THE UNIVERSITY OF ADELAIDE
DEPARTMENT OF MECHANICAL ENGINEERING

EXAMINATION FOR THE DEGREE OF B.E.

MECHATRONICS IM 8197

NOVEMBER 2001

TIME: 2 HOURS 10 MINUTES

[Students are advised to devote 10 minutes to reading the paper and planning their approach.]

[The use of notes, textbooks and calculating devices other than computers is permitted in the examination room.]

Total 3 pages in this exam paper.

Answer ALL questions (total 100 points).

Part 1. Fundamental Questions (Total 50 points; 10 questions, 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.

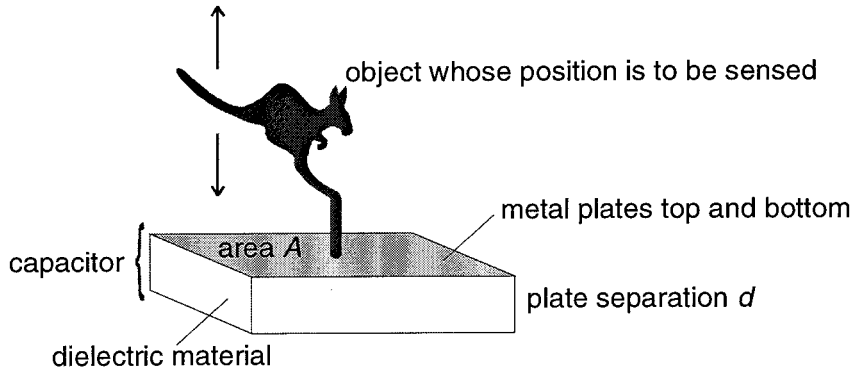

Figure 1.

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. How would you find velocity using a variable reluctance tachogenerator?
4. Define the energy gap in a semiconductor.
5. Give two applications of the Hall effect.

6. A thermocouple with a reference junction is used to measure a temperature of a chemical process. The reference junction is held in a water bath with a constant temperature of 10°C. We have a thermocouple table referenced to 0°C, as shown in Table 1. If the measured output voltage is negative 1.551mV, what is the temperature of the process? Which thermocouple law are you 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. State two desired characteristics of an output from a deflection bridge.

8. What happens if a solenoid in a double solenoid valve controlling a double acting cylinder is de-energised half way through the cylinder movement? What happens if the same situation occurs for a single solenoid control valve?

9. A ladder diagram involving two 10ms timers is shown in Figure 2. Given the time diagram for input signal I0.0, complete the time diagram for Q0.0.

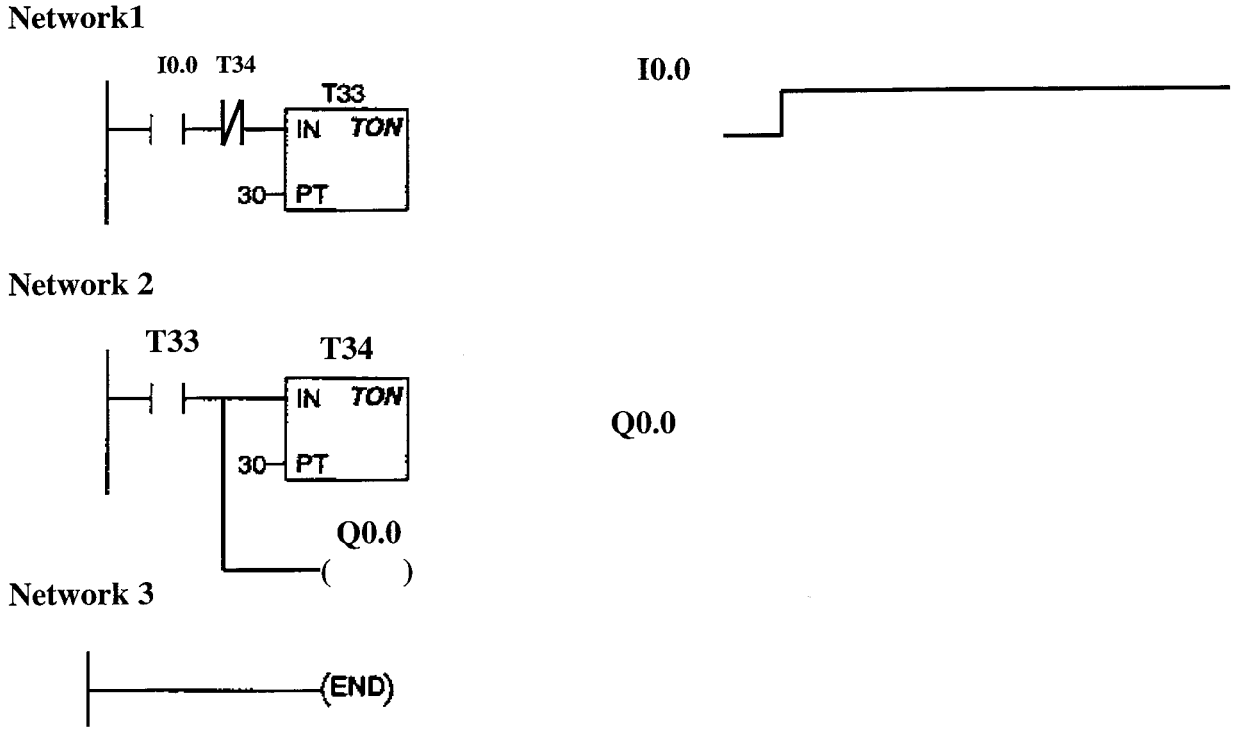

Figure 2.

10. Derive the equivalent hexadecimal number for the binary number 01111101.

Please turn to the next page

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

11. A magnet mounted on a float arm is to actuate a reed switch when the liquid level in a container drops below a required level (Figure 3). When the reed switch is actuated a supply valve opens and increases the level in the tank. A lamp is to blink with a period of 1 second (0.7sec. on, 0.3sec. off) when the valve is open. The valve is to close automatically after the required level in the container is reached. An operator must be able to stop the process at any time.

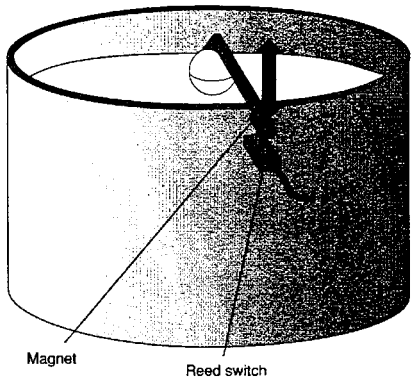

Figure 3.

Design a PLC program for this task. You need to
a) Draw a circuit diagram (10 points)
b) Draw the connection circuit (2 points)
c) Write the ladder diagram (8 points)
d) Write the statement list diagram (5 points)

12. A platinum resistance thermometer with a resistance-temperature relationship of $R_T = R_o(1+\alpha T)$ is connected to a deflection bridge with a 10 V voltage supply (as shown in Figure 4). It is used for an input temperature range of 100 to 200^{0}C.

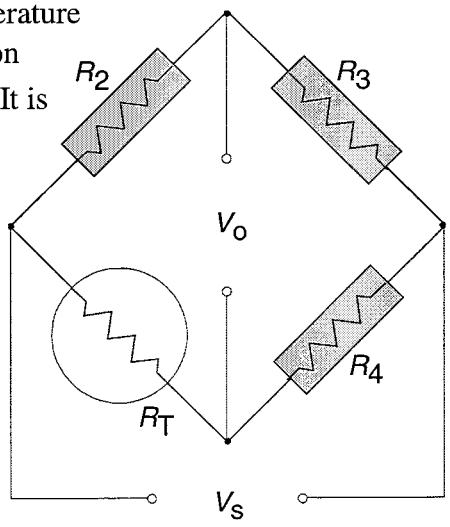

Figure 4

a) Calculate the values of R_o and α given R_{100} = 140 Ω, and R_{200} = 180 Ω (5 points)
b) R_4 was selected to be 5.7 kΩ. Select other resistors in the bridge (5 points)
c) Find the output voltage at 200^{0}C (5 points)
d) Find the non-linearity of the bridge at 150°C as a percentage of full scale deflection (5 points)
e) Select a differential amplifier for the bridge to obtain 1 V output at 200^{0}C (5 points)