University of KwaZulu-Natal

Electrical, Electronic & Computer Engineering

Examinations: June 2026

Subject, Course & Code: Electrical Principles 1 ENEL2EA

Duration: 3 Hours **Total Marks: 100**

Examiner/s:

S Rezenom (Internal)
N Sibanda (Internal)
Prof T Quazi (Moderator)

Instructions:

1. This paper consists of "**Section A**" and "**Section B**"**.** Use **separate answer sheets** for each section.

2. Clearly label the answer sheets as "**Section A**" or "**Section B**" to provide clarity.

3. **Section A** consists of **three questions.** All questions must be answered in full. All relevant assumptions must be documented clearly.

4. **Section B** consists of **two questions**. All questions must be answered in full. All relevant assumptions must be documented clearly.

5. A dark pencil may be used.

ENEL2EA SECTION A

Question 1A Mesh and Thevenin's Theorem [15 marks]

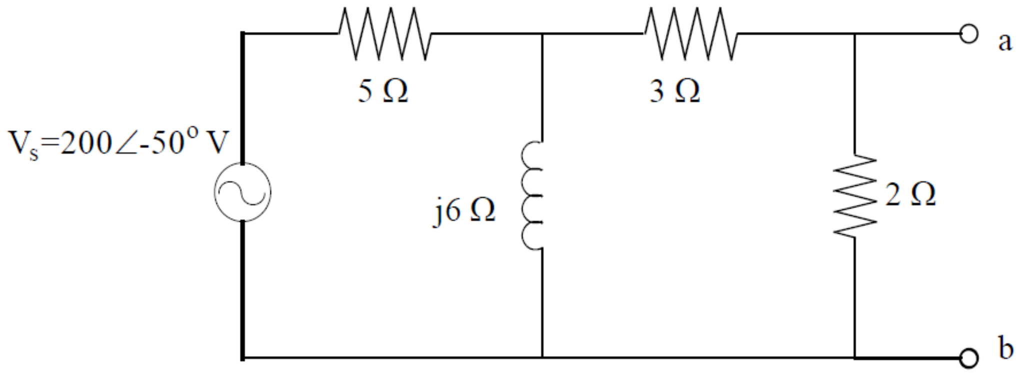

Figure Q1A.

For the circuit shown in Figure Q1A above:

a) Using Kirchoff's voltage laws, determine the expression for the loop currents. [2]

b) Solve for the loop currents. [5]

c) Determine the Thevenin voltage. [2]

d) Solve for the Thevenin impedance. [4]

e) If maximum power is to be transferred to a load Z_L at a-b terminals, determine Z_L and the power transferred to the load. [2]

Question 2A Nodal and Nortons Theorem [15 marks]

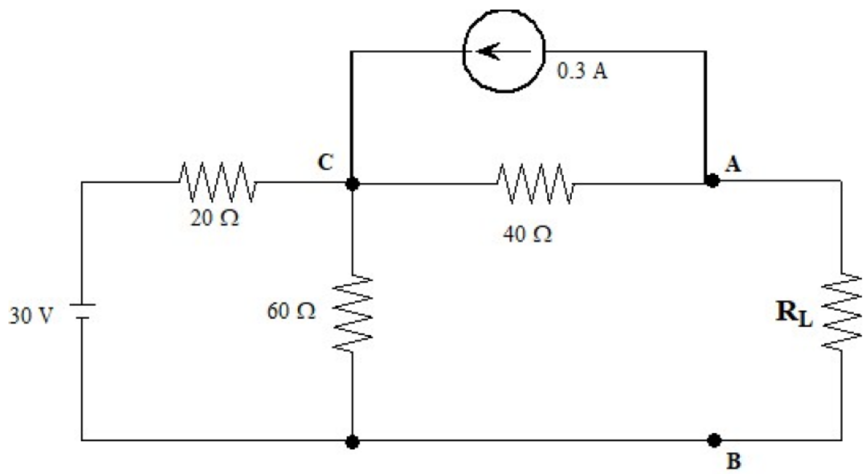

Figure Q2A.

a) Using Nodal analysis, determine the Norton equivalent of the circuit in Figure Q2A. (In other words, find I_N of the circuit in Figure Q2A, assuming the load will be connected between A and B. Also, find R_N of the circuit in Figure Q2A, assuming the load will be connected between A and B. Finally, draw the equivalent circuit). [13]

b) Determine the value of R_L that results in maximum power transfer, and the actual power delivered to the load. [2]

Question 3A RLC Circuits [20 marks]

For the network in Figure Q3A:

a) Determine the mathematical expression for the inductor current following the closure of the switch S at time t=0 onto position 1. [5]

b) Determine the inductor voltage and current at *t = 0* and *t =100* milliseconds. [6]

c) If the switch is closed onto position 2 when *t =100* milliseconds, determine the new expression for the inductor current, and the voltage across resistor R. [5]

d) Plot the inductor current waveform from *t =0* to *t =200* milliseconds. [4]

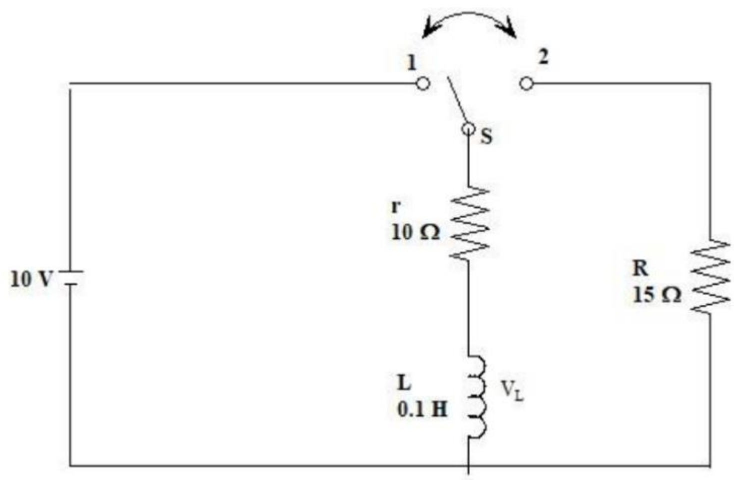

Figure Q3A.

ENEL2EA SECTION B

Question 1B [25 marks]

a) Consider the circuit shown in Figure Q1B. Three loads are connected in parallel across a 250 V (rms) voltage source **Vs**.

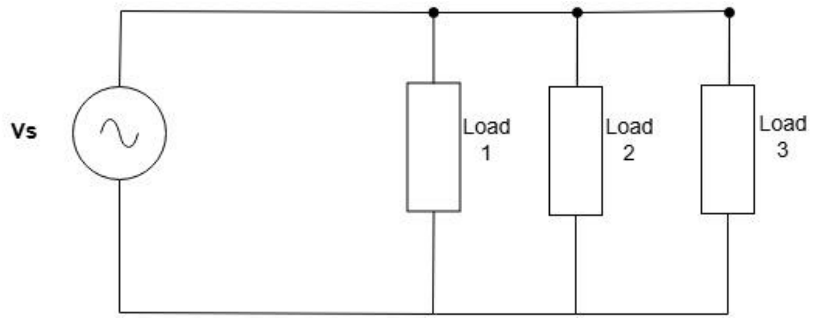

Figure Q1B.

Load 1 absorbs 30 kVA at power factor of 0.8 leading.
Load 2 absorbs 20 kVA at power factor of 0.6 lagging.
Load 3 absorbs 6 kW at unity power factor.

i) Clearly plot the power diagrams for each of the three loads. [3]
ii) Compute the power factor of the equivalent load. [2]
iii) Compute the value of the reactance that would be connected across the loads that brings the power factor of the loads to 0.9 leading. [5]

b) A three-phase Y-connected generator is connected to a three-phase Y-connected load. Assume the phase voltage is 220 V (rms) at 0° at *phase a* of the generator. Assume positive phase sequence (*abc* phase sequence). The balanced load consists of $100 + j\,200\ \Omega$ impedances. Compute

i) the line voltages V_{ab}, V_{bc}, and V_{ca}. [3]
ii) line currents I_a, I_b, and I_c. [3]

c) The line voltage (magnitude in rms) at the terminals of a balanced Y-connected load is 6600 V. The load impedance is $200 + j\,60\ \Omega$. Assume the line connecting the voltage source to the load has an impedance of $0.5 + j\,4.0\ \Omega$.

i) Compute the magnitude of the line current. [3]
ii) Compute the magnitude of the line voltage at the source. [3]

d) Briefly explain the significance of power factor correction in the context of power generation and distribution systems. [3]

Question 2B [25 marks]

a) Consider the magnetic circuit shown in Figure Q2B that is made of sheet steel with relative permeability of 6000. A coil of 500 turns coil is applied at the sections between points *b-e*. All sections have an area (Ac) of $5.0\ cm^2$. The length between the points shown is $20.0\ cm$, expect for the right leg of the system which has an air gap of $2.0\ mm$. Assume there is no fringing in the air gap. Calculate the value of current that causes a flux in the gap of $2x10^{-4}\ Wb$. [10]

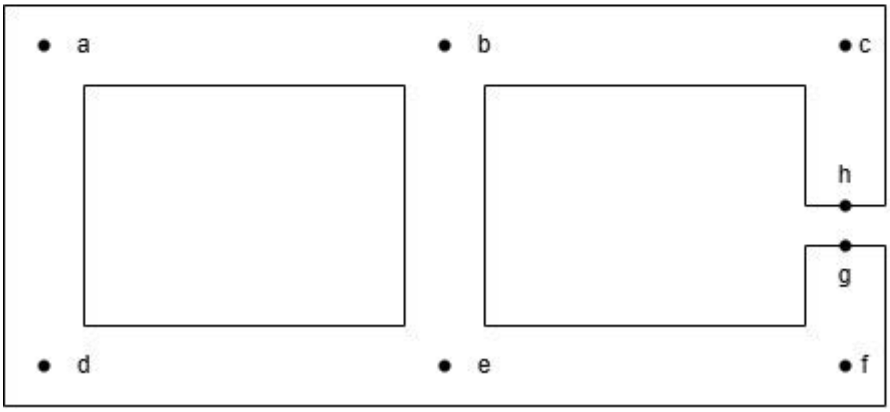

Figure Q2B.

b) A 23 kVA, 2300/230-V, 60-Hz, step-down transformer has the following parameters (Ω):

$R_1 = 1.2 \qquad X_1 = 3.0$
$R_2 = 0.012 \qquad X_2 = 0.03$
$R_c = 2000 \qquad X_m = 1800$

Assume the transformer is operating at 80% of its load at rated terminal voltage and 0.6 pf lagging. Compute the efficiency of the transformer. [6]

c) Briefly explain the concept of eddy currents in transformers and describe how its effect is reduced. [4]

d) A series DC generator supplies 200 V at 40 A to a load. The resistance of the series field is 10 Ω and that of the armature is 0.06 Ω. Calculate the generated voltage. [5]