
UNIVERSITI SAINS MALAYSIA

Second Semester Examination
2015/2016 Academic Session

June 2016

EEM 253 – MECHATRONIC DESIGN I
[REKABENTUK MEKATRONIK I]

Duration 1 hours

[Masa : 1 jam]

Please check that this examination paper consists of **FIFTEEN (15)** pages of printed material before you begin the examination. This examination paper consist of two versions, The English version and Malay version. The English version from page **TWO (2)** to page **EIGHT (8)** and Malay version from page **NINE (9)** to page **FIFTEEN (15)**.

*Sila pastikan bahawa kertas peperiksaan ini mengandungi **LIMA BELAS (15)** muka surat bercetak sebelum anda memulakan peperiksaan ini. Kertas peperiksaan ini mengandungi dua versi, versi Bahasa Inggeris dan Bahasa Melayu. Versi Bahasa Inggeris daripada muka surat **DUA (2)** sehingga muka surat **LAPAN (8)** dan versi Bahasa Melayu daripada muka surat **SEMBILAN (9)** sehingga muka surat **LIMA BELAS (15)**.*

Instructions: This question paper consists of **THREE (3)** questions. Answer **TWO (2)** questions. All questions carry the same marks.

*[Arahan: Kertas soalan ini mengandungi **TIGA (3)** soalan. Jawab **DUA (2)** soalan. Semua soalan membawa jumlah markah yang sama]*

Begin your answer to each question on a new page.

[Mulakan jawapan anda untuk setiap soalan pada muka surat yang baru]

“In the event of any discrepancies, the English version shall be used”.

[Sekiranya terdapat sebarang percanggahan pada soalan peperiksaan, versi Bahasa Inggeris hendaklah diguna pakai]

ENGLISH VERSION

1. (a) Explain and discuss the advantages and differences of PLC, PAC and PC as an industrial controller

(40 marks)

- (b) Given the diagram of Silo filling automation process in Figure 1(a) and ladder diagram shown in Figure 1(b). Perform the modification on the ladder diagram to incorporate the following conditions

- (i) A 2-second time-delay preceding the filling of the box after the conveyor has stopped.

(30 marks)

- (ii) A 4-second time-delay period preceding the starting of the conveyor after the box is filled.

(30 marks)

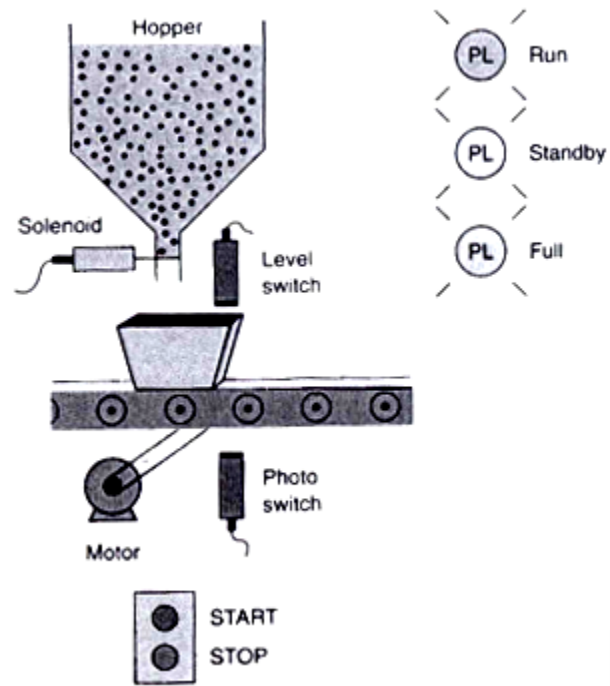


Figure 1(a) : Silo filling automation process

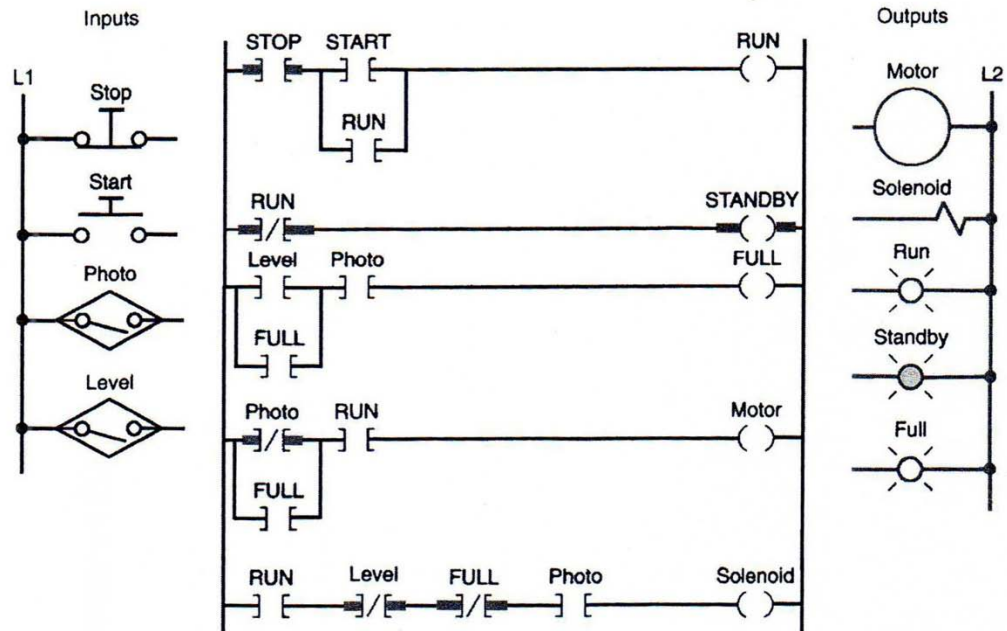


Figure 1(b) : Ladder diagram for silo filling automation process

2. A roller conveyor is monitored by a sensor as to whether a package is present as shown in Figure 2.1. If this is the case, the package is picked up by a cylinder 1A (lifting cylinder) and then transferred to another conveyor by means of cylinder 2A (transfer cylinder) Cylinder 1A is to retract first, followed by cylinder 2A. The cylinders are retracted and advanced by means of solenoid valves. On the feed side, packages have been previously arranged in such a way that they reach the lifting device individually. The process will continuously run when a start switch is pressed. It will stop when a stop switch is pressed. The cylinders are controlled with double solenoid 5/2 directional control valves respectively as shown in Figure 2.2. Each cylinder is monitored with two sensors to sense the retracting and extending position.

(a) Suggest one type of sensor to be used to detect the package and gives justification

(20 marks)

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(b) Draw the step diagram for the proses.

(20 marks)

(c) Design the sequential function chart solution for the above process.

(60 marks)

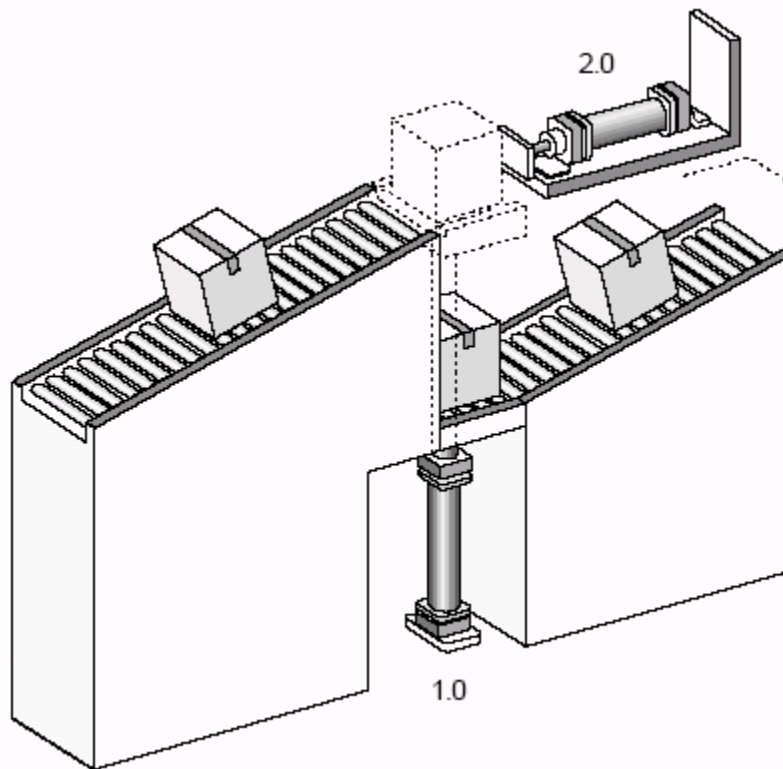


Figure 2.1

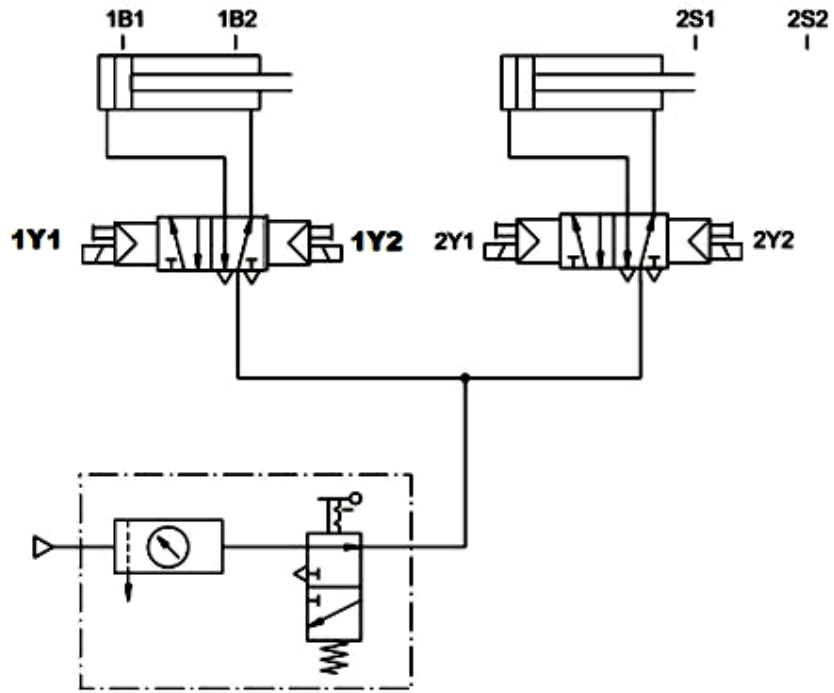


Figure 2.2

3. A mixing tank is used to heat a liquid as shown in Figure 3. A start push button is used to initiate the processes, and a stop push button is used to stop the pump. The inlet's pipe's pump delivers fluid to the tank. Two level switches, L1 (low level float switch) and L2 (high level float switch), control the fill and empty cycles in the process. When the start switch is pressed the fill pump is activated. Liquid rises in the tank until L2 is activated and stops the fill cycle. The heater is activated in the fill cycle when the liquid activates the L1. The heater turns off when the process liquid exceeds the set point temperature (185° F) and make temperature sensor TS1 active. Due to the temperature of the input liquid, the set point temperature is not reached until after the tank has been finished filing. When the tank is full and the liquid is at the desired temperature, TS1 is active, the outlet valve is turned on (opened), and the tank empty cycle starts. The outlet valve is closed at the end of the empty cycle when the liquid level is below L1.
- (a) The specification of input device and output device are given in Table 3.1 and Table 3.2 respectively, suggest a suitable type of input module and output module to be used and draw the wiring connections.

(30 marks)

Table 3.1

Input devices	Power specification
Start switch	DC power switches, 24V
Stop Pushbutton	DC power switches, 24V
Low level float switch,L1	NPN /PNP sensor, 10-30V
High level float switch, L2	NPN/PNP sensor, 10-30V
Temperature Sensor,TS1	NPN sensor, 10-30V

Table 3.2

Output devices	Power specification
Pump inlet	240 V AC
Outlet valve	240V AC
Heater	240 V AC

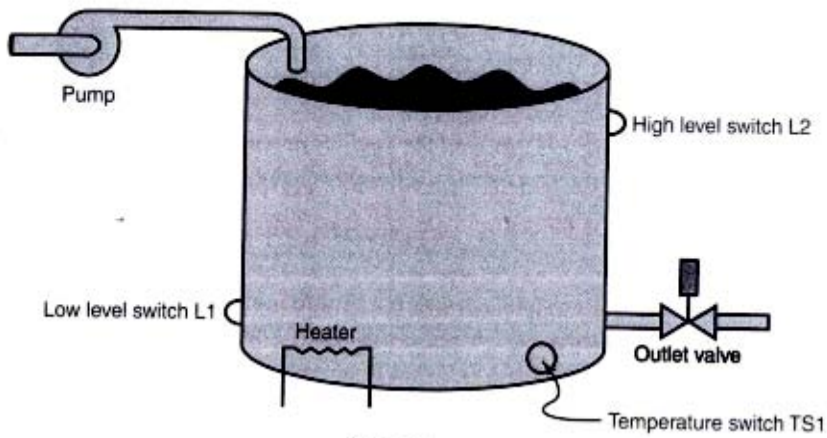


Figure 3

(b) Design the ladder diagram solution for the above process.

(70 marks)

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VERSI BAHASA MALAYSIA

1. (a) Terangkan dan bincangkan kelebihan dan perbezaan PLC, PAC dan PC sebagai pengawal industri.

(40 markah)

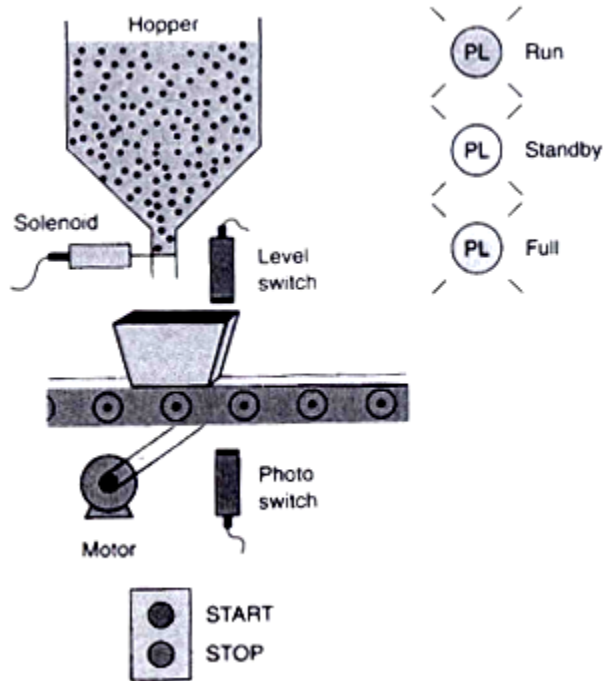
- (b) Diberi gambarajah proses automasi pengisian Silo dan gambarajah tangga yang ditunjukkan dalam Rajah 1(a) dan Rajah 1(b). Lakukan pengubahsuaian pada gambarajah tangga untuk menggabungkan syarat-syarat berikut

- (i) 2-saat kelewatan sebelum pengisian kotak dimulakan selepas penghantar telah berhenti.

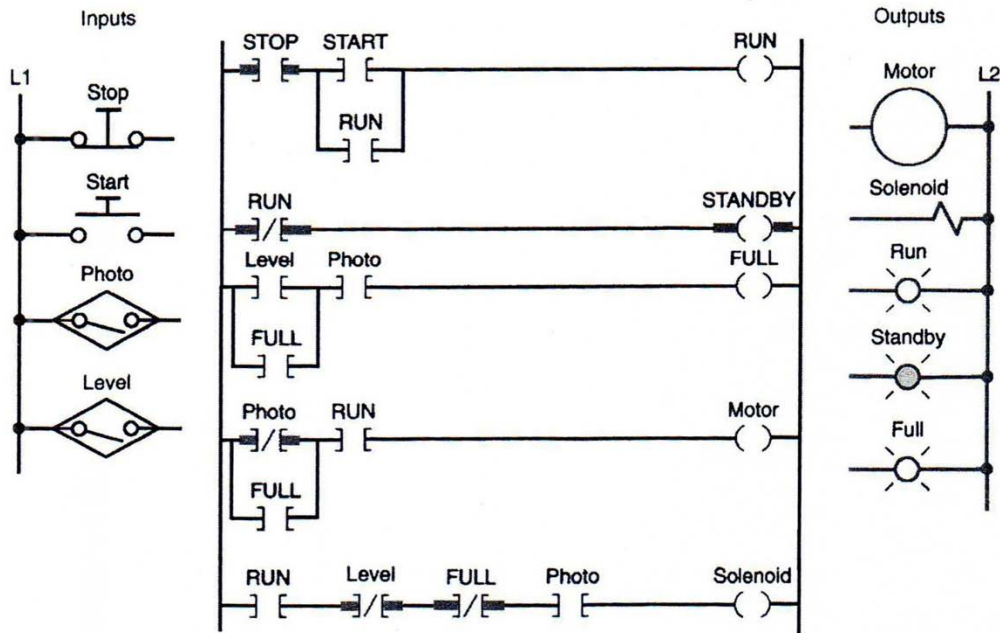
(30 markah)

- (ii) Tempoh kelewatan masa 4 saat sebelum permulaan penghantar selepas kotak ini dipenuhi .

(30 markah)



Rajah 1(a) Proses automasi pengisian silo



Rajah 1(b) Gambarajah tangga untuk proses automasi pengisian silo

2. Satu penghantar jenis roller dipantau oleh satu penderia yang mengesan sama ada pakej yang hadir seperti dalam Rajah 2.1. Jika pakej dikesan, pakej akan diangkat oleh silinder 1A (silinder mengangkat) dan kemudian dipindahkan ke penghantar lain melalui silinder 2A (silinder pemindahan). Silinder 1A menganjak balik ke kedudukan asal dan diikuti oleh silinder 2A. Silinder dikawal oleh injap solenoid. Pada sebelah suapan, pakej dianggap telah sebelum ini disusun di tempat lokasi peranti mengangkat secara individu. Proses ini akan berterusan berjalan apabila suis mula ditekan. Ia akan berhenti apabila suis berhenti ditekan. Silinder dikawal dengan injap kawalan 5/2 dua solenoid seperti yang ditunjukkan pada Rajah 2.2. Setiap silinder dipantau dengan dua penderia untuk mengesan kedudukan asal dan kedudukan yang dianjurkan.
- (a) Cadangkan satu jenis sensor yang akan digunakan untuk mengesan pakej dan memberikan justifikasi.

(20 markah)

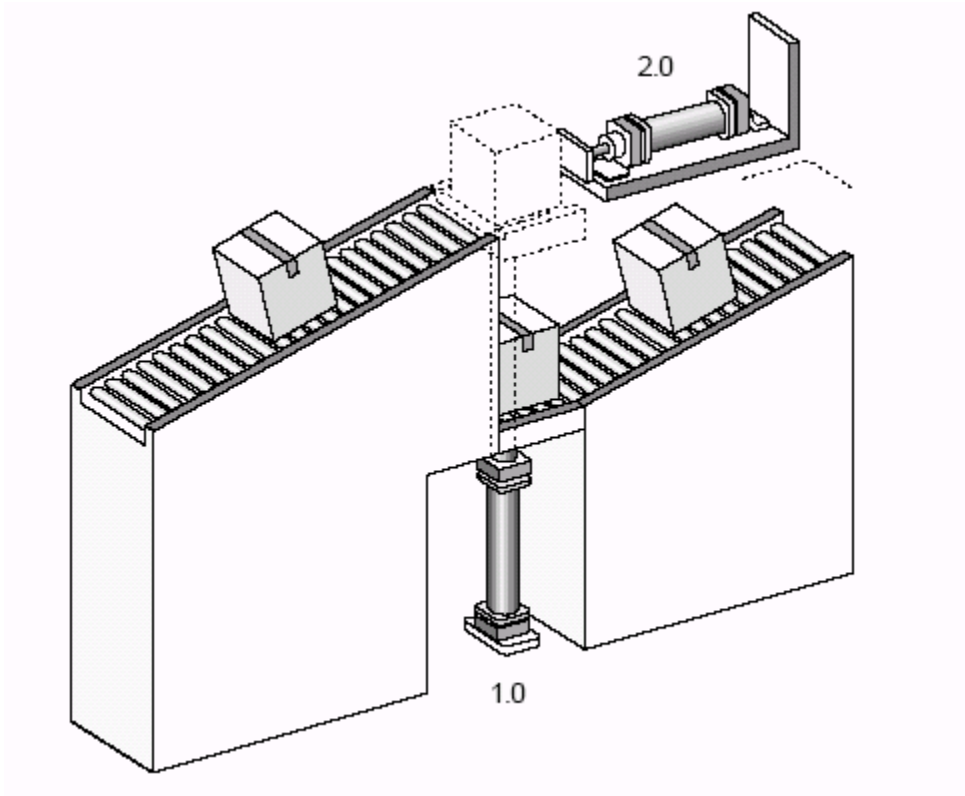
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(b) Lukiskan gambarajah langkah untuk proses tersebut.

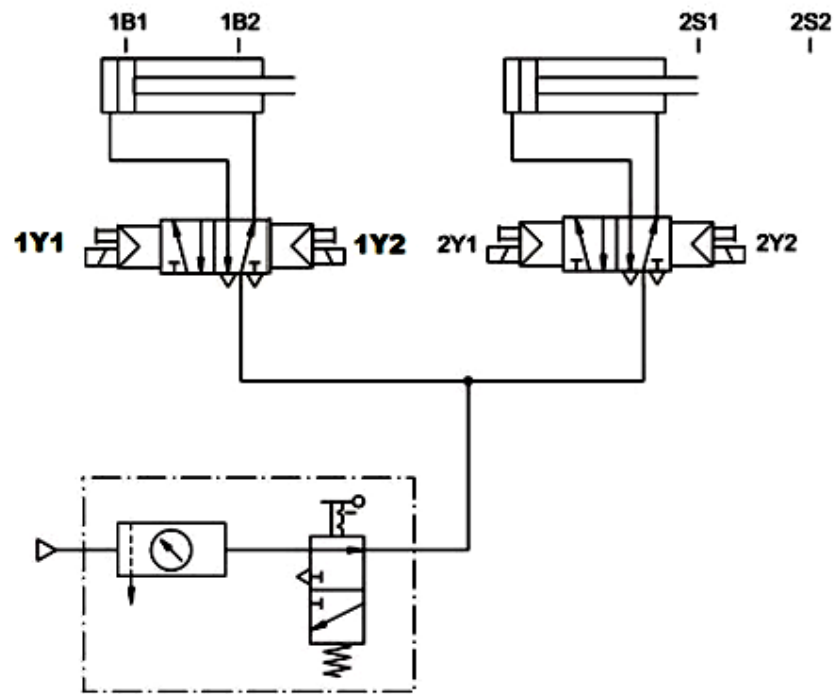
(20 markah)

(c) Rekabentuk penyelesaian carta fungsi berturutan untuk proses di atas.

(60 markah)

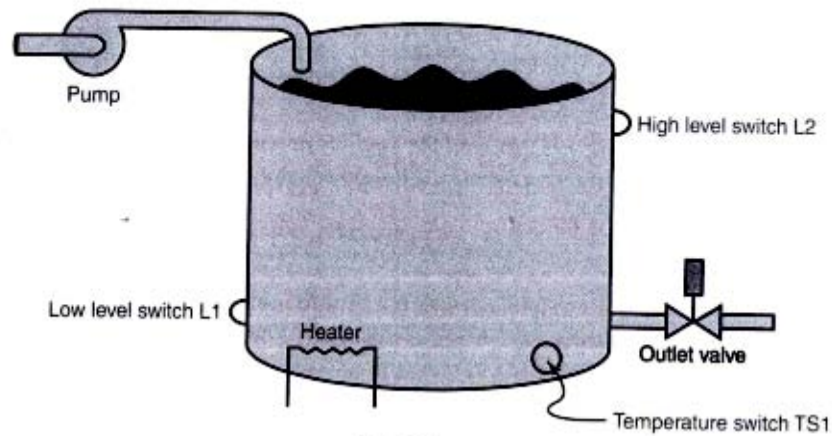


Rajah 2.1



Rajah 2.2

3. Sebuah tangki pencampuran digunakan untuk memanaskan cecair seperti dalam Rajah 3. Satu suis mula digunakan untuk memulakan proses, dan satu suis henti digunakan untuk menghentikan pam. Pam paip inlet yang menghantarkan cecair ke tangki. Dua suis aras, L1 (suis aras rendah) dan L2 (suis aras tinggi), mengawal kitaran mengisi dan kitaran mengosongkan dalam proses. Apabila suis mula ditekan, pam mengisi diaktifkan. Kenaikan cecair dalam tangki sehingga L2 diaktifkan dan menghentikan kitaran mengisi. Pemanas diaktifkan dalam kitaran pengisian apabila cecair mengaktifkan L1. Pemanas dimatikan apabila cecair proses melebihi suhu titik set (185° F) dan membuat penderia suhu TS1 aktif. Oleh kerana suhu cecair input, suhu titik set tidak dicapai sehingga selepas tangki telah selesai diisi. Apabila tangki sudah penuh dan cecair pada suhu yang dikehendaki, TS1 aktif, injap keluaran dihidupkan (dibuka), dan kitaran mengosongkan tangki bermula. Injap keluaran ditutup pada akhir kitaran mengosongkan apabila paras cecair di bawah L1.



Rajah 3

- (a) Diberikan spesifikasi alatan masukan dan alatan keluaran dalam Jadual 3.1 dan Jadual 3.2, cadangkan jenis modul input dan output yang sesuai dan melukis sambungan pendawaian tersebut.

(30 markah)

Jadual 3.1

Alatan masukan	Spesifikasi kuasa
Suis mula jenis tekan	Suis kuasa DC, 24V
Suis henti jenis tekan	Suis kuasa DC , 24V
Suis apungan aras rendah, L1	Penderia NPN /PNP sensor, 10-30V
Suis apungan aras tinggi, L2	Penderia NPN/PNP , 10-30V
Penderia Suhu TS1	Penderia NPN , 10-30V

Jadual 3.2

Alatan luaran	Spesifikasi kuasa
Pam Masukan	240 V AC
Injap Keluaran	240 V AC
Pemanas	240 V AC

- (b) Rekabentuk gambarajah tangga untuk proses tersebut.

(70 markah)