MUEO

MOI UNIVERSITY

OFFICE OF THE DEPUTY VICE CHANCELLOR
(ACADEMICS, RESEARCH & EXTENSION)

UNIVERSITY EXAMINATIONS
2016/2017 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER EXAMINATION

FOR THE DEGREE OF

BACHELOR OF ENGINEERING

IN

ELECTRICAL & ELECTRONICS, TELECOMMUNICATION AND MECHANICAL & PRODUCTION ENGINEERING

COURSE CODE: ECE 231

COURSE TITLE: ELECTRICAL MEASUREMENTS

DATE: 14TH DECEMBER, 2016 **TIME:** 2.00 P.M. – 5.00 P.M.

INSTRUCTION TO CANDIDATES

- ANSWER ANY FIVE OF THE FOLLOWING SEVEN QUESTIONS
- ALL QUESTIONS CARRY EQUAL MARKS
- CANDIDATES ARE ADVISED TO BRING AN ORDINARY SCIENTI

THIS PAPER CONSISTS OF (7) PRINTED PAGES

PLEASE TU

Question One

A)

A method for estimating the value of an inductance is suggested below, Fig. Q1A. Following is a description of the method.

{ *This approximate method consists of connecting the unknown inductance in series with a variable resistance, in a circuit excited with a sinusoidal voltage, as shown in Figure Q1A. The variable resistance is adjusted until the voltage measured across the resistance is equal to that measured across the inductance. The two impedances are then equal.* }

(i) Identify two forms of measurement involved in this method? **(2 mark)**

(ii) If you were to organise this experiment, assuming you can adjust R and achieve balance when R=1.5 Ohms, the sinusoidal frequency $\omega = 2\Pi f$, where f=50 Hz how will you determine L from the results of measurement and formulae? Can you suggest a measurement procedure to get L based on this setup? **(4 marks)**

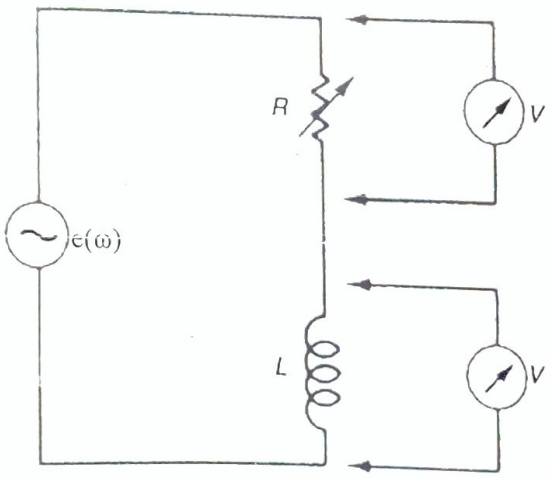


Fig Q1 A

B)

A PMMC meter is connected in the circuit shown, Fig. Q1 B. Find the meter current I if it is known that:

Rm=480 Ohms

R= 20 Ohms

Rx=80 Ohms

V= 15 Volts.

(8 marks)

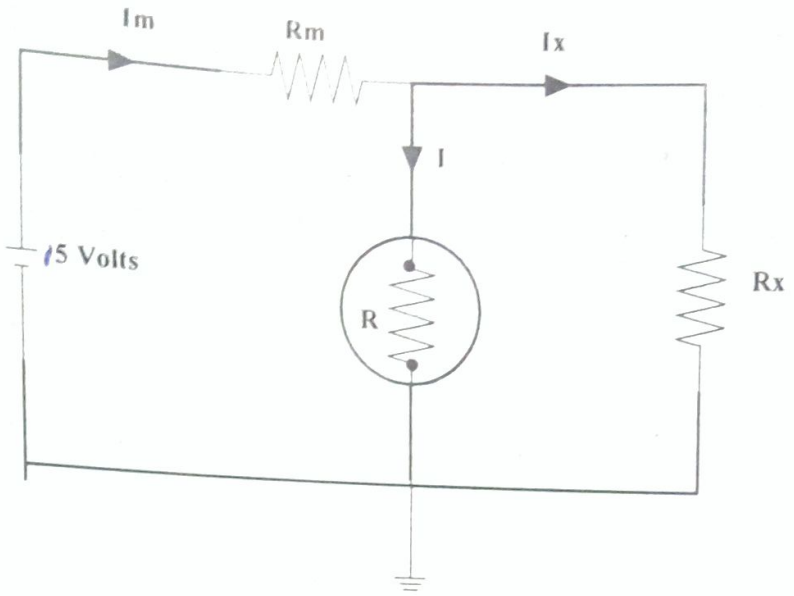


Fig. Q1 B

Question Two

A)

A moving coil meter has a resistance of, Rm, of 100 Ohms. The meter has a full-scale deflection of 0.5 mA. It is required that a multi-range voltmeter is to be built to enable the meter to work on the scale ranges 0-25 V, 0-50 V and 0-200 V. Find the design values for the resistances R1, R2 and R3 (Fig. Q2 A).**(5 marks)**

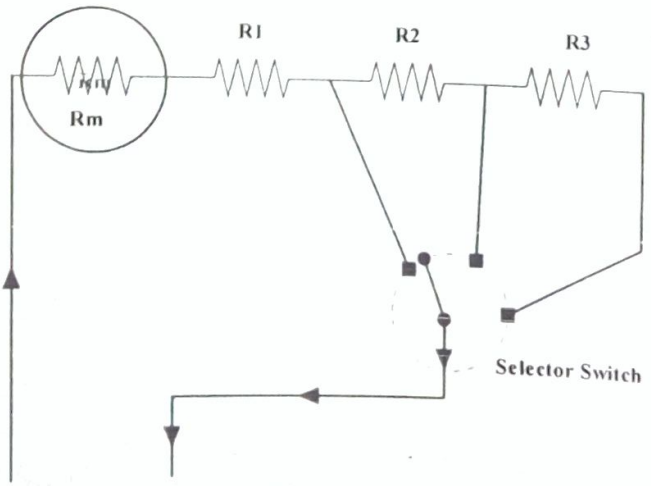


Fig. Q2 A

B)

You are given a meter movement with the following specifications:

Moment of inertia, J = 60 NM RAD^{-1} SEC^2
Restoring spring constant, C= 180 NM RAD^{-1}
Damping ratio, ξ = 1.1

Suddenly a 200 NM moment is applied at the drum. Find the deflection of the pointer assuming zero initial conditions.

(9 marks)

Question Three

A)
The circuit, Fig Q3 A, shows a bridge that is not balanced with current, I, flowing in the meter. Calculate the unbalanced current in **A**, an ideal ammeter with zero internal resistance.

(7 marks)

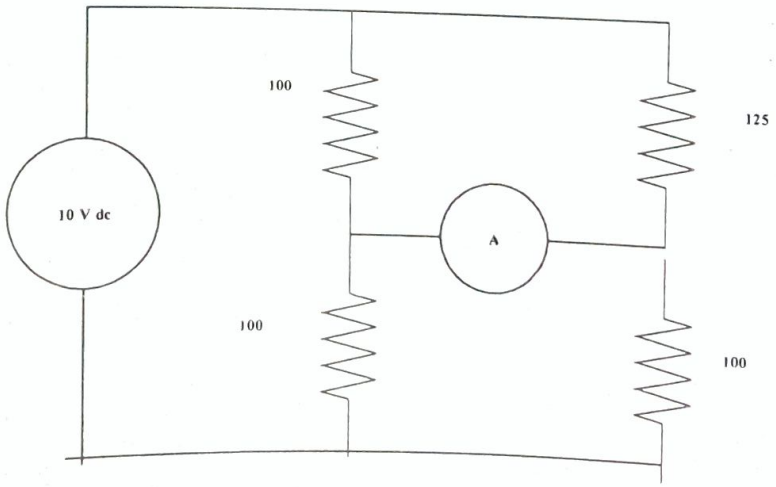


Fig. Q3 A

B)

(i) Explain why the Gaussian law is popular in estimation of most random processes **(2 marks)**

(ii) Table Q3B is a set of readings taken off a voltmeter when repeat readings of the same value under varied conditions were taken. Find the Systematic Error, Standard Deviation of the errors, the Probable Error (at 50% confidence limit) and the Total Error of the measurement device.

(5 marks)

Table Q3B

Volts(Measured)	**10.2**	**9.9**	**10.0**	**10.1**	**9.7**	**10.1**
Volts (Exact)	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**	**10.0**

Question Four

A)
Draw the electromagnetic circuit of a simple inductive transducer. Derive an expression for this inductance L as displacement X varies. **(6 marks)**
B) Find an expression for the sensitivity of this inductance.**(4 marks)**

B)
In an inductive transducer, the average length of flux within the core be 0.1 meters. The area, A, is 5×10^{-4} M^2, the number of coil turns is 250, the permeability of free space and relative permeability are $4\pi \times 10^{-7}$ H/ M and 450 respectively. Calculate the inductance when the displacement, Δx, is 5×10^{-5} Metres.

(4 marks)

Question Five

A)
List three forms measurements. For each form give a sketch example.

(3 marks)

B)
Using a chart or block diagram show how the total error is created.

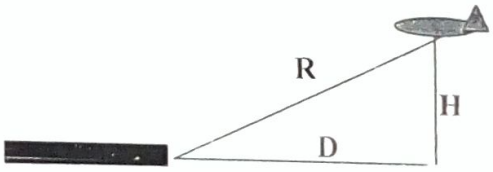
(3 marks)

C)
In an airplane the distance D to the airport is estimated by measuring the slant range R at an altitude of H, then assuming R equal to D.

(i) What kind of error is committed in this measurement? **(2 marks)**

(ii) Find a mathematical expression for this error. **(4 marks)**

(iii) From your expression derived in (ii) above, assuming the flight attitude is fixed at H=constant and an airplane is flying over level ground at what stages of flight is this error likely to grow to intolerable proportions?**(2 marks)**



Question Six

A)
Define zero drift of an instrument. What would you say of an instrument's precision if the sensitivity varies due to some external condition? **(4marks)**

B)(i)
An instrument is calibrated in an environment at a temperature of 20°C and the following output readings y are obtained for various input values x. Estimate the measurement sensitivity of y to x. **(5 marks)**

y	13.1	26.2	39.3	52.4	65.5	78.6
x	5	10	15	20	25	30

Table. Q 6 B(i)

method error
instrument error
person error

6 7 5

B)(ii)
When the instrument is subsequently used in an environment at a temperature of 50°C, the input/output characteristic changes to the following:

y	14.7	29.4	44.1	58.8	73.5	88.2
x	5	10	15	20	25	30

Determine the new measurement sensitivity. Hence determine the sensitivity drift (sensitivity change/degree] due to the change in ambient temperature of 30°C.
(5 marks)

Question Seven

A)
i) Derive an expression for the deflection of an electro-dynamic meter movement.
(4 marks)

ii) Explain the difference between an electro-dynamic and a ferro-dynamic meter.
(2 mark)

B)
i) Sketch the essential parts of an oscilloscope (tube type) and explain how spot on the screen is generated.
(5 marks)

ii) Prove, that the deflection of a PMMC meter is affected by temperature.
(3 marks)