NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
FACULTY OF INDUSTRIAL TECHNOLOGY

DEPARTMENT OF ELECTRONIC ENGINEERING

BACHELOR OF ENGINEERING (HONS) DEGREE

AUGUST 2009

TEE 1241 ELECTRICAL MEASUREMENTS

Duration of Examination – 3 Hours

INSTRUCTIONS TO CANDIDATES

1. This question paper consists of **3** printed papers and **7** questions.
2. Answer any **FIVE** questions.
3. Each question carries 20 marks.
4. Start the answers for each question on a fresh page.
5. Use relevant concrete examples to support your answers.

QUESTION 1

Draw the block diagram of an electronic measurement system's elements. 5

Using an open loop temperature measurement system example, describe how each stage functions and its typical components. 10

Describe how the block diagram can be modified to control the temperature range 5

QUESTION 2

a) What is a transducer? 2

b) Derive the capacitance C for a parallel plate system whose plates have area A_C with one plate rotated through an angle α. 5

c) Calculate the angle rotated through by a capacitor with a maximum area of $0.1 m^2$ and air spacing of 0.8 mm if the resultant capacitance is 220pF. 6

d) How does a capacitance microphone work? 3

e) Explain how an op amp voltage subtractor works 4

QUESTION 3

a) An open wire copper route used in an overhead telephone carrier system has 2.5 ohms per kilometer resistance. Find the distance to the nearest metre at which a short circuit occurs on the line if when one end of the route connected to a 10Volt DC generator with internal resistance 25 ohms causes a current of 20 milliamps to flow around the circuit. **6**

b) Two strain gauges are fastened to the upper and lower faces of a 150mm thick cantilever beam. The gauge sensitivity factor is 3 and the initial resistance is 200 ohms. When the free end of the beam is loaded both gauges change their resistance by 2 ohms. Calculate the radius of curvature of the centre line of the bent beam at the point where the gauges are fixed. **14**

QUESTION 4

The table below describes the illumination-resistance behaviour for a certain light dependent resistor or photocell.

Illumination lm/m^2	**Resistance Kohm**
10 000	0.4
200	5
100	8
10	60

Using a similar photocell to the one described in the table, design an op amp circuit that ensures that the room light intensity in a car does not exceed $100lm/m^2$ luminance.
The circuit should cause the car hooter to blow if the light is left on when the driver leaves the vehicle. Explain the circuit giving any assumptions made in your design.
Practical component values must be used. **20**

QUESTION 5

The CR-CN junction temperature at 1000degC with the reference kept at 0 degC generates an emf of approximately 75 mV.

a) Design a circuit that will provide an amplified output from 3 such junctions and give an alarm when the total output exceeds 12 volts. Provide any reasons for assumptions made in the design. **15**

b) List 3 measurement system classifications with examples. **5**

QUESTION 6

Describe an experiment to produce Lissajous' figures. 10

Draw the output wave shapes for at least 3 phases. 6

Explain why it is difficult to, using an oscilloscope, obtain a stable waveform at mains utility frequency level. 4

QUESTION 7

a) Explain fully the functioning of a ramp type analogue to digital converter. 10

b) Design an analogue multi meter to measure the following DC quantities

i 0-100 Volts

ii 0-10 Amps

iii 0-10 K ohms

The meter coil has resistance of 100 ohms and the voltage at which full scale deflection occurs is 2 Volts. 8

c) On a separate diagram show how you can modify the circuit for AC measurements. 2

END OF PAPER