higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T560 (**E**)(A11) T

# NATIONAL CERTIFICATE

# ELECTRO-TECHNOLOGY N3

(11040343)

**11 April 2018 (X-Paper)**
**09:00–12:00**

**Calculators may be used.**

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

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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. Keep subsections of questions together.
5. Round ALL calculations off to THREE decimal places.
6. Use the correct symbols and units.
7. Start each question on a NEW page.
8. All circuit diagrams and vector diagrams must be at least one third of a page and must be fully labelled.
9. Write neatly and legibly.

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## QUESTION 1

1.1 Give TWO reasons why mica is used as insulating material between the segments of the commutator in a DC machine. (2)

1.2 Why are the segments of a DC machine wedge-shaped? (2)

1.3 Draw a neat fully labelled circuit diagram of a separately excited DC generator. (4)

1.4 Name TWO types of brushes used in a DC machine. (2)
**[10]**

## QUESTION 2

2.1 Name THREE types of self-excited generators. (3)

2.2 Draw a neat, fully labelled circuit diagram of a series wound generator, clearly showing all currents, power input and power output. (4)

2.3 Briefly describe a *cumulative compound-wound generator*? (2)

2.4 Name the current which flows through compensating windings used to improve commutation. (1)
**[10]**

## QUESTION 3

3.1 Make a neat, fully labelled sketch of a manual face-plate starter which is used to start a series motor. (6)

3.2 A 300 V DC shunt motor draws 45 A from the supply.

If the armature and shunt field resistances are 0,3 Ω and 200 Ω respectively, calculate the speed of the motor if the useful flux per pole is 25 mWb.Take the constant of the motor to be 12. (4)
**[10]**

## QUESTION 4

4.1 Name TWO types of iron losses that occur in the field poles, pole shoes and armature cores of n DC machines. (2**)**

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4.2 An overload relay is used to disconnect the motor automatically from the supply in the event of an over-current.
Make a neat fully labelled sketch of a simple thermal-type overload relay.

Your sketch must contain the following labels:

- Bimetal strip
- Heating element
- Contacts
- temperature adjusting cam (4)

4.3 The following data was recorded in a DC motor tested by means of the rope brake method

Terminal voltage = 200 V
Current drawn from supply = 2,5 A
Pulley diameter = 30 cm
Weight (W) = 436 N
Spring balance reading = 210 N
Speed of shaft (n) = 20 r/s

Calculate the efficiency of the motor. (4)
**[10]**

**QUESTION 5**

5.1 An alternating EMF is represented by the following expression: e = 240 sin (471,239 t).
Determine the following:

5.1.1 Maximum value of this EMF. (1)

5.1.2 Average value of the EMF (1)

5.1.3 RMS value of the EMF (1)

5.1.4 Form factor (1)

5.1.5 Frequency (2)

5.2 State FOUR effects that a poor power factor has on an AC circuit. (4)
**[10]**

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## QUESTION 6

A parallel circuit consists of a 60 Ω resistor, an inductor of 65 mH and a 90 µF capacitor. The circuit is connected to a 220 V, 50 Hz supply.

Calculate the following:

6.1 Current flowing through each of the branches of the circuit (5)

6.2 Total current flowing through the circuit (2)

6.3 Impedance of the circuit (1)

6.4 Power factor at which the circuit is operating. Also state the nature of the power factor. (2)

**[10]**

## QUESTION 7

7.1 Derive a formula that can be used to determine the frequency that will produce resonance in a series circuit. (3)

7.2 Make a neat, fully labelled circuit diagram showing how the stator windings of a three-phase induction motor are connected in star. (4)

7.3 A poor power factor reduces the efficiency of a plant and also costs the consumer more.
State TWO methods used to improve the power factor of a plant. (2)

7.4 Indicate whether the following statement is TRUE or FALSE. Write only TRUE or FALSE next to the question number (7.4) in the ANSWER BOOK.

Capacitive reactance opposes voltage changes which causes the current to lead the voltage. (1)

**[10]**

## QUESTION 8

8.1 Show by means of a neat, fully labelled circuit diagram how THREE single phase transformers are connected to form a delta-star transformer. (4)

8.2 A three-phase distribution transformer has a delta-connected primary and a star-connected secondary winding. The transformer is connected to a 6, 6kV supply. If the secondary phase voltage is 220V,
Calculate the following

8.2.1 Turns ratio of the transformer (2)

8.2.2 Primary line current if the transformer delivers a current of 200A to the load (2)

8.2.3 Full-load rating of the transformer in kVA (2)

**[10]**

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## QUESTION 9

9.1 State TWO functions of the controlling mechanism of an Indicating type instruments (2)

9.2 The dynamometer-type instrument is an example of a moving-coil instrument.

State TWO advantages and TWO disadvantages of a dynamometer-type instrument. (2 × 2) (4)

9.3 Make a neat, fully labelled sketch to show how an ammeter, voltmeter and wattmeter are connected to a low voltage circuit. Clearly show the supply as well as the load. (4)

**[10]**

## QUESTION 10

10.1 State TWO functions of diodes used in rectifier circuits. (2)

10.2 Draw a switching circuit for the AND gate. (3)

10.3 Subtract $1011_2$ from $10010_2$ using the rules for binary subtraction. Convert the answer to its decimal equivalent. (5)

**[10]**

**TOTAL: 100**

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**ELECTRO-TECHNOLOGY N3**

**FORMULA SHEET**

Any letter 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. $N = \frac{V}{K\Phi}$
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. $e = E_m \text{Sin} 2\pi ft$
12. $i = I_m \text{Sin} 2\pi ft$
13. $e_{ave/gem}$ or $i_{ave/gem}$ = 0,637 $E_m$ or $I_m$
14. $e_{rms/wgk}$ or $i_{rms/wgk}$ = 0,707 $E_m$ or $I_m$
15. $E_{ave/gem} = \frac{e_1 + e_2 + e_3 + e_4 + ... + e_n}{n}$

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Or $I_{ave/gem} = \frac{i_1 + i_2 + i_3 + ... + i_n}{n}$

16. $E_{rms/wgk} = \sqrt{\frac{e_1^2 + e_2^2 + e_3^2 + ... + e_n^2}{n}}$

Or $I_{rms/wgk} = \sqrt{\frac{i_1^2 + i_2^2 + i_3^2 + ... + i_n^2}{n}}$

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 θ = $\frac{X_C}{R}$

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 θ = $\frac{X_L - X_C}{R}$; Tan θ = $\frac{X_C - X_L}{R}$

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

28. $P = VI\cos\theta$

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

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

31. P = VI Cos θ

    Q = VI Sin θ

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

33. I = $\sqrt{I_R{}^2 + I_L{}^2}$ ; Tan θ = $\frac{I_L}{I_R}$

34. I = $\sqrt{I_R{}^2 + I_C{}^2}$ ; Tan θ = $\frac{I_C}{I_R}$

35. I = $\sqrt{I_R{}^2 + (I_L - I_C)^2}$ ; Tan θ = $\frac{I_L - I_C}{I_R}$

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

37. Cos θ = $\frac{I_R}{I}$

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

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

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

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

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

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

44. $I_T = I_m + I_s$

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

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