

LOCATION: SWANSEA

LLEOLIAD: ABERTAWE

LEVEL 5

LEFEL 5

EXAMINATION PERIOD
MAY 2026

CYFNOD ARHOLIADAU
MAI 2026

MODULE CODE: GOEE5000

ELECTRICAL POWER

TIME: 2 HOURS

ANSWER ALL QUESTIONS

SHOW ALL CALCULATIONS AND WORKINGS CLEARLY

Equipment or materials required – Calculator & Formula booklet

Question One (25 Marks)

- a. The single-phase a.c. power system shown in Figure 1 operates at 50Hz with a supply voltage of 240V (RMS). The circuit consists of a load supplied through an internal source reactance and an overhead transmission line, with component values as shown. Calculate the power factor of the circuit and state whether it is leading or lagging.

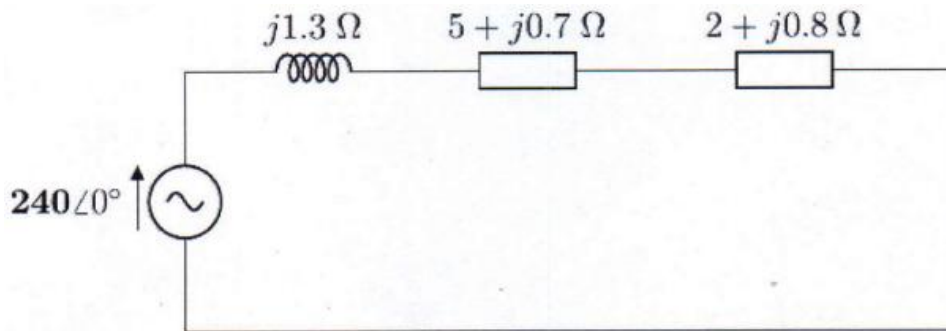


Figure 1

[5]

- b. In Figure 2 below, calculate the complex apparent power (S) delivered by the source, as well as the total real power (P) and the total reactive power (Q).

[20]

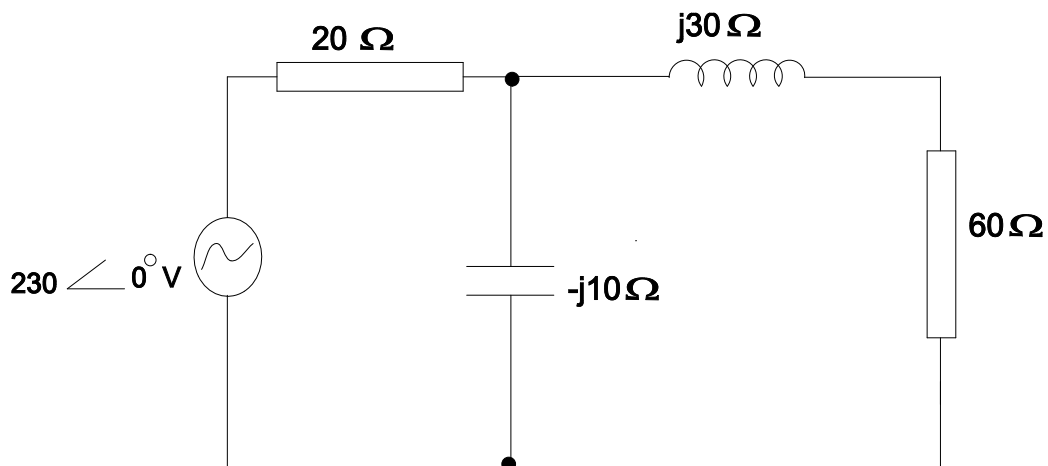


Figure 2

Question Two (25 marks)

- a. A balanced Delta (Δ) - connected load with an impedance of $20 - j15 \Omega$ is supplied by a delta (Δ) connected, positive sequence generator with a line voltage $V_{ab} = 330 \angle 0^\circ \text{ V}$ as shown in Figure 3 below. Calculate:

1. The phase voltages V_{AB} , V_{BC} and V_{CA} [2]
2. The phase currents I_{AB} , I_{BC} and I_{CA} [6]
3. The line currents I_a , I_b and I_c [2]
4. The per phase real power dissipated in the load [3]

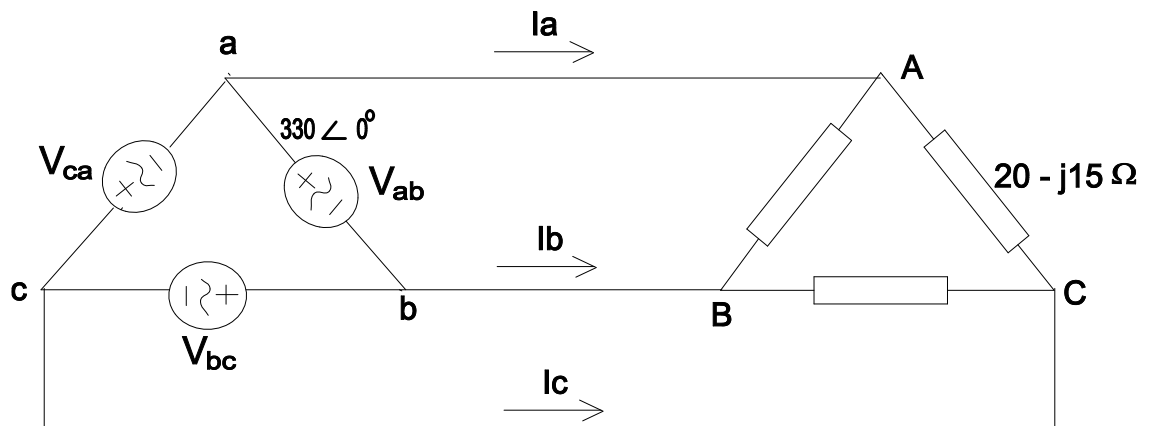


Figure 3

- b. The balanced three-phase circuit shown in Figure 4 consists of a three-phase Y-connected source supplying a balanced load through identical line impedances. The phase voltage of the source is $V_{an} = 220 \angle 0^\circ$ and each line has an impedance of

$Z_{line} = 6 - j2 \Omega$. The load is balanced, with each phase having an impedance of $Z_{load} = 12 + j8 \Omega$. Calculate:

1. The phase voltages V_{bn} and V_{cn} [2]
2. The line voltages V_{AB} , V_{BC} and V_{CA} [2]
3. The phase currents I_{AN} , I_{BN} and I_{CN} [3]
4. The line currents I_a , I_b and I_c [2]
5. Calculate the complex power absorbed by total three-phase load and state the total real and reactive power. [3]

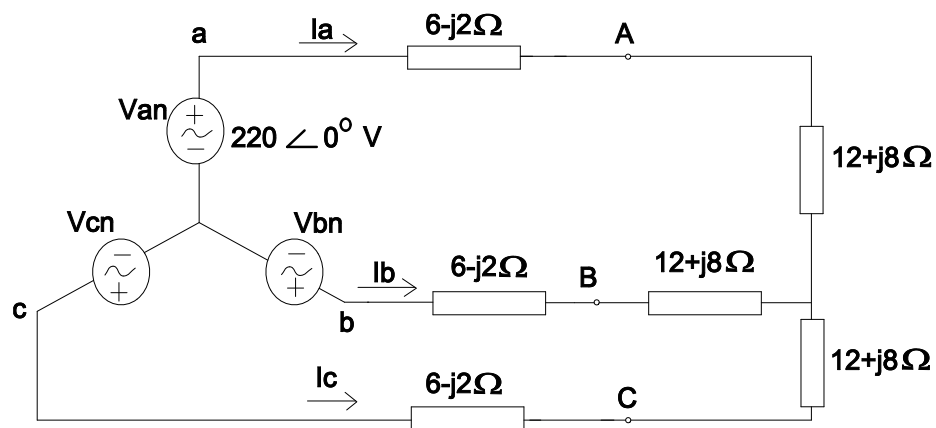


Figure 4

Question Three (25 marks)

- a. A single-phase inductive load draws 120 kVA at a lagging power factor of 0.65 from a 240 V, 50 Hz supply. A capacitor is connected in parallel with the load to improve the overall power factor to 0.9 lagging. Calculate the capacitance value (in mF) required to achieve the desired power factor.

[20]

- b. Explain the significance of maintaining a high power factor in industrial electrical installations. In your answer, discuss the causes of low power factor and describe its effects on system losses, equipment loading, and operating costs.

[5]

Question Four (25 marks)

- a. Consider a single-phase power system comprising a generator, transmission line and load as shown in Figure 5. The system operates with a base apparent power of $S_B = 20\text{kVA}$, and an applied voltage at the generator end of 400V . The system includes two transformers: the first transformer has a turns ratio of $a_1 = 0.2$ and the second transformer has a turns ratio of $a_2 = 10$. The load impedance is given by $Z_{\text{Load}} = 10\angle 30^\circ \Omega$ and the transmission line impedance is $Z_{\text{Line}} = 18 + j36 \Omega$.

Given this information, perform the following tasks:

1. Using the specified system base apparent power, determine the base quantities in each region of the network (generator side, transmission line side, and load side). This should include the base voltage, base current, base impedance, and base apparent power. [8]
2. Express all system components in per-unit form and draw the corresponding per-unit equivalent circuit referred to a common base. [4]
3. Using the per-unit equivalent circuit, determine the real power absorbed by the load under the given operating conditions. [3]

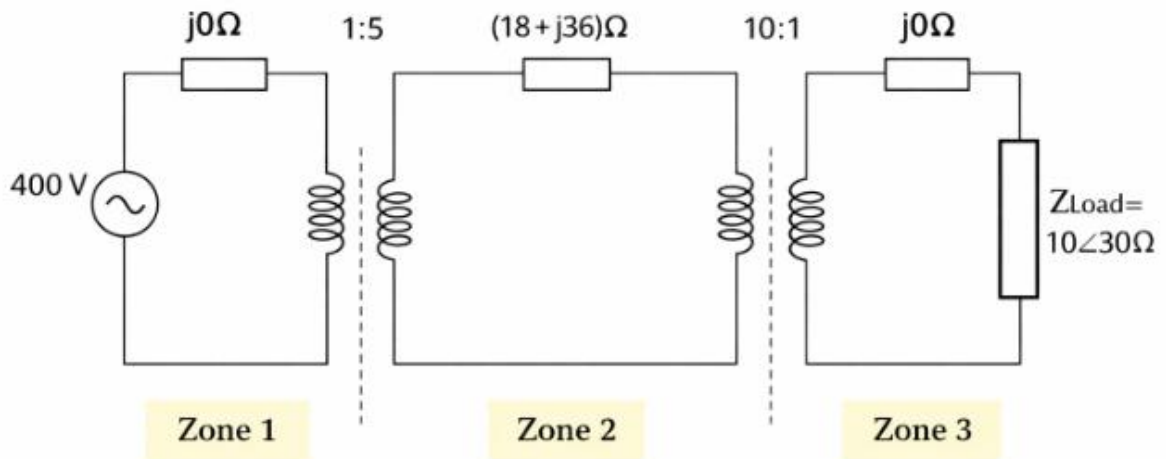


Figure 5

b. A battery-powered electric winch used for maintenance work on the UK rail network is driven by a DC series motor supplied from a 72 V DC source.

The motor has an armature resistance of $0.12\ \Omega$ and a series field resistance of $0.05\ \Omega$.

When lifting equipment, the motor draws a current of 30 A and operates at a speed of 1200 revolutions per minute (rpm). The motor's equivalent circuit is shown in Figure 6 below.

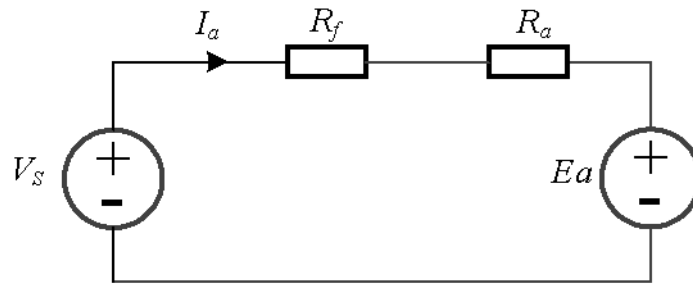


Figure 6

1. Calculate the back EMF E_a of the motor. [2]
2. Calculate the angular speed ω of the motor in radians per second. [2]
3. Calculate the mechanical power developed by the motor. [2]
4. Calculate the torque developed by the motor. [4]