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

DEPARTMENT OF MECHATRONICS
III SEMESTER B. TECH (MECHATRONICS)
END SEMESTER EXAMINATION [Jan] [2023]

Subject: Microcontroller-Based System Design **Subject Code: MTE 2153**

Date

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

Instructions to Candidates:

- *Answer ALL the questions.*
- *Missing data may be suitably assumed and justified.*
- *Refer Formula book wherever required*

Q. No	Question	M	CO	PO	LO	BL
1A	The ABS system is used for safety braking of a car. A magnetic sensor mounted on each wheel near the teeth generates electrical pulses when the pole wheel rotates. The rate at which the pulses are generated is used to measure the wheel speed. This signal is read by an electronic control unit (ECU). When a wheel is locked, the ECU sends an electrical signal to the modulator valve solenoid, which releases pressure from the brake chamber. When the wheel recovers sufficiently, the brake pressure is reapplied again to the modulator valve. The cycling of the modulator valve (5 to 6 times per second) is continued till the vehicle comes to a controlled stop. With ABS, the vehicle remains completely stable even when the driver continues to press the brake pedal, thus avoiding accidents. Identify the modules that help to detect the speed of the wheels and control the brake pressure if MSP432 is employed in the ECU. Also, mention the industry standards to be complied with.	4	1	2	2	4
1B	Consider windshield washer pumps used in vehicles for cleaning the front glass. Pressing the wash button will operate the wipers and washer motor pump continuously until the washer button is released. Releasing the button will stop the washer pump but the wipers will complete the current wipe cycle two times. Assume wash button is connected to P1.4 pin, water pump relay is connected to P1.5, DC motor pins are connected to P1.6, P1.7 of MSP432 launchpad. Develop an Embedded C code to perform the above-mentioned operation.	4	3	3	5	6
1C	Compare and contrast parallel and serial communication processes in the embedded system design.	2	3	7	2	2
2A	Describe the role of PRIMASK, BASEPRI, and FAULTMASK registers in the MSP432.	3	3	1	1	2
2B	An electric vehicle with a rear wheel drive with two separate DC motors on each wheel. MSP432 is used to control the speed of wheels. Develop a logic using PWM concept to achieve the differential drive properties in DC motors and write an Embedded C code for the same using the TIMER_A0 module.	4	3	3	1	3

2C	Consider a car with a safety airbag system to protect the driver and front passenger. Gas inflators expand the front airbags when a high brake impact is detected by the sensors. For maximum protection, the airbag must be fully inflated before the occupant comes into contact with it. The airbag needs approximately 40ms to inflate completely. Write an Embedded C code to inflate the airbag when it senses the sudden break. Use Timer 32 module to count the time.	3	**3**	**1,3**	**5**	**6**
3A	A sounder alarm controller is used to sense the risk situations in the nearby area and switch the speaker for 1 minute. It is designed using an MSP432 controller and a few sensors connected to GPIO pins. Develop an Embedded C code to switch on the alarm based on sensor input. Suggest a method to avoid faulty alarm conditions while designing the controller.	5	**4**	**1,3**	**2,5**	**6**
3B	Summarise the functional safety requirements required in the sounder alarm controller design process.	3	**4**	**6**	**5**	**4**
3C	Justify the importance of IEC in embedded system design and IEC/ISO standards needed in the sounder alarm controller.	2	**4**	**6**	**5**	**4**
4A	Write an ARM assembly language code for implementing the expression Y=(MX+C)/A. Each variable takes a 1-byte memory location.	4	**2**	**1**	**1**	**3**
4B	Write an assembly program to reverse the order of the 10 numbers (8-bit) stored in the data memory starting from 0x20001000 onwards using PUSH/POP instructions.	**4**	**2**	**1**	**1**	**3**
4C	Choose an ARM assembly instruction where the V flag is set and reset.	**2**	**2**	**2**	**2**	**4**
5A	Write an Embedded C code to switch on RED LED (connected to pin P1.0) in the MSP432 launchpad when only one switch connected to pin P1.1 or P1.4 is pressed.	**4**	**3**	**1**	**1**	**3**
5B	Explain the working of the UART communication process in the MSP432 module.	**4**	**3**	**1**	**1**	**2**
5C	Compute the required parameters for generating the baud rate of 57600 using the clock settings of 12 MHz. Explain the role of each module of a Baud rate generator in the MSP432 launchpad. Compute the values to be loaded into the registers BRW, BRS, and BRF for UART communication.	**2**	**3**	**1**	**1**	**3**