



# AMERICAN INTERNATIONAL UNIVERSITY – BANGLADESH (AIUB)

## Faculty of Engineering

### Department of Electrical and Electronic Engineering

Course/Lab Name: EEE4103 Microprocessor and Embedded Systems

Semester: Fall 2023-23

Term: Final

Quiz: 01F

Total Marks: 10

Time: 20 Minutes

#### Question Mapping with Course Outcomes:

Item	COs	POIs	K	P	A	Marks	Obtained Marks
Q1-2	CO1	P.a.4.C.3	K4			2×5	
Total:						10	

#### Student Information:

Student Name:	Solve Sheet			Section:	O
Student ID #:	Solve Sheet		Date:	20.11.2023	Department:

1. Find the baud rate for the synchronous master operating mode when the oscillator frequency,  $f_{osc} = 18$  MHz, and register data is,  $UBRRn = 011100101011$ . Calculate the baud error and comment on whether there will be any communication error or not. Standard Baud rates are: 300, 600, 1200, 2400, 4800, 9600, 14400, 19200, 38400, 57600, 115200, 230400, ... bps. [5]

#### Answer:

$$UBRRn = 011100101011 = 0 \times 2^{11} + 1 \times 2^{10} + 1 \times 2^9 + 1 \times 2^8 + 0 \times 2^7 + 0 \times 2^6 + 1 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 0 \times 2^2 + 1 \times 2^1 + 1 \times 2^0 \\ = 1024 + 512 + 256 + 32 + 8 + 2 + 1 = 1835$$

$$\text{For the asynchronous normal operating mode, Baud Rate} = \frac{f_{osc}}{2(UBRRn+1)} = \frac{16 \times 10^6}{2(1835+1)} = 4357 \text{ bps}$$

$$\text{Baud Error Rate, } \varepsilon = \frac{\text{Standard baud rate} - \text{calculated baud rate}}{\text{Standard baud rate}} \times 100\% = \frac{4800 - 4357}{4800} \times 100\% = 9.23\%$$

This value is  $>> 2\%$ , therefore, there will be communication errors.

2. For the following program, determine the output and the SPI clock frequency when the oscillator frequency,  $f_{osc} = 24$  MHz. Determine the slave state at the end of the program. [5]

```
#include <SPI.h>

void setup (void) {
    Serial.begin(115200);
    digitalWrite(SS, HIGH);
    SPI.begin ();
    SPI.setClockDivider(SPI_CLOCK_DIV8);
}

void loop (void) {
    char c;
    digitalWrite(SS, LOW);
    // send test string
    for (const char * p = "Hello, world!\r" ; c = *p; p++) {
        SPI.transfer (c);
        Serial.print(c);
    }
    digitalWrite(SS, HIGH);
    delay(2000);
}
```

**Answer:**

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From this command in the code, `Serial.begin(115200);`  
We find the baud rate is 115200 bps

From this command in the code, `SPI.setClockDivider(SPI_CLOCK_DIV8);`  
We find the SPI clock frequency as  $24/8 = 3$  MHz.

From this command in the code, `delay(2000);`  
We find the string sending repetition rate as 2 seconds per string.

From this command in the code, `digitalWrite(SS, HIGH);`  
We find that the slave state (SS) at the end of the program is HIGH.