THE UNIVERSITY OF ADELAIDE
DEPARTMENT OF MECHANICAL ENGINEERING

EXAMINATION FOR THE DEGREE OF B.E.

MECHATRONICS IM 8197

NOVEMBER 2000

TIME: 2 HOURS

[In addition, candidates are allowed ten minutes before the examination begins to read the paper.]
[The use of notes, textbooks and calculating devices other than computers is permitted in the examination room.]

Total 5 pages in this exam paper.

Part 1. Fundamental Questions (Total 50 points, 10 questions, with 5 points each)
Provide a **short** answer (a few sentences and a sketch at most) to each of the following questions.

Both Questions 1 and 2 are based on Figure 1.

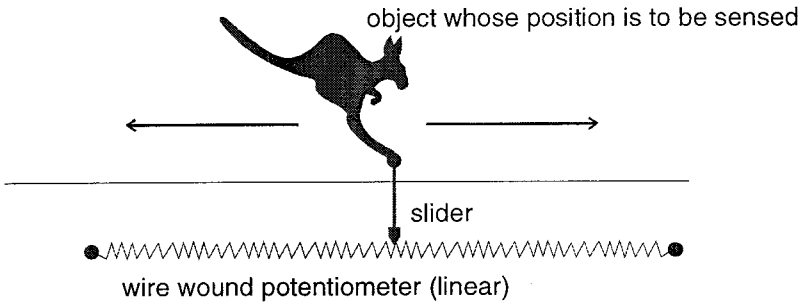

Figure 1.

1. What is the physical effect involved in the designing of the sensor in Figure 1?
2. Is the sensor in Figure 1 a self-generator, modulator or modifier, why?
3. Can the measurement system shown in Figure 2 work, why?

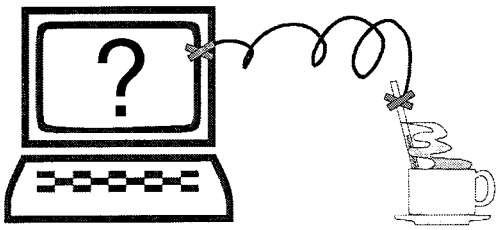

Figure 2

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4. Suggest two types of sensors that are made of piezoelectric material. Discuss the physical effects of these two sensors.

Both Questions 5 and 6 are based on Figure 3.

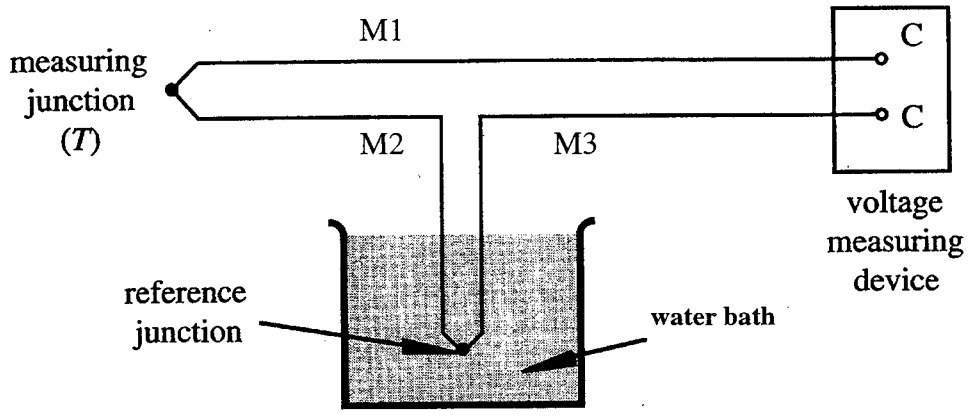

Figure 3

5. A standard configuration for thermocouple measurement is shown in Figure 3. It consists of wires of two metals, A and B, attached to a voltage-measuring device with terminals made of metal C. The reference junction is used to establish a temperature reference for one of the junctions to ensure accurate temperature measurements at the other junction relative to the reference. If wire M1 is made of metal B, wire M2 is made of metal B, wire M3 is made of metal A, is this a right design, why?

6. Use this temperature measurement configuration to measure the temperature of a chemical process. If the reference junction being held is a water bath with a constant temperature of 20°C. We have a thermocouple table referenced to 0°C, as shown in Table 1. If the measured output voltage is negative 0.517mv, what is the temperature of the process? And which thermocouple law you are using for this calculation?

Table 1.

Junction Temperature (°C)	Output Voltage (mV)
-40	-2.058
-30	-1.536
-20	-1.019
-10	-0.507
0	0
10	0.507
20	1.019
30	1.536
40	2.058

7. A PLC has a 16 bit, bi-polar DA converter. The voltage input ranges from -5v to 5v. If the input to the PLC is -3v, what is the decimal reading?

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Questions 8 and 9 are based on Figure 4.

8. A ladder diagram involving a 10-ms timer is shown in Figure 4. Given the time diagram for input signal I0.0, complete the time diagrams for T33 and Q0.0.

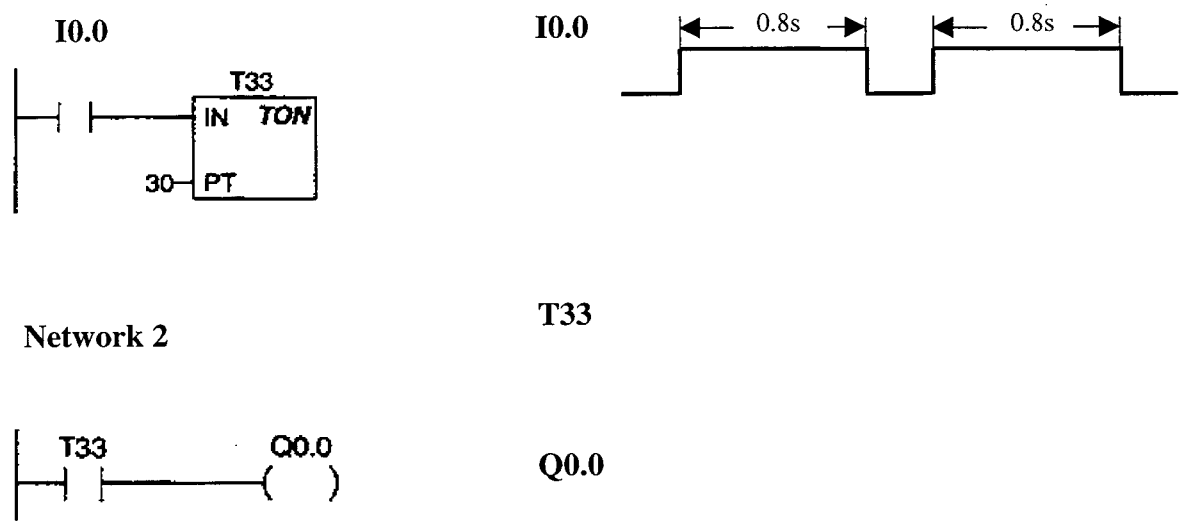
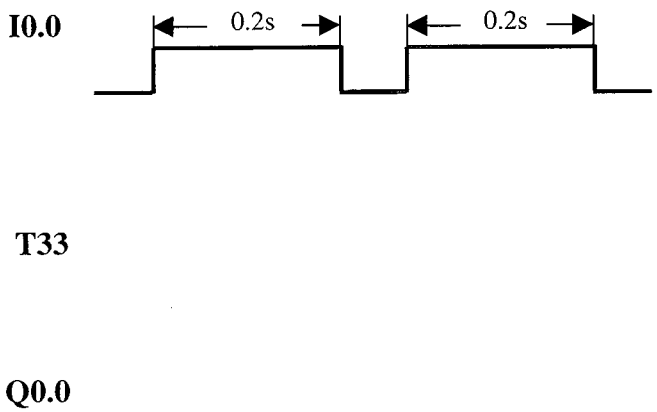


Figure 4. Timer

9. Change the timer to a retentive one. Given the new I0.0 input signal, complete the time diagram.



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10. Suggest two methods to modify the electro-pneumatic system shown in Figure 5 so that it has the latching function.

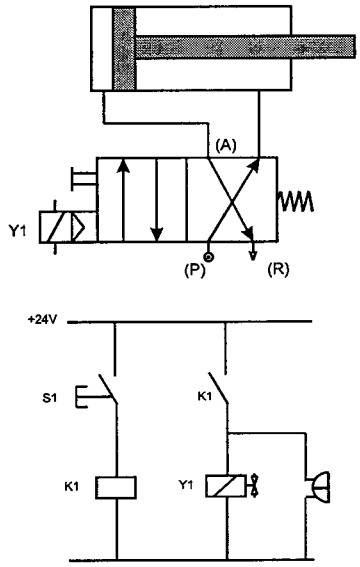

Figure 5.

Part 2. Design and Calculation Questions (Total 50 marks, 25 points each)

11. Boxes are lifted to conveyor height by a double acting cylinder (see Figure 6). The piston is to extend fully when a switch is operated. The piston must reach the fully extended position before the operator can initiate piston retraction by a second switch. A roller limit switch confirms full extension. The piston is to continue forward even if the extension switch is released before full extension is reached. The control panel is remotely located. A lamp is light up when the piston is fully extended. The process is to stop after 20 boxes are lifted.

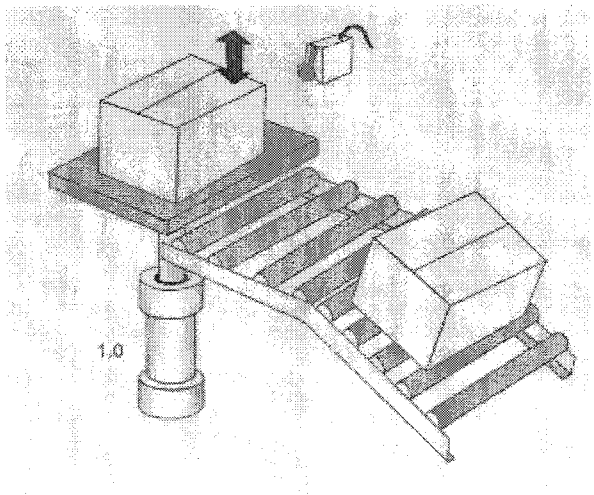

Figure 6

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Design a PLC program for this task. You need to

1). Draw a circuit diagram (8 points)
2). Draw the connection circuit (2 points)
3). Write the ladder diagram (10 points)
4). Write the statement list diagram (5 points)

12. A platinum resistance sensor is to be used to measure temperatures between 0 and 200^0C. Given that the resistance $R_T\Omega$ at T°C is given by $R_T = R_0(1 + a_1T + a_2T^2)$, and R_0=100.0, R_{100}=138.50, R_{200}=175.83 Ω.

a. Find a_1, a_2 (10 points).
b. Find the non-linearity at 100^0C as a percentage of full scale (8 points).
c. Find the sensitivity at 100^0C (7 points).

End