



UNIVERSITY
OF
JOHANNESBURG

PROGRAM : BACHELOR OF ENGINEERING TECHNOLOGY
ELECTRICAL

SUBJECT : **ELECTROTECHNOLOGY 1B**

CODE : **ELTELB1**

DATE : MAIN EXAMINATION / NOVEMBER 2017
16/NOV/2017 ; 12:30

DURATION : 3 HOURS

WEIGHT : 40: 60

TOTAL MARKS : 100

FULL MARKS : 100

ASSESSOR : Dr. W. DOORSAMY

MODERATOR : Dr. P. BOKORO

NUMBER OF PAGES : 6 PAGES

REQUIREMENTS

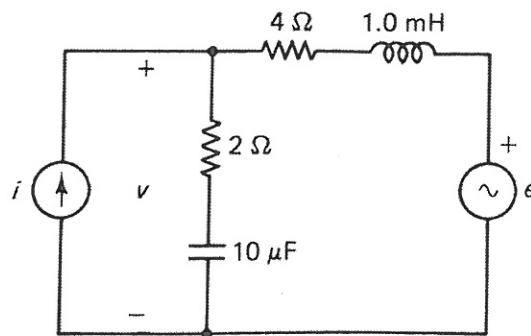
- STANDARD STATIONARY.
- A NON-PROGRAMMABLE CALCULATOR MAY BE USED

INSTRUCTIONS

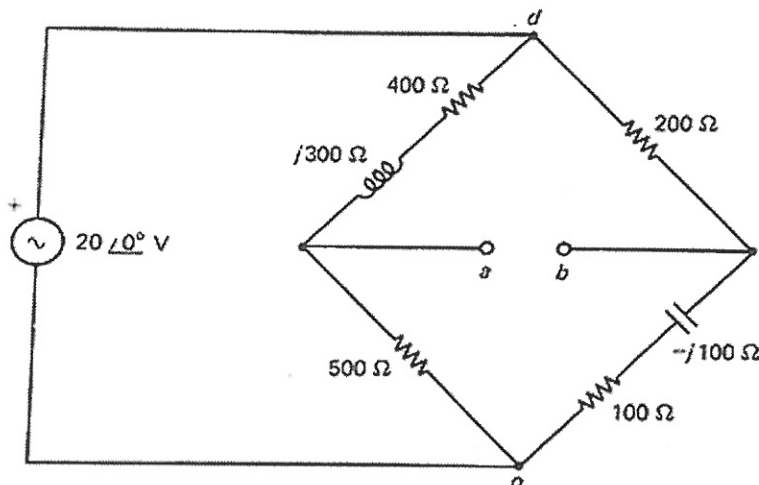
- READ INSTRUCTIONS CAREFULLY.
- ALL CALCULATIONS AND ANSWERS MUST BE DONE WITH A MINIMUM OF 3 DECIMALS.
- WRITING MUST BE IN BLUE OR BLACK INK PEN ONLY- NO PENCIL WRITING WILL BE MARKED
- WORK NEATLY, UNTIDY WORK MAY BE PENALIZED.
- ALL UNITS MUST BE SHOWN-MARKS WILL BE DEDUCTED FOR NO OR WRONG UNITS
- ALL CALCULATIONS MUST BE DONE IN COMPLEX NOTATION AND ANSWERS MUST BE WRITTEN IN POLAR FORM, WHERE APPLICABLE.
- ALL VOLTAGES AND CURRENTS ARE GIVEN IN PEAK UNLESS STATED OTHERWISE

SECTION A:AC Theory, Circuits and Network Analysis**QUESTION 1****[6 Marks]**

In the circuit shown in Figure 1, $i = 1.414 \sin(5000t + 90^\circ) \text{ A}$ and $e = 7.071 \sin(10000t - 45^\circ) \text{ V}$. Find the time-domain expression for the waveform of the voltage v .

**Figure 1: Circuit for question 1****QUESTION 2****[10 Marks]**

Obtain the Thevenin and Norton equivalent circuits for the network shown in Figure 2 between the terminals a and b . Calculate the current in a load impedance $Z_L = 50 \angle 60^\circ \Omega$ when connected across terminals a and b .

**Figure 2: Network for question 2**

QUESTION 3

[10 Marks]

A power supply with output voltage $v = 20 \angle 0^\circ \text{ V}$ at $f = 150 \text{ Hz}$ with an internal impedance $Z_{in} = 20 \angle 20^\circ \Omega$ is connected to terminals **a** and **b** of the network shown in Figure 3. What is the output current of the power supply if $R = 10 \Omega$, and $C = 50 \mu\text{F}$?

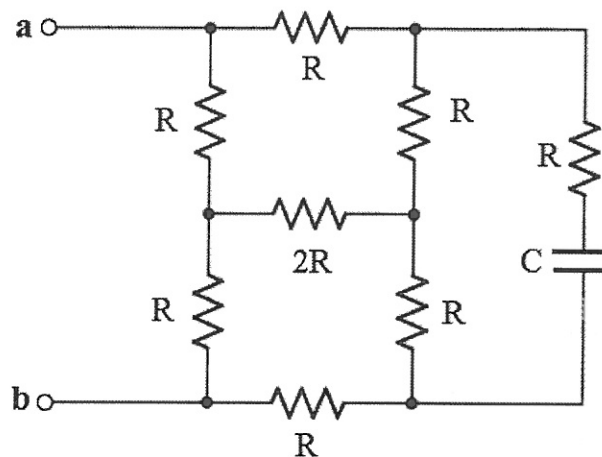


Figure 3: Network for question 3

[26 Marks]

SECTION B

Power in AC circuits

QUESTION 4

[9 Marks]

Choose **one** correct answer and **give a reason** for your choice:

4.1 The average power absorbed by an ideal inductor is zero. (3)

(a) True

(b) False

4.2 The Thevenin impedance of network seen from the load terminals is $80 + j55 \Omega$. For maximum power transfer, the load impedance must be: (3)

- (a) $-80 + j55 \Omega$
- (b) $-80 - j55 \Omega$
- (c) $80 - j55 \Omega$
- (d) $80 + j55 \Omega$

4.3 A source is connected to three load impedances Z_1 , Z_2 and Z_3 in parallel. Which of the following is not true: (3)

- (a) $P = P_1 + P_2 + P_3$
- (b) $Q = Q_1 + Q_2 + Q_3$
- (c) $|S| = |S_1| + |S_2| + |S_3|$
- (d) $S = S_1 + S_2 + S_3$

QUESTION 5

[15 Marks]

Figure 4 shows a load being fed by a voltage source through a transmission line. The combined impedance of the line and return path is $4 + j2 \Omega$.

5.1 Find the real and reactive powers absorbed by the line and the load. (10)

5.2 Determine the impedance to be added to load for maximum power transfer. (5)

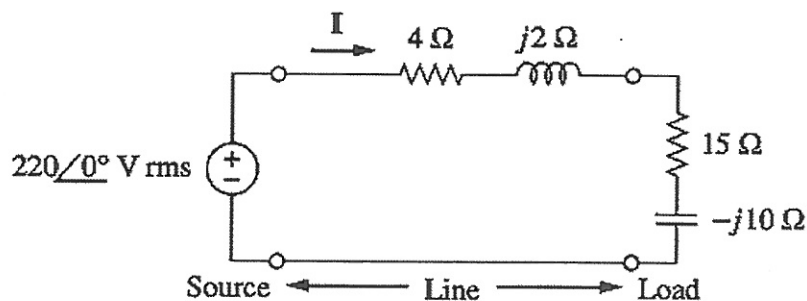


Figure 4: Network for question 5

QUESTION 6**[12 Marks]**

A 450 kW slurry pump at a plant operates for 21 days a month. The pump operates at 0.76 lagging power factor for 8 hours each morning, and then at 0.83 lagging power factor for 4 hours each night. Determine the monthly electricity bill based on the following tariff structure.

Energy Charge: 12 cents per kWh

Power Factor penalty: 1.25% of energy charge for every 0.01 that pf falls below 0.80

Power Factor credit: 1.25% of energy charge for every 0.01 that exceeds 0.80

[36 Marks]**SECTION C:**Magnetically Coupled Circuits**QUESTION 7****[8 Marks]**

Coils 1 and 2 are wound on an insulating core and are connected with via terminals **B** and **C** in Figure 5(a), and connected via terminals **B** and **D**, in Figure 5(b).

7.1 What terms are used to describe how the coils are coupled in Figures 5(a) and 5(b)? (2)

7.2 Explain, using suitable equations, how to determine mutual inductance of the coils. (6)

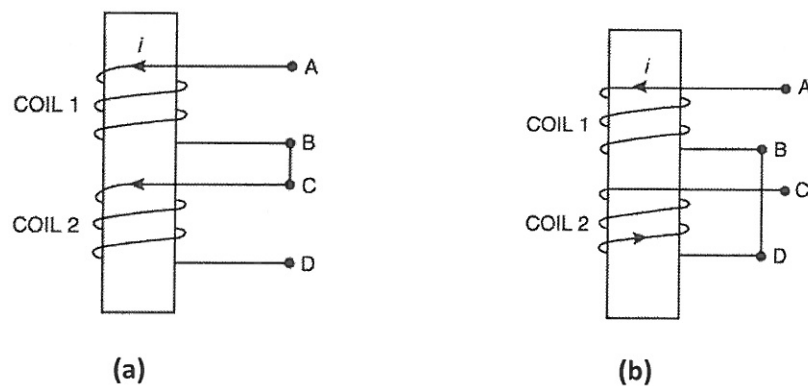
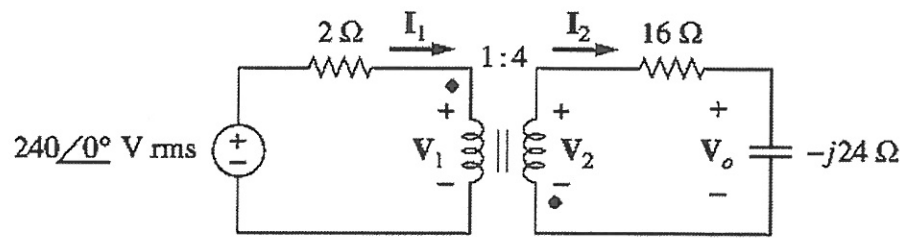


Figure 5: Connected coils for question 7

QUESTION 8**[12 Marks]**Find V_o in the circuit given in Fig. 7.**Figure 7: Connected coils for question 8****[20 Marks]****SECTION D:**Three-Phase Systems**QUESTION 9****[9 Marks]**

A load consisting of three identical coils, each of resistance $15\ \Omega$ and inductance $60\ \text{mH}$ are connected in star to a balanced $400\ \text{V rms}$, $50\ \text{Hz}$, three-phase supply. Determine the total power dissipated in the load.

QUESTION 10**[9 Marks]**

The input power to a three-phase motor was measured by the two wattmeter method. The readings were $5.2\ \text{kW}$ and $-1.7\ \text{kW}$, and the line voltage was $400\ \text{V rms}$. Calculate:

- 10.1 Total active power; (2)
- 10.2 Power factor; (4)
- 10.3 Line current. (3)

[18 Marks]**END**