



MACHAKOS UNIVERSITY

University Examinations for 2021/2022

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

THIRD YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (TELECOMMUNICATION AND INFORMATION TECHNOLOGY)

SPH 304 AC CIRCUIT THEORY

DATE: 16/3/2022

TIME: 8:30 – 10:30 AM

INSTRUCTIONS:

Answer Question One and Any Other Two Questions

QUESTION ONE (COMPULSORY) (30 MARKS)

- a) Discuss half wave rectification of a.c. voltage (5 marks)
- b) Determine the magnetic field strength and the mmf required to produce a flux density of 0.25 T in an air gap of length 12mm. (4 marks)
- c) For the circuit shown in Figure 1, determine the p.d. E_2 which appears across the open-circuited secondary winding, given that $E_1 = 8\sin 2500t$ volts. (5 marks)

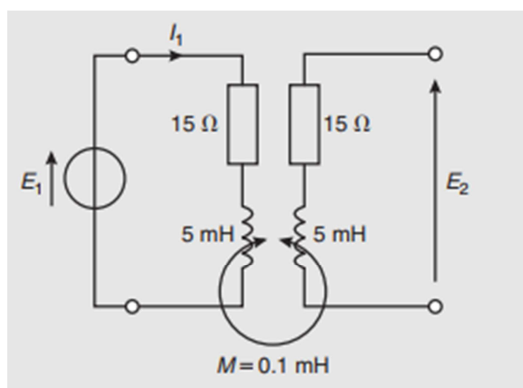


Figure 1

- d) Determine the optimum value of load resistance for maximum power transfer if the load is connected to an amplifier of output resistance 448Ω through a transformer with a turns ratio of 8:1 (3 marks)

- e) Why are parallel resonant circuits called rejector circuits? (2 marks)
- f) An alternating voltage is given by $v = 75\sin(200\pi t - 0.25)$ volts. Find (a) the amplitude, (b) the peak-to-peak value, (c) the r.m.s. value, (d) the periodic time, (e) the frequency and (f) the phase angle in degrees relative to $75 \sin 200\pi t$. (6 marks)
- g) List the advantages of auto transformers over double-wound transformers (5 marks)

QUESTION TWO (20 MARKS)

- a) A pure inductance of 1.273mH is connected in series with a pure resistance of 30Ω . If the frequency of the sinusoidal supply is 5kHz and the p.d. across the 30Ω resistor is 6V , determine the value of the supply voltage and the voltage across the 1.273mH inductance. Draw the phasor diagram. (8 marks)
- b) The current at resonance in a series L–C–R circuit is $100\mu\text{A}$. If the applied voltage is 2mV at a frequency of 200 kHz , and the circuit inductance is $50\mu\text{H}$, find (a) the circuit resistance, and (b) the circuit capacitance. (5 marks)
- c) Determine the p.d.s V_1 and V_2 for the circuit shown in Figure 2 if the frequency of the supply is 5 kHz . Draw the phasor diagram and hence determine the supply voltage V and the circuit phase angle. (7 marks)

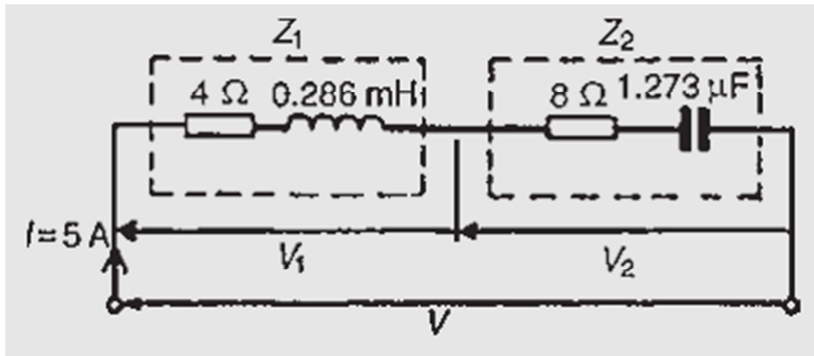


Figure 2

QUESTION THREE (20 MARKS)

- a) A coil of inductance 159.2mH and resistance 40Ω is connected in parallel with a $30\mu\text{F}$ capacitor across a 240 V , 50Hz supply. Calculate (a) the current in the coil and its phase angle, (b) the current in the capacitor and its phase angle, (c) the supply current and its phase angle, (d) the circuit impedance, (e) the power consumed, (f) the apparent power and (g) the reactive power. Draw the phasor diagram. (12 marks)
- b) An inductance of 80mH is connected in parallel with a capacitance of $10\mu\text{F}$ across a 60 V , 100Hz supply. Determine (a) the branch currents, (b) the supply current, (c) the circuit phase angle, (d) the circuit impedance and (e) the power consumed. (8 marks)

QUESTION FOUR (20 MARKS)

- a) A 1 kHz a.c. bridge ABCD has the following components in its four arms: AB – a pure capacitor of $0.2\ \mu\text{F}$; BC – a pure resistance of 500Ω ; CD – an unknown impedance; DA – a 400Ω resistor in parallel with a $0.1\mu\text{F}$ capacitor. If the bridge is balanced, determine the series components comprising the impedance in arm CD. (7 marks)
- b) A filter is required to pass all frequencies above 25 kHz and to have a nominal impedance of 600Ω . Design (a) a high-pass T section filter and (b) a high-pass π section filter to meet these requirements. (7 marks)
- c) Define a filter and give the frequency responses of the 4 basic types of filters (6 marks)

QUESTION FIVE (20 MARKS)

- a) A 5 kVA single-phase transformer has a turns ratio of 10:1 and is fed from a 2.5 kV supply. Neglecting losses, determine (a) the full load secondary current, (b) the minimum load resistance which can be connected across the secondary winding to give full load kVA and (c) the primary current at full load kVA. (5 marks)
- b) Discuss transformer losses (8 marks)
- c) A 400 kVA transformer has a primary winding resistance of 0.5Ω and a secondary winding resistance of 0.001Ω . The iron loss is 2.5 kW and the primary and secondary voltages are 5 kV and 320V, respectively. If the power factor of the load is 0.85, determine the efficiency of the transformer on full load. (7 marks)