

MARKING CRITERIA AND STUDENT FEEDBACK

This section details the assessment criteria. The *extent* to which these are demonstrated by you determines your mark. The marks available for each criterion are shown. Lecturers will use the space provided to comment on the achievement of the task(s), including those areas in which you have performed well and areas that would benefit from development/improvement.

Common Assessment Criteria Applied	Marks available	Marks awarded
1. Research-informed Literature Extent of research and/or own reading, selection of credible sources, application of appropriate referencing conventions	10	5
Good.		
2. Knowledge and Understanding of Subject Extent of knowledge and understanding of concepts and underlying principles associated with the discipline	25	18
Excellent		
3. Analysis Analysis, evaluation and synthesis, logic, argument and judgement, analytical reflection, organisation of ideas and evidence	25	15
Very good.		
4. Practical Application and Deployment Deployment of methods, materials, tools and techniques; application of concepts; formulation of innovative and creative solutions to solve problems	30	28
Exceptional		
5. Skills for Professional Practice Attributes in professional practice: individual and collaborative working, deployment of appropriate media, presentation and organisation	10	6
Very good.		

Assignment Mark (Assessment marks are subject to ratification at the Exam Board. These comments and marks are to give feedback on module work and are for guidance only until they are confirmed.)	Late Submission Penalties (tick if appropriate)		72 %
	Up to one week late		
	First Attempt?	✓	



PLC PROGRAM DESIGN AND SIMULATION

PDSE4005 Programmable Logic Controllers

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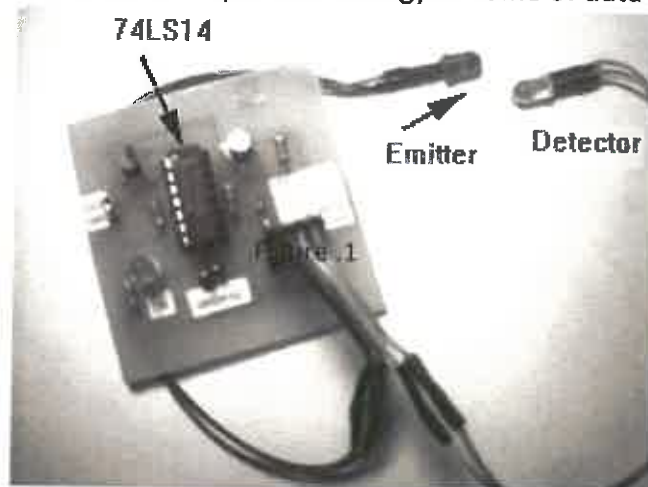
TASK 1.

a)

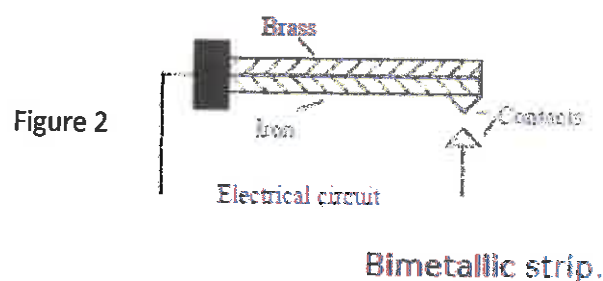
Input devices:

Infrared emitter and detector

An infrared emitter is a source of light energy from the electromagnetic infrared spectrum. Usually light emitting diodes (LED) are used in order to transmit a signal to a remote control. In general terms the stronger the emitter the stronger the signal received will be. A remote or a device with a strong emitter can often be used without directly pointing at the detection end. An infrared emitter generates infrared light that transmits packets of quantum energy through the air from one particular device to another. Quantum energy is data that is carried in very small packets but the data travels fast. Typically the device transmitting the signal will contain the most amount of quantum energy as some of data can be lost in transmitting the signal to the receiving device.

**Temperature Sensors**

A temperature sensor can be used to provide an on/off signal when a set temperature has been reached. This consists of two strips of different metal bonded together, these having different coefficients of expansion (Figure 2). Therefore when the temperature of the bimetal strip increases the strip curves due to one metal expanding more than the other and making the contact.



Mechanical Switches

A mechanical switch generates an on/off signal as a result of some mechanical input causing the switch to open or close. Switches are available with normally open (NO) or normally closed (NC) contacts. A NO switch has its contacts open in the absence of a mechanical input and the mechanical input is used to close the switch. An NC switch has its contacts closed in the absence of a mechanical input and the mechanical input is used to open the switch.

Limit Switches

Mechanical limit switch is a contact sensing device widely used for detecting the presence or position of an object in industrial applications. In the example in figure 3 the moving object comes in contact with the Actuator/ operating head, which consequently opens or closes the switch. These can be used in various applications and are commonly used.

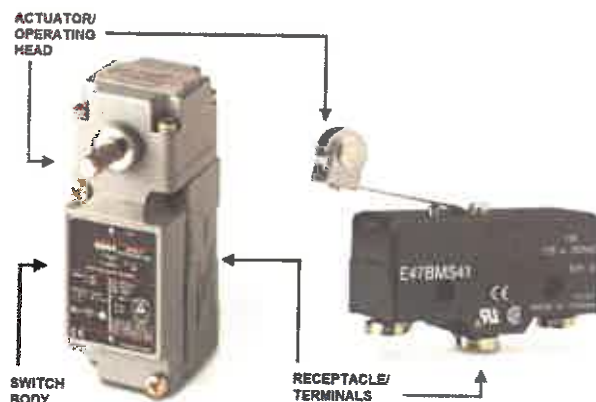


Figure 3

Flow Switch

A flow switch is a mechanical instrument that is used to control the flow of air, steam or liquid. Flow switches work by sending trip signals to another device within the system, telling it to shut off or to turn on. This will further protect it from damage and for cooling circuit protection.

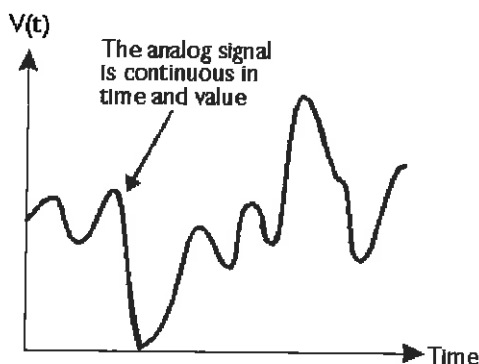


Figure 4

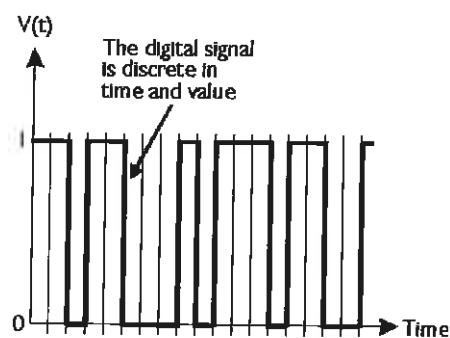
b)

An Analogue to Digital Converter (ADC) is an electric device that converts a continuous analogue input signal to a discrete digital number in binary.

An Analogue input is a real-world signal that contains noise and is continuous in time (Graph 1). Whereas a digital input is discrete in time and value and are binary digits that contain values 0 or 1 (Graph 2).



Graph 1

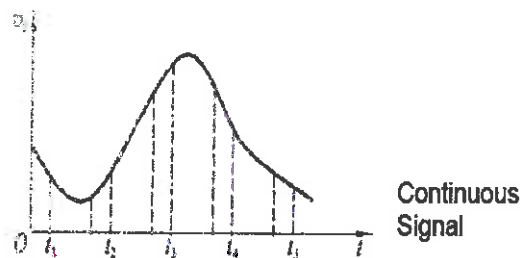


Graph 2

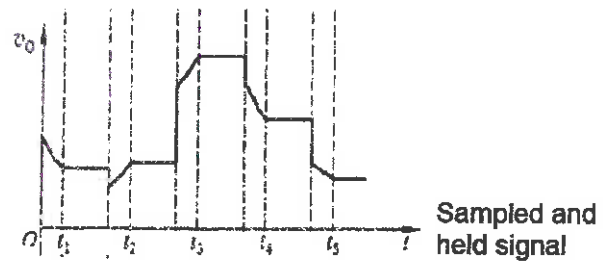
All microcontrollers store information using digital logic, this is more efficient and robust for storing data and is easily transferable. An Analogue to Digital Converter provides a link between real world signals and data storage.

Sampling is the process used to reduce the continuous signal (Graph 3) to a discrete signal. This is achieved through sampling the circuit then holding the circuit (Graph 4). It samples the circuit on an

ON-OFF process and stores the ON sample. Sampling rate depends on the clocks frequency, increasing the sampling rate increases the accuracy of the conversion.

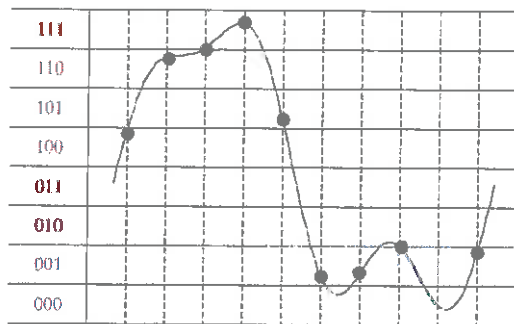


Graph 3



Graph 4

Quantizing approximates a continuous range of values and replaces it with a binary number. An error is introduced between the input voltage and the output binary representation. The error is dependant on the resolution of the ADC.



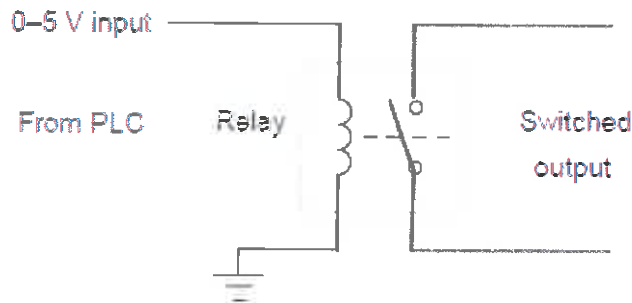
c)

Output devices:

Solenoids form the basis of several output control actuators.

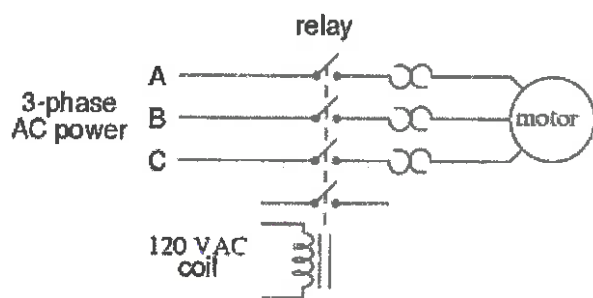
relay

When a current passes through a solenoid a magnetic field is produced and this can then attract ferrous metal components. When the output from the PLC is switched on, the solenoid magnetic field is produced and pulls in the contacts and therefore closes a switch or switches. This allows larger currents to be switched on, such as the supply current to a motor.



Contactor

When the output from the PLC is switched on, the solenoid closes a switch/switches. The result is that much larger currents can be switched on. e.g. Switch on motor.



Solenoid Valve

A solenoid valve is an electromechanical device used for controlling liquid or gas flow. The solenoid valve is controlled by electrical current, which is run through a coil. When the coil is energized, a magnetic field is created, causing a plunger inside the coil to move.

Electric heater

An electric heater is an electrical device that converts electric current to heat. The heating element inside every electric heater is an electrical resistor and works on the principle of Joule heating: an electric current passing through a resistor will convert that electrical energy into heat energy.

Light-emitting diode (LED)

A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p-n junction diode that emits light when activated. When a suitable current is applied to the leads, electrons can recombine with electron holes within the device, releasing energy in the form of photons.

d)

One of the most common types of outputs available is the relay output. Existence of relays as outputs makes it easier to connect with external devices. A relay is non-polarized and typically it can switch either AC or DC.

Transistor type outputs can only switch a dc current. The PLC applies a small current to the transistor base and the transistor output "closes". When it's closed, the device connected to the PLC output will be turned on.

A transistor typically cannot switch as large a load as a relay. If the load current you need to switch exceeds the specification of the output, you can connect the plc output to an external relay, then connect the relay to the large load.

A transistor is fast, switches a small current, has a long lifetime and works with dc only. A relay is slow, can switch a large current, has a shorter lifetime and works with ac or dc. ✓

Task 2

/50P

a)

PLC's are covered under Good Automated Manufacturing Practice (GAMP). GAMP is a committee that confirms that the design, commissioning, management, maintenance and testing are carried out correctly and documented. All this ensures that the correct process is carried out and therefore a good product produced.

Creating a routine maintenance schedule for programmable logic controllers will increase the life and minimise the chance of malfunctions. The period to which the PLC should be maintained is dependent on the controller's location and environment.

The PLC should always be backed up to ensure the program can be transferred to a replacement PLC if required. The LED indicators should be checked to ensure the power supply and battery are functioning correctly, changing the battery if necessary. The location should be checked for temperature, humidity and other environmental factors, confirming that good airflow is sustained to the PLC. Input voltage should be checked to verify that it is operating within the PLC's range.

During the maintenance the I/O's should be checked for correct operation and functionality, as the program was designed and developed for.

Visual and tightness checks should also be carried out to safeguard integrity. ✓

b)

When designing a program for a PLC it must always fail safe. This means if any external or internal devices fail to operate correctly then safety would not be compromised.

Monitoring systems can be built into the programs to prevent a loss or failing output. This can be achieved by using Human Machine Interfaces, which could involve the use of lamp indications, Gauges, alarms, communication units etc. The simulation mode can also be used to check the operation of the program and carry out fault scenarios.

PLC's can be tested for correct operation in a workshop environment before being installed on site using test beds or prototypes. This checks the PLC's real time operation.

/SDP

Task 3

Task 3 required the design and development of a program in Mitsubishi alpha computer software. The program monitors an analogue and initiates alarms when the signal is below 20% and above 80% of the input span (0 to 10 volts). In-between those values the alarm system indicates a healthy state.

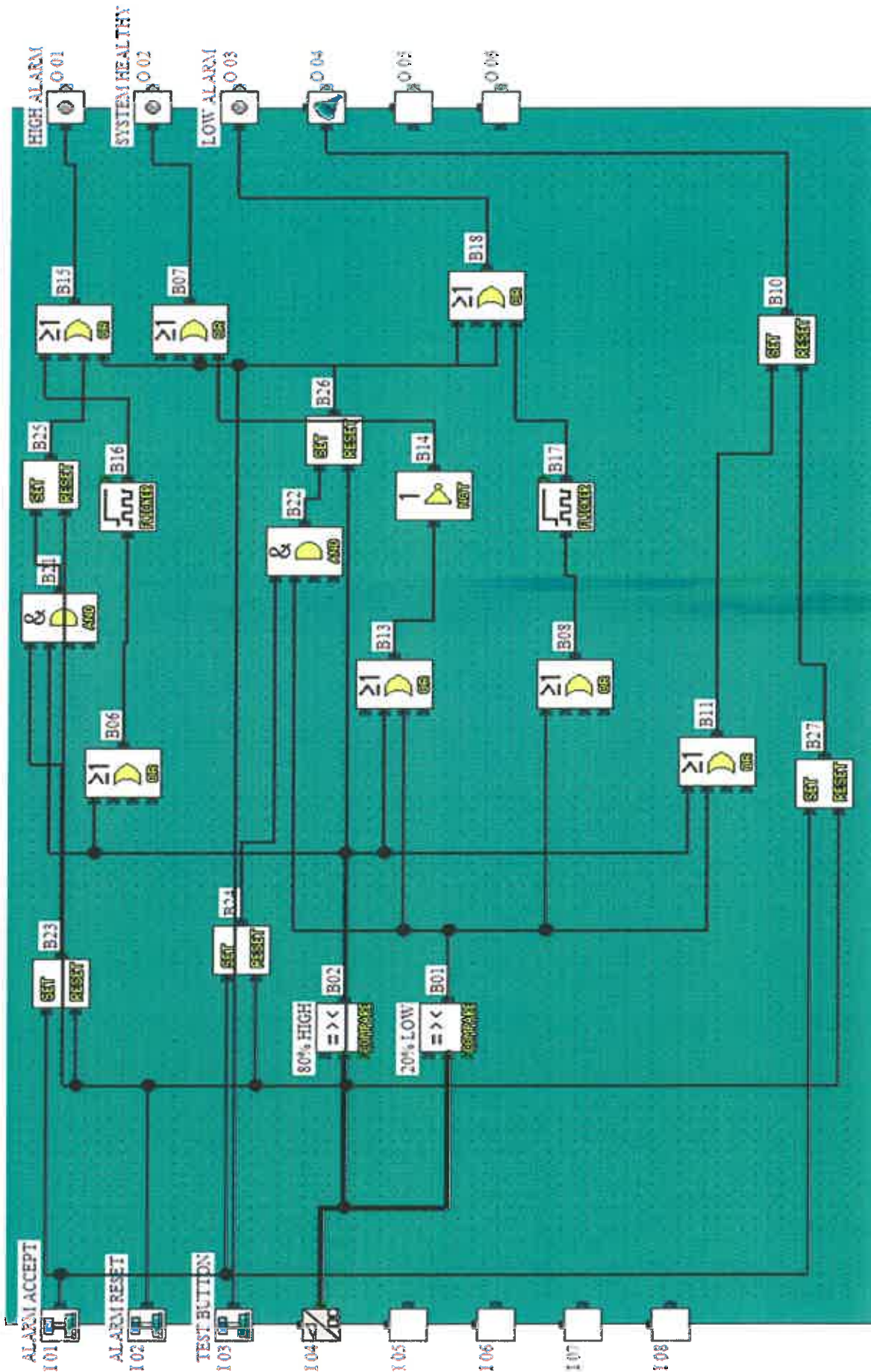
When an alarm is activated through the compare function, an audible alarm sounds and a visual light flash. A momentary 'alarm accept' button mutes the audible alarm and sets the flashing light to a constant state. This process is achieved through set/ reset functions and a series of 'OR' function blocks.

When the system returns to a safe condition, a momentary button resets the alarm by resetting the set/reset functions. The alarm clears and the system healthy lamp illuminates.

The lamps can be checked through a momentary test button.

The program was demonstrated for correct functionality to the tutor.

/



/SDP

Program written
Met design criteria,

Task 4

For task 4 a program was developed using Mitsubishi FX computer software. This program controls the process in a ladder logic format. The task description requires the program to operate the simulator in a sequence to obtain the correct operating procedure and to incorporate certain safety precautions.

The following steps are required to ensure the correct process is carried out.



Step 1. Fill tank TA201 with syrup.

Step 2. Fill tank TA202 with water.

Step 3. Start TA203 agitator.

Step 4. Hold contents in TA202 for 30 seconds.

Step 5. Transfer the contents of TA202 to TA203.

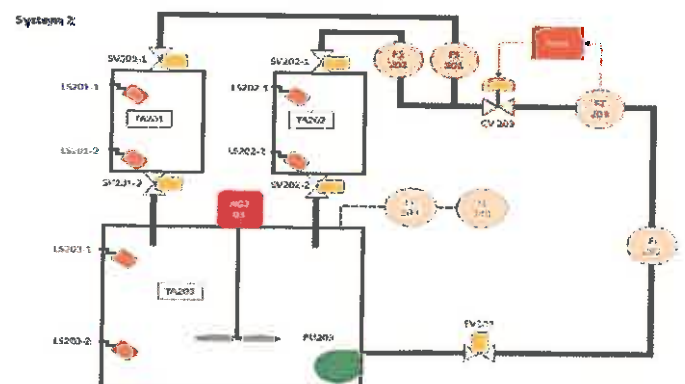
Step 6. Hold contents in TA201 for 60 seconds.

Step 7. Transfer the contents of TA201 to TA203.

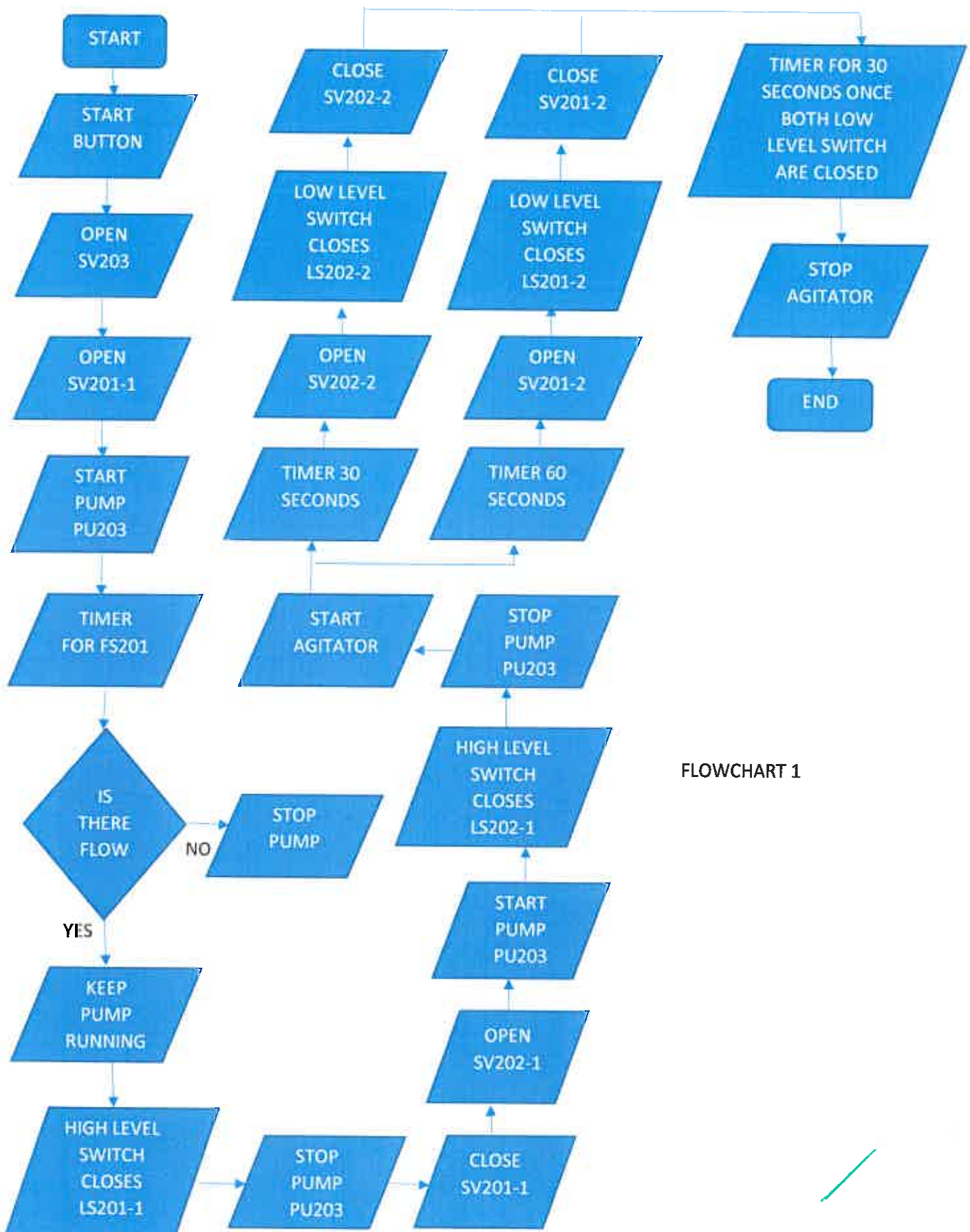
Step 8. Blend contents in TA203 for a further 30 seconds.

Step 9. Stop agitator AG203.

Operation complete.



A Flowchart was created to assist with the design and development of the program, taking into consideration the sequence provided in the task description and the safety precautions that need to be adhered to. See flowchart 1.



PROGRAM

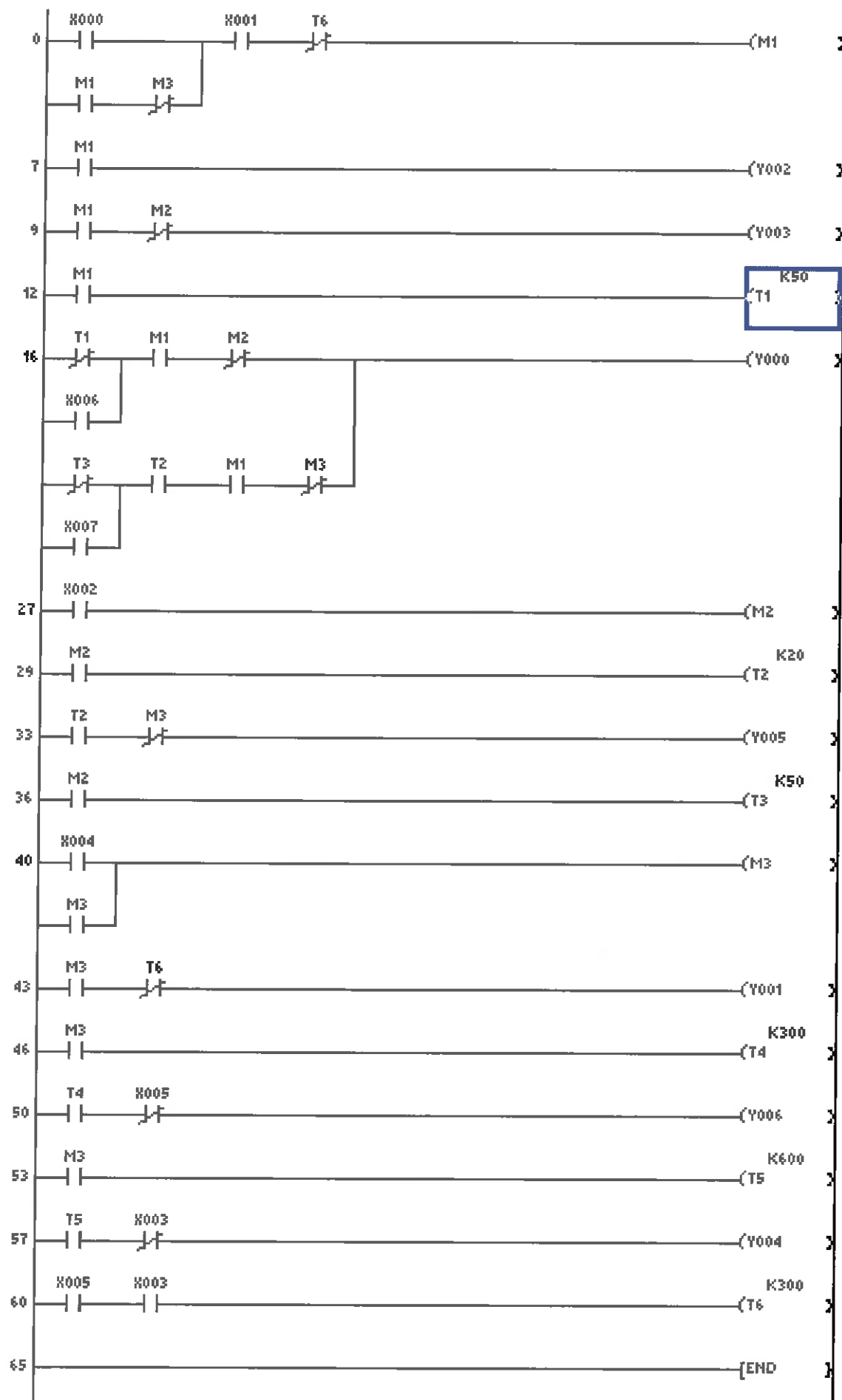
The program is started with a momentary switch that closes contact M1 and then M1 retains that circuit. The contact M1 also opens valves SV203 and SV201-1 to prevent a dead head pumping condition. Timer T1 provides a 5 second allowance for the flow switch FS201 to detect a flow in the system. If there isn't a flow after 5 seconds the normal closed contact of T1 opens and therefore stops the pump.

When the tank fills and the high-level switch LS201-1 closes it closes the contact M2, which stops the pump, closes SV201-1 and opens SV202-1. Contact M2 also starts a timer T2 for a duration of 2 seconds before the pump starts filling TA202. When the high-level switch LS202-2 operates it closes contact M3, this retains itself and therefore prevents the pump operating when the fluids drain from the tanks. M3 starts the agitator for 30 seconds before the first drain valve SV202-2 opens and then a further 30 seconds until drain valve SV201-2 opens.

When the fluid levels drop and operate the low-level switches, the normally closed contacts of the low-level switches close the drain valve associated to that switch. Once both drain valves are closed a timer is started to ensure the agitator runs for a further 30 seconds. The program is complete when the agitator stops.

Input		Output	
0	Filling process start switch (NO)	0	Pump (PU203) run + Mimic panel light
1	Process emergency stop switch (NC)	1	Agitator (AG203) run + Mimic panel light
2	TA201 high level switch (LS201-1)	2	SV203 + Mimic panel light
3	TA201 low level switch (LS201-2)	3	SV201-1 + Mimic panel light
4	TA202 high level switch (LS202-1)	4	SV201-2 + Mimic panel light
5	TA202 low level switch (LS202-2)	5	SV202-1 + Mimic panel light
6	Flow switch (FS201)	6	SV202-2 + Mimic panel light
7	Flow switch (FS202)	7	Spare
8	Spare		
9	Spare		
10	Spare		
11	Spare		

Table 1



CONCLUSION

The design and development of the program met all criteria outlined in the task description and adhered to all Safety precautions specified.

The program was successfully demonstrated to the tutor using the process simulator.

Although the program met specifications, I would consider changes to the program to ensure that if valves SV203, SV202-1 or SV 201-1 failed to operate then the pump would not start. This would prevent a dead head pumping condition and would guarantee the system would fail safe.

References and bibliography

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