**TECHNICAL UNIVERSITY OF MOMBASA**

**FACULTY OF APPLIED AND HEALTHY SCIENCES**

**DEPARTMENT OF MATHEMATICS AND PHYSICS**

**UNIVERSITY EXAMINATION FOR THE DEGREE OF BACHELOR OF TECHNOLOGY IN APPLIED PHYSICS (BTAP) AND BACHELOR OF TECHNOLOGY IN RENEWABLE ENERGY AND ENVIROMENTAL PHYSICS (BTRE)**

## APS 4305: AC CIRCUIT THEORY

## SPECIAL/ SUPPLIMENTARY EXAMINATIONS

## SERIES: SEPTEMBER 2018

**TIME: 2** HOURS **DATE: SEPTEMBER 2018**

**INSTRUCTION TO CANDIDATES**

You should have the following for this examination: *-Answer Booklet, examination Pass and student ID.* This paper consists of FIVE questions. Answer question **ONE (COMPULSORY)** and **ANY** other **TWO** questions. The maximum marks for each question is shown. Mathematical tables and scientific calculators may be used. Do not write on the question paper.

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**QUESTION ONE (30 mks)**

a) Superposition theorem and Reciprocality theorem are famous circuit analysis theorems. State them. (2mks)

b) Figure 1 is Delta resistive network. Convert it into an equivalent Star resistive network. (6mks)

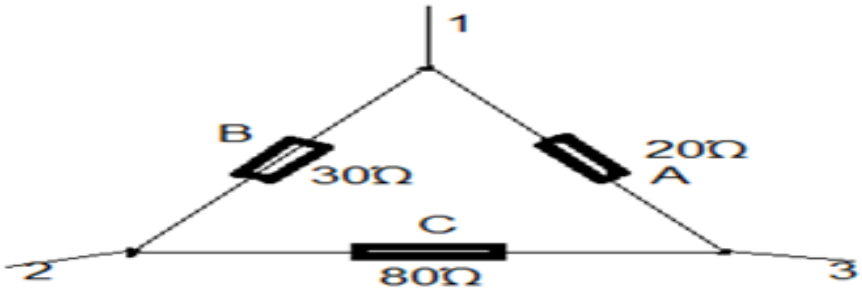


Figure 1 : Resistive Network

c) Define the magnetic dipole and transformer: (4mks)

d) (i) A single phase transformer with 200KVA rating has 480V primary and a 120V secondary voltage. Calculate;

a) Its primary full load current (2mks)
b) Its secondary full load current (2mks)

(ii) Consider a circuit whose instantaneous voltage is out of phase with current by a phase angle of Φ, such that current is given by $i = I_P \sin \omega t$ and voltage $v = V_P \sin(\omega t + \Phi)$. Show that for this circuit, the power factor can be given by; $\cos\phi = \frac{P}{VI}$ where Φ =phase angle, V and I are R.M.S values of voltage and current, P= power. (6mks)

e) An AC current varying sinusoidal at a frequency of 60Hz has R.M.S value of 2.5A.
(i) Write down the equation for its instantaneous value. (2mks)
(ii) Find the current after passing a positive value maximum at
(a) 0.0025 seconds (2mks)
(b) 0.0125 seconds (2mks)
(iii) State the Norton theorem and Thevenin theorem respectively. (2mks)

**QUESTION TWO (20 mks)**

a) A 50Hz voltage source effective value is impressed on a capacitor of 26 μF.
(i) Sketch the diagram of its circuit and its phasor. (3mks)
(ii) Write the time equation for the voltage and current by letting the zero axis of the voltage be at t = 0. (5mks)
(iii) Find the relative heating effects of the current waves of equal peak sinusoidal and the other being in rectangular in form. (2mks)

b) A 50 μF capacitor is connected across a 230V, 50Hz power supply. Calculate;
(i) the capacitive reactance offered by this capacitor. (2mks)
(ii) the mean R.M.S current ($I_{rms}$) drawn by the capacitor. (2mks)
(iii) the maximum current drawn by this capacitor. (2mks)

c) The field winding of a DC electromagnet is wound with 960 turns and has a resistance of 50Ω. When the exciting voltage is 230V, the magnetic flux linking the coil is 0.0025Wb. Calculate;
(i) the self inductance of the coil. (2mks)
(ii) the energy stored in the magnetic field (2mks)

**QUESTION THREE (20 mks)**

a) State the following circuit analysis theorems: (4mks)
(i) Thevennin's theorem
(ii) Norton's theorem

Study the Maxwel-Wien bridge shown in figure 2. The arms are arranged as follows: AB is a non-reactive inductive resistance of 100Ω in parallel with a capacitor of capacitance 0.5 μF. BC is a non-inductive resistance of 600Ω. CD is an inductive impedance of unknown value and DA is a non-inductive resistance of 400Ω. If the balance point is obtained under these conditions, find the value of
(i) The resistance of branch CD (2mks)
(ii) The inductance of branch CD (2mks)

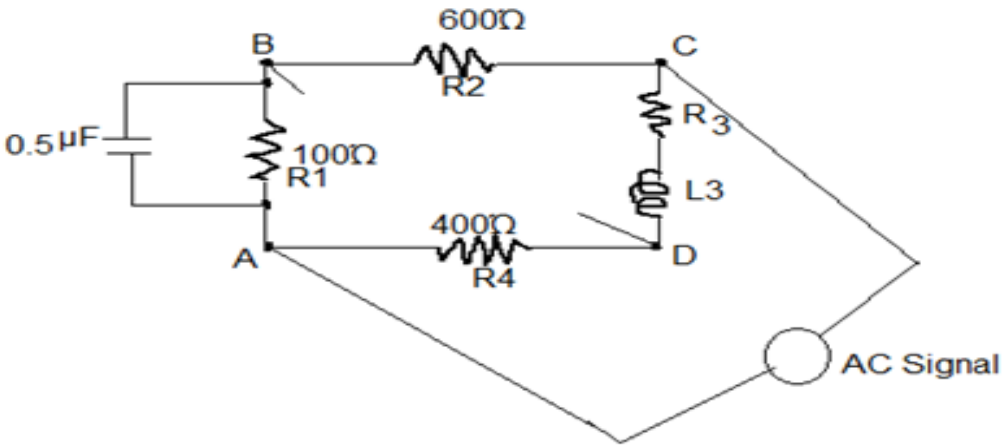


Figure 2 : Resistive circuit in an Ac curcuit

b) Consider an AC current with R.M.S value of 2A and frequency of 50Hz.
   (i) Write down the expressions for its instantaneous value. (2mks)
   (ii) Determine its current after passing a positive maximum value at;
   (a) 0.0025 seconds (1mk)
   (b) 0.0125 seconds (1mk)
   (iii) Determine the instant at which the current will be 14.14A measured from the positive value (1mk)

c) Consider a special case where in a circuit, the instantaneous voltage is out of phase with current by phase angle of Φ, such that current is given as $I = I_P \sin \omega t$ and voltage, $v = V_P \sin(\omega t + \Phi)$. Show that for this circuit, the power factor can be given by

$\cos\phi = \frac{P}{VI}$ where Φ = phase angle; P=power; V and I are r.m.s values of voltage and current.
(6mks)

d) State the maximum power transfer theorem. (1mk)

**QUESTION FOUR (20 mks)**

a) Convert the following delta resistive network into an equivalent star resistive network. (6mks)

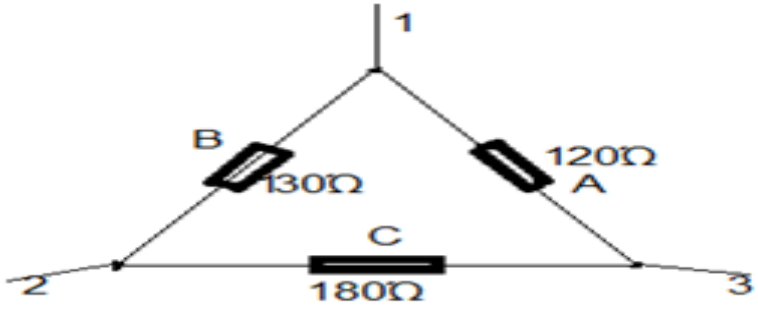


Figure 3 Deita resistive network

b) Convert the following star resistive network into an equivalent delta resistive network. (6mks)

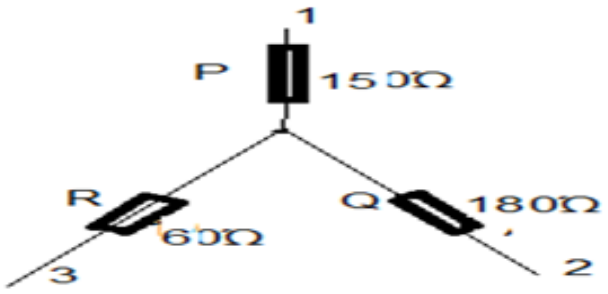


Figure 4: Star Configuration resistive network

c) (i) Define the term coefficient of self-induction. (2mks)
(ii) A step down transformer has a turn ratio of 4:1. If the transformer's secondary voltage is 120V, determine the primary voltage (2mks)
(iii) A single phase transformer with 2KVA rating has 480V primary and a 120V secondary voltage. Determine
(a) The primary full load current of the transformer (2mks)
(b) The full secondary current of the transformer (2mks)

**QUESTION FIVE (20 mks)**

a) Define the following terms as used in AC circuit theory: (4mks)
(i) Magnetic anisotropy
(ii) Transformer

b) A ring of diameter of 21 cm and cross sectional area of 10 $cm^2$ is made up of semi-circular sections using cast steel and cast iron as shown in figure 5. If each joint has a reluctance equal to an air gap of 0.2mm, find the ampere-turn required to produce a flux of 5 x $10^4$ weber in the magnetic circuit. (Take $\mu_r$ for steel and iron as 825 and 165 respectively. Neglect fringing and leakages). (10mks)

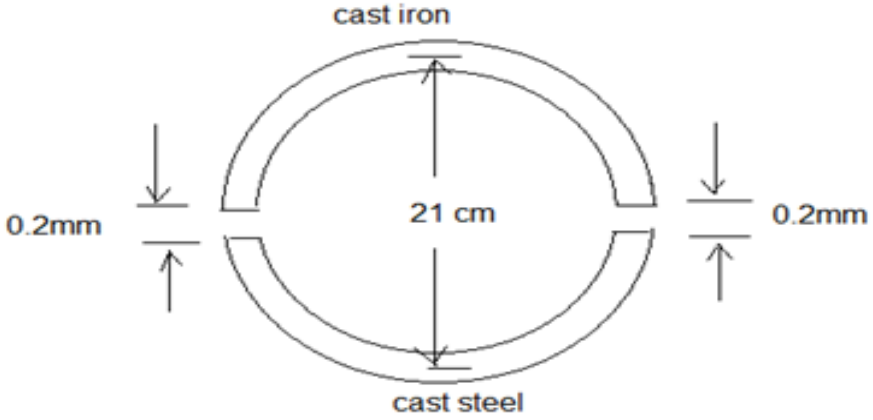


Figure 5 : Semi-circular magnetic circuit

c) (i) Discuss any two properties of an AC signal. (4mks)
(ii) Define the term root mean square (RMS) current (2mks)