MACHAKOS UNIVERSITY

University Examinations 2016/2017

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

THIRD YEAR FIRST SEMESTER EXAMINATION FOR BACHELOR OF EDUCATION

SPH 304: A.C. CIRCUIT THEORY

DATE: 31/7/2017 **TIME: 11:00 – 1:00 PM**

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

SECTION A: (COMPULSORY)

QUESTION ONE (30 MARKS)

a) Draw a diagram of a simple a.c generator comprising of two magnets, a coil and an output circuit. (3 marks)

b) An a.c generator produce a voltage with the signal $\in = 260 \sin wt$, find its average value (3 marks)

c) Draw the phasor and waveform of the following two signals on same diagram $\in = 100 \sin \omega t$ and $\in = 50 \sin(\omega t - 90^o)$

where ϵ is voltate

ω is angular frequency

t is time (4 marks)

d) Draw an a.c resistor (R) circuit, whose voltage signal varies as $V = V_{max}\, cost\, wt$ and show that $i = \frac{V_{max}}{R} \cos wt$ (4 marks)

e) Convert a complex number $Z = x + jy$ to $Z = r < \theta$ (3 marks)

f) Explain the condition necessary for resonance in an a.c series RLC circuit to occur and state it's application. (2 marks)

g) Define the term Q-factor (2 marks)

h) The voltage in an electric circuit is represented by $V = 50 - j\,6$ and current $I = 10 + j\,4$. Determine

i. Impedance as a complex number (3 marks)

ii. Resistance and reactance of the circuit (3 marks)

iii. Phase angle (3 marks)

SECTION B: ANSWER ANY OTHER TWO QUESTIONS

QUESTION TWO (20 MARKS)

a) Using complex algebra, find the voltage *v* for the circuit shown in Figure 1. (4 marks)

b) Sketch the waveforms of *v* and *i* and represent the waveforms using phasors. (4 marks)

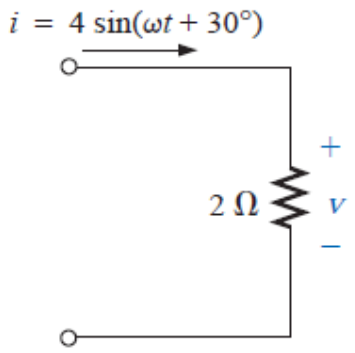

Figure 1

c) An inductor (L) a.c circuit has a voltage signal of the form $\in = \in_{max} \sin wt$.

i Draw the circuit and label (2 marks)

ii Derive its current (I) signal (5 marks)

iii show that its inductive reactance is $X_L = 2\pi fL$ (5 marks)

QUESTION THREE (20 MARKS)

a) The arms of an ac Maxwell bridge are arranged as in figure 3; AB and BC are non reactive resistors of 100 Ω each, DA is a standard variable reactor L_1 of resistance 32.7 Ω and CD comprises a standard variable resistor R in series with a coil of unknown impedance. Balance was obtained with $L_1 = 47.8\,mH$ and R = 1.36 Ω. Find the resistance and inductance of the coil.

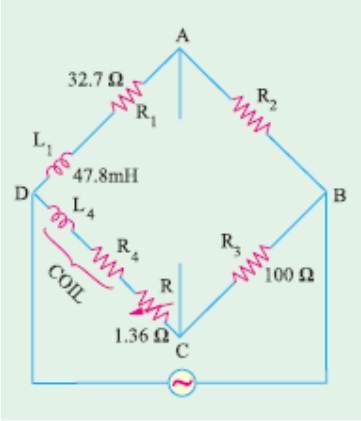

Figure 3 (6 marks)

b) A source of an a.c has an output of impedance of 400 Ω which is to be transformed using a transformer to match 80 Ω load.

i. Design a transformer that can be used for this purpose. (3 marks)

ii. Illustrate with a well labelled diagram (3 marks)

c) The diagram in figure 4 shows an ac rectifier circuit

i. Show the wave form of the output signal (3 marks)

ii. Show how a capacitor can be connected to smooth the signal (2 marks)

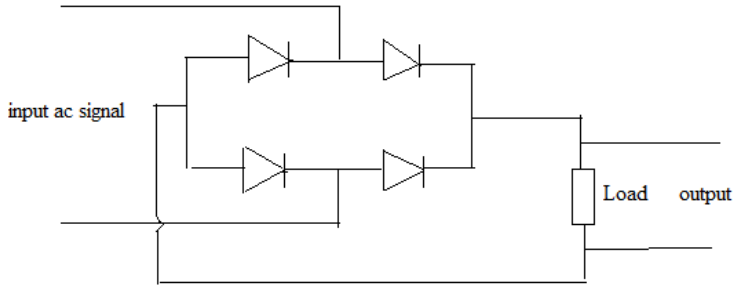

Figure 4

d) Draw a LC filter setup and explain how it works (3 marks)

QUESTION FOUR (20 MARKS)

a) Describe the working of a coupling capacitor and show with a diagram (3 marks)

b) i Define impedance matching (2 marks

ii State the maximum power transfer theorem (2 marks)

iii Draw a circuit that can be used to illustrate b (i) and b (ii) above (2 marks)

c) i Draw a capacitor (C) circuit with a voltage signal $V = V_{max} \cos wt$ (1 mark)

ii Show that $i = -\omega c V_{max} \sin wt$. (4 marks)

iii Hence draw the waveforms of the two voltage and current signals on a common axes. (3 marks)

iv Proceed to derive capacitive reactance (3 marks)

QUESTION FIVE (20 MARKS)

a) A series circuit consisting of a capacitance of 1.00 F, a resistor of 3 Ω and an inductor of 2.0 H are connected to 240 V (rms) supply of frequency $\omega = 300$ rad/s. Given that V_R is in phase with I, V_L leads I by 90^o and V_C lags I by 90^o. (definitions of symbols are given as you read on)

i. Find rms voltage (2 marks)

ii. Find the equations for

I) Voltage signal (V) i.e (sine wave signal) (4 marks)

II) Current signal (I) i.e (sine wave signal) (4 marks)

III) Maximum voltage across the resistor V_{RO}, across the inductor V_{LO}, across the capacitor V_{CO} (4 marks)

IV) Sine wave signal for voltage across the resistance V_R, across the inductor V_L and across the capacitor V_C (4 marks)

iii. Find

I) The values of the capacitive reactance X_C and inductive reactance X_L (2 marks)