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

DEPARTMENT OF MECHATRONICS

IV SEMESTER B.TECH. (MECHATRONICS)
END-TERM MAKEUP EXAMINATION

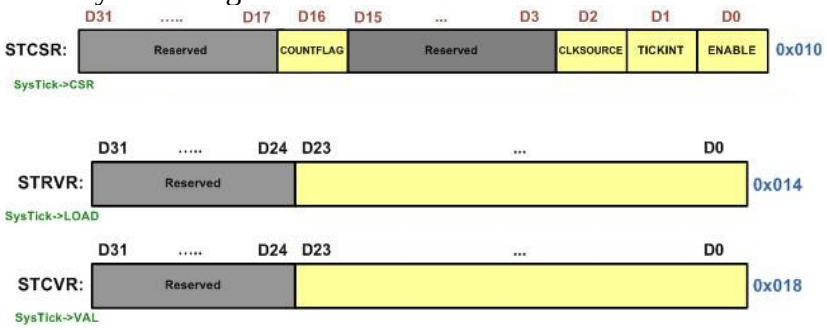
SUBJECT: Microcontroller-based System Design Subject Code: MTE 2225

Date:

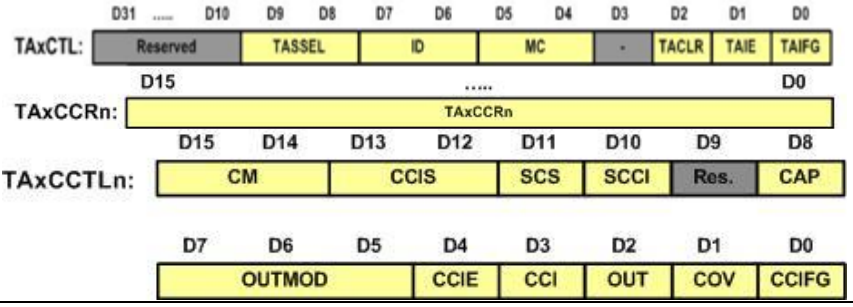
Time: 3 Hrs **Exam Time** **MAX. MARKS:50**

- Answer **ALL** the questions. Assume data suitably if missing.

Q. No.		M	CO	PO	LO	BL
1(a)	You are designing an embedded system to track the pressure in a boiler. The embedded system will continuously receive data from the pressure sensor for analysis. The system must be programmed to look for anomalies or potentially dangerous situations in the pressure data. Develop an assembly language program to determine the highest pressure from the continuously gathered sensor data. The alarm will go off once the highest pressure has been determined. Also, briefly explain the steps to estimate the highest pressure values.	**5**	**2**	**5**	**3**	**5**
1(b)	Examine the risk and ethical assessment of autonomous road vehicle controllers.	**3**	**4**	**8**	**9**	**3**
1(c)	A company employs you as a program engineer. You are asked to improve the functionality of the washing machine by making its processor three times faster. As a program engineer, you have implemented the algorithm using the concept of a 3-stage pipeline and making the processor three times faster. Use a diagram to demonstrate how intermediate values can be held temporarily between successive stages.	**2**	**1**	**1**	**1**	**3**
2(a)	You are tasked with programming a microcontroller to read temperature data from a sensor. The program should precisely determine whether the current temperature reading is even or odd. Develop an assembly language program to find whether the temperature is even or odd. Sum all the even and odd temperatures separately. Save the results in the separate memory locations 0x20000000 and 0x2FFFFFFF, respectively	**5**	**2**	**5**	**3**	**2**
2(b)	A given ARM chip has the following address assignment. Calculate the amount of memory. 1. The address range of 0x00100000 to 0x00100FFF. 2. The address range of 0x40000000 to 0x40007FFF. 3. The address range of 0x00200000 to 0x0020FFFF.	**3**	**2**	**1**	**1**	**3**
2(c)	Develop an assembly program to generate the ten numbers of the Fibonacci series and store the results in memory starting from 0x20000000	**2**	**2**	**2**	**2**	**3**

3(a)	Develop an Embedded C program to make an LED connected to GPIO pin P.2.0 on a microcontroller blink for 1 msec using the SysTick timer. The program should allow adjusting the blink frequency to 3MHz. Whereas SysTick Registers are 	**5**	**3**	**5**	**3**	**3**
3(b)	Develop an assembly language program to calculate the factorial of 7 for MSP432P401R and save the result into the memory location 0x20000000.	**3**	**2**	**2**	**2**	**3**

3(c)	Estimate the contents of R2, R1, and memory location 0x20 after the following program:
	MOV R2,#0x5 ;
	MOV R1,#0x2 ;
	ADD R2, R1,R2 ;
	ADD R2,R1,R2 ;
	MOV R5,#0x20 ;
	STRB R2,[R5] ;
		2	**2**	**1**	**1**	**3**

4(a)	Create an embedded C program that generates a 50% square wave and uses it to control the direction of the wheel of the autonomous vehicle. The wheel should move forward during the on-time of the square wave and backward during the off-time of the square wave. 	**5**	**3**	**5**	**3**	**4**

4(b)	Examine the following code and give the result in R0, R1, and R2 registers.
	MOV R1,#0 ;
	MOV R0,#0 ;
	LDR R2,=0x99999999 ;
	ADDS R0,R0,R2 ;
		3	**2**	**1**	**1**	**3**

<table>
<tr><td></td><td>BCC L1 ;if C = 0,
ADDS R1,R1,#1 ;
L1 ADDS R0,R0,R2 ;
BCC L2 ;if C = 0,
ADDS R1,R1,#1 ;
L2 ADDS R0,R2 ;
BCC L3 ;if C = 0,
ADDS R1,R1,#1 ;
L3 ADDS R0,R2 ;
BCC L4 ;if C = 0,
ADDS R1,R1,#1 ;
L4</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>4(c)</td><td>Estimate the status of flags NZCV during the execution of the following program:
MOV R2,#4 ;
MOV R3,#2 ;
MOV R4,#4 ;
SUBS R5,R2,R3 ;
SUBS R5,R2,R4 ;</td><td>2</td><td>2</td><td>2</td><td>2</td><td>3</td></tr>
<tr><td>5(a)</td><td>You have a robotic arm that needs to be controlled using a DC motor. The motor needs to be turned on and off every 1 second using a blue LED as an indicator. Write an embedded C program for MSP432P401R that uses the one-shot mode of Timer32 to toggle the blue LED every 1 second and control the DC motor accordingly. Consider the Mclock = 3MHz
<table>
<tr><td>Bits</td><td>7</td><td>6</td><td>5</td><td>3-2</td><td>1</td><td>0</td></tr>
<tr><td>TIMER32_y->CONTROL</td><td>ENABLE</td><td>MODE</td><td>IE</td><td>PRESCALE</td><td>SIZE</td><td>ONESHOT</td></tr>
<tr><td>TIMER32_CONTROL_XX_x</td><td>1-enable,
0-disable</td><td>0- free runnin g mode,
1- periodic</td><td>1- enable interr upt
0- disabl e</td><td>00=/1,
01=/16,
10=/256</td><td>1- 32 bit,
0- 16 bit</td><td>1-oneshot,
0-wrap</td></tr>
</table>
<table>
<tr><td>25</td><td>Timer32_INT1</td><td>T32_INT1_IRQn</td><td>T32_INT1_IRQHandler</td></tr>
<tr><td>26</td><td>Timer32_INT2</td><td>T32_INT2_IRQn</td><td>T32_INT2_IRQHandler</td></tr>
</table>
<table>
<tr><td>TIMER32_y->LOAD</td><td>Load register</td></tr>
<tr><td>TIMER32_y->INTCLR</td><td>Clear flag</td></tr>
<tr><td>TIMER32_y->VALUE</td><td>Check the counter value</td></tr>
</table></td><td>5</td><td>3</td><td>2</td><td>2</td><td>5</td></tr>
<tr><td>5(b)</td><td>Develop an embedded C program for MSP432P401R that constantly checks the switch's state P.1.1. and toggles the LED's state connected to P.2.2.</td><td>3</td><td>3</td><td>5</td><td>3</td><td>3</td></tr>
<tr><td>5(c)</td><td>Evaluate the value for TAxCTL if we want to program Timer_A in continuous mode with no clock division. Use ACLK for the clock source.</td><td>2</td><td>3</td><td>1</td><td>1</td><td>2</td></tr>
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