higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

ELECTRICAL PRINCIPLES AND PRACTICE
NQF LEVEL 4

(12041004)

15 November 2024 (X-paper)
09:00–12:00

Calculators may be used.

This question paper consists of 8 pages and a formula sheet of 3 pages.

203Q1N2415

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)
ELECTRICAL PRINCIPLES AND PRACTICE
NQF LEVEL 4
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

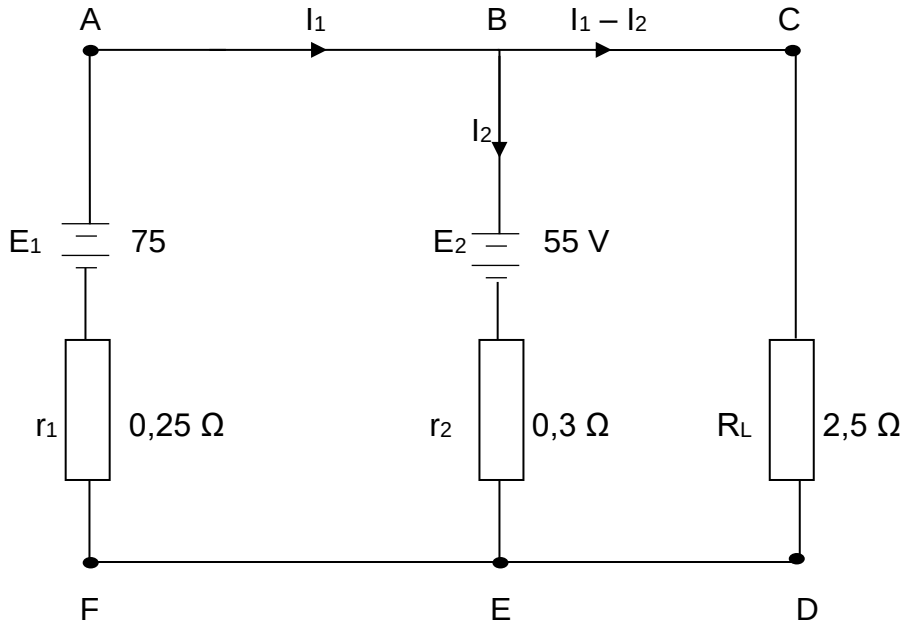
1. Answer all the questions.
2. Read all the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. Start each section on a new page.
5. Use only a black or blue pen.
6. Write neatly and legibly.

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QUESTION 1

1.1 Two batteries of EMF 75 volts and 55 volts with internal resistances of 0,25 Ohm and 0,3 Ohm respectively are connected in parallel to supply a load having a resistance of 2,5 Ohm.

Use Kirchhoff's laws to calculate the currents I_1 and I_2. Use loop ABEFA and loop BCDEB. (11)



1.2 Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–F) next to the question number (1.2.1–1.2.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
1.2.1	A set of branches forming a closed path in a network.	A	electrical network
1.2.2	A part of the network that connects the various points of the network with one another.	B	node
1.2.3	Any individual circuit with two terminals, which can be connected to another circuit.	C	loop
1.2.4	A point at which two or more elements are joined together.	D	network element
1.2.5	A system of interconnected electrical elements.	E	branch
		F	battery

(5 × 1) (5)

1.3 Explain the relationship between the supply frequency and the following reactances in an AC circuit:

1.3.1 Inductive reactance

1.3.2 Capacitive reactance

(2 × 1) (2)

1.4 In a series AC RLC circuit, the circuit could be inductive, capacitive or at resonance.

State TWO conditions that makes a series RLC circuit capacitive. (2)

1.5 A tong tester is used to measure current.

1.5.1 By using a labelled sketch, show how a tong tester can be connected in a circuit to measure current. (3)

1.5.2 Describe how a tong tester can be connected in a circuit to measure current. (3)

1.6 Complete the following sentences by filling in the missing word or words. Write only the word or words next to the question number (1.6.1–1.6.2) in the ANSWER BOOK.

1.6.1 … is the ratio of the rms value to the average value.

1.6.2 … is the value of the alternating quantity at any instant of time.

(2 × 1) (2)

1.7 With alternating voltages and currents, the sine waveform plays an important role in understanding the relationship between the current and voltage in an AC circuit.

Define the following terms:

1.7.1 Waveform

1.7.2 Sine waveform (2)

(2 × 1) **[30]**

QUESTION 2

2.1 Show, by means of a labelled sketch, how a three-phase AC supply is generated. (3)

2.2 Mention FIVE advantages of generating electricity using the supply system in QUESTION 2.1. (5)

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2.3 The input power to a three-phase AC motor is 5 kW and the voltage and current to the motor are 380 V and 10 A respectively.

Calculate the power factor. (3)

2.4 Use the table below to show which formula to use when calculating line values for both star and delta connections.

Complete the table by writing only the answer next to the question number (2.4.1–2.4.4) in the ANSWER BOOK.

	Star connection	**Delta connection**
Line voltage (V_L)	2.4.1	2.4.2
Line current (I_L)	2.4.3	2.4.4

(4 × 1) (4)
[15]

QUESTION 3

3.1 List THREE types of earthing systems. (3)

3.2 Refer to FIGURE 1 below and answer the following questions:

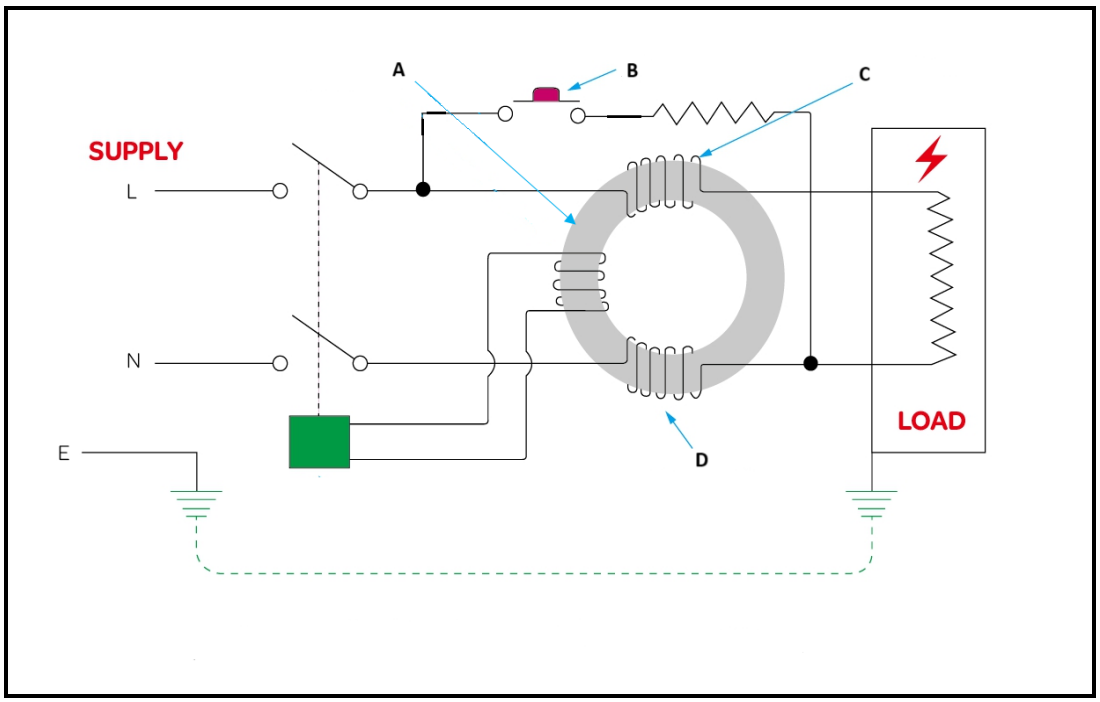


FIGURE 1

3.2.1 Identify the sketch. (1)

3.2.2 Name the parts indicated on the sketch by writing only the answer next to the letter (A–D) in the ANSWER BOOK. (4)

3.2.3 Explain the operating principle of the sketch under normal working conditions. (3)

3.3 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (3.3.1–3.3.4) in the ANSWER BOOK.

3.3.1 Earth leakage current is the current that flows to earth in an electrically damaged circuit.

3.3.2 Fault current is the current that flows to earth.

3.3.3 The consumer's earth terminal is earthed by connecting it to the supply earth terminal.

3.3.4 The term earthed means that an object is connected to the general mass of earth so as to ensure, at all times, an immediate discharge of electrical energy without danger.

(4 × 1) (4)

[15]

QUESTION 4

4.1 Define the following losses as they occur in a transformer:

4.1.1 Eddy current losses

4.1.2 Copper losses

(2 × 1) (2)

4.2 Draw a labelled phasor diagram of the transformer at no-load. (4)

4.3 Describe the difference between a *shell-type transformer* and a *core-type transformer*. (2)

4.4 You are given three single-phase transformers, each with a winding ratio of 20:1, to connect in star-star to a 400 V supply. The secondary phase current is 20 ampere.

4.4.1 Calculate the secondary phase voltage. (4)

4.4.2 Calculate the primary line current. (3)

4.4.3 When measuring the secondary phase voltages, you observe that the third phase voltage is 0 V.

What could be the TWO possible faults on the third transformer? (2)

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4.5 Complete the following sentences by filling in the missing word or words. Write only the word or words next to the question number (4.5.1–4.5.2) in the ANSWER BOOK.

4.5.1 Instrument transformers are used to change … … and …… from high values to low values that can be used by LV meters. (2)

4.5.2 A potential transformer is also referred to as … . (1)
[20]

QUESTION 5

5.1 Refer to FIGURE 2 below and answer the following question:

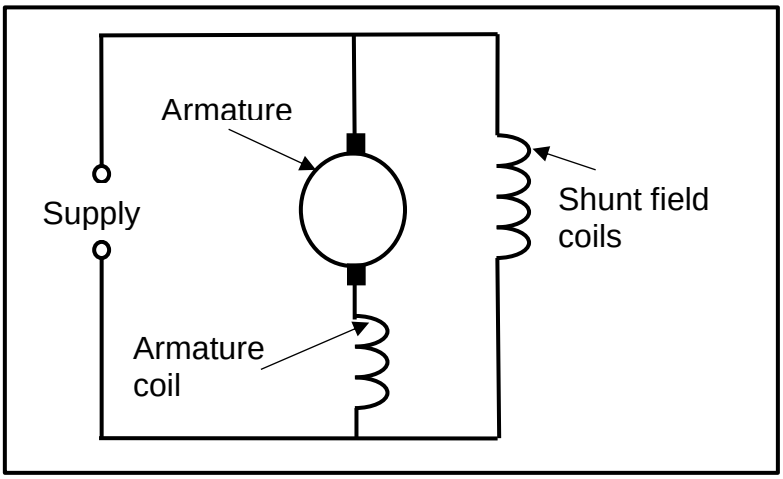


FIGURE 2

When reversing direction of rotation of a DC motor, you can either reverse one of the two windings.

Illustrate, by means of TWO labelled sketches, how you would reverse the direction of rotation of a DC motor. (4)

5.2 A long-shunt compound generator has armature, series field and shunt field resistances of 0,02 Ω; 0,01 Ω and 100 Ω, respectively. It supplies a load current of 50 A at 300 V.

Calculate:

5.2.1 The armature current (3)

5.2.2 The EMF generated (3)

5.3 A permanent-capacitor motor is commonly used in fans and other small domestic appliances.

List FOUR main parts of a permanent-capacitor motor. (4)

5.4 Name TWO conditions in which a no-volt protection device will protect the motor against damage. (2)

5.5 List FOUR factors that affect the performance of induction motors. (4)
[20]



TOTAL: 100

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FORMULA SHEET

1. $\boldsymbol{Cos\phi = \frac{R}{Z}}$

2. $\boldsymbol{P = V\ I\ Cos\phi}$

3. $Q = V\ I\ Sin\phi$

4. $\boldsymbol{S = V\ I}$

5. $V_1 = \left(\frac{R_1}{R_t}\right) V_T$

6. $\boldsymbol{I_1 = \left(\frac{R_2}{R_1 + R_2}\right) I_T}$

7. $R_T = R_1 + R_2 + R_3 + \cdots + R_n$

8. $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots + \frac{1}{R_n}$

9. $\frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{I_2}{I_1}$

10. $V_L = \sqrt{3}\, V\ p\ h$

11. $\boldsymbol{E = V - I_a\ R_a}$

12. $n_s = \frac{f}{p}$

13. $S = \frac{N_s - N_r}{N_s}$

14. $\boldsymbol{R_{sh} = \frac{I_m\ R_m}{I_{sh}}}$

15. $R_{se} = \frac{V_t}{I_t} - R_m$

16 $\tan\boldsymbol{\phi} = \sqrt{3}\left(\frac{\boldsymbol{W_1 - W_2}}{\boldsymbol{W_1 + W_2}}\right)$

17 $E = V + I\ r$

18 $\boldsymbol{V = I\ R}$

19 $R = \frac{p\ l}{A}$

20 $\boldsymbol{R_t = R_0(1 + \alpha t)}$

21 $R_t = R_0[1 + \propto_0 (t - \emptyset)]$

22 $P = V\ I$

23 $E = I^2\ R\ t$

24 $\boldsymbol{\eta = \frac{P_0}{P_{in}} \times 100}$

25 $\boldsymbol{X_L = 2\pi\ f\ L}$

26 $X_C = \frac{1}{2\pi\ f\ C}$

27 $\boldsymbol{Z = \sqrt{R^2 + (X_L - X_C)^2}}$

28 $Mmf = N\ I$

29 $H = \frac{Mmf}{l}$

30 $B = \frac{\Phi}{A}$

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31 $F = B\,I\,l$

32 $E = -L\dfrac{di}{dt}$

33 $A = \dfrac{\pi\, d^2}{4}$

34 $E = \dfrac{1}{2}\ C\,V^2$

35 $Q = C\,V$

36 $F = 2\times10^{-7}\times\dfrac{I_1\ I_2}{d}$

37 $I = \dfrac{Emf}{R_T + r_T}$

38 $L = N\dfrac{\Delta\,\phi}{\Delta\,I}$

39 $v = V_m \sin(\omega t\ \pm\ \emptyset)$

40 $Z = \dfrac{V}{I}$

41 $I_T = \sqrt{I_R^2 + (I_L - I_C)^2}$

42 $tan\emptyset = \dfrac{X_L - X_C}{R}$

43 $I_{sh} = \dfrac{V + I_{se}R_{se}}{R_{sh}}$

44 $T = \dfrac{0{,}318 I_a Zp\emptyset}{c}$

45 $E = V - I_a(R_a + R_{se})$

46 $E = B\,l\,\nu$

47 $E = -N\ \dfrac{d\emptyset}{dt}$

48 $E = \dfrac{V}{d}$

49 $E = \dfrac{1}{2}LI^2$

50 $Q = It$

51 $C_T = C_1 + C_2 + C_3 + \cdots + C_n$

52 $\dfrac{1}{C_T} = \dfrac{1}{C_1} + \dfrac{1}{C_2} + \dfrac{1}{C_3} + \cdots + \dfrac{1}{C_n}$

53 $L_T = L_1 + L_2 + L_3 + \cdots + L_n$

54 $\dfrac{1}{L_T} = \dfrac{1}{L_1} + \dfrac{1}{L_2} + \dfrac{1}{L_3} + \cdots + \dfrac{1}{L_n}$

55 $tan\emptyset = \dfrac{I_L - I_C}{I_R}$

56 $E = V + I_a R_a$

57 $I_{sh} = \dfrac{V - I_{se}R_{se}}{R_{sh}}$

58 $E = V + I_a(R_a + R_{se})$

59 $E = V + I_a R_a + IR_{se}$

60 $E = V - I_a R_a - IR_{se}$

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61 $E = \frac{2p\emptyset ZN}{60\ c}$

62 $V_T = \sqrt{V_R^2 + (V_L - V_C)^2}$

63 $V_L = IX_L$

64 $E_{rms}\ or\ I_{rms} = 0{,}707\ E_m\ or\ I_m$

65 $N = \frac{V}{k\emptyset}$

66 $E = 4{,}44\ f\emptyset_m N$

67 $V_C = IX_C$

68 $E_{ave} or\ I_{ave} = 0{,}637\ E_m\ or\ I_m$

69 $P = \sqrt{3}\ V_L I_L\ cos\theta$

70 $S = \sqrt{3}\ V_L I_L$

71 $Q = \sqrt{3}\ V_L I_L\ sin\theta$

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