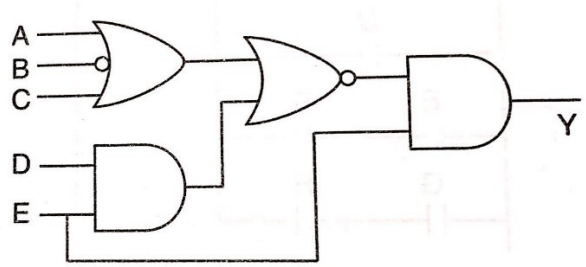
Name: Enrolment No:	UPES UNIVERSITY WITH A PURPOSE

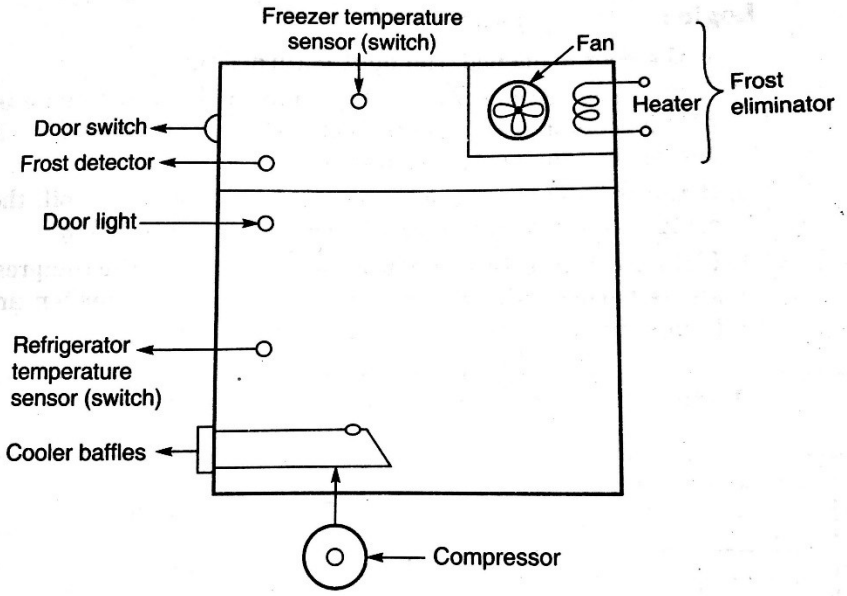
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2019

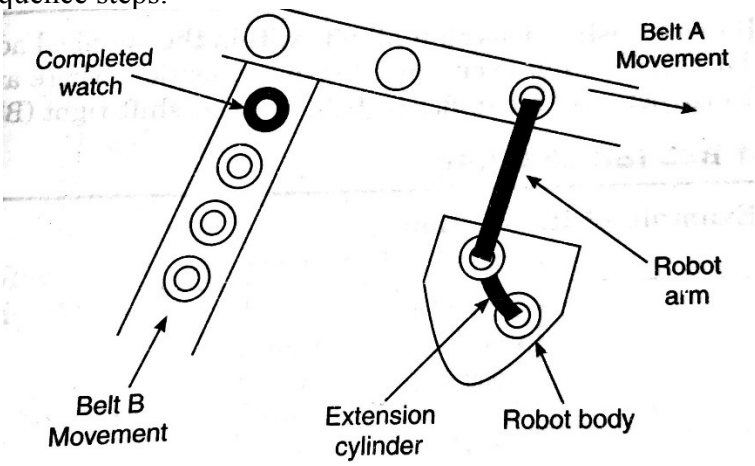
Course: PLC and HMI **Semester:** VI
Program: B.Tech Mechatronics **Time 03 hrs.**
Course Code: MEEL 321 **Max. Marks: 100**

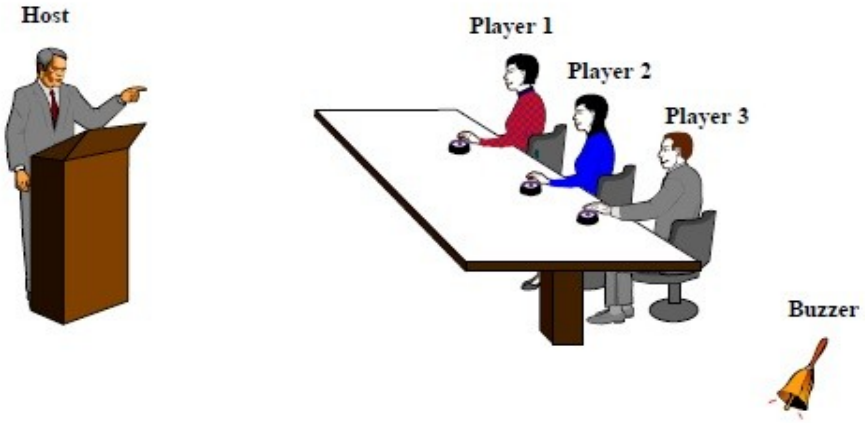
Instructions:
Assume data as per requirement.
Mention PLC's make, model, inputs and outputs.

SECTION A

S. No.		Marks	CO
Q 1	Convert the digital gate circuit shown in below figure into ladder diagram. 	5	CO3
Q 2	What is the difference between relays and contactors.	5	CO2
Q 3	In industrial perspective, why push buttons are preferred over toggle switches.	5	CO1
Q 4	In reference to HMI, provide the significance of recipe.	5	CO4
	SECTION B		
Q 5	RTD sensor is wired at analog input. The RTD sensor provides 4 - 20 mA signal for 0 to 200 deg. C temperature. The digital panel meter, which displays 0 to 200 deg. C temperature for 4 – 20 mA signal is wired to output. Develop a ladder logic for the following conditions: i. Scale analog input from RTD sensor. ii. Display the temperature on digital panel meter. Analog output is wired to digital panel meter. iii. ON lamp 1, if the temperature is greater than 45 deg.C. iv. ON lamp 2, if the temperature is less than 30 deg.C. v. ON lamp 3, if the temperature is between 30 deg.C and 45 deg.C.	10	CO5
Q 6	PLC is used to control the operation of refrigerator/ freezer. The refrigerator consists of compressor, heater, temperature sensor, frost detector, fan, cooler and baffles.	10	CO5

	 Develop a ladder program for the following logic: i. If the refrigerator door is opened, light is turned ON. ii. If the cooler temperature is high and the frost eliminator is off, the compressor is turned ON, and baffle is opened until the cooler temperature is low. iii. If the freezer temp is high and frost eliminator is off, the compressor is turned on until the temperature is low. iv. If the frost detector is ON, the timer is started , the compressor is turned OFF, and the frost eliminator heater/ fan are turned ON until the timer times out (60 seconds).		
Q 7	In perspective of HMI, provide the significance of the following: i. Trends ii. Alarms	**10**	**CO4**
Q 8	List the driving factors (in perspective of an automation engineer) in the decision of whether to use a PLC-HMI based system or a hardwired relay system.	**10**	**CO2**
	SECTION-C		
Q 9	A pick and place machine in which a pneumatic robot takes watch covers from one conveyor belt and inserts them onto the back of the watch bodies on another conveyor belt. The six step operation begins when the suction cup at the end of the arm makes a contact with a cover on conveyor belt A. The robot has only two movements: Rotate and Extension. Rotate: When 1 is applied to the rotate solenoid, air forces the body to turn counterclockwise 90 deg. When 0 is applied, the solenoid deactivates and air pressure stops, allowing spring to turn the body clockwise 90 degrees. Extension: When a 1 is applied to the extension solenoid, air forces a cylinder to extend the arm upward to a height 1 mm above the watch covers on conveyor belt A.	**20**	**CO5**

	When 0 is applied to the solenoid, it deactivates and air pressure stops, allowing spring to retract the arm to a height equal to the top of the watch bodies on conveyor belt B. When a 1 is applied to the suction solenoid a vacuum port is activated, causing suction to occur. The conveyor belts are activated when a 1 is applied to the driver motor. The speed of the motor is set so that the belts travel the correct distance during the sequence steps.  Step1: The cylinder extends over belt A and the suction at the end of the arm picks up the watch cover. Step 2: While the cylinder is extended and the cover is held In place, the solenoid for the robot body is actuated, causing the arm to swing counterclockwise by 90 degrees. Step 3: While the cover is held in place and the robot arm is positioned over conveyor belt B, the extension solenoid deactivated, causing the cylinder to lower the cover snaps securely onto the watch body. Step 4: While the robot body is in position at conveyor belt B, the suction pressure is removed and the extension solenoid is activated, causing the arm to rise. Step 5: When the cylinder fully extends the arm, the body solenoid is deactivated, causing the arm to rotate clockwise by 90 deg. Step 6: While the arm is extended and positioned above conveyor belt A, both conveyor belt motors are activated and run until the end of the sequence step. Step 7: A cover on conveyor belt A and a body on conveyor belt B are in the required positions to repeat the entire sequence of step.		
Q 10	A buzzer game has been organized for 3 participants, following are the game buzzer control requirements for it:	**20**	**CO4**



Develop a ladder program for the following logic:

i. After the host has finished with question.
ii. The three players will press the switch in front of them to fight to be first to answer the question.
iii. The buzzer will sound for 10 sec after any one of the players has touched the switch.
iv. The light indicator in front of each player will light up and only reset by the host switch

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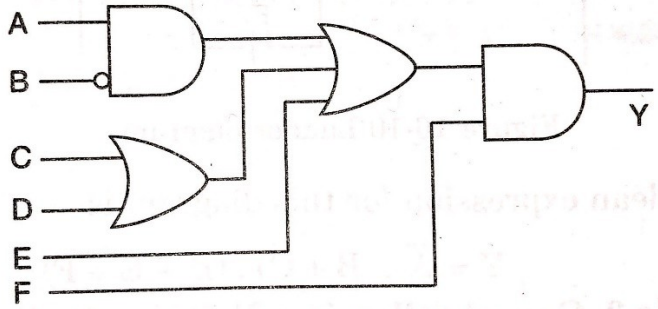
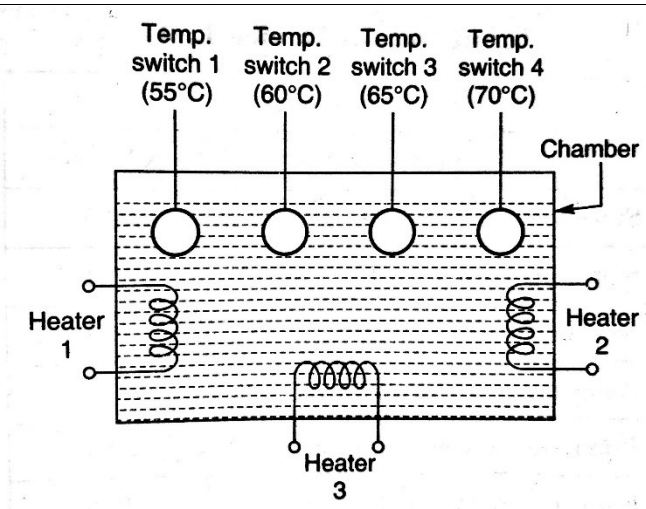
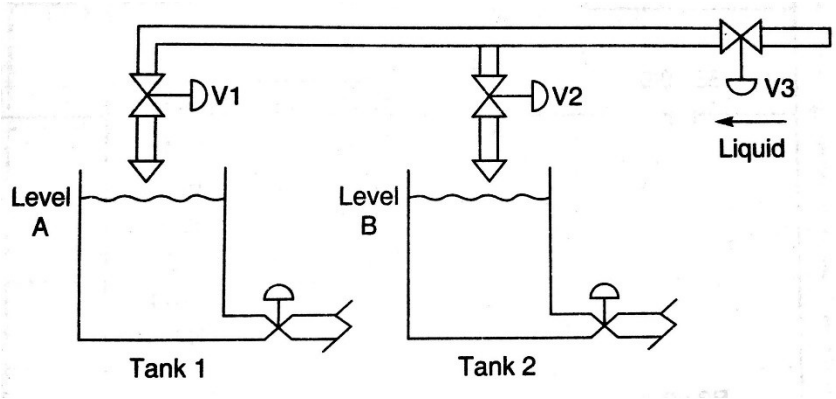
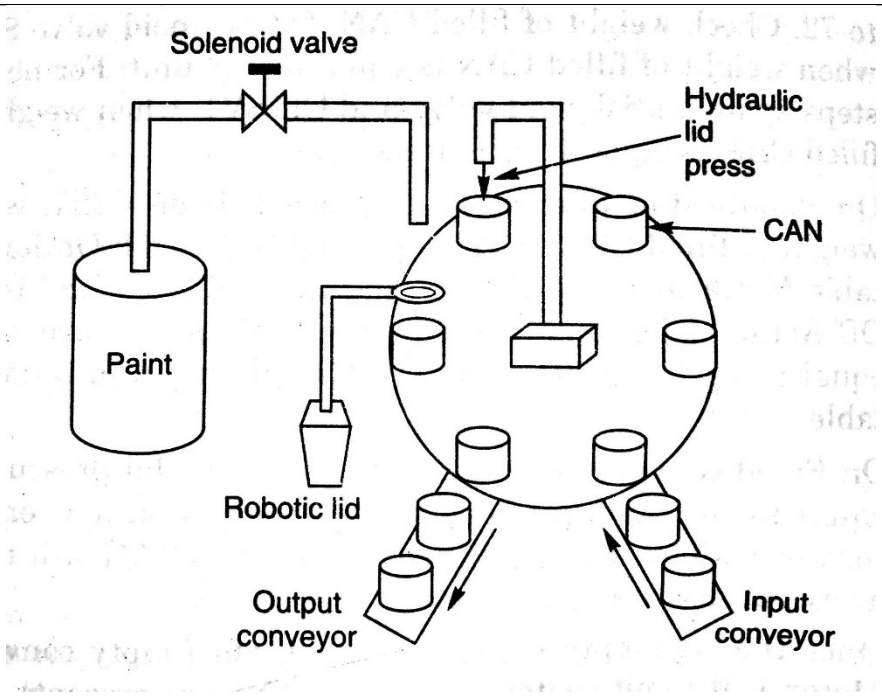
Q 1	Convert the digital gate circuit shown in below figure into ladder diagram. 	5	CO1
Q 2	Explain the working of electromechanical relay.	5	CO2
Q 3	What is the difference between inching switch and push button.	5	CO2
Q 4	State the difference between real time trend and historical trend.	5	CO4
	SECTION B		
Q 5	Develop a ladder logic for a temperature control system consists of three heater and four temperature switches. Three heaters are connected to PLC through relays The input devices temperature switches are wired to input terminals of PLC. These temperature switches are set at 55, 60, 65 and 70 deg. C temperatures. The liquid is filled into chamber. The liquid temperature is controlled by the PLC. The start and stop push buttons are used to start the operations and stop the operations of the system.	10	CO4

	 Logic: i. Temperature switches are set at 55, 60, 65 and 70 deg. C. ii. If temperature is below 55 deg. C, three heaters are ON. iii. If temperature is between 55 deg. C to 60 deg. C, two heaters are made ON. iv. If temperature is between 60 deg. C to 65 deg. C, one heater is turned ON. v. If temperature is above 70 deg. C, all heaters are turned OFF. vi. Start and stop push buttons are used to start and stop the operation of system.		
Q 6	Design the power circuit diagram for starting a 3 phase induction motor using voltage reduced/ star-delta method. Also develop a PLC ladder program to obtain the above result.	**10**	**CO3**
Q 7	Develop a PLC program (ladder logic program) for the fluid tank for following process: The tank will start filling (via a valve) whenever the start process button is enabled and the tank is below 50% full. It will shut off when the tank is 100% full. In case the level sensor is out of calibration or not working properly, there is a high-level safety limit to prevent the tank from overfilling. If the high limit is met at a preset value of 102% full the process will shut down and a strobe light will turn on. Indicator lights are activated when the tank level reaches 50%, 75% and 100% full. There is a slight dead band to prevent flickering lights when tank levels vary slightly due to filling or splashing. If the tank for some reason does not fill up to a minimum level of 50% within 5 minutes after the valve energizes, an alarm will notify an operator. The operator will be able to silence the alarm for 5 minutes by pressing a silence button. After five minutes the alarm will trigger notifying the operator once again. The operator will be able to silence the alarm two times. If the silence button is pressed a third time, the alarm will remain on and an energized strobe light will notify anyone within the site of the tank. If the tank remains under 50% full, the only way to de-energize the alarm and strobe is to stop the process.	**10**	**CO5**
Q 8	In perspective of HMI, answer the following: i. Do we have to configure alarms for all items of hardware? ii. Can we send alarms to a printer and file as well as display them on the screen?	**10**	**CO4**

	iii. How can we prioritize alarms?		
	SECTION-C		
Q 9	Develop a ladder logic program for level control system shown in figure. The start and stop buttons are used to start and stop the operation of the system.  Logic: i. If start button is pressed, the valves V1, V2 and V3 will be opened and liquid is filled into tank for 30 seconds. ii. After that, if the liquid level of the tank 1 is below 50% the valves V1 and V3 will be opened. iii. If the liquid level of the tank 2 is below 40% the valves V2 and V3 will be opened. iv. If the average level of both tanks is above 95% the valves V1, V2 and V3 will be closed, otherwise opened. v. By pressing stop button, system operation can be stopped. Level sensors are analog devices.	**20**	**CO5**
Q 10	The main objective of the system is to fill the empty cans with paint and then to place lids on them. As shown in the figure, a rotating table is used to move the cans in a circular fashion. The rotating table motor is used to rotate the table in six steps to complete the one rotation. When motor is on, 1 step movement is for 72 deg. The encoder is mounted on its shaft, to motor 1 is used to move the input conveyor over which empty cans can enter into table.	**20**	**CO4**



Logic:

i. Press start PB to start the system.

ii. On empty conveyor motor 1, if (empty can is present) LS1 is on. Off empty conveyor motor 2, if LS1 is off (if all six empty cans are placed on rotating table.)

iii. On rotate table motor 3, if (if lid is present at proper position) the sealing limit switch LS2 is on. Off rotating table motor 3, when encoder pulses are equal to 72. Then 2nd empty can will enter on rotating table.

iv. Rotate on rotating table motor 3, if (if lid is present at proper position) the LS2 is on. Off table motor 3, when encoder pulses are equal to 72. Then 3rd empty can will enter on rotating table.

v. Rotate on rotating table motor 3, if (if lid is present at proper position) the LS2 is on. Off table motor 3, when encoder pulses are equal to 72. Then 4th empty can will enter on rotating table.

vi. On hydraulic lid for a moment, to place the lid on can by hydraulic machine, when encoder pulses are equal to 72. For next 5 steps again on hydraulic lid for a moment.

vii. On rotate table motor 3 again, if (if lid is present at proper position) the sealing limit switch LS2 is on. Off rotating table motor 3, when encoder pulses are again equal to 72. Then 5th empty can will enter on rotating table.

viii. On solenoid valve SV1, when encoder counts are equal to 72. Check weight of filled can. Off solenoid valve SV1, when weight of filled can is equal to 128 unit. For next 5 steps again on solenoid valve and off SV1, when weight of filled can is equal to 128 units.

ix. On robotic lid placement to place lid on can, when weight of filled can is 128 unit and SV1 is off. On rotate table motor again, if LS2 is on. Off rotate table motor 3, when encoder pulses are again equal to 72. Then 6th empty can will enter on rotating table.

	x.	On filled conveyor motor 2, if (if hydraulic lid pressure is equal to set pressure) pressure switch PS1 is on and empty conveyor motor 1 is off. Filled and packed can will move away out of rotating table.		
	xi.	Once the six empty cans are filled, on empty conveyor motor 1, if limit switch is on (six cans are present), and repeat the process again.		
	xii.	Press stop push button to stop the process.		