higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

ELECTRICAL PRINCIPLES AND PRACTICE
NQF LEVEL 4

(12041004)

10 November 2022 (X-paper)
09:00–12:00

This question paper consists of 6 pages and a formula sheet of 3 pages.

219Q1N2210

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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. Start each question 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 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (1.1.1–1.1.5) in the ANSWER BOOK.

1.1.1 An ohmmeter is used to measure resistance on a live circuit.

1.1.2 A wattmeter consists of two coils.

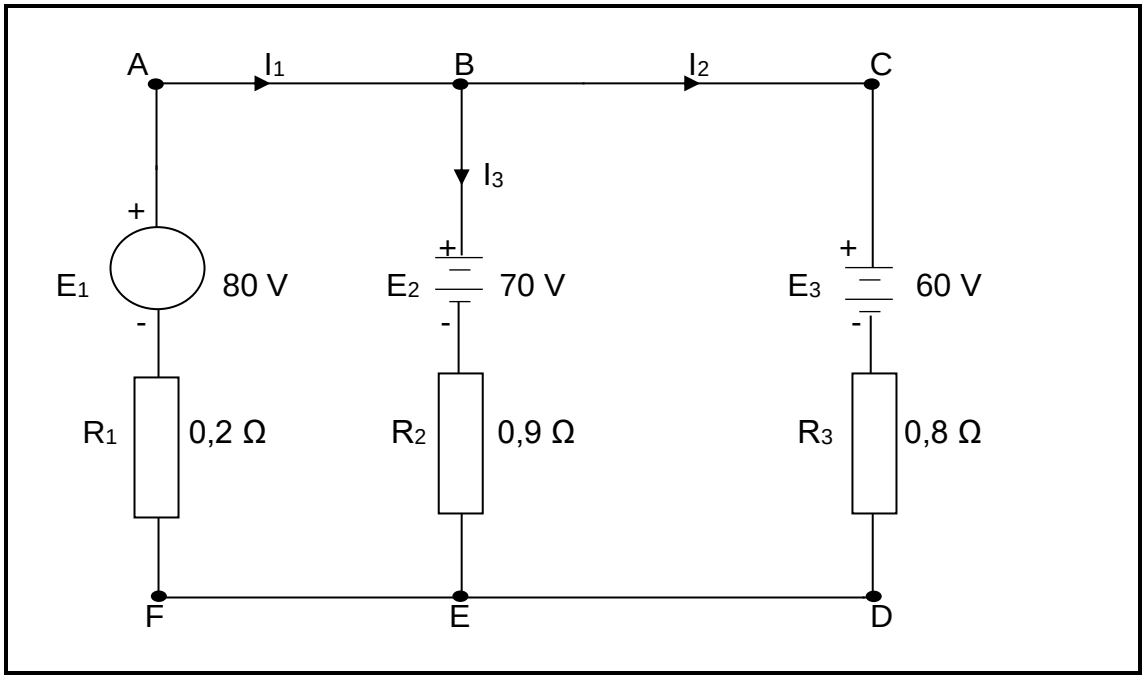
1.1.3 An insulation resistance tester cannot be used as a continuity tester.

1.1.4 A frequency meter is connected in parallel in a circuit.

1.1.5 Potential transformers are step-up transformers.

(5 × 1) (5)

1.2



Apply Kirchhoff's laws to the current to determine I_1, I_2 and I_3 using loop ABEFA and loop ABCDEFA. (10)

1.3 Calculate the frequency at which a 0,2 H inductor will have a reactance of 400 Ω. (2)

1.4 The power factor is the ratio between the true power and apparent power. It is important to have an improved power factor.

Mention at least THREE methods used to improve the power factor. (3)

1.5 An alternating current with a frequency of 100 Hz has an RMS value of 2,121 A.

Write down the equation for the instantaneous value of this current. (5)

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1.6 Explain each of the following terms with reference to a sine wave:

1.6.1 Peak value

1.6.2 Peak to peak value

(2 × 2) (4)

1.7 What is another name for the RMS value of an alternating quantity? (1)

[30]

QUESTION 2

2.1 A 300 kW, three-phase AC motor is connected in delta and the supply voltage is 380 V. The power factor is 0,96.

Calculate:

2.1.1 The line current drawn by the motor (3)

2.1.2 The phase current of the motor (2)

2.2 Describe how nuclear energy is generated. (6)

2.3 Explain the function of each of the following:

2.3.1 Lightning arrester

2.3.2 Switchgear

(2 × 2) (4)

[15]

QUESTION 3

3.1 Draw a neatly labelled diagram of a TN-S earthing system. (7)

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

3.3 Define each of the following terms used for earthing according to current regulations and standards:

3.3.1 Earth continuity conductor

3.3.2 Earth electrode

(2 × 2) (4)

[15]

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QUESTION 4

4.1 We test machines and transformers so that we can find out about operating characteristics, losses and efficiency.

4.1.1 Name TWO tests that can be performed on a transformer. (2)

4.1.2 State the purpose of each test named above in 4.1.1 (2)

4.2 Explain how a potential transformer is connected in a circuit. (2)

4.3 A three-phase, delta-star connected transformer delivers a line voltage of 346,41 V when connected to a 6 kV supply.

Calculate:

4.3.1 The transformer ratio (4)

4.3.2 The primary-phase current when the transformer draws its full-load current of 120 A from the supply (2)

4.4 Give THREE advantages of a delta-star connected transformer. (3)

4.5 Iron or core losses are made up of two parts that is eddy current loss and hysteresis loss.

4.5.1 What is hysteresis loss? (2)

4.5.2 Mention THREE factors on which the hysteresis loss depends on. (3)

[20]

QUESTION 5

5.1 A four-pole wave-wound series motor having 315 armature conductors draws a current of 50 A from a 1 000 V supply. The armature and series field resistances are 0,6 Ω and 0,4 Ω respectively. The flux per pole is 0,1 Wb.

Calculate:

5.1.1 The induced emf

5.1.2 The speed of the motor

(2 × 3) (6)

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5.2 Complete the following sentences by writing only the missing word or words next to the question number (5.2.1–5.2.4) in the ANSWER BOOK.

5.2.1 Protective devices in motor starters include a/an … and a/an … (2)

5.2.2 To reverse the direction of rotation of a DC motor, the rule is to reverse the connections of either the … or the …. (2)

5.2.3 In a DC motor, the back emf is … than the applied voltage. (1)

5.2.4 At … load, a series motor has a dangerously high speed. (1)

5.3 Compare the characteristics of *squirrel-cage motors* and *wound-rotor motors* with regard to each of the following:

5.3.1 Rotor construction

5.3.2 Starting

5.3.3 Starting torque

(3 × 2) (6)

5.4 Name TWO types of mechanical losses that occur in an induction motor. (2)

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

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. $E = B\ l\ v$

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

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

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

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