Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent institution of MAHE, Manipal)

VII SEMESTER B.TECH. (MECHATRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, NOV 2018

SUBJECT: MECHATRONICS SYSTEM DESIGN [MTE 4101]

(20/11/2018)

Time: 3 Hours **MAX. MARKS: 50**

Instructions to Candidates:

- Answer ALL the questions.
- Data not provided may be suitably assumed with justification.

1A. Explain any two types of data transfer method suitable for USB device. **4**

In a doctor's clinic, a 5V bulb outside the door is switched ON to indicate the next patient to enter. As and when the doctor completes a consultation with a patient he presses the 'SPACE' key in his keyboard connected to a PC, to switch on the bulb on the door. The bulb switches ON or OFF through the controller LPC1768. Identify the type of USB data transfer method used for this application and develop a mbed program to perform this task.

1B. Discuss reasons for power consumption in an embedded system. Suggest and explain any two techniques to reduce power consumption. **4**

1C. With suitable examples, describe the following **2**

i) ARM pseudo instructions: LDR

ii) ARM Assembler Directive: DCD

2A. Describe the format of branch instruction used for switching from ARM state to Thumb state and with a neat diagram explain the data path activity for the same. **4**

2B. For the following conditional C code, construct an ARM assembly level program: **3**

```
if (a>b)  {
            c = ((a*a + b*b)>>14)+ a+ b;
          }
else      {
            c = a/8;
          }
```

Assume a, b are stored in Registers R1, R2 respectively. Store the result c in any memory location.

2C. Define hardware software co-simulation and describe the need for it. Also explain the advantages of co-simulation. **3**

3A. Discuss the elements needed by the processor to communicate with the co-processor. Determine how the presence of co-processor affects the performance of a processor. Trace the actions taking place when ARM encounters a co-processor instruction. **4**

3B. A microcontroller is interfaced to 3 slave devices, temperature sensor, LCD controller and an EEPROM. These slaves are accessed by the master using the addresses 0xA1, 0xA2, **4**

and 0xA3 respectively. Between SPI and I2C protocols, elicit the most suitable choice for communication between the master and slaves. Justify your choice and also explain the protocol structure along with sequence of operation using suitable diagram.

3C. Indicate the problem in Read –Modify-Write operation used in updating the data stored in a particular memory location. Elucidate how it is overcome in ARM Cortex M3. **2**

4A. Describe the significance of ARM Cortex. Differentiate ARM cortex pipeline from other ARM processor pipeline. **4**

4B. A chemical reaction takes place in a chamber. The chamber conditions have to be monitored using a temperature sensor and a humidity sensor, interfaced to two pins of LPC1768 controller. The temperature sensor is calibrated to give a HIGH output when temperature goes above 50^0C and humidity sensor is calibrated to give a HIGH output when value goes below 30%RH (Relative Humidity). A stirrer (paddle wheel connected to a motor) is connected via a servo motor to a pin of LPC1768. An electric heater is also connected to LPC1768 via a relay to increase the heat. Develop a mbed program to perform appropriate actions based on the conditions given in table Q4B. Assume that PWM out pin in LPC1768 is p21. **3**

Table Q4B

	Temperature (^{o}C)	Humidity (%RH)	Action to be performed
Condition 1:	$T \geq 60$	$H \geq 40$	Slow stirring of the liquid and heater ON
Condition 2:	$T \leq 40$	$H \leq 20$	Fast stirring of the liquid and heater OFF
Condition 3:	$T \geq 55$	$H \leq 25$	Stirring OFF and heater OFF

4C. In a ball packaging industry, the boxes are attached with the barcode label indicating the number of balls present in each box. The barcode reader reads this value and stores it in consecutive memory location of ARM processor starting from memory address 0x00000048. A container of 10 boxes is read and total number of balls present in all the 10 boxes has to be computed and stored in memory location 0x000000E0. Propose an ARM assembly language program to perform the task of computing the sum of 10 boxes containing balls. **3**

5A. At a time ARM processor is running in user mode. A fast interrupt request occurs by the external device attached to it. Demonstrate the steps involved when an exception occurs and also the instruction and steps to return to user mode. Explain how many processor cycles latency is experienced by FIQ in a worst case scenario. **4**

5B. With reference to embedded system design, define the terms Testing, Validating and Debugging. Discuss the different strategies involved in testing of an Embedded system. **3**

5C. You are a part of a team assigned with the task of developing a complete embedded system for a given process and releasing it to the market. List and describe at least 6 factors that are important to optimize the implementation of your embedded system. **3**