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MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

VI SEMESTER B.TECH. (ELECTRICAL & ELECTRONICS ENGINEERING)
END SEMESTER EXAMINATIONS, APRIL 2018

SUBJECT: EMBEDDED SYSTEM DESIGN [ELE 4001]

REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 24, April 2018** **Max. Marks: 50**

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.
- Support all your programs with relevant comments

1A. Describe the following methods with respect to improving the overall processing power of a processor

i. Harvard architecture
ii. Multicore Processor (Parallel processing) ***(03)***

1B. i. List the various on chip peripherals and salient features of PIC16f877 microcontroller.
ii. Write PIC16f877 (assembly language) instructions to do the following
a. Configure RC3 and RC5 pins as inputs, without affecting configuration of other port 'C' pins.
b. Check the status of 'D2' ($\overline{DONE}$) bit of ADCON0 register and wait till it is reset. (ADCON0 is in bank '0'). ***(04)***

1C. Write equivalent ARM assembly code for the following 'C' program.

```
unsigned int num[100] = {0x12345678, 0xA0305070, ---------- };
long long sum =0;
for (int i=0; i<100; i++)
{
    if (num[i] > 0x00000050 &&  num[i] <= 0x9FFFFFFF)
    {
        sum+=num[i];
    }
}
```

(03)

2A. Describe the following ARM7TDMI instructions.

STMDB R13!, {R0 – R2} and *LDMIA R13!, {R0 – R2}.*

Which type of stack is realized with these instructions? Justify your answer. ***(03)***

2B. Write an ARM7TDMI subroutine to determine the factorial of a '32' bit number (between '0' and '15'). Assume the number to be passed to subroutine through R0 register and return the result through R1 register. If the number passed is greater than 15, return back (without determining factorial) with 01 as error code in R2 register. ***(03)***

2C. i. List the various ARM7TDMI exceptions as per their priority and also mention the new mode of operation and exception vector address.

ii. Write a note on FIQ interrupt exception. Also mention the special features in ARM7 to ensure that FIQ interrupt will be processed quickly. ***(04)***

3A. Show the interfacing circuit to interface a pushbutton to p10 and a common anode seven segment display to pins p11 to p18 of mbedNXPLPC1768 microcontroller. Configure p10 as an interrupt pin and write a main program to keep waiting for the interrupt. When falling edge is detected at p10, write an ISR to display 'i','n','t','e','r','r','u','p','t' , with a delay of 2.4 seconds and then return back to main program. ***(04)***

3B. Write a note on multiple levels of cache memory. Draw the memory hierarchy diagram in a system with two levels of cache and separate instruction and data cache at level 1. In such a system, describe the operation of processor attempting to access memory to read data. ***(03)***

3C. With the help of a relevant timing diagram, explain PCI bus protocol for memory write operation to transfer four '16' bit data in the data field. Assume that no wait cycles are required in case of data '1' and '2'. Target requests for two wait cycles for data '3' and initiator requests for one wait cycle during data '4'. ***(03)***

4A. Write a 'C' program for PIC16f877 to configure MSSP in SPI master mode to transmit data bytes 5AH, 6BH and 7CH to a slave device at a baud rate of 1Mbps and store the (simultaneously) received data bytes from slave. Use low state as idle state for clock, transmit data at the rising edge and sample input data at the middle of data output time. Use RB5 pin to select the slave device and assume fosc = 16MHz. ***(03)***

4B. Describe the bus arbitration scheme (CSMA / CD) used by CAN serial communication bus to support multi master configuration.

Illustrate the scheme with respect to three nodes (node 10, 11 and 12) initiating communication on CAN bus simultaneously with message IDs 20CH, 204H and 21EH respectively. ***(03)***

4C. Describe the protocol used by USB in case of bulk transfer. (Explain token packet, data packet and status packet) ***(04)***

5A. i. Describe the algorithm for converting analog input to digital by on chip ADC in PIC 16f877 microcontroller.

ii. Write a 'C' program to convert the analog input applied to RA0 / AN0 pin of PIC16f877 microcontroller and display the result at ports 'B' and 'D'. Use left justified result, conversion time of 24μs, positive and negative reference voltages from RA3 / AN3 and RA2 / AN2 pins. All the remaining pins of ports A and E should be available as digital I / O pins. Take F_{osc} = 4MHz. ***(03)***

5B. Compare priority and daisy chain arbitration schemes with respect to interrupt expansion. Consider 3 peripherals (1, 2 & 3) to be connected to a processor in daisy chain arbitration scheme. Peripherals 2 & 3 are daisy chain compatible however peripheral 1 is not. Design a suitable logic circuit to make peripheral 1 daisy chain compatible. ***(03)***

5C. List and describe the various charateristics of real time (embedded) systems. Also explain clearly how these characteristics distinguish real time systems from non real time systems ***(04)***