



MERU UNIVERSITY OF SCIENCE AND TECHNOLOGY

P.O. Box 972-60200 – Meru-Kenya.
Tel: +254(0) 799 529 958, +254(0) 799 529 959, +254 (0)712 524 293
Website: www.must.ac.ke Email: info@mucst.ac.ke

UNIVERSITY EXAMINATIONS 2023/2024

THIRD YEAR, SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE (PHYSICS OPTION) AND BACHELOR OF SCIENCE IN PHYSICS

SPH 3304: AC CIRCUIT THEORY

DATE: APRIL 2024

TIME: 2 HOURS

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

- a) State three power losses in a practical transformers (3 Marks)
- b) Express the polar form of $V = 5 \angle 45^\circ$ in trigonometrical and rectangular forms (4 Marks)
- c) Design a R-L-C series circuit and state the equation of impedance (3 Marks)
- d) The current in a circuit is given by $(4.5 + j12)$ A when the applied voltage is $(100 + j150)$ V.

Determine

- i. Magnitude of impedance (3 Marks)
- ii. Phase Angle (1 Mark)
- e) For a Series Resonant, show that

$$Q\text{-factor} = \frac{1}{R} \sqrt{\frac{L}{C}} \quad (3 \text{ Marks})$$

- f) Express the following Phasors in polar form

- i. $5 + j6$ (2 Marks)
- ii. $4 + j0$ (2 Marks)



- g) A pure inductive coil allows a current of IOA to flow from a 230V,50Hz supply. Find
- Inductive reactance (2 Marks)
 - Inductance of the coil (2 Marks)
 - Power absorbed (1 Mark)
 - Write the equations of instantaneous voltage and current (4 Marks)

QUESTION TWO (20 MARKS)

- a) Define the following terms in relation to AC circuits

Waveform (1 Mark)

Cycle (1 Mark)

- b) Three phasors are given as follows:

$$A=5+j5 \quad B=4+j0 \quad C= 50 \angle 40^\circ$$

Perform the indicated operations giving your answer in polar form

- AB (3 Marks)
 - $\frac{BC}{A}$ (2 Marks)
- c) A 318 μ f capacitor is connected across a 230V, 501-Hz system. Find
- Capacitive reactance (4 Marks)
 - Root mean square value of current (2 Marks)
 - Equations for current and voltage (2 Marks)
- d) An alternating current is given by $i=120 \sin 120\pi t$. Find
- Maximum value (I_{max}) (1 Mark)
 - Frequency (2 Marks)
 - Time period (2 Marks)

QUESTION THREE (20 MARKS)

- a) Differentiate between step-up and step-down transformer (2 Marks)
- b) Derive an expression for induced emf in a transformer in terms of frequency, maximum value of flux and number of turns on the windings (6 Marks)



- c) The applied voltage in a series circuit is given by $V = 200 \angle 0^\circ$ volts. The impedance offered by the current is $Z = 83.3 \angle 40^\circ \Omega$. Determine
- Magnitude of current (2 Marks)
 - Phase angle (2 Marks)
- d) A 230V, 50Hz A.C frequency is applied to a coil of 0.06H inductance and 2.5Ω resistance connected in series with a $6.8 \mu\text{f}$ capacitor. Calculate
- Impedance (4 Marks)
 - Current (1 Mark)
 - Phase angle (1 Mark)
 - Power factor (1 Mark)
 - Power consumed (1 Mark)

QUESTION FOUR (20 MARKS)

- a) What is a phasor diagram? (2 Marks)
- b) In a R-L-C series circuit, show that $Z = \sqrt{R^2 + (X_L - X_C)^2}$ where Z is the impedance of the circuit (4 Marks)
- c) Express the rectangular form of voltage $V = 40 + j30$ in trigonometrical and polar forms (4 Marks)
- d) The voltage applied to a parallel circuit is $68 + j154$ volts. The current in one branch is $10 + j14$ Amperes and the current in the other branch is $2 + j8$ Amperes. Calculate
- Line current (2 Marks)
 - Magnitude of resistance (5 Marks)
 - Phase difference (2 Marks)
 - Power factor (1 Mark)