higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

ELECTRICAL PRINCIPLES AND PRACTICE
NQF LEVEL 3

(12041003)

18 February 2025 (X-paper)
09:00–12:00

Calculators may be used.

This question paper consists of 6 pages and a 2-page formula sheet.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)
ELECTRICAL PRINCIPLES AND PRACTICE
NQF LEVEL 3
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. Use only a black or blue pen.
5. Write neatly and legibly.

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QUESTION 1

1.1 Draw the atomic structure of bromine. It has an atomic number of 35. (4)

1.2 The longer the conductor, the greater its resistance.

Apart from the length of a conductor, name THREE other factors affecting the resistance of a material. (3)

1.3 The field coils of a motor have a resistance of 125 ohms at 20 °C. After a run at full-load, the resistance of the coils has increased to 150 ohms. Take the temperature of the coefficient of resistance to be 0,004 per °C at 20 °C.

Determine the temperature of the coils. (4)

1.4 Explain what is meant by the following fundamental terms used in electricity:

1.4.1 Potential difference

1.4.2 Electromotive force

(2 × 2) (4)

[15]

QUESTION 2

2.1 A conductor has an effective length of 150 mm and moves at a constant velocity of 3 m/s perpendicular to a magnetic field of uniform flux density of 0,5 T.

Calculate the following:

2.1.1 The EMF induced in the conductor

2.1.2 The force acting on the conductor when it carries a current of 20 A

(2 × 2) (4)

2.2 A relay is an electromagnetic device.

2.2.1 Explain the purpose of a relay. (2)

2.2.2 State FOUR practical applications of a relay. (4)

2.3 State TWO factors that influence the magnetomotive force (MMF). (2)

2.4 Calculate the flux density when the flux is 500 µWb and the area is 0,003 m^2. (2)

2.5 Two current-carrying conductors are placed 2 mm apart and carry a current of 60 A.

Calculate the magnitude of the force between these conductors. (2)

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2.6 Complete the following sentence by writing only the missing word or words next to the question number (2.6.1–2.6.4) in the ANSWER BOOK.

The ampere is the amount of electrical current which,

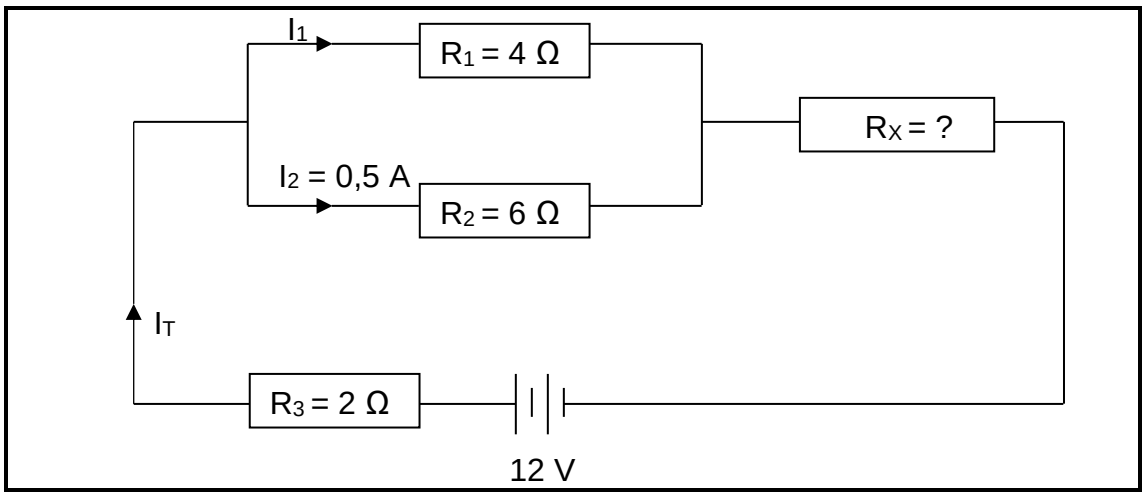
- if maintained in two straight (2.6.1 …) conductors of infinite length
- and negligible (2.6.2 …),
- and placed (2.6.3 …) apart in a vacuum,
- produces a force of (2.6.4 …) newton per metre length between these conductors. (4)

[20]

QUESTION 3

3.1 Name FOUR types of non-polarised capacitors. (4)

3.2



Refer to the above circuit diagram and calculate:

3.2.1 The total current of the circuit (I_T) (3)

3.2.2 The value of the unknown resistor R_X (6)

3.2.3 The total current of the circuit when there is a short circuit in a parallel branch (3)

3.3 Name TWO ways in which conductors can be connected in a three-phase AC supply system. (2)

3.4 Three inductors of 2 mH, 4 mH and 8 mH are connected in parallel.

Calculate the total inductance. (3)

3.5 State THREE advantages of autotransformers. (3)

3.6 Name TWO types of grouping of cells to get the desired EMF. (2)

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3.7 Name TWO methods of cooling dry-type transformers. (2)

3.8 A transformer has a turns ratio of 1:5 and draws a current of 12 A from the supply.

Calculate the secondary current. (2)

[30]

QUESTION 4

4.1 Choose an item from COLUMN B that matches a description in COLUMN A. Write only the letter (A–F) next to the question number (4.1.1–4.1.4) in the ANSWER BOOK.

COLUMN A		COLUMN B	
4.1.1	Prevents the pointer from oscillating	A	controlling device
4.1.2	Can only be used for DC measurements	B	damping device
4.1.3	Ensures that the deflection shown on the meter is the measured quantity	C	moving-coil permanent magnet-type instrument
4.1.4	Has a non-linear scale	D	deflecting device
		E	moving-iron instrument
		F	digital multimeter

(4 × 1) (4)

4.2 Draw a circuit diagram consisting of a voltmeter, ammeter, battery and a load resistor. (4)

4.3 Distinguish between an *analogue meter* and a *digital meter*. (2)

4.4 Name THREE practical applications of an analogue multimeter. (3)

4.5 A moving-coil instrument with an internal resistance of 145 ohms gives full-scale deflection when a current of 20 mA flows through it.

Calculate the value of an additional component required to enable the instrument to be used as a voltmeter to measure 300 V. (2)

[15]

QUESTION 5

5.1 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (5.1.1–5.1.3) in the ANSWER BOOK.

5.1.1 The yoke of a DC machine carries the magnetic flux produced by the poles.

5.1.2 The stator provides a magnetic field.

5.1.3 Armature reaction is the collection of current from armature conductors.

(3 × 1) (3)

5.2 The armature resistance of a DC machine is 0,4 Ω and the generated EMF is 120 V.

Calculate the terminal voltage when the machine is used as a:

5.2.1 Motor supplying an armature current of 20 A

5.2.2 Generator supplying an armature current of 40 A

(2 × 2) (4)

5.3 Name FOUR applications of a capacitor-start induction run motor. (4)

5.4 Explain how the following types of motor starters are used to start squirrel-cage induction motors:

5.4.1 Direct-on-line starter

5.4.2 Star-delta starter

(2 × 2) (4)

5.5 Name TWO types of field coils that are found in a compound generator. (2)

5.6 State THREE advantages of a shaded-pole induction motor. (3)

[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. $\boldsymbol{f = \frac{Np}{60}}$

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

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

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

16. $E = V + I\ r$

17. $\boldsymbol{V = I\ R}$

18. $R = \frac{p\ l}{A}$

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

20. $R_t = R_\theta[1 + \propto_\theta (t - \theta)]$

21. $P = V\ I$

22. $E = I^2\ R\ t$

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

24. $\boldsymbol{X_L = 2\pi\ f\ L}$

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

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

27. $Mmf = N\ I$

28. $H = \frac{Mmf}{l}$

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

30. $F = B\ I\ l$

31. $E = -L\frac{di}{dt}$

32. $A = \frac{\pi\ d^2}{4}$

33. $E = \frac{1}{2}\ C\ V^2$

34. $Q = C\ V$

35. $F = 2\times10^{-7} \times \frac{I_1\ I_2}{d}$

36. $I = \frac{Emf}{R_T + r_T}$

37. $L = N\frac{\Delta\ \phi}{\Delta\ I}$

38. $E = V + R_a I_a$

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

40. $S = \sqrt{3}\ V_L I_L$

41. $B = \frac{\Phi}{A}$

42. $E = B\ l\ v$

43. $E = -N\ \frac{d\emptyset}{dt}$

44. $E = \frac{V}{d}$

45. $E = \frac{1}{2}LI^2$

46. $Q = It$

47. $C_T = C_1 + C_2 + C_3 + \cdots + C_n$

48. $\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots + \frac{1}{C_n}$

49. $L_T = L_1 + L_2 + L_3 + \cdots + L_n$

50. $\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \cdots + \frac{1}{L_n}$

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

52. $Pf = cos\theta$

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