



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF ELECTRONIC ENGINEERING

ELECTRICAL MEASUREMENTS

TEE 1241

Final Examination Paper

May 2015

This examination paper consists of 6 pages

Time Allowed : **3 hours**
Total Marks : **100**
Special Requirements : **Graph Paper**
Examiner's Name : **Mr Bhekisisa Nyoni**

INSTRUCTIONS

1. Answer BOTH QUESTIONS in Section A and any THREE questions from Section B.
2. Each question carries 20 marks
3. Show all your steps clearly in any calculation (Use of calculators is permissible)
4. Start the answers for each question on a fresh page.

MARK ALLOCATION

QUESTION	MARKS
1.	20
2.	20
3.	20
4.	20
5.	20
TOTAL	100

SECTION A (*Answer BOTH*)

Question 1

a) Define the following terms as applied to the Schmidt Trigger circuit.

- i) Upper Trigger Voltage,
- ii) Lower Trigger Voltage,
- iii) Hysteresis.

[6]

b) The Schmidt Trigger circuit shown in Figure Q1 receives an input in the form of a sinewave of frequency 10 kHz and peak-to-peak voltage of 24 volts. If the supply voltages of the op amp are ± 12 V, on the same axis, draw both the input waveform V_{in} and the output waveform V_o against time. Show clearly the voltage values, and the times at which the output voltage crosses the zero axis.

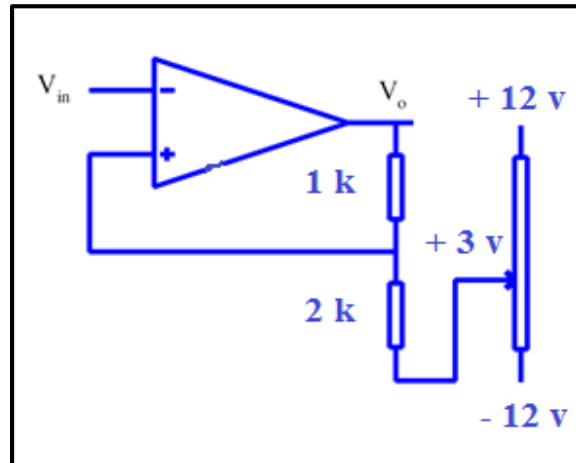


Figure Q1

[14]

Question 2

a) Design an A-D Converter using a ramp generator and pulse counting, with the following specifications:

- | | |
|----------------------------|--------------|
| D.C. input range: | 0 – 10 volts |
| Binary output: | 8 bits |
| Clock frequency: | 10 kHz |
| Sampling (gate) frequency: | 100 Hz |

Draw the complete circuit for the converter and show realistic values of resistors and capacitors in the ramp generator section.

[12]

b) For this A-D converter, what are the binary outputs when the inputs are 2 volts, 5 volts or 8 volts? What input voltage would produce an output of 10101010?

[8]

SECTION B (Answer any 3)

Question 3

- a) A photo transistor having the characteristics shown in Figure Q3a is connected in series with a load resistor of 2.5 kohms across a supply of voltage 25 volts. What would be the voltages across the transistor when the light intensities are 100, 200 and 400 W/m^2 ?

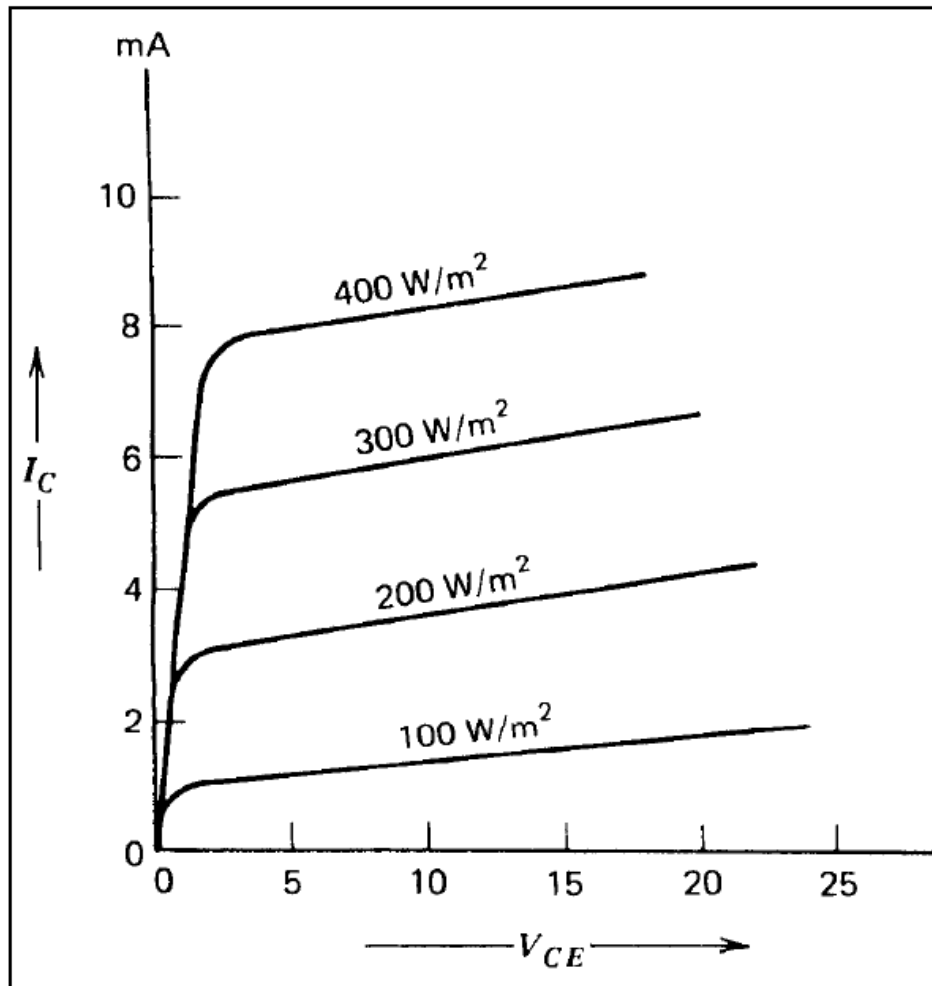


Figure Q3a

[10]

- b) Draw a typical circuit using a thermistor to automatically maintain the temperature of an enclosure at 20°C using an electric heater (similar to the central heating room thermostat or thermostat in an electric heater).

[5]

- c) For the open loop measuring system shown in Figure Q3b, copy and complete the table below.

Element of the measuring system e.g	How it is implemented in Figure Q3b
Quantity being measured	

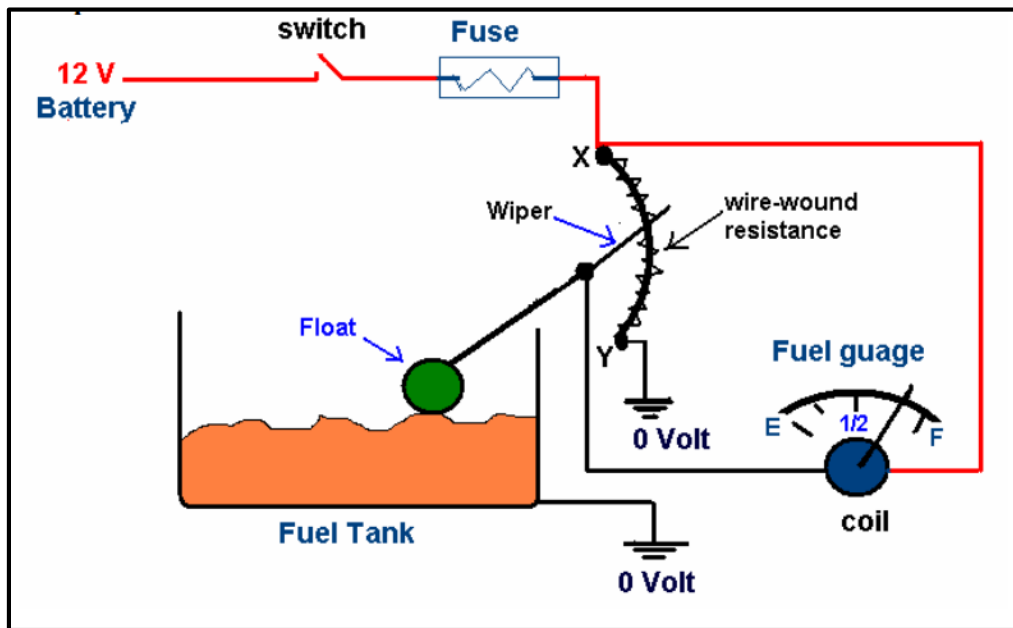


Figure Q3b

[5]

Question 4

Laser printing is one method of producing a permanent record of measurement data by transferring the data onto a piece of paper.

- a) State the six stages of the laser printing process and give a **brief** description of what happens at each of the stages.

[6]

- b) Explain briefly with the aid of a diagram the operation of a stepper motor.

[6]

- c) State at least 4 terms that describe measurement errors which can occur in measurement systems, indicating briefly how these can be reduced in each case.

[8]

Question 5

- a) A strain gauge is affixed to the outside skin of a jetliner to assess strain in the material during take-off. The gauge is connected in series with a 200 ohm resistor across a 5 volt d.c. supply. The voltage across the strain gauge is taken to a 10-bit A-to-D converter, which gives a maximum output for 6 volts input. If the gauge sensitivity factor is 2.3, and the resistance of the unstressed gauge is 150 ohms, what would be the binary output of the system when the material of the plane is stressed by 5%.

[10]

- b) Classify the following measuring systems; a pothole counter APP in an iPhone, a typical domestic Cash power meter, and an intelligent self-service fuel pump?

[3]

- c) As an attachee at Advertele Private Limited, you have been assigned to draw up a pitch of sale for some telemetry equipment to be used between the Bulawayo vehicle toll plaza and the ZINARA offices. The pitch should include a definition of telemetry, the best type of telemetry to implement and a brief outline of the advantages of implementing this solution. Write notes on the pitch you would draw up including the 3 requirements in your presentation.

[7]

Question 6

- a) A resistive temperature transducer of resistance 1500 ohms at 20°C and temperature coefficient 0.004 is connected in series with a resistor of 2500 ohms across a 12 volt supply. The voltage across the transducer is passed to the input of an op amp integrator circuit with input resistor of 100 kohm and feedback capacitor of 1000 uF. The transducer is placed in an electric oven at temperature 20°C and the integrator switch is opened. The oven heats linearly with time to a temperature of 300°C in a time of 100 seconds. What would be the output voltage of the op amp at the end of the time?

[8]

- b) Describe with the aid of a diagram the construction of an oscilloscope.

[8]

- c) Briefly describe the four main levels of a Virtual Instrumentation system.

[4]

Question 7

- d) Describe the mechanical construction of the d'Arsonval meter movement, using a fully labelled diagram.

[6]

- e) A dynamometer movement produces a full-scale deflection when the product of the currents in the two coils is 10^{-3} A^2 . If a load of 100 Ohms across a supply voltage of 50 volts produces a half-scale deflection, what is the value of the series resistance in the series resistance in the voltage-measuring part of the circuit?

[6]

- f) A meter has an internal resistance of 500 Ohms and a full-scale deflection of 1 mA. Design suitable circuits to make this into
- i. A voltmeter reading from 0-10 volts, and
 - ii. An ammeter to read 0-2 amps.

[8]