Reg. No.										

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

DEPARTMENT OF MECHATRONICS
III SEMESTER B.TECH. (MECHATRONICS)
END SEMESTER EXAMINATIONS, MARCH 2021
SUBJECT: MICROCONTROLLER BASED SYSTEM DESIGN [MTE 2153]
(Date: 08-03-2021 Time: 2:00 PM – 5:00 PM)

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

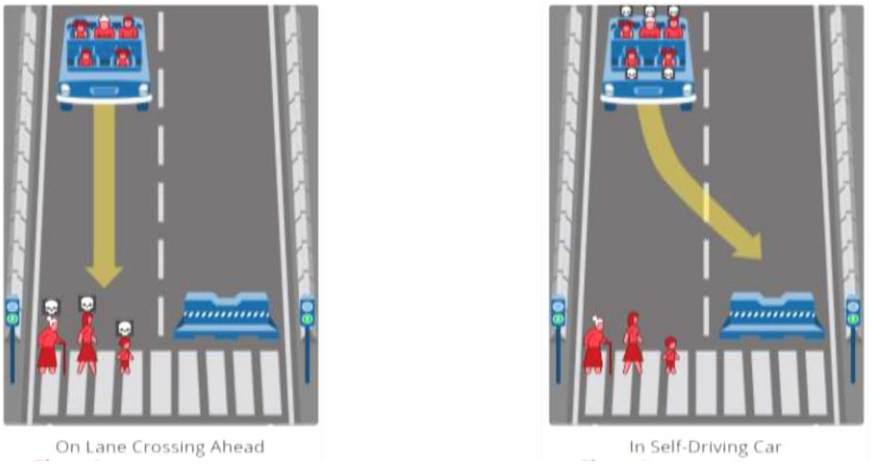
Instructions to Candidates:

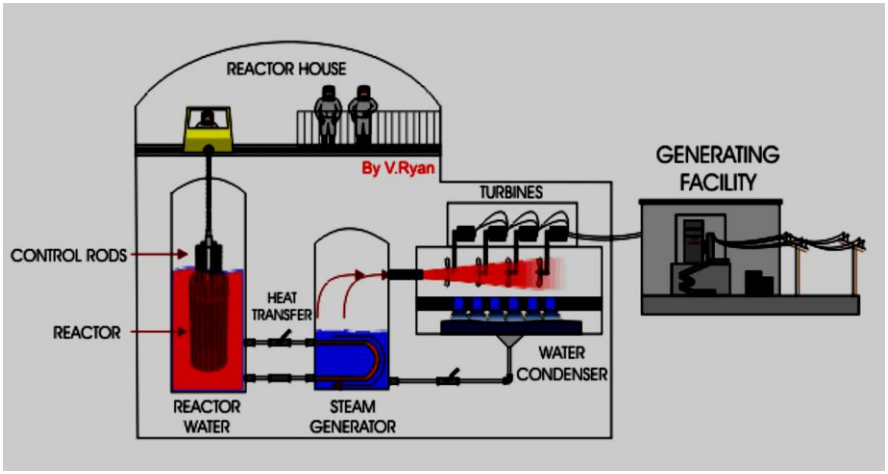
- Answer **ALL** the questions.
- Any data not provided may be suitably assumed.

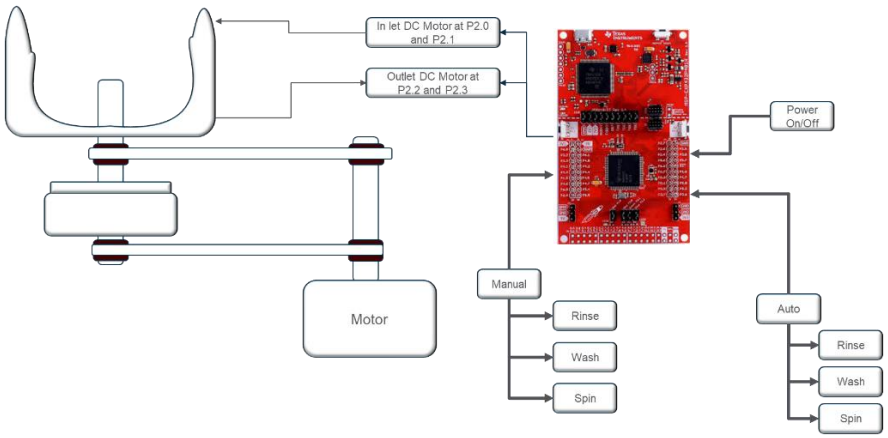
Q. No	Question	M	CO	PO	LO	BL
1A	An electric vehicle is a rear wheel drive with two separate DC Motors on each wheel. The control part of wheels is connected to MSP432P401R. Develop a logic using PWM concept to achieve differential drive properties in DC motors.	**3**	**3**	**1,2**	**1**	**4**
1B	Compute 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 MSP432 lanchpad.	**4**	**3**	**1,2**	**1,2**	**2**

1C	Write an assembly language program for the C code shown below:
	void main()
	{
	int count;
	int *P;
	int i;
	P = & count;
	for (i=0; i<10; i++)
	{
	Pt = Pt + 1;
	(*Pt) + = 1;
	}
	}
		3	**3**	**1**	**1**	**2**

2A	Write an assembly language program to perform Fibonacci series upto n terms. Store the values from address location 0x20000000.	**4**	**2**	**1,2**	**1**	**2**
2B	Write an assembly program to reverse the order of the 10 numbers (32 bit) stored in the data memory starting from 0x20001000 onwards using PUSH/POP instructions.	**2**	**2**	**1**	**1**	**2**

2C	Write an assembly language code for the following expression in ARM cortex M4 Core. a. Y=(MX+C)/A b. $A=\pi r(h^2+r^2)$ Note: Do not replace the variables with any decimal number.	**4**	**2**	**1**	**1**	**2**
3A	An Autonomous car has to go through ethical paradox to address the concept of self-driving.  Fig 3A: Designed using moralmachine.net. A self-driving car is approaching towards traffic junction and the signal has turned green, i.e., its legal to drive through the junction but at the same time three people are crossing the junction. Analyze the ethical dilemma and workout the work states from Figure 5. Mention the possible Functional Safety Management required with respect to embedded system design.	**5**	**1**	**6,8**	**7,8**	**4**
3B	Steam generators are heat exchangers used to convert water into steam from heat produced in a nuclear reactor core. The steam water is used under pressurized condition between primary and secondary loops. Secondary loop is channelled with turbine chamber for generating electricity from low pole AC synchronous generators. The turbine is enclosed with a proximity sensor to observe / monitor the movement and connected with MSP432P401R. Nuclear reactor core has cooling rods/control rods to control the fission rate. A DC motor is connected to move the controlling rods in Z axis. Also, the entire system has master shut down mechanism using an emergency stop connected to a relay which can disconnect the power supply and generate emergency siren. Develop an embedded C code to address the application using the mentioned conditions. Use fig 3B for visualization. Conditions: 1. The proximity sensor is connected to P1.2. 2. The relay for master shut down mechanism is connected to P1.3. 3. The DC motor is connected to P1.4 and P1.5. 4. The DC motor should rotate clockwise when proximity sensor is high and anti-clockwise when proximity sensor is low.	**3**	**4**	**2**	**2**	**3**

	5. If the proximity sensor is continuously at zero for 10 counter operations of core clock frequency then the microcontroller should activate the master shut down mechanism. 6. The proximity sensor is purely digital in nature.  Fig 3B					
3C	Refer fig 3B, to address functional safety standards.	**2**	**4**	**6**	**8**	**2**
4A	Outline the importance of functional safety management in embedded systems and mention the taxonomy.	**3**	**1**	**1**	**1**	**2**
4B	An automatic gate opening system when a car enters near the gate is designed as follows: The IR sensor is used to detect the car at 2 places (left and right).  When both IR sensors detect the low signal, gate opens automatically using servo motors attached to it. Also, gate closes after car enters into the campus. The PWM signal generated by the MSP432 will be fed to the continuous servo motor directly. In the servo motor, 1-millisecond pulse (with the period 50 Hz) corresponds to full speed in one direction (90 degree), while 2-millisecond pulse corresponds to full speed in the other direction (-90 degree). A 1.5-millisecond pulse should cause the servo motor to stop. Develop embedded c code for the application using the above said sensors and actuators. Show the connection between them.	**5**	**4**	**1,2**	**2**	**3**

4C	Summarize the importance of watch dog timer in ARM Cortex M4F as a timer and counter?	**2**	**2**	**1**	**1**	**2**
5A	MSP432P401R is used by "White & White washing company" as a controller for a product "Extraordinary Washing Machine V2.0". The hardware engineer designed the setup as per figure 1. Develop a methodology to address the manufacturers specifications with Embedded C code. Condition: 1. Power ON and OFF is connected to P2.4. 2. Auto Button is connected to P5.1. 3. Manual Button is connected to P3.5. 4. In Auto mode each operation is changed automatically after 3 seconds and each duration lasts for 120 seconds. 5. In manual mode next process waits for user to set. And each mode lasts for 120 seconds, but if any switch is provoked the existing operation is terminated and follows the user command. 6. The motor is connected to P1.1 and P1.2 to spin clockwise and counter clockwise for each 3 seconds.  Fig 5A	**5**	**4**	**2,3**	**2**	**3**
5B	Mention the Functional Safety standards required and analyze the risk parameters. Use Figure 5A for visualization.	**3**	**4**	**6**	**9**	**2, 4**
5C	Mention the importance of IEC in Embedded/Controller systems and its classifications on the basis of engineering applications.	**2**	**1**	**1**	**1**	**2**