higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

ELECTRICAL PRINCIPLES AND PRACTICE
NQF LEVEL 4

(12041004)

27 February 2018 (Y-Paper)
13:00–16:00

This question paper consists of 7 pages and a formula sheet of 3 pages.

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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. Write neatly and legibly.

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QUESTION 1

1.1 Kirchhoff's second law deals with voltage, and is one of two fundamental laws in electrical engineering.

Explain Kirchhoff's voltage law. (2)

1.2 FIGURE 1 below represents an electrical network.

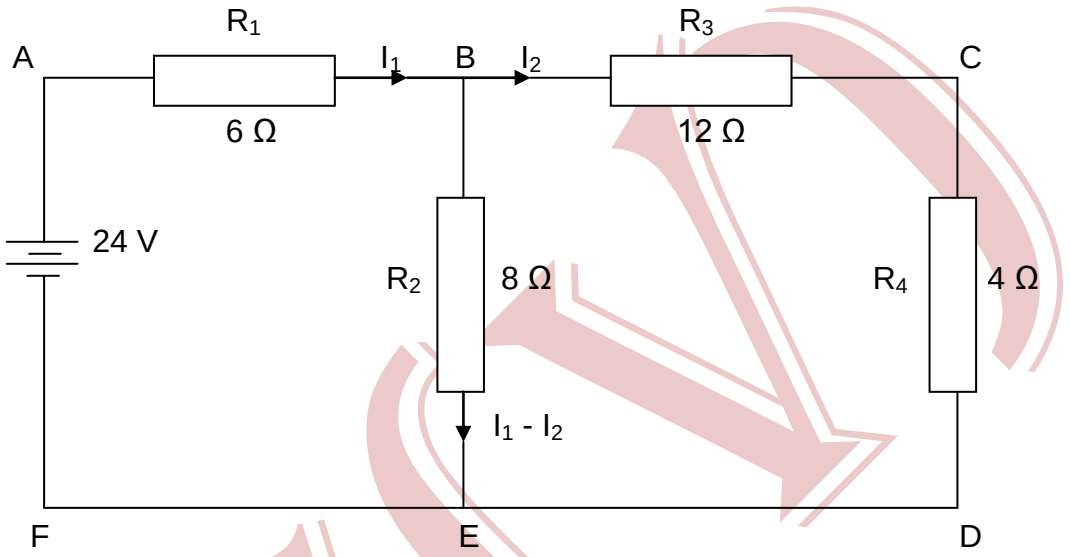


FIGURE 1

Using Kirchhoff's laws:

1.2.1 Write or set up an equation for loop ACDFA. (2)

1.2.2 Write or set up an equation for loop ABEFA. (2)

1.2.3 Calculate the value of I_1 and I_2. (4)

1.2.4 Calculate the voltage across the 8-ohm resistor. (2)

1.3 FIGURE 1 has a power supply in the circuit.

What type of electrical network is it? (1)

1.4 If R_2 was a short circuit (0 Ω), what would be the total resistance (R_T) of the circuit? (1)

1.5 An RLC series circuit consists of a 15 Ω resistor, an inductor with an inductive reactance of 15,71Ω and a capacitance of 45 microfarad. The circuit is connected across a 230V 50 Hz supply.

Calculate the following:

1.5.1 The value of the inductor (2)

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1.5.2 The capacitive reactance (2)

1.5.3 The impedance of the circuit (3)

1.6 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (1.6.1–1.6.2) in the ANSWER BOOK.

1.6.1 When the impedance of the circuit is halved, the current will remain the same.

1.6.2 The power factor decreases when kVA increases.

(2 × 1) (2)

1.7 Frequency is named after the German physicist, Heinrich Rudolf Hertz.

1.7.1 What do you understand by the term *frequency?* (1)

1.7.2 What is the standard frequency of the electricity supply in South Africa? (1)

1.8 An alternating voltage is represented by the expression v = 150 sin (60πt + 0,75) V.

Calculate the following:

1.8.1 The RMS value of the voltage (2)

1.8.2 The instantaneous value of the voltage 5 milliseconds after the commencement of the cycle (3)

[30]

QUESTION 2

2.1 FIGURE 2 below shows a pin insulator.

Identify the parts labelled A to D. Write only the answer next to the letter (A–D) in the ANSWER BOOK.

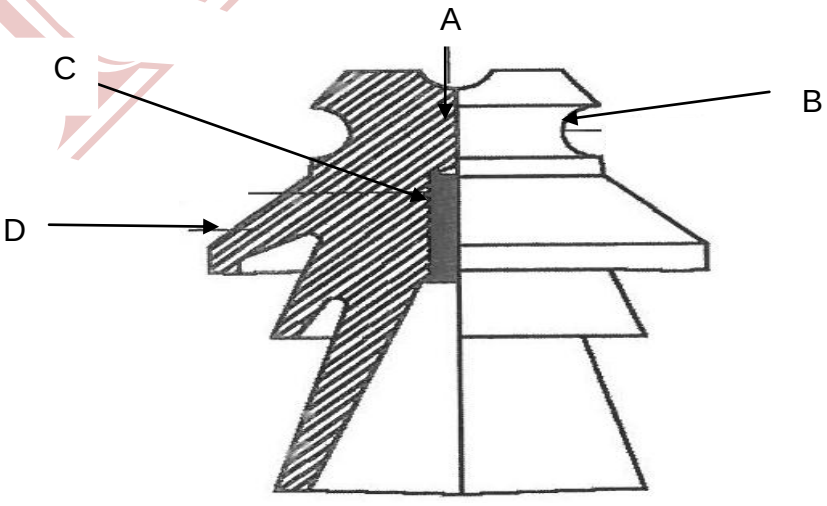


FIGURE 2

(4 × 1) (4)

2.2 State THREE disadvantages of single-phase distribution. (3)

2.3 Single phase voltage and three phase voltages are generated in the same way.

Briefly explain, with the aid of simple sketches, how a three phase supply is generated. (6)

2.4 Name TWO resources used for generating electrical energy/electricity. (2)
[15]

QUESTION 3

3.1 The purpose of testing is to ensure that an installation complies with all relevant statutory requirements and regulations.

State THREE tests that can be performed to ensure that an installation conforms to earthing regulations. (3)

3.2 Electrical circuits may have a ground (earth) connection for several reasons.

Give FOUR reasons for earthing the neutral of a low-voltage (LV) system. (4)

3.3 As an artisan from a local municipality, you have been called to find a fault in a domestic installation.

Explain how a single-phase earth-leakage relay operates when there is a fault in an installation. (4)

3.4 Explain the difference between *fault* and *fault current* as used in the field of earthing. (2 × 2) (4)
[15]

QUESTION 4

4.1 In practical terms, the output power of a transformer is never exactly equal to the input power, due to a number of electrical losses inside the core and windings of the transformer.

Explain what you understand by each of the following:

4.1.1 Eddy current loss

4.1.2 Hysteresis loss

(2 × 2) (4)

4.2 Name TWO types shapes of cores used in laminated steel-core transformers. (2)

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4.3 The primary and secondary windings of a transformer can be connected in different configuration to meet practically any requirement.

Give FOUR advantages of delta delta connection. (4)

4.4 A three-phase transformer is connected in delta-star. The primary line voltage is 15 kV and the secondary line voltage is 400 V.

Calculate the following:

4.4.1 The primary phase voltage

4.4.2 The secondary phase voltage

4.4.3 The transformation ratio

(3 × 2) (6)

4.5 Instrument transformers are high-accuracy class electrical devices used to isolate or transform voltage or current levels.

Briefly explain each of the following:

4.5.1 A current transformer

4.5.2 A voltage transformer

(2 × 2) (4)

[20]

QUESTION 5

5.1 You have been employed as a maintenance technician for DC machines in a packaging plant.

Explain what you understand by each of the following:

5.1.1 Overcompounded generator

5.1.2 Undercompounded generator

(2 × 2) (4)

5.2 A DC compound motor is basically formed by a combination of a series DC motor and a shunt DC motor to achieve the better-off properties of both these types.

Draw the load characteristic curves of cumulative compound and differential-compound motors. (4)

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5.3 A six-pole DC generator is wave-wound and the armature contains 612 conductors. The generator is driven at 900 r/min and the useful flux per pole is 0,025 Wb.

Calculate the terminal voltage if the armature resistance is 0,4 Ω and the armature current is 80 A. (5)

5.4 Thomas has been appointed as a production manager for single-phase induction motors.

Name FOUR factors that affect the performance of induction motors. (4)

5.5 Briefly explain the significance/advantage of back EMF in a DC motor. (3)

[20]

TOTAL: 100

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ELECTRICAL PRINCIPLES AND PRACTICE

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. $I = \dfrac{Emf}{R + r_T}$

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. $T = \dfrac{0{,}318 I_a Z p \emptyset}{c}$

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

46. $E = B\,l\,v$

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. $V = E - I(R_a + R_{se})$

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. $V_{rms} = 0{,}707\ V_m$

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