



MACHAKOS UNIVERSITY

University Examinations for 2023/2024 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

THIRD YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN TELECOMMUNICATION ENGINEERING

SPH 304: AC CIRCUIT THEORY

DATE:

TIME:

INSTRUCTIONS

1. This paper contains 5 questions.
2. Attempt **Question One** and **Any Other Two** questions
3. Show calculations where applicable.

QUESTION ONE [30 MARKS]

a) For the circuit shown in Fig. Q1 a), determine

(i) the mesh currents I_1 , I_2 and I_3

[6 marks]

(ii) the voltage across 12.5Ω .

[1 mark]

(iii) Power dissipated in the 2.5Ω

[1 mark]

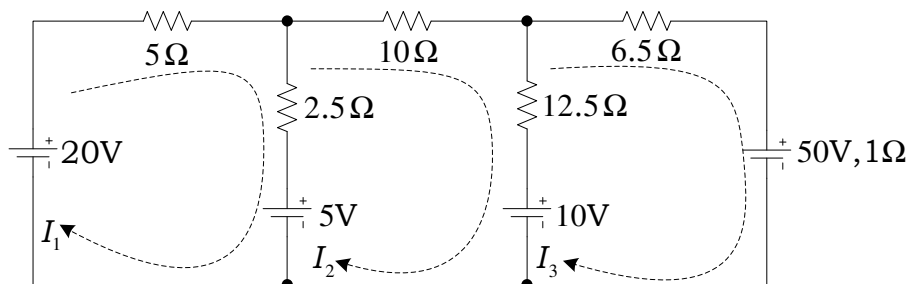


Fig.Q1 a)

- b) In the parallel RLC circuit shown in Fig.Q1 b)
- (i) Calculate the values of ω_0 , Q-factor, and Bandwidth [3 marks]
 - (ii) Find half-power frequencies, ω_1 and ω_2 [3 marks]
 - (iii) Determine the power dissipated at ω_0 , ω_1 and ω_2 . [4 marks]

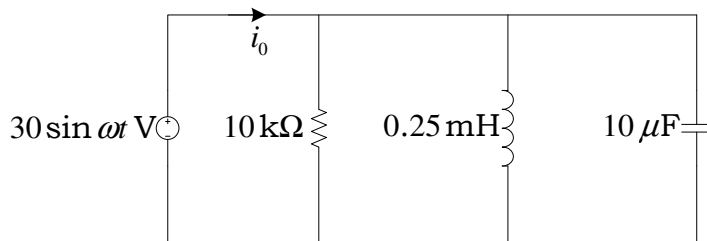


Fig. Q1 b)

- c) A resistance of 75Ω and an inductance of 0.2 H are connected in series across a 220 V , 50 Hz supply. Find
- (i) Circuit impedance [1½ marks]
 - (ii) Circuit Current [1 mark]
 - (iii) power factor [½ mark]
 - (iv) apparent power [1 mark]
 - (v) active power [1 mark]
 - (vi) reactive power [1 mark]
 - (vii) voltage across resistance and [1 mark]
 - (viii) voltage across inductance [1 mark]
- d) Briefly explain the following terms as used in circuit analysis:
- (i) *Circuit* [1 mark]
 - (ii) *Branch* [1 mark]
 - (iii) *Node* [1 mark]
 - (iv) *Loop* [1 mark]

QUESTION TWO [20 MARKS]

- a) For the circuit shown in Fig.Q2 a), find
- (i) Total circuit impedance [2 marks]
 - (ii) Current drawn from supply, I [1 mark]
 - (iii) Voltage across the parallel branches [1 mark]
 - (iv) Currents I_1 and I_2 [2 marks]
 - (v) Power factor [1 mark]
 - (vi) Apparent power [1 mark]
 - (vii) Active power [1 mark]
 - (viii) Draw the phasor diagram showing V , I , I_1 and I_2 . [2 marks]

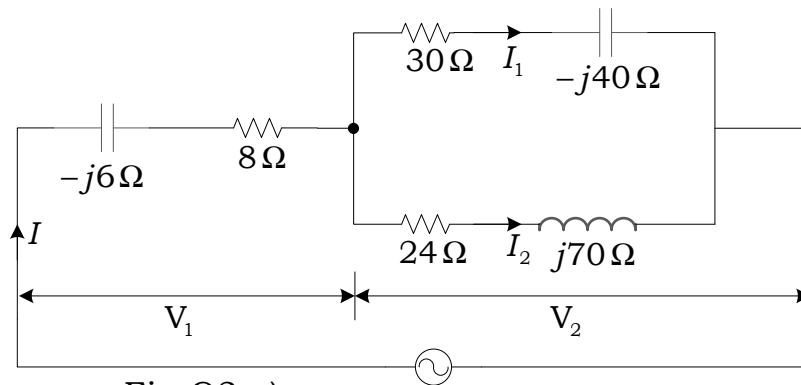


Fig. Q2 a) $100\angle 0^\circ \text{ V}, 50 \text{ Hz}$

- b) Three voltages represented by $v_1 = 25 \sin(\omega t + 15^\circ)$; $v_2 = 15 \sin(\omega t + 60^\circ)$ and $v_3 = 20 \sin(\omega t + 45^\circ)$ act together in a circuit. Find an expression for the

resultant voltage graphically.

[4 marks]

- e) Apply Kirchhoff's laws to determine the voltage across and power dissipated in the 15Ω resistor in the circuit of Fig Q2 b).

[6 marks]

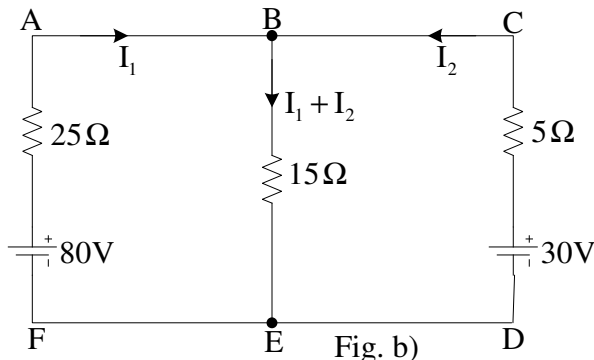


Fig. b)

QUESTION THREE [20 MARKS]

- a) Using the nodal analysis method, find the branch currents I_1, I_2, I_3 and I_4 in the circuit shown in Fig. Q3 a).

[10 marks]

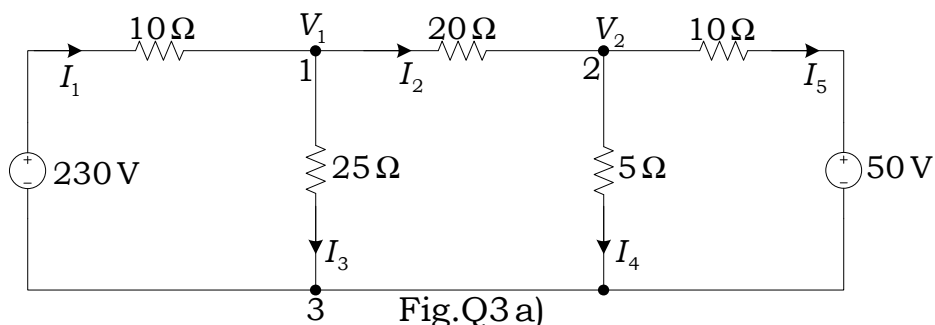
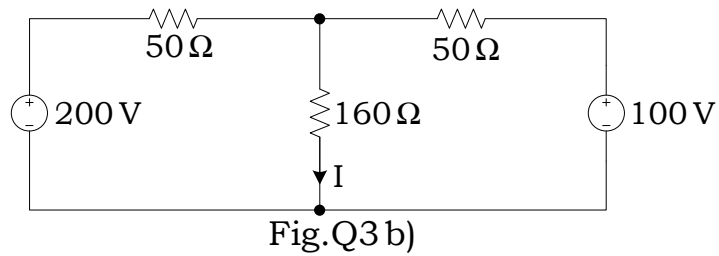


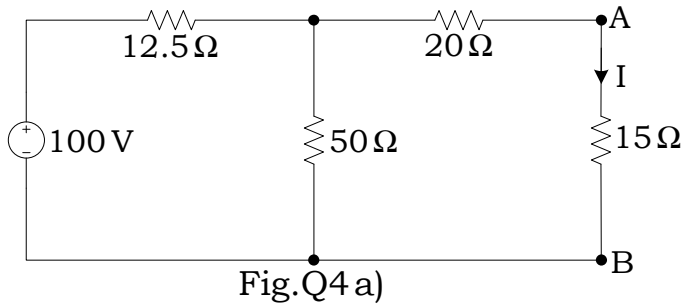
Fig. Q3 a)

- b) Using superposition theorem, calculate the current I in the circuit shown in Fig. Q3 b).
[10 marks]



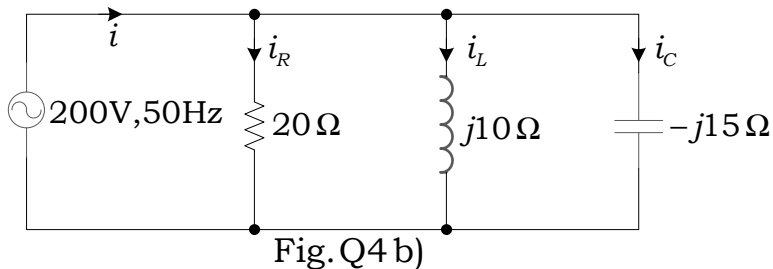
QUESTION FOUR [20 MARKS]

- a) Find Norton's equivalent circuit for Fig. Q4 a) at terminals A-B and hence find the current, I , through the 15Ω .
[8 marks]



- b) For the circuit shown in Fig.Q4 b), find

- | | |
|---|-----------|
| i) Current in each branch | [3 marks] |
| ii) Total circuit current | [1 mark] |
| iii) Circuit impedance | [2 marks] |
| iv) Power factor | [1 mark] |
| v) Parameters of an equivalent series circuit | [3 marks] |
| vi) Draw a phasor diagram of the circuit | [2 marks] |

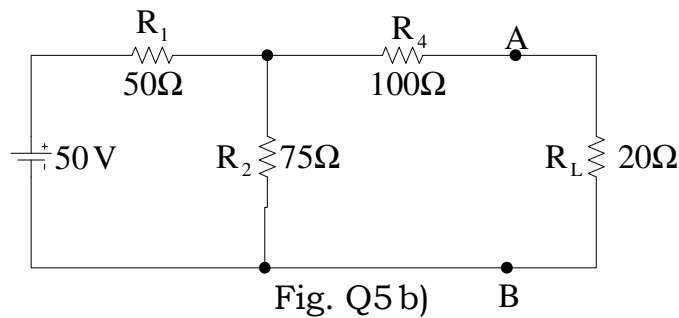


QUESTION FIVE [20 MARKS]

a) A series RLC circuit has $R = 20\ \Omega$, $L = 0.25\ H$ and $C = 50\ \mu F$. The applied voltage is 200 V. Find

- (i) Resonant frequency [2 marks]
- (ii) Q [1 mark]
- (iii) Upper and lower half power frequencies [3 marks]
- (iv) Band width [1 mark]
- (v) Current at resonance [1 mark]
- (vi) Current at half power points [1 mark]
- (vii) Voltage across inductance at resonance [1 mark]

b) Find the Thevenin's equivalent circuit for Fig. Q5 b) at terminals A-B and hence find the current through the R_L . [7 marks]



c) Briefly explain the following terms:

- (i) Phase [1 mark]
- (ii) Average value [1 mark]
- (iii) The root mean square value [1 mark]