higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

# NATIONAL CERTIFICATE

# ELECTRO-TECHNOLOGY N3

(11040343)

**6 December 2023 (X-paper)**
**09:00–12:00**

**Nonprogrammable calculators may be used.**

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

282Q1G2306

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# DEPARTMENT OF HIGHER EDUCATION AND TRAINING
# REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ELECTRO-TECHNOLOGY N3
TIME: 3 HOURS
MARKS: 100

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**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. Keep subsections of questions together.
6. Round off all calculations to THREE decimals.
7. Use the correct symbols and units.
8. Use only blue or black pen.
9. Write neatly and legibly.

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## QUESTION 1

Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question number (1.1–1.10) in the ANSWER BOOK.

1.1 Used to make an electrical connection between a stationary circuit and a rotating commutator in a direct current machine:

A Yoke
B Pole shoe
C Commutator
D Brush

1.2 The armature assembly of a direct current machine:

A Pole core
B Stator
C Rotor
D Lap winding

1.3 The process of changing the square face of a brush to a concave shape:

A Bedding
B Commutation
C Armature reaction
D Sparking

1.4 Method used to perform a test on two large similar compound machines simultaneously:

A Direct method
B Hopkinson method
C Indirect method
D Swinburne method

1.5 The time taken to complete one full cycle:

A Frequency
B Average value
C Period
D Root mean square value

1.6 Method used to determine the average and rms values for nonsinusoidal waves:

A Indirect method
B Mutual inductance
C Form factor
D Midordinate rule

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1.7 In this alternating current circuit, the current is always in phase with the voltage:

A Resistive circuit
B Inductive circuit
C Capacitive circuit
D Separately excited circuit

1.8 The transformer core is laminated to reduce …

A residual magnetism.
B eddy currents.
C resistance.
D apparent power.

1.9 The process of adding impurities to a semiconductor material:

A Doping
B Forward bias
C Reverse bias
D Rectification

1.10 Electronic device made up of two back-to-back PN-junctions:

A Diode
B Capacitor
C SCR
D Transistor

(10 × 1) **[10]**

**QUESTION 2**

2.1 Draw a neat, fully labelled circuit diagram of a cumulative compound generator. (3)

2.2 Explain the term *under compounded generator*. (2)

2.3 Give TWO applications of shunt-wound generators. (2)

2.4 A series-wound generator delivers 40 A at 200 V to a certain load.

Calculate the magnitude of the generated emf if the series field and armature resistances are 0,25 Ω and 0,3 Ω respectively. (3)

**[10]**

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## QUESTION 3

3.1 Define the term *back emf* with reference to a direct current motor. (3)

3.2 A six-pole motor runs at 1 500 r/min when supplying a load. The motor generates a back emf of 230 V.

Calculate the flux per pole if the armature is lap wound with a total of 700 conductors. (4)

3.3 Draw a neat, labelled load characteristic curve of a series motor. (3)
**[10]**

## QUESTION 4

4.1 Draw a neat, labelled circuit diagram of Swinburne's test. (5)

4.2 Name ONE type of iron loss that occurs in DC machines. (1)

4.3 Two identical 220 V, 25 kW shunt generators are tested simultaneously by means of the Hopkinson's test.

Calculate the efficiency of each machine if the supply current is 35 A. Assume the current circulating between the machines to be the full-load current. (4)
**[10]**

## QUESTION 5

5.1 Define the term *form factor* as it relates to an alternating current waveform. (2)

5.2 An alternating current waveform has a maximum value of 220 V at a frequency of 50 Hz.

Calculate:

5.2.1 The rms value (2)

5.2.2 The average value (2)

5.2.3 The period it will take to reach 180 V after passing through zero (4)
**[10]**

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## QUESTION 6

A coil with an inductance of 20 mH is connected in series with a 9 Ω resistor across a 100 V, 50 Hz supply.

Calculate:

| | | | |
|---|---|---|---|
| 6.1 | The inductive reactance | | (1) |
| 6.2 | The impedance of the circuit | | (2) |
| 6.3 | The total current flowing through the circuit | | (2) |
| 6.4 | The voltage across each component | (2 + 2) | (4) |
| 6.5 | The power factor at which this circuit is operating | | (1) |
| | | | **[10]** |

## QUESTION 7

A three-phase motor is connected in delta across a 400 V supply and it draws a line current of 30 A at a power factor of 0,9 lagging.

Calculate:

| | | | |
|---|---|---|---|
| 7.1 | The input power | | |
| 7.2 | The apparent power | | |
| 7.3 | The phase current | | |
| 7.4 | The phase angle | | |
| 7.5 | The reactive power | | |
| | | (5 × 2) | **[10]** |

## QUESTION 8

| | | | |
|---|---|---|---|
| 8.1 | Name ONE method of cooling transformers. | | (1) |
| 8.2 | A 12 kV/230 V single-phase transformer has 3 800 primary turns. | | |
| | Calculate: | | |
| 8.2.1 | The transformer turns ratio | | (3) |
| 8.2.2 | The number of secondary turns | | (2) |
| 8.2.3 | The primary current if 1 100 A is drawn from the secondary winding | | (2) |
| 8.2.4 | The rating of the transformer in kVA | | (2) |
| | | | **[10]** |

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## QUESTION 9

9.1 Give TWO advantages and TWO disadvantages of moving-iron instruments. (2 + 2) (4)

9.2 A moving-coil instrument has a resistance of 10 Ω and gives a full-scale deflection when 12 mA flows through it.

9.2.1 Draw a neat, labelled circuit diagram that shows how the instrument can be used as a voltmeter. (3)

9.2.2 Calculate the value of the series resistor to be used with the meter so that it will be able to measure the voltage of 300 V. (3)

**[10]**

## QUESTION 10

10.1 Give FOUR applications of an SCR. (4)

10.2 A truth table has a certain number of possibilities.

Determine the number of possibilities for a three-input gate. (2)

10.3 Convert each of the following numbers:

10.3.1 $110,11_2$ to a decimal number

10.3.2 $0,125_{10}$ to a binary number

(2 × 2) (4)

**[10]**

**TOTAL: 100**

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## FORMULA SHEET

Any applicable formula may also be used.

1. $E = V - I_a R_a$

2. $E = V + I_a R_a$

3. $E = 2p\Phi \frac{ZN}{60c}$

4. $N = \frac{E}{k\Phi}$

5. $T = \frac{0{,}318 I_a Z p \Phi}{C}$

6. Efficiency = $\frac{VI}{VI + I_a^2 R_a + I_s V + C} \times 100\%$

7. Efficiency = $\frac{VI - (I_a^2 R_a + I_s V + C)}{VI} \times 100\%$

8. Efficiency = $\frac{2\pi N(W - S)r}{60VI} \times 100\%$

9. Efficiency = $\sqrt{\frac{I_1}{I_1 + I_2}} \times 100\%$

10. E = Blv

11. $e = E_m \sin 2\pi ft$

12. $i = I_m \sin 2\pi ft$

13. $e_{ave}$ or $i_{ave} = 0{,}637\ E_m$ or $I_m$

14. $e_{rms}$ or $i_{rms} = 0{,}707\ E_m$ or $I_m$

15. $E_{ave} = \frac{e_1 + e_2 + e_3 + e_4 + ... + e_n}{n}$ or $I_{ave} = \frac{i_1 + i_2 + i_3 + ... + i_n}{n}$

16. $E_{rms/wgk} = \sqrt{\frac{e_1^2 + e_2^2 + e_3^2 + ... + e_n^2}{n}}$ or $I_{ave} = \sqrt{\frac{i_1^2 + i_2^2 + i_3^2 + ... + i_n^2}{n}}$

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17. Form factor = $\frac{E_{rms/wgk}}{E_{ave/gem}}$ or $\frac{I_{RMS/WGK}}{i_{AVE/GEM}}$

18. Crest factor = $\frac{E_m}{E_{rms/wgk}}$ or $\frac{I_m}{I_{rms/wgk}}$

19. I = $\frac{V}{R}$

20. $X_L = 2\pi fL$; I = $\frac{V}{X_L}$

21. $X_C = \frac{1}{2\pi fC}$; I = $\frac{V}{X_C}$

22. Z = $\sqrt{R^2 + X_L^2}$; Z = $\sqrt{R^2 + X_C^2}$; I = $\frac{V}{Z}$

23. $\tan\theta = \frac{X_L}{R}$; $\tan\theta = \frac{X_C}{R}$

24. $V_R = I \times R$; $V_L = I \times X_L$; $V_C = I \times X_C$

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

26. $\tan\theta = \frac{X_L - X_C}{R}$; $\tan\theta = \frac{X_C - X_L}{R}$

27. $P = V \times I$; $P = I^2 R$; P = $\frac{V^2}{R}$

28. $P = VI\cos\theta$

29. $\cos\theta = \frac{R}{Z}$; $\cos\theta = \frac{W \text{ or } kW}{VA \text{ or } kVA}$

30. $I_{active} = ICos\theta$; $I_{reactive} = ISin\theta$

31. $P = VI\cos\theta$

32. $Q = VI\sin\theta$

33. $f_r = \frac{1}{2\pi\sqrt{LC}}$

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34. $I = \sqrt{I_R^{\,2} + I_L^{\,2}}$ ; $\tan\theta = \frac{I_L}{I_R}$

35. $I = \sqrt{I_R^{\,2} + I_C^{\,2}}$ ; $\tan\theta = \frac{I_C}{I_R}$

36. $I = \sqrt{I_R^{\,2} + (I_L - I_C)^2}$ ; $\tan\theta = \frac{I_L - I_C}{I_R}$

37. $I = \sqrt{I_R^{\,2} + (I_C - I_L)^2}$ ; $\tan\theta = \frac{I_C - I_L}{I_R}$

38. $\cos\theta = \frac{I_R}{I}$

39. $V_L = V_p$ ; $I_L = \sqrt{3} I_p$

40. $V_L = \sqrt{3} V_p$ ; $I_L = I_p$

41. $W = \sqrt{3} V_L I_L Cos\theta \times \eta$

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

43. $kVA = \frac{\sqrt{3} V_L I_L}{1000}$

44. $V_{shunt} = V_{meter}$ ; $I_s R_s = I_m R_m$

45. $I_T = I_m + I_s$

46. $I_t = \frac{V_t}{R_t}$

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