Tutorial Letter 101/3/2018

Electrical Engineering II - Theory

ELE2601

Semesters 1 and 2

Department of Electrical and Mining Engineering

IMPORTANT INFORMATION

This tutorial letter contains important information about your module.

BARCODE

CONTENTS

Page

1 INTRODUCTION

Dear Student

Welcome to the subject **Electrical Engineering II (ELE2601)** at UNISA. This tutorial letter serves as a guideline to this course. It provides you with general administrative information as well as specific information about the subject. Read it carefully and keep it safe for future reference. We trust that you will enjoy this course.

2 PURPOSE OF AND OUTCOMES FOR THE MODULE

2.1 Purpose

Students who complete this module can solve problems on single-phase alternating current, power and power factor correction, and apply network theorems in AC circuits. They can also solve problems relating to resonance and complex waves as well as balanced three-phase systems.

2.2 Outcomes

On completion of this module the student must be able to do following:

- Solve problems related to AC circuits by means of calculations.
- Solve problems related to different forms of AC power and power factor correction as applied to single-phase AC circuits.
- Apply AC network theorems to calculate the magnitude of the currents and the voltages in single-phase AC circuits.
- Identify resonance circuits and determine resonance frequency.
- Solve problems and find the correct parameters relating to complex waveforms
- Solve for line and phase quantities of the current, voltage and power in balanced three-phase star- or delta-connected AC circuits.

3 LECTURER(S) AND CONTACT DETAILS

3.1 Lecturer(s)

Your Lecturer for Electrical Engineering II is Mr TS Hlalele. He can be contacted at the following number for any theoretical questions:

Contacts: 011 471 2099

Email: hlalets@unisa.ac.za

Contact hours: 08:00 – 16:00 Mondays and Wednesdays

3.2 Department

Department of Electrical and Mining Engineering: electrical&mining@unisa.ac.za

3.3 University

If you need to contact the University about matters not related to the content of this module, please consult the publication *My studies @ Unisa* that you received with your study material. This brochure contains information on how to contact the University (e.g. to whom you can write for different queries, important telephone and fax numbers, addresses and details of the times certain facilities are open).Always have your student number at hand when you contact the University.

4 MODULE-RELATED RESOURCES

4.1 Prescribed books

Electrical Technology by Edwards Hughes, 12th edition

4.2 Recommended books

Van Zyl, S. J *Circuit Analysis in Electrical Engineering* (3rd Edition)- (Source B)

B.L. Theraja &A.K Theraja-*A textbook of Electrical technology* in SI Units(Source C)

Bird, J. *Electrical Circuit Theory and Technology* (5th Edition)- (Source D)

4.3 Electronic Reserves (e-Reserves)

There are no electronic reserves for this module.

4.4 Library services and resources information

For brief information, go to www.unisa.ac.za/brochures/studies

For detailed information, go to the Unisa website at http://www.unisa.ac.za/ and click on **Library**.

For research support and services of personal librarians, go to

http://www.unisa.ac.za/Default.asp?Cmd=ViewContent&ContentID=7102.

The Library has compiled numerous library guides:

- finding recommended reading in the print collection and e-reserves – http://libguides.unisa.ac.za/request/undergrad
- requesting material – http://libguides.unisa.ac.za/request/request
- postgraduate information services – http://libguides.unisa.ac.za/request/postgrad
- finding , obtaining and using library resources and tools to assist in doing research – http://libguides.unisa.ac.za/Research_Skills
- how to contact the library/finding us on social media/frequently asked questions – http://libguides.unisa.ac.za/ask

5 STUDENT SUPPORT SERVICES

Important information appears in your *my Studies @ Unisa* brochure.

6 STUDY PLAN

Students' Study Plan ELE2601

Consult *my Studies @ Unisa* for suggestions about general time management and planning skills.

This is a semester module offered over 15 weeks, and requires at least 120 hours of study time. This means that you will have to study at least 8 hours per week for this module.

Here is a suggested schedule that you could use as a **guideline** for studying this module.

ACTIVITY	HOURS
Reading and re-reading Tutorial Letter 101 and Introduction	3
Skimming study units and textbook, forming a thorough general impression of the whole	3
In-depth study of study unit 1: reading the text, going through worked examples, and doing learning activities	10
In-depth study of study unit 2: reading the text, going through worked examples, and doing learning activities	14
In-depth study of study unit 3	20
In-depth study of study unit 4-6 (@ 12 hours per unit)	36
Completing 2 assignments for marking, and one for self-assessment	15

Examination revision and preparation	16
Writing the examination	3
Total	**120**

Below is an example of how you could structure your study plan. Note that this study plan starts on the 15th January, to allow you to complete 120 hours for the module at a rate of eight hours per week. If you have started studying later, you would need to adapt the schedule and would probably need to fit in more hours per week.

If you are doing this module in the second semester, please amend the dates accordingly.

Week	Activity (each week represents a minimum of 8 hours of study time)
1 (15 January/July)	• Read and re-read Tutorial Letter 101 and the Introduction in your study guide • Skim the study guide and textbook, forming a thorough general impression of the whole • Start studying unit 1 – spend at least 2 hours
2 (22 January)	• Finish unit 01 and complete all related learning activities
3 (29 January)	• Start studying unit 02
4 (5 February)	• Complete Unit 02 and do all related activities • Start assignment 01
5 (12 February)	• Complete and submit assignment 0.1 Depending on how you will submit your assignment, allow sufficient time for the assignment to reach Unisa on or before the due date) • Start studying unit 03 and do related activities (spend at least 5 hours)
6 (19 Feb)	• Continue with unit 03 and do all related activities
7 (26 Feb)	• Complete unit 03 and do all related activities. • Start studying unit 04
8 (12 March)	• Complete unit 04 and do all related activities.
9(19 March)	• Complete unit 05 and do all related activities. • Start studying unit 06.
10 (26 March)	Complete unit 06 and do all related activities.
11 (02 April)	• Complete and submit assignment 02 (depending on how you will submit the completed assignment, allow sufficient time for the assignment to reach Unisa on or before the due date.
12 (09 April)	• Do assignment 03, the self-assessment assignment (this is not for submission and will not be marked).

13(16 April)	Revision and preparation for the exam.
14 (23 April)	Revision and preparation for the exam.
15 (30 April)	

7 PRACTICAL WORK AND WORK-INTEGRATED LEARNING

The practical part of this subject is covered in ELEPRA2.

8 ASSESSMENT

8.1 Assessment criteria

Your final mark will be calculated by using a ratio of 20% year mark and 80% examination mark.

8.2 Assessment plan

You will find your assignments for this subject in this Tutorial Letter. **Assignment 1 and 2 are compulsory and** both assignments will be used in the calculation of your year mark. Please send the completed assignments to UNISA before the closing dates stated in this section.

The mark for Electrical Engineering II (ELE2601) is calculated as follows:

- The year mark contributes to 20%.
- The examination mark contributes to 80%

The year mark is based on all the assignment marks obtained and their contribution towards the final year mark are as shown in the table below:

ASSIGNMENT NUMBER	CONTRIBUTION TOWARDS YEAR MARK
1 (Compulsory)	10%
2 (Compulsory)	90%
TOTAL	**= 100 %**

8.3 Assignment numbers

8.3.1 General assignment numbers

Assignments are numbered consecutively per module, starting from 01.

8.3.2 General assignment numbers

SEMESTER 1

Assignment 1: (Compulsory)	686623
Assignment 2: (Compulsory)	870024

SEMESTER 2

Assignment 1: (Compulsory)	789117
Assignment 2: (Compulsory)	716811

8.4 Assignments due dates

SEMESTER 1

THE CUT-OFF SUBMISSION DATES FOR THE ASSIGNMENTS ARE :	
Assignment 1: (Compulsory)	**2 March 2018**
Assignment 2: (Compulsory)	**9 April 2018**

SEMESTER 2

THE CUT-OFF SUBMISSION DATES FOR THE ASSIGNMENTS ARE :	
Assignment 1: (Compulsory)	**29 August 2018**
Assignment 2: (Compulsory)	**28 September 2018**

8.5 Submission of assignments

ALL ASSIGNMENTS (submitted) HAVE TO BE ATTEMPTED!!!!!!!

THE SUBMISSION OF AN EMPTY ASSIGNMENT COVER IS UNACCEPTABLE.

IT IS VERY IMPORTANT TO CONSIDER THE FOLLOWING POINTS :

- NO LATE ASSIGNMENT SUBMISSIONS WILL BE ACCEPTED.
- KEEP A CLEAR COPY OF THE ASSIGNMENT FOR YOUR OWN REFERENCE. THIS IS IMPORTANT, AS ASSIGNMENTS DO GET LOST.
- **SUBMISSIONS OF ASSIGNMENTS MUST BE IN ACCORDANCE WITH "MY STUDIES @ UNISA".**

Please note that model answers for the assignments will be dispatched to all students within 1 week of the closing date of the assignment. This implies that you cannot submit your assignment later than the stipulated submission date.

For detailed information and requirements as far as assignments are concerned, see the brochure *my Studies @ Unisa* that you received with your study material.

To submit an assignment **via *myUnisa*:**

- Go to *myUnisa*.
- Log in with your student number and password.
- Select the module.
- Click on assignments in the menu on the left-hand side of the screen.
- Click on the assignment number you wish to submit.
- Follow the instructions.

8.6 The assignments

SEMESTER 1

THE CUT-OFF SUBMISSION DATES FOR THE ASSIGNMENTS ARE :	
Assignment 1: (Compulsory)	**2 March 2018**
Assignment 2: (Compulsory)	**9 April 2018**

ASSIGNMENT 1
Complete on mark reading form:

1. What is the fourth harmonic of a fundamental frequency of 400Hz?

1) 1.6kHz
2) 4Hz
3) 4kHz
4) 100Hz

2. In both induction and synchronous ac motors

1) The operating speed is very steady
2) The stator magnetic field rotates
3) The squirrel cage forms the rotor
4) The stator magnetic field is stationary

3. The “Superposition theorem” is essentially based on the concept of

1) duality.
2) linearity.
3) reciprocity.
4) non-linearity.

4. The power factor of a purely resistive circuit is

1) zero.
2) unity.
3) lagging.
4) leading.

5. The power taken by a 3-phase load is given by the expression

1) $3\,VL\,IL\cos\emptyset$.
2) $\sqrt{3}\,VL\,IL\cos\emptyset$.
3) $\sqrt{3}\,VL\,IL\sin\emptyset$.
4) $3\,VL\,IL\sin\emptyset$.

6. Which of the following definitions are correct for root mean square voltage (r.m.s) of a sinusoid?

1) That AC value which is equivalent to non-sinusoidal value
2) That AC value which is equivalent to an average value.
3) That value which will produce the same heating effect as an equivalent DC voltage
4) The value of a sinusoidal wave, which is a square, times the supply.

7. A sinusoidal e.m.f can be generated by:

1) Rotating a rectangular coil in a uniform magnetic field
2) A coil in a stationary magnetic field
3) Frequency supply
4) Field current

8. A heater is rated 220V, 15KW, A.C. The value 220V refers to

1) Average voltage
2) r.m.s voltage
3) peak voltage
4) Vmax

9. A resistance of 100Ω is connected in series with a 200Ω resistor. What is the phase shift (angle) between voltage and current?

1) 90°
2) -90°
3) 0°
4) 120° BC

10. In a series resonant circuit, increasing inductance to its twice value and reducing capacitance to its half value will

1) Change the maximum value of current at resonance
2) Change the resonance frequency
3) Increase selectivity of the circuit
4) All of the above are correct.

11. Which of the following motors has a high starting torque?

1) ac series motor.
2) dc series motor.
3) induction motor.
4) synchronous motor.

12. The Q- factor of a coil is given by

1) Its power factor cos j.
2) Ratio of max. energy stored & energy dissipated per cycle..
3) Reciprocal of its power factor.
4) Ratio R/Z.

13. In an ac circuit, the ratio of kW / kVA represents

1) Power factor.
2) Load factor.
3) Form factor.
4) Diversity factor.

14. Thevenin's equivalent circuit consists of _____.

1) Series combination of RTh, ETh and RL.
2) Series combination of RTh, ETh.
3) Parallel combination of RTh, ETh.
4) Parallel combination of RTh, ETh and RL.

15. In an R – L –C circuit, the phase of the current with respect to the circuit voltage will be_____.

1) Leading.
2) Same.
3) Lagging.
4) Depended upon the value of L and C.

16. If the readings of the two wattmeters in the 2-wattmeter method of power measurement are 4.5kW and 3.5 kW respectively and the latter reading has been obtained after reversing the current coil of the wattmeter. What will be the total power in kW?

1) 1 KW
2) 3.5KW
3) 4.5 KW
4) 8 KW

17. A network that does not have either voltage or current sources is called

1) Active network.
2) Passive network.
3) Resistive network.
4) Dummy network.

18. In the current equation $i_1 = -4\sin(377t + 25°$ and $i_2 = 5cos377t - 40°$

1) i_2 lead i_1 by $155°$
2) i_1 lags i_2 by $15°$
3) i_1 leads i_2 by $155°$
4) i_1 leads i_2 by $15°$

19. Which of the following statements are true for power factor correction?

1) The design of power transmission system is not very sensitive to the magnitude of the current in the lines as determined by the applied loads
2) The design of the power transmission system is very sensitive to the load resistance
3) The design of the power transmission system is sensitive to current magnitude only.
4) The design of any power transmission system is very sensitive to the magnitude of the current in the lines as determined by the applied loads.

20. Which of the following statement is true concerning the reactive power?
1) It is the peak rate of energy storage in the active elements
2) It is the rate of doing work expressed in kW
3) It is the peak rate of energy storage in the reactive elements

4) It is the rate of energy storage in the purely resistive load.

ASSIGNMENT 2

QUESTION 1

1.1 Refer to figure 1 and determine:

a) Thevenin's equivalent circuit at terminals A and B (11)

b) Norton's equivalent circuit at terminals A and B. (4)

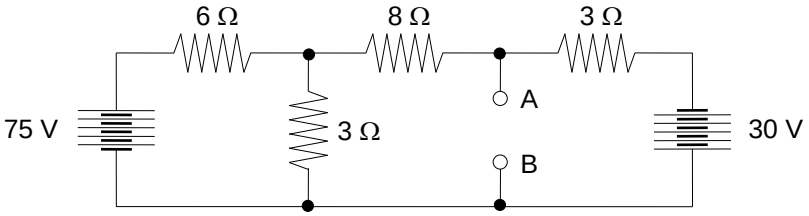

Figure 1

1.2 Refer to figure 2. Use the superposition theorem and calculate the current flowing through the 20Ω resistor. (11)

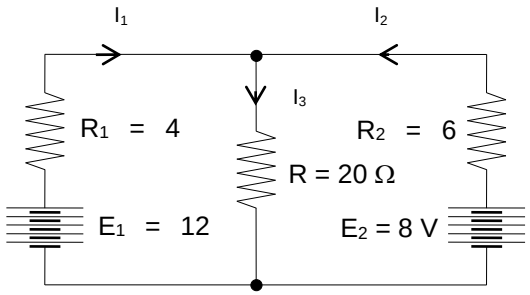

Figure 2

1.3 Refer to figure 3 and determine the star-connected equivalent of the circuit. (6)

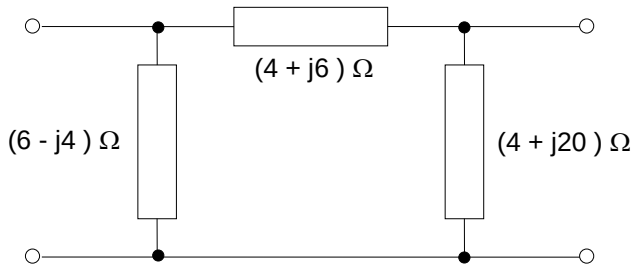

Figure 3

[32]

QUESTION 2

2.1 The coil is connected across a 360-V, 60 Hz supply and potential difference of 30 V is measured across a coil when a current of 3A flows through the coil. When an alternating current of 5A flows through the coil at 45 Hz, the potential difference is 210 V across the coil. calculate:

a) the total current, (9)

b) the power dissipated, and (2)

c) the power factor of circuit. (2)

2.2 A non-inductive resitor is connected in series with a coil across a 240-V, 50 Hz supply. The potential differences across the coil and resistor are 180 V and 90 V respectively. The current flow is 2,4 A. Calculate:

a) the inductance and resistance of the coil, and (10)

b) the phase difference between the current and supply voltage. (2)

[25]

QUESTION 3

3.1 A three-phase, three-wire, 207,85-V, ABC-rotation system consists of the following three balanced loads:

- a star-connected load with an impedance of $15\angle 0°\ \Omega$ per phase;
- a delta-connected load with an impedance of $36\angle 90°\ \Omega$ per phase;
- a star-connected load with unknown impedance.

Draw the circuit. Take V_{BC} as reference and calculate the value of the unknown impedance. The supply line current is $45\angle 53{,}1°$ A. (10)

3.2 A star-connected load with the following impedances is supplied by a 416-V, three-phase, four-wire, ABC-system:

Z_A = (30 + j0) Ω

Z_B = (12 + j9) Ω

Z_C = (0 + j15) Ω

Take V_{BC} as reference and calculate:

a) the line currents; (3)

b) the current in the neutral conductor; (2)

c) the total power. (4)

d) Draw the polar current phase diagram. (3)

[22]

QUESTION 4

4.1 The complex supply voltage of a circuit is equal to:

$$V = 600 \sin\left(2\text{wt} + \frac{\pi}{3}\right) + 90\sin\left(\text{wt} + \frac{\pi}{6}\right) \text{V}$$

The corresponding current in the circuit is equal to:

$$i = 60\sin(\omega t) + 12(3\omega t) \text{ A}$$

Calculate:

a) the total power in the circuit, (2)

b) the r.m.s.value of the supply current, (2)

c) the r.m.s.value of the current, and (2)

d) the resultant power factor of the circuit. (1)

4.2 A balanced three-phase load is connected to a three-phase, 380-V supply. The load takes 7,5 kW at a power factor of 0,8 lagging. Calculate the resistance and reactance of each phase if the load is star-connected. (7)

4.3 A three-phase cable supplies power to a balanced three-phase load. Each conductor carries a current of 120 A per phase and each conductor has a resistance of 0,4 Ω per phase. The power factor of the load is improved so that the line current is reduced to 90 A. Calculate the percentage change in power loss in the cable. (5)

4.4 Refer to figure 4. The phasor diagram and connection diagram is applicable on a three-phase system. Calculate the reading on the wattmeter. (2)

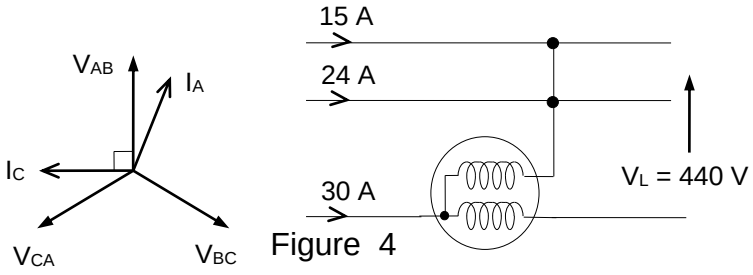

Figure 4

[21]

QUESTION 5

5.1 What is a summetrical three-phase supply? (1)

5.2 Define the term power factor. (2)

5.3 Explain why a load will have a lagging power factor. (1)

5.4 Mention five detrimental effects of harmonics in electrical networks. (5)

[9]

TOTAL: [109]

ASSIGNMENT 3

Only for self-evaluation

QUESTION 1

A series RL-circuit consist of a 21.6Ω resistor and a 74mH inductor. The radial velocity in the circuit is 377rad/s and the supply voltage is represented by the equation:

$$e(t) = 220 + 150\ sin\omega t + 120\sin\left(\omega t + \frac{\pi}{9}\right) + 80\sin\left(5\omega t + \frac{\pi}{7.5}\right) volt$$

1.1 Determine an equation for the instantaneous current in the circuit. (10)

1.2 Calculate the active power dissipated in the resistor. (3)

1.3 Calculate the over-all power factor of the circuit. (2)

[15]

QUESTION 2:

3.1 Name six disadvantages of a low power factor (6)

3.2 Name three equipment that can be used to improve power factor (6)

3.3 A coil is connected in series with a resistor of 1,4 Ω.These components are connected in parallel with a resistor of 19,5 Ω and a capacitor of $1110\ \mu F$.A coil with an impedance of $(15{,}9 + j\ 34{,}1)\ \Omega$ in series with a capacitor of 110 µF is connected in series with a parallel circuit. The voltage drop measured across the coil is $286\angle 55{,}75°\ V$. The whole is connected across a sinusoidal **a.c.** supply represented by the equation:

$$e(t) = 270\ cos\ (310t - 72°)\ V$$

3.3.1 Calculate the voltage drop across the parallel part of the circuit (7)

3.3.2 Calculate the resistance and the inductance of the unknown coil (6)

3.3.3 Calculate the power factor of the circuit (2)

3.3.4 Calculate the value of each of three series capacitors connected in parallel to the circuit to raise the overall power factor to 0,95106 lagging. (3)

[30]

QUESTION 3:

Refer to the circuit diagram depicted in **Figure 1** below:

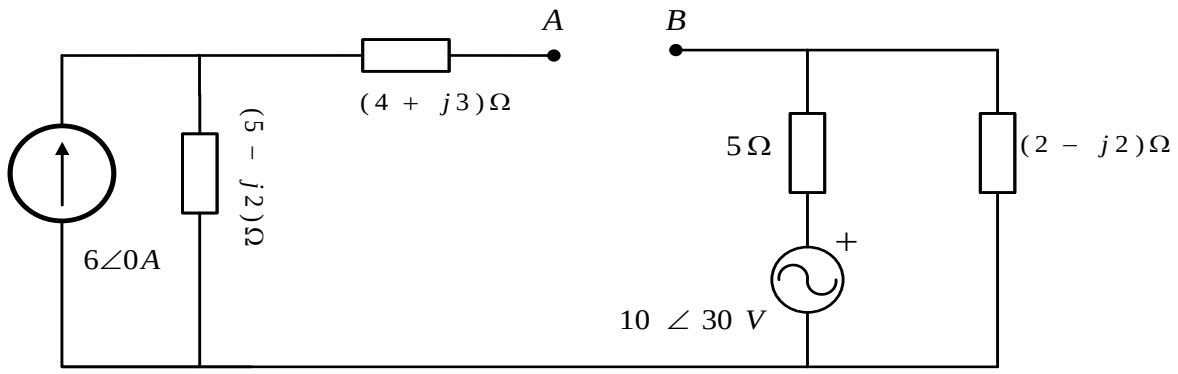

Figure 1

3.1 Apply the Thevenin theorem and determine the open circuit voltage V_{AB} as well as the Thevenin equivalent impedance. (7)

3.2 Determine the load impedance that will cause maximum power to be transferred from the circuit. (2)

3.3 Find the maximum active and reactive currents that would flow through the load. (3)

3.4 Find the maximum power dissipated in the load impedance. (2)

3.5 Convert the Thevenin equivalent circuit obtained in (3.1) into the Norton equivalent circuit. (2)

[16]

QUESTION 4:

Study the circuit diagram given in **Figure 2** and answer the following questions:

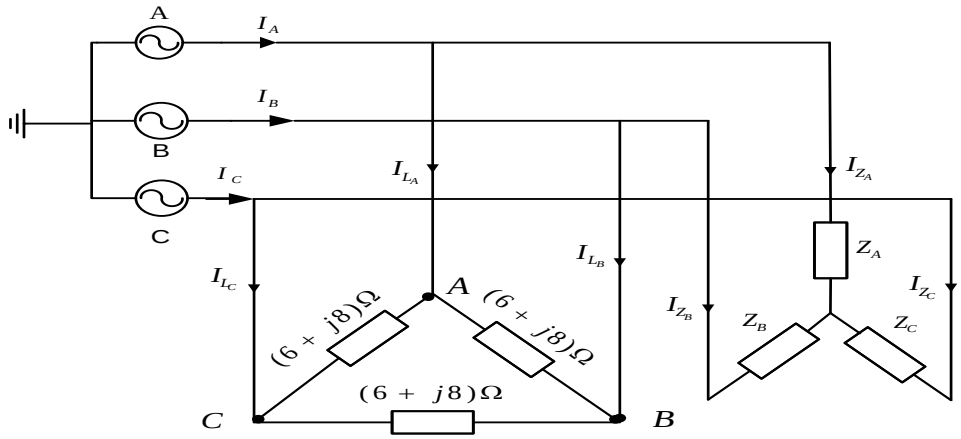

Figure 2

The 3-phase system shown on Figure 2 consists of 380 V; 50 Hz, ABC sequence with V_{AB} as reference, a delta-connected load of 6+ j8 Ω impedance and a star- connected load of 1.5 kW, 80% efficiency at 0.85 lagging power factor areconnected as indicated on the circuit diagram.

4.1 Determine the magnitude and angle of the phase currents of the delta-connected load. (6)

4.2 Use **Kirchoff's current law** at each node and find the magnitude and angle of the line currents (I_{LA}, I_{LB} and I_{LC}) of the delta connected-load. (6)

4.3 Calculate the respective impedances of the star-connected load system (Z_A, Z_B and Z_C). (6)

4.4 Determine the total source currents (magnitude and angle) I_A, I_B and I_C. (6)

4.5 Use the two-wattmeter method with current coils on line A and on line C and determine the total power drawn by the two loads. (5)

[29]

QUESTION 5:

A series RL circuit is subjected to the following complex voltage waveform: $e = 100 + 50\sin\omega t + 25\sin 3\omega t$ where $\omega = 314.159$ rad/s. If the resistance R = 5Ω and the inductance L = 0.02H. Determine:

5.1 The resulting complex current equation. (4)

5.2 The RMS values of the non-sinusoidal voltage and current. (4)

5.3 The average load power factor power. (2)

[10]

TOTAL: 100

Semester 2

THE CUT-OFF SUBMISSION DATES FOR THE ASSIGNMENTS ARE :	
Assignment 1: (Compulsory)	**29 August 2018**
Assignment 2: (Compulsory)	**28 September 2018**

Assignment 1

To be completed on Mark reading sheet

1. In a Y-connected ac generator, each phase voltage has a magnitude of 90 Vrms. What is the magnitude of each line voltage?

1) 140V
2) 153V
3) 155.8V
4) 135.945V

2. In a three-phase system, when the loads are perfectly balanced the neutral current is

1) 3A
2) 120A
3) 0A
4) 0.15A

3. A constant load power means a uniform conversion of
1) Current to voltage
2) Electrical to mechanical energy
3) Mechanical to electrical energy
4) Voltage to current

4. Conventional flow assumes charges flow from:

1) Positive to negative
2) Positive to positive
3) Negative to positive
4) Negative to negative

5. Electron flow assumes charges flow from:

1) Negative to positive
2) Negative to negative
3) Positive to negative
4) Positive to positive

6. Series resonance occurs when:

1) XL = Xc
2) XL=R
3) Z=R
4) Both A and C

7. In complex waves, the symbol Q refers to:

1) Resonance quotient
2) Quality factor
3) Power quotient
4) Qualification test

8. The ratio of W/VA in an AC circuit means:

1) Power Factor
2) Reactive factor
3) Quality factor
4) Load factor

9. What is the reciprocal of quality factor?

1) Power factor
2) Dissipation Factor
3) Reactive factor
4) 1 /Q factor

10. VL = Vc in a series RLC circuit when:

5) A. The value of the impedance is minimum
6) B. The power factor is zero
7) C. The current leads the total voltage by 90°
8) D. The total voltage is zero

11. At what frequency will an inductor of 5mH have the same reactance as a capacitor of 0.1 μF?

1) 7.12 KHz
2) 1/5
3) 7.12 Hz
4) 7.12MHz
5) 7.12 GHz

12. In a series RLC circuit

1) The current lags VL by 90°
2) The current leads VL by 90°
3) XL leads X. by 90°
4) Z = jXL at resonance

13. In a resonant circuit, if Q > 10 resonant frequency_____ bandwidth.

1) Bisects
2) Exceeds
3) Is less than
4) Is equal to

14. The current is ---------- times the maximum current at half-power points of a resonance curve.

1) 0.707
2) 1.414
3) 0.5
4) 0.632

15. In an ac circuit with inductive reactance, the

1) Phase angle of the circuit is always 45°
2) Voltage across the inductance must be 90° out-of-phase with the applied voltage
3) Current through the inductance lags its induced voltage by 90°
4) Current through the inductance and voltage across it are l80° out-of-phase

16. Kirchhoffs voltage law is related to

1) junction currents
2) battery e.m.fs.
3) IR drops
4) both (2) and (3)

17. Superposition theorem can be applied only to circuits having

1) resistive elements
2) passive elements
3) non-linear elements
4) linear bilateral elements

18.The concept on which Superposition theorem is based is

1) reciprocity
2) duality
3) non-linearity
4) linearity

19. Thevenin resistance Rth is found

5) by removing voltage sources along with their internal resistances
6) by short-circuiting the given two terminals
7) between any two ‘open’ terminals
8) between same open terminals as for Etk

20. In a certain Y-Y system, the source phase currents each have a magnitude of 10 A. The magnitude of each load current for a balanced load condition is

1) 3A
2) 17.3A
3) 5A
4) 10A

ASSIGNMENT 2

QUESTION 1

Determine the power dissipated if a 1-Ω resistor is connected between terminals AB of the network in figure 1.

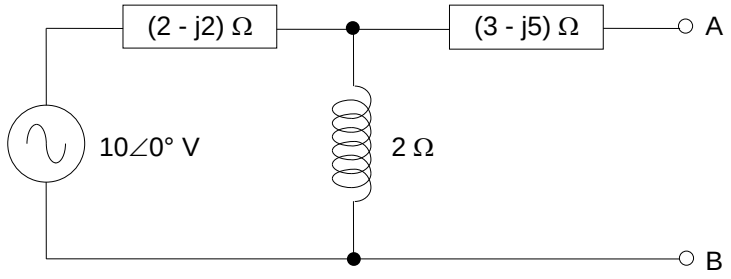

Figure 1

[8]

QUESTION 2

Determine the maximum power transferred if a variable resistor and a fixed capacitor are connected between terminals AB, as shown in the figure 2.

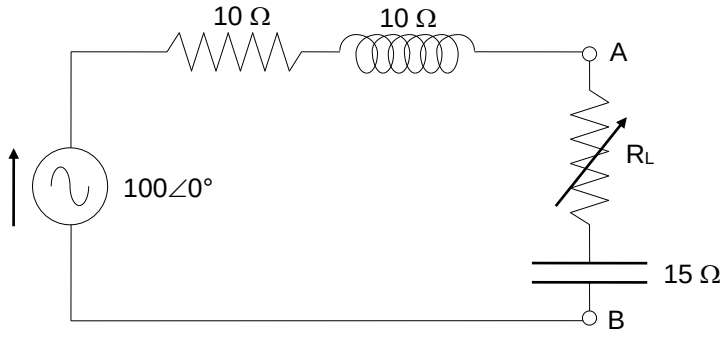

Figure 2

[6]

QUESTION 3

A 250 kVA transformer is at full load with a power factor of 0,8 lagging. The power factor is to be corrected to 0,9 lagging by parallel capacitors.

a) What kVA'r of capacitors does this require? (4)

b) What kW of new load at unity power factor may now be added without exceeding the rated transformer kVA? (3) **[7]**

QUESTION 4

The power factor of a certain load is corrected to 0,9 lagging with the addition of 20 kVA'r of capacitors. If the final kVA value is 185 kVA, determine the power triangle of the load and power factor before correction.

[5]

QUESTION 5

A load of 300 kW with a power factor of 0,65 lagging has the power factor improved to 0,9 lagging by the addition of parallel capacitors. What kVA'r of capacitors does this require and what percentage reduction in kVA results?

[9]

QUESTION 6

A 18,75-kW induction motor with a full load efficiency of 82% and a power factor of 0,75 lagging, is connected to a three-phase, 208 V system. Find the equivalent delta-connected impedance which can replace this motor and find the readings obtained by the two-wattmeter method. Assume an ABC rotation with V_{BC} as reference phasor.

[4]

QUESTION 7

A 100-V, CBA system supply a balanced load and has wattmeters in lines A and B. If IB = 10,9∠-40° A, calculate the two wattmeter readings. Use VBC as reference phasor.

[8]

QUESTION 8

A three-phase, three-wire, 240-V, ABC system has a delta-connected load with Zab = 10∠0° Ω, Zbc = 10∠30° Ω and Zca = 15∠-30° Ω. Determine the three line currents and the total power consumed.

[16]

QUESTION 9

A two-element series circuit with R = 10 Ω and L = 20 mH, contains a current of i = (5.sin 100t + 3.sin 300t + 2.sin 500t) A. Calculate the effective applied voltage and the average power.

[13]

QUESTION 10

A 130 Ω resistor and a 32-μF capacitor are connected in parallel across a 200 V, 50-Hz supply. Calculate:

a) the current in each circuit, (5)

b) the resultant current, (1)

c) the phase difference between the resultant current and the applied voltage, (1)

d) the power, and (2)

e) the power factor. (1) **[10]**

QUESTION 11

A potential difference of 30 V is measured across a coil when a direct current of 3 A flows through the coil. When an alternating current of 5 A at 45 Hz flows through the coil, the potential difference is 210 V across the coil. If the coil is connected across a 360-V, 60-Hz supply, calculate:

a) the current, (9)

b) the power dissipated, and (2)

c) the power factor of circuit. (1) **[12]**

QUESTION 12

Three 60-W, 100-V lamps are connected in parallel with each other, then in series with a capacitor. The circuit is supplied by a 230-V, 50-Hz supply.

a) Determine the value of the capacitor so that the lamps will operate at their rated voltage. (6)

b) If one lamp fuses, to what value will the voltage across the other two rise? (5) **[11]**

TOTAL: [109]

ASSIGNMENT 3

Only for self-evaluation

QUESTION 1

A series RL-circuit consist of a 21.6Ω resistor and a 74mH inductor. The radial velocity in the circuit is 377rad/s and the supply voltage is represented by the equation:

$$e(t) = 220 + 150\ sin\omega t + 120\sin\left(\omega t + \frac{\pi}{9}\right) + 80\sin\left(5\omega t + \frac{\pi}{7.5}\right) volt$$

1.1 Determine an equation for the instantaneous current in the circuit. (10)

1.2 Calculate the active power dissipated in the resistor. (3)

1.3 Calculate the over-all power factor of the circuit. (2)

[15]

QUESTION 2:

3.1 Name six disadvantages of a low power factor (6)

3.2 Name three equipment that can be used to improve power factor (6)

3.4 A coil is connected in series with a resistor of 1,4 Ω.These components are connected in parallel with a resistor of 19,5 Ω and a capacitor of $1110\ \mu F$.A coil with an impedance of $(15{,}9 + j\ 34{,}1)\ \Omega$ in series with a capacitor of 110 µF is connected in series with a parallel circuit. The voltage drop measured across the coil is $286\angle 55{,}75°\ V$. The whole is connected across a sinusoidal **a.c.** supply represented by the equation:

$$e(t) = 270\ cos\ (310t - 72°)\ V$$

3.4.1 Calculate the voltage drop across the parallel part of the circuit (7)

3.4.2 Calculate the resistance and the inductance of the unknown coil (6)

3.4.3 Calculate the power factor of the circuit (2)

3.4.4 Calculate the value of each of three series capacitors connected in parallel to the circuit to raise the overall power factor to 0,95106 lagging. (3)

[30]

QUESTION 3:

Refer to the circuit diagram depicted in **Figure 1** below:

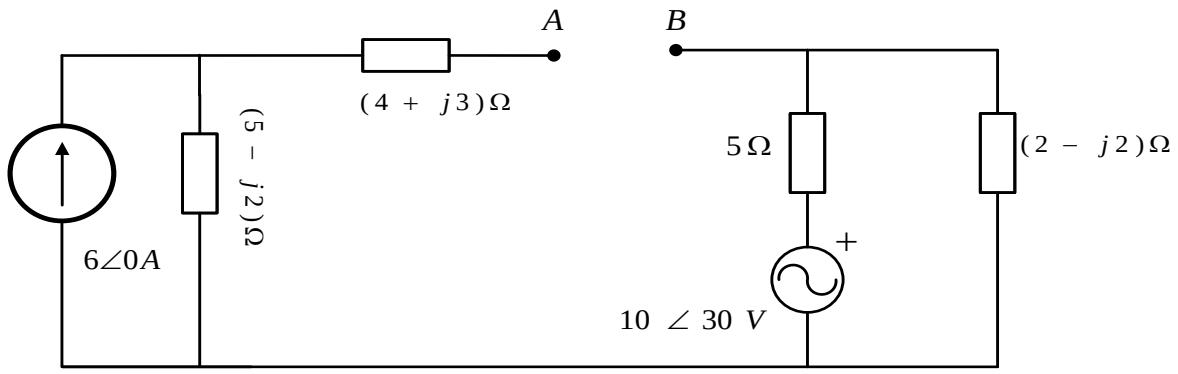

Figure 1

3.1 Apply the Thevenin theorem and determine the open circuit voltage V_{AB} as well as the Thevenin equivalent impedance. (7)

3.2 Determine the load impedance that will cause maximum power to be transferred from the circuit. (2)

3.3 Find the maximum active and reactive currents that would flow through the load. (3)

3.4 Find the maximum power dissipated in the load impedance. (2)

3.5 Convert the Thevenin equivalent circuit obtained in (3.1) into the Norton equivalent circuit. (2)

[16]

QUESTION 4:

Study the circuit diagram given in **Figure 2** and answer the following questions:

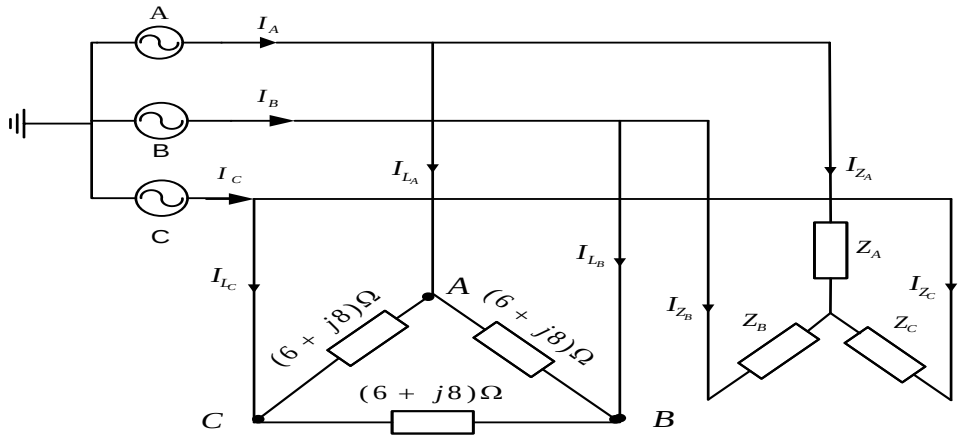

Figure 2

The 3-phase system shown on Figure 2 consists of 380 V; 50 Hz, ABC sequence with V_{AB} as reference, a delta-connected load of 6+ j8 Ω impedance and a star- connected load of 1.5 kW, 80% efficiency at 0.85 lagging power factor areconnected as indicated on the circuit diagram.

4.1 Determine the magnitude and angle of the phase currents of the delta-connected load. (6)

4.2 Use **Kirchoff's current law** at each node and find the magnitude and angle of the line currents (I_{LA}, I_{LB} and I_{LC}) of the delta connected-load. (6)

4.3 Calculate the respective impedances of the star-connected load system (Z_A, Z_B and Z_C). (6)

4.4 Determine the total source currents (magnitude and angle) I_A, I_B and I_C. (6)

4.5 Use the two-wattmeter method with current coils on line A and on line C and determine the total power drawn by the two loads. (5)

[29]

QUESTION 5:

A series RL circuit is subjected to the following complex voltage waveform: $e = 100 + 50\sin\omega t + 25\sin 3\omega t$ where $\omega = 314.159$ rad/s. If the resistance R = 5Ω and the inductance L = 0.02H. Determine:

5.1 The resulting complex current equation. (4)

5.2 The RMS values of the non-sinusoidal voltage and current. (4)

5.3 The average load power factor power. (2)

[10]

TOTAL: 100

8.7 Other assessment methods

None

8.8 The examination

Use your *my Studies @ Unisa* brochure for general examination guidelines and examination preparation guidelines.

9 FREQUENTLY ASKED QUESTIONS

The my Studies @ Unisa brochure contains an A-Z guide of the most relevant study information.

10 SOURCES CONSULTED

None

11 CONCLUSION

Please ensure that you have all the tutorial letters and prescribed book available before starting with your studies.

12 ADDENDUM

None