these days, but what about an LED that can change color. We all know that we can use a combination of Red, Green, and Blue (RGB) to get any color. In this question, you are to design and write code for an Arduino application that can give 16 million color combinations with an RGB LED.

     i)   Draw a possible wire connection on the breadboard for the case   [4 marks]

     ii)   Write code that will make the RGB LED change the few colors.   [6 marks]

QESTION TWO (15 marks)

Given the following timing diagram and the light on/off SM, determine the value of B0 at the specified times. [15 marks]
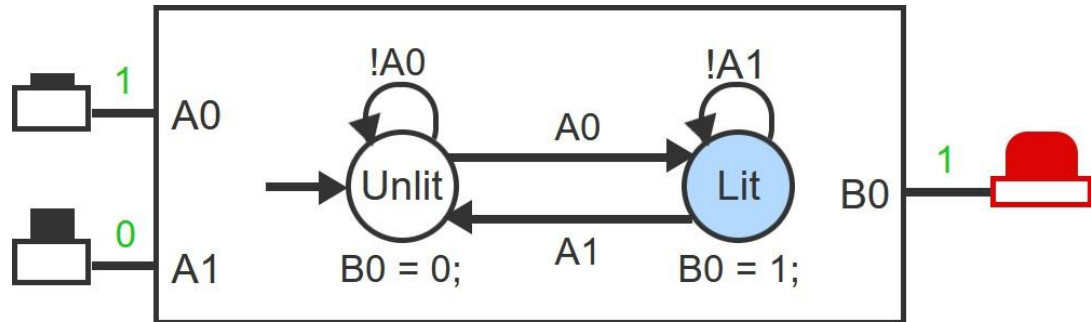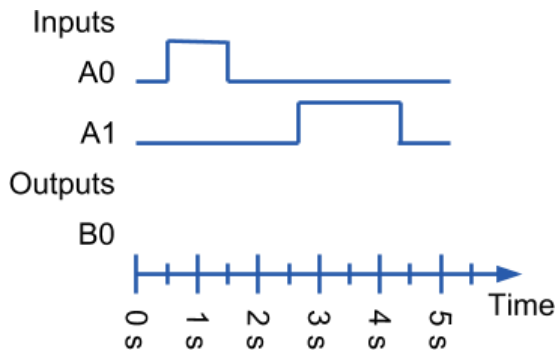
i) 0 s [3 marks]

ii) 1 s [3 marks]

iii) 2 s [3 marks]

iv) 3 s [3 marks]

v) 4 s [3 marks]

QESTION THREE (15 marks)

a). Explain TWO main differences between Embedded System and General Purpose Computing System. **[4marks]**

b). Other than the number of bits and memory architecture, outline three other ways of classifying microcontrollers and give one example for each. **[3marks]**

c).Explain the main difference between a microprocessor and a microcontroller in terms of the Tasks executed. **[2marks]**

d).Write a program using *a selected a* language that reads a pushbutton connected to a digital input pin 7 and turns on an LED connected to a digital output 13 when the button is pressed.

[6marks]

QESTION FOUR (15 marks)

a).Explain and give an example of an embedded system   [5 marks]

b).Consider the following schematic diagram for a serial communication
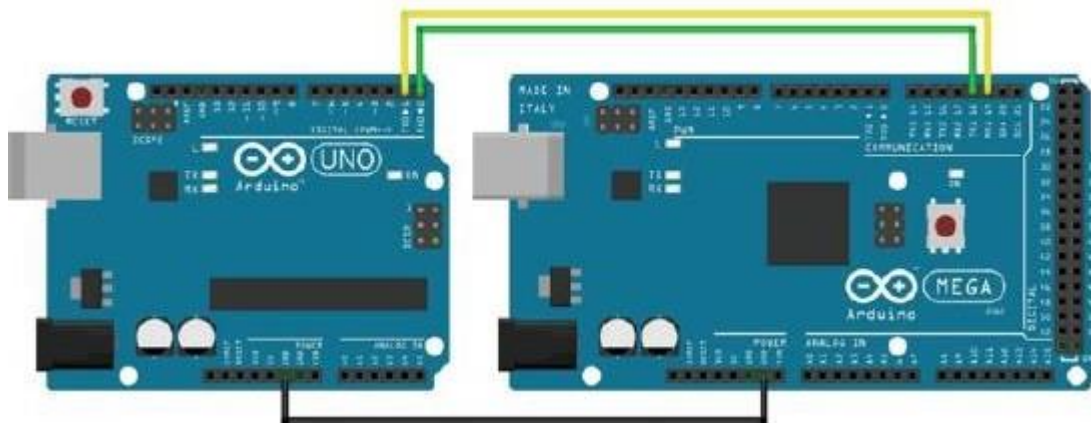
Two Arduino boards are used. The Arduino Uno on the left is the sender and the Arduino Mega on the right is the receiver. We use the Mega to make it easier to display debugging information on the computer. The Arduinos are connected together using digitals 0 and 1 (RX and TX) on the Uno and digitals 16 and 17 (RX2 and TX2) on Mega. The receiver on one needs to be connected to the transmit on the other and vice versa. The Arduinos also need to have a common reference between the two, this is done by running a ground wire. The first step in creating a serial communication system is to package the string to be communicated. In general a packet is comprised of some start byte, a payload (the data you wish to send), and a checksum to validate your data. Here, the packet is: [0x53]

+[counter value]+[static value]+ [checksum]. The receiver code is shown below:

```
// Receiver Information
unsigned char START_BYTE = 0x53; // ASCII "S"
unsigned char counterValue = 0;
unsigned char staticValue = 0;
unsigned char checksum = 0;
boolean syncByteFound = 0; // Sync Byte flag
// Serial1  and Serial2 declarations in external library reference
extern HardwareSerial Serial1;
extern HardwareSerial Serial2;
void setup() {
Serial.begin(9600);
Serial2.begin(9600);
}
void loop() {
unsigned char rxByte = 0;
unsigned char calculatedChecksum = 0;
// Check to see if there's something to read
if (Serial2.available() > 0) {
// If we're waiting for a new packet, check for the sync byte
if (syncByteFound == 0) {
rxByte = Serial2.read();
if (rxByte == 0x53)
syncByteFound = 1;
}
// If we've found our sync byte, check for expected number of bytes
if (Serial2.available() > 2) {
counterValue = Serial2.read();
staticValue = Serial2.read();
checksum = Serial2.read();


checksum = Serial2.read();
calculatedChecksum = counterValue + staticValue;
// Print out our serial information to debug
Serial.print("[");
Serial.print("S");
Serial.print("]");
Serial.print("[");
Serial.print(counterValue);
Serial.print("]");
Serial.print("[");
Serial.print(staticValue);
Serial.print("]");
Serial.print("[");
Serial.print(checksum);
Serial.print("]");
if (calculatedChecksum == checksum)
Serial.println("[Checksum Passed]");
else
Serial.println("[Checksum FAILED]");
syncByteFound = 0;
}
}
}
```

Write the sender code for the above receive information.   [10 marks]