THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A Constituent College of Jkuat)

Faculty of Engineering and Technology in Conjunction with Kenya Institute of Highways and Building & Technology (KIHBT)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

HIGHER DIPLOMA IN TECHNOLOGY

ELECTRICAL POWER ENGINEERING
ELECTRONIC & AUTOMATION ENGINEERING

EEP 3105 : ELECTRICAL TECHNOLOGY II

SEMESTER EXAMINATIONS

SERIES: AUGUST/SEPTEMBER 2011

TIME: 2 HOURS

Instructions to Candidates:

You should have the following for this examination

- *Answer booklet*
- *Scientific calculator*
- *SMP Table*

Answer Question **ONE** (**COMPULSORY**) in **section I** and any other **TWO** questions from **Section II**
This paper consists of **SIX** printed pages

SECTION I (compulsory **–** 30 marks)

Question 1

a) (I) With the aid of circuit sketches, distinguish between the following electrical quantities

(i) Statically induced and Dynamically Induced e.m.f
(ii) Self Inductance and Mutual Inductance

(II) Show that the:

(i) Self inductance of a single coil is given by:

$$L = \frac{\mu_O N^2 A}{l}$$

(ii) Hence derive the Coefficient of Coupling, k between two current carrying coils near each other (10 marks)

b) (I) Define the following terms:

(i) Free response
(ii) Forced response

(II) Derive the System Transfer function for the Circuit Figure 1 below then:

(i) Determine its response to a step input in the time domain
(ii) Calculate for a step input of 12V, the:-

- Output voltage at time $t = 5\tau$ where τ is the time constant, with switch positioned at A for a time t that is many times greater that t.
- Voltage across the capacitor at $t = 0.01\tau$, with switch instantly taken to position B

c) (I) With the aid of equations and vector diagrams distinguish between:

(i) Scalar Field and Vector Field
(ii) Dot and Cross Product

$$\bar{\gamma} = (3t+1)\,\hat{i} + 3t^3\,\hat{j} - 5t\,\hat{k}$$

(II) The is vector displacement of a certain satellite in space at time t. Find the:

(i) Velocity and acceleration of satellite at (t = 1 second)
(ii) Angle between velocity and acceleration (10 marks)

SECTION II (Answer any **TWO** questions (Each question carries 20 marks**)**

Question 2

a) (I) Derive the corresponding equations for determining the:-

(i) Magnitude of a Dynamically Induced e.m.f
(ii) Energy stored in an Inductor

(II) A ring made a certain material has a mean circumstance of 400mm and cross sectional area of $500mm^2$ has a winding of 200 copper wire turns around it. The B-H curve for the soft iron is as show in the table below:

B	1.2	1.3	1.4	1.5	1.55	1.6
H	400	500	650	900	1300	12500

Calculate the inductance of the coil corresponding to a reversal of current of 5A in the windings (10 marks)

b) (I) Draw circuits of the following:

(i) Double Tuned Circuit
(ii) Stagger Tuned Circuit

(II) The Circuit Figure 2 is an example of a single tuned circuit:

Given that R = 60 Ω ; L = 600mH and V in is a sinusoidal supply with constant r.m.s value of 100V at all frequencies. Calculate:-

(i) The value of the variable capacitance required to obtain a bandwidth of 22Hz.
(ii) The Current Magnification
(iii) The new Bandwidth when the resistance value in the circuit it increased by 50%. (10 marks)

Question 3

a) (I) With the aid of suitable sketches explain the meaning of Second Order Filter

(II) A series RL circuit with resistance R = 1 Ω , and Inductance L = 2H was connected such that the output was taken across the inductor.

(i) Determine the transfer function of the circuit
(ii) Sketch the Magnitude and Phase Plot of the Transfer Function
(iii) From the plots explain why such a Circuit is called a High Pass Filter
(iv) Explain the effect of increased time constant on the response (10 marks)

b) (I) With the aid of suitable sketches, describe the following types of test signals in 's' domain

(i) Ramp Input
(ii) Exponential Rise

(II) If you are provided with a Battery, a Potentiometer a Switch and a Circuit System. Explain how the two types of inputs above may be modeled for the Circuit System

(III) The Circuit Fig 3 below was started at rest by closing the switch as shown:

Perform the corresponding circuit analysis to determine the:

(i) Circuit Transfer Function

(ii) Response of the circuit to a 100 Hz sinusoidal Input given by $V_m(t) = 200 \cos \omega t$ (10 marks)

Question 4

a) (I) State the following laws as applied in Magnetic Fields Theory

(i) Faraday's Law
(ii) Ampere's Law

(II) Write the FOUR Maxwell's Equations in:

(i) Integral Form
(ii) Differential Form (10 marks)

b) (I) The electrical field $\bar{F} = 3x^2 y\, i + 5x\, j + 20xz^2\, k$. Find the value of electronic charge at P_o (3,2,1)

(II) Evaluate both sides of divergence theory for the field $\bar{F} = x\, i + y\, j + z\, k$ over the sphere $x^2 + y^2 + z^2 = 25cm^2$

(10 marks)

Question 5

a) (I) State any FOUR properties of electromagnetic waves
(II) From Maxwell's Equations, show that:-

$$\Delta^2 E = \mu_O E_O \frac{\partial^2 E}{\partial t^2}$$

$$\Delta^2 B = \mu_O E_O \frac{\partial^2 B}{\partial t^2}$$

b) (I) Write down the expressions relating the energy in a wave with the characteristics of the medium as it travels.

(II) An electromagnetic wave of wavelength λ =30cm is travelling in air. Calculate the:

(i) Frequency of the wave
(ii) New speed, frequency, and wavelength, if such a wave passes from air into a block of quartz, for which K = 4.3.

(III) The intensity of a telecommunication E-M wave falling on the surface of a flat dish antenna on particular day is $140 Wm^2$. Estimate the peak values of the:

(i) Electric field
(ii) Magnetic field associated with the incident radiation (10 marks)