THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A Constituent College of Jkuat)

Faculty of Engineering & Technology

DEPARTMENT OF MECHANICAL & AUTOMOTIVE ENGINEERING

DIPLOMA IN TECHNOLOGY
ELECTRONICS ENGINEERING
ELECTRICAL POWER ENGINEERING
ELECTRONICS & AUTOMATION ENGINEERING
TELECOMMUNICATION & INFORMATION ENGINEERING
COMPUTER SCIENCE ENGINEERING
INSTRUMENTATION & CONTROL ENGINEERING ENGINEERING

EEP 2102: ELECTROMAGNETISM I

SPECIAL/SUPPLEMENTARY EXAMINATION

SERIES: OCTOBER 2011

TIME: 2 HOURS

Instructions to Candidates:
You should have the following for this examination

- *Answer booklet*
- *Non-programmable scientific calculator*

This paper consists of **FIVE** questions
Questions **ONE** is **COMPULSORY**. Answer any other **TWO** questions
Maximum marks for each part of a question are clearly shown
This paper consists of **FIVE** printed pages

Question 1 (Compulsory)

a) Derive the expression for the total capacitance of three capacitors connected in series

b) For the circuit of fig 1, calculate
   i. The charge across each capacitor
   ii. The energy stored in the 10 μF capacitor

Fig 1

a) An 8 μF capacitor is connected in series with a 500k Ω resistor across a 200V dc supply. Calculate
   i. The time constant
   ii. The initial charging current
   iii. The time take for the pd across the capacitor to grow to 16V
   iv. The current and the pd across the capacitor 4 seconds after it is connected to the supply (16 marks)

b) (i) State any **THREE** properties of magnetic flux lines

(ii) An electromagnet has a magnetic circuit that consists of three sections in series each of uniform cross-sectional area are shown in table 1 sections A and B are made from a material having B/H characteristics in table 2. Determine the current necessary in a coil of 4000 turns wound on part B to produce a flux density of 0.3T in the air gap. Take $\mu_0 = 4\Pi \times 10^{-7}$ permeability of three space H/m (8 marks)

Table 1

Section	Length (mm)	Area (mm^2)
A	80	50

Table 2

B(T)	0.9	0.5
H(At/m)	620	

B	60	90
C (air gap)	0.5	150

c) (i) Identify the poles of the magnet in fig 2, if the current is supplied as shown

Fig.2

(ii) A conductor of length 1.5m is situated in a uniform magnetic field of flux density 0.6W/b/m and carries a current of 25A. Calculate the force exerted on the conductor when;

i. It is right angles to the field
ii. It is inclined at 45^{o} to the direction of the field
iii. Two coils of self inductance 3.4H and 1.4h respectively are connected in series aiding. If the coefficient of coupling between the coils is 0.5. Determine the total inductance of the circuit (6 marks)

Question 2

a) Define the following terms:
i. Electric flux density
ii. Electric field strength (2 marks)

b) (i) State Coulomb's laws of Electrostatics
(ii) State any **TWO** factors affecting the capacitance of capacitor
(iii) Point charges in air are located at the corners of rectangle 3cm x 4cm as shown in fig 3, Calculate:

i. The resultant electric field strength at point D
ii. The force exerted on the charge at D

Fig 3

c) A capacitor consists of two parallel metal plates each of area 0.4m2 and 7mm apart. The space between the plates is filled with a layer of paper 3mm thick and sheet of glass 4mm thick. The relative permittivities of paper and glass are 2 and 8 respectively. Determine:
   i. The total capacitance
   ii. The energy stored in the capacitor if a pd of 1000V is applied between the plates
(5 marks)

Question 3

a) Define the following terms
   i. Magnetic flux density
   ii. Magnetic field strength (2 marks)

b) Sketch the hysteresis loop of a ferromagnetic and explain its shape (10 marks)

c) A magnetic circuit made of wrought iron is arranged as shown in fig 4,500 turns of coil are wound in the central limb. Cross-sectional area of centre limb is 8cm2 and that of the side limbs is 5cm2. Determine the current in the central limb to produce a flux of 1mWb
The B/H characteristics of wrought iron are given in table 3 (8 marks)

Table 3

B $(Wb/m)^2$	1	1.25
H At/m	200	500

Fig. 4

Question 4

a) (i) State Faraday's laws of electromagnetic induction
(ii) Derive the expression for the total inductance of two coils connected in series aiding (6 marks)

b) With the aid of a diagram, explain the operation of an ideal transformer (6 marks)

c) (i) A coil of resistance 5 Ω and inductance of 1H is connected to a supply of 60V. Determine:

i. The rate of change of current at the instant of closing the switch
ii. The final steady value of current
iii. The time constant
iv. The time taken for the current of reach 5A

(ii) The field windings of a DC machine consists of eight coils in series containing 1500 turns. When the current is 5A, the flux linked with each coil is 25mWb. Calculate:
i. The inductance
ii. The energy stored (8 marks)

Question 5

a) (i) State any **TWO** factors that determine the inductance of a coil

(ii) Sketch the magnetic patterns of two parallel conductors carrying current in opposite direction in a magnetic field and determine the resultant forces on the conductors

(iii) State any **TWO** applications of the mechanical force exerted on a current carrying conductor situated in a magnetic field (8 marks)

b) (i) With the aid of a labeled diagram, describe the operation of a simple dc motor
(ii) Indicate the direction of the induced current in fig. 5

Fig. 5

c) A conductor 0.6m long is carrying a current of 75A and is placed at right angles to a magnetic field of uniform flux density of 0.667T. Calculate:

i. The value of the mechanical force of the conductor
ii. The emf induced in it if the force causes the conductor to move at a velocity of 10m/s (4 marks)