

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY DEPARTMENT OF ELECTRONIC ENGINEERING BACHELOR OF ENGINEERING (HONS) DEGREE

Final Examination May 2011

TEE 2295

ELECTRICAL AND ELECTRONIC TECHNOLOGY II

Duration of Examination – 3 Hours

INSTRUCTIONS TO CANDIDATES

1. Answer any FIVE questions only.
 2. Each question carries 20 marks.
 3. Show your steps clearly in any calculation.
 4. Start the answers for each question on a fresh page.
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Question 1

Describe and explain how the following transducers work. Describe an example of an application where each can be used.

- | | |
|------------------------------------|-----------|
| a) Strain gauge | [4 marks] |
| b) Resistance temperature detector | [4 marks] |
| c) Phototransistor | [4 marks] |
| d) Tachogenerator | [4 marks] |
| e) Capacitive transducer | [4 marks] |

Question 2

A chromium-constantan thermocouple is placed in a furnace at 1200°C with the reference junctions held at 100°C. Its calibration curve is shown in Figure 1.

- | | |
|---|------------|
| a) What would be the emf produced by the thermocouple? | [4 marks] |
| b) Design an amplifier circuit to give an output of 8V at 1200°C. | [10 marks] |

- c) The output of the amplifier is used to monitor the temperature of a furnace. At some instant, the amplifier output voltage is 6.7V, what is the furnace temperature then? [6 marks]

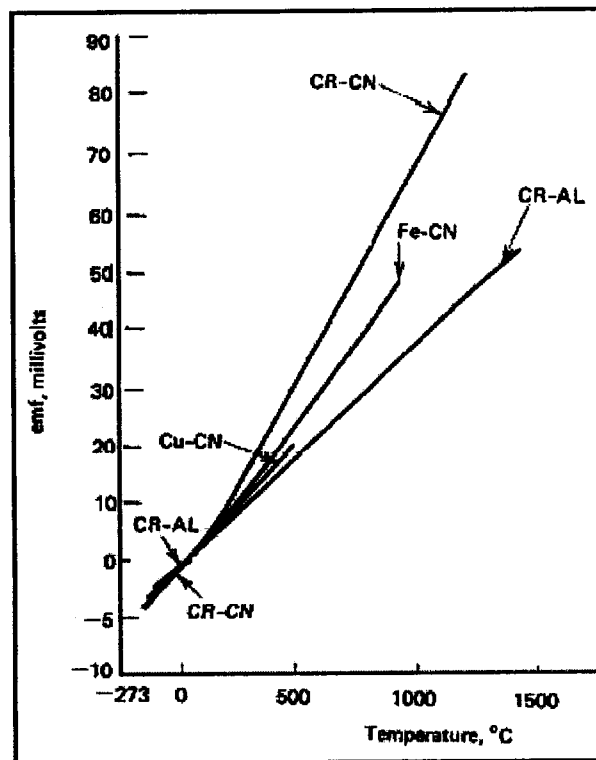
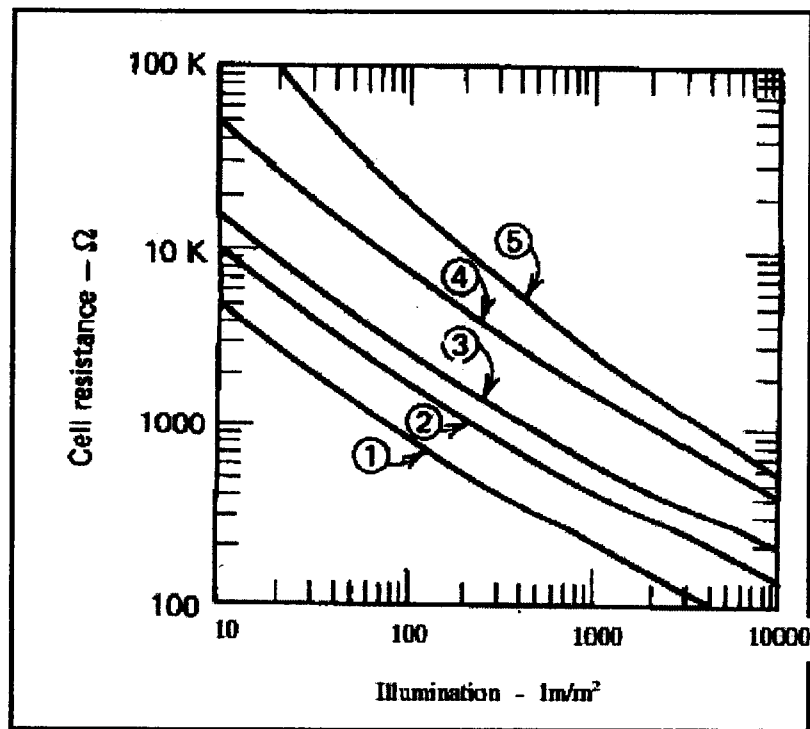


Figure 1.

Question 3

- a) A type 4 photocell from the calibration curves shown in figure 2 is connected in series with a $20\text{k}\Omega$ across a 6V power supply. Calculate the voltage across the photocell if 100lm/m^2 of light falls on it. [4 marks]
- b) A d'Arsonval meter movement with a sensitivity of $5\text{k}\Omega/\text{V}$, an internal resistance of $1\text{k}\Omega$ and a full scale deflection of 100° is used to monitor the voltage across the thermistor in (a).
- Design the voltmeter circuit and show how it is interfaced to the photocell circuit in (a). [8 marks]
 - Calculate the light intensity for which the meter deflection is 45° . [6 marks]
 - Explain why a buffer amplifier may be necessary in this measurement system. [2 marks]



Characteristics for various photocells

Figure 2

Question 4

The position of the tool on a lathe is to be measured using a resistor slider sensor of total length 900 mm and total resistance 1000 ohms. A voltage of 20 V is connected across the sensor with the positive on the left side. The output of the sensor is fed to an analog to digital converter to enable the measurement system to be part of a direct digital control system for the tool position.

- a) Draw a circuit diagram to indicate the measurement system. [6 marks]
- b) The input range of the analog to digital converter is 20V and it gives an 8 bit output.
 - i. Calculate the resolution of the analog to digital converter [3 marks]
 - ii. Calculate the output range of the analog to digital converter [3 marks]
- c) At some instant the output of the digital to analog converter is 10110011.
 - i. What is the input to the analog to digital converter? [3 marks]
 - ii. What is the tool displacement then? [3 marks]
- d) What advantages may be offered by digital measurements? [2 marks]

Question 5

- a) A controller has a transfer function of 12 and controls a motor with a transfer function of 0.10rpm/V.
- What would be the steady state error when the system is open loop? [3 marks]
 - What would be the new steady state error if due to environmental changes the transfer function of the motor changes by 10%? [3 marks]
- b) The system in part (a) is converted into a closed loop control system by means of addition of a feedback loop with a transfer function of 1V/rpm.
- What would be the steady state error for the new system? [4 marks]
 - What would be the new steady state error if due to environmental changes the transfer function of the motor changes by 10%? [4 marks]
- c) Compare and contrast the effects of transfer function changes on closed loop and open loop systems based on the results obtained in questions 5 a) and 5 b). Give advantages and disadvantages of each system. [6 marks]

Question 6

- a) Discuss and explain the effect of the following control strategies on a control system
- Derivative control [4 marks]
 - Integral control [4 marks]
 - Proportional control [4 marks]
- b) Using a circuit consisting of an inductor and a resistor as an example, show and explain how mathematical models for electrical circuits are derived. [8 marks]

END OF PAPER