higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T510(E)(J29)T
**AUGUST 2010**

NATIONAL CERTIFICATE

# ELECTRO-TECHNOLOGY N3

(11040343)

**29 July (X-Paper)**
**09:00 – 12:00**

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

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

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

## INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
2. Read ALL the questions carefully.
3. Full marks can be obtained by answering questions to the value of 100 marks correctly.
4. The correct information must be copied from the question paper and to be substituted for the correct symbol.
5. Number the answers correctly according to the numbering system used in this question paper.
6. Keep the question subsections together, for example QUESTION 1: 1.1, 1.2, 1.3, et cetera.
7. Rule off across the page on completion of each question.
8. Sketches and diagrams must be done in pencil. The sketches/diagrams must be neat, reasonably large and fully labelled.
9. The answers must be worked to THREE decimal digits after the comma, for example 3,142.
10. Use the correct units for answers.
11. Write neatly and legibly.

## QUESTION 1

1.1 Describe the following terms as applied in direct current machines:

1.1.1 Armature reaction (2)
1.1.2 Commutation (2)

1.2 Briefly explain the effects of the following armature reactions that are used for minimisation:

1.2.1 Brush shifting (2)
1.2.2 Interpoles (2)
1.2.3 Increasing the field flux (2)
**[10]**

## QUESTION 2

2.1 Briefly describe the term *cumulative compounded* and support the answer with a suitable sketch. (4)

2.2 Which law in electrotechnology is associated with back EMF? (1)

2.3 Draw a neat sketch which explains the basic principles of a generator and shows the different component's relative directions. (5)
**[10]**

## QUESTION 3

3.1 Name ONE use (application) of the following types of direct current machines:

3.1.1 Compound generator (1)
3.1.2 Differentially compounded generator (1)

3.2 Draw a circuit diagram of the following terms in direct current machine and clearly show ALL directions of the different components:

3.2.1 A short shunt compounded motor (3)
3.2.2 A long shunt compounded motor (3)

A 380 volts DC generator has an armature resistance of 0,2 ohms.
Determine the generated EMF when armature current is 25 A. (2)
**[10]**

## QUESTION 4

4.1 State TWO factors which the speed of an electric direct-current motor depends upon. (2)

4.2 Briefly name and explain TWO safety devices applications in the face plate starter. (4)

4.3 Briefly explain the operation of oil dashpot type mechanisms. (4) **[10]**

## QUESTION 5

During a test on TWO similar 440 V and 198 kW generators the current between the machines is equal to the full-load current and in addition 60 A are taken from the supply.

Determine the following:

5.1 The load current of the generator in amperes (2)

5.2 The approximate efficiency of each generator (5)

5.3 Briefly name THREE types of losses which occur in a DC machine. (3) **[10]**

## QUESTION 6

The following ordinates points are read from the even wave of an alternating quantity:

$i_1$ = 12 A; $i_2$ = 34 A; $i_3$ = 54 A; $i_4$ = 75 A; $i_5$ = 94 A; $i_6$ = 112 A; $i_7$ = 100 A; $i_8$ = 87 A; $i_9$ = 68 A; $i_{10}$ = 48 A; $i_{11}$ = 27 A; $i_{12}$ = 10 A.

Determine the following:

6.1 Average value (3)

6.2 RMS value (4)

6.3 The maximum value of the alternating quantity (1)

6.4 Form factor (1)

6.5 Crest factor (1) **[10]**

## QUESTION 10

10.1 Give THREE configurations of a transistor. (3)

10.2 Briefly explain what is a *positive ion*. (2)

10.3 Name TWO uses of the cathode ray oscilloscope. (2)

10.4 Determine the number of possibilities for the following:

10.4.1 A four input gate (1)
10.4.2 An eight input gate (1)
10.4.3 A three input gate (1)
**[10]**

**TOTAL: 100**

31. $P = VI \text{ Cos } \theta$

$Q = VI \text{ Sin } \theta$

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

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

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

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

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

37. $Cos\ \theta = \frac{I_R}{I}$

38. $V_L = V_P$ ; $I_L = \sqrt{3}\, Ip$

39. $V_L = \sqrt{3}\, Vp$ ; $I_L = I_P$

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. $KVA = \frac{\sqrt{3}\, V_L I_L}{1\,000}$

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

44. $I_T = I_m + I_s$

45. $I_T = \frac{V_T}{R_T}$

higher education & training

Department:
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REPUBLIC OF SOUTH AFRICA

T520(E)(J21)T
**AUGUST 2010**

NATIONAL CERTIFICATE

# ELECTROTECHNICS N4

(8080074)

**21 July (X-Paper)**
**09:00 – 12:00**

**REQUIREMENTS: Graph paper.**

**Calculators may be used.**

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

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

NATIONAL CERTIFICATE
ELECTROTECHNICS N4
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 correctly according to the numbering system used in this question paper.
4. Write neatly and legibly.

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**QUESTION 1**

1.1 An aluminium conductor 50 m long is connected in parallel with a copper conductor with the same length. When a current of 80 A is passed through the combination, it is found that the current through the copper conductor is 30 A. The diameter of the aluminium conductor is 5 mm.

Determine the following:

1.1.1 Diameter of the copper conductor, if the resistivity of copper is 0,017 micro-ohm metres and that aluminium 0,027 micro-ohm metres

1.1.2 Voltage drop across the conductors (8)

1.2 A resistance of 1,25 ohms is connected in parallel with a resistance of 5 ohms. The combination is connected in series with a THIRD resistance of 3 ohms.

If the whole circuit is connected across a battery having an EMF of 30 V and an internal resistance of 1 ohm, calculate the following:

1.2.1 The terminal voltage of the battery

1.2.2 The current through each resistor (2 × 3) (6)

1.3 Define *temperature coefficient of resistance at 0 °C.* (3)

1.4 A conductor of effective length of 400 mm moves with a velocity of 20 m/s perpendicular to a magnetic field of uniform flux density of 0,5 T.

Calculate the following:

1.4.1 EMF inducted in the conductor

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

1.4.3 The power required to move the conductor (3)
**[20]**

**QUESTION 2**

2.1 Two capacitors each having a potential difference (PD) of 300 V and 60 V, respectively, are connected in series across DC supply.

Calculate the total capacitance and the capacitance across each capacitor if a charge of 900 micro-coulomb is measured across the capacitors. (4)

2.2 The field coils of a motor have a resistance of 150 ohms at 50 °C. After a run at full load, the resistance increases to 300 ohms.

Determine the temperature of the coils, if the temperature coefficient of resistance is 0,004 per °C at 50 °C . (4)

2.3 A battery having EMF of 14 volts an internal resistance of 0,2 ohms is connected in parallel with a direct-current generator of EMF 24 volts and internal resistance of 0,3 ohms. The combination is used to supply a load having a resistance of 0,6 ohms.

Use Kirchhoff's laws to determine the following:

2.3.1 The value and direction of the current through the battery

2.3.2 The value and direction of the current through the generator

2.3.3 The potential difference across the load (9)

2.4 Define the term *ampere*. (3)
**[20]**

**QUESTION 3**

3.1 Calculate the speed at 8 pole series generator having a wave wound armature with 480 conductors and resistance of 0,3 ohm supplying a load of 36 kW at 360 V. The resistance of the field winding brush contact resistance is 0,1 ohm. The field sets up a flux per pole of 0,05 Wb. (5)

3.2 What type of winding would be used for each of the following:

3.2.1 A high-voltage low-current

3.2.2 A high-current low-voltage DC machine (2)

3.3 The open-circuit characteristics of a shunt-excited DC machine is as follows:

| Terminal voltage (V) | 4 | 8 | 12 | 16 | 17 | 18 |
|---|---|---|---|---|---|---|
| Field current (A) | 0,2 | 0,4 | 0,6 | 1,0 | 1,2 | 1,5 |

Plot a graph and determine the open circuit voltage if the field circuit resistance is 12 ohms. (8)

3.4 A short-shunt compound generator supplies a load of 100 A. It has a shunt-field resistance of 20 ohms, an armature resistance of 0,455 ohms and a field resistance of 0,2 ohms.

Calculate the armature EMF, if the terminal voltage is 180 V. (5)
**[20]**

## QUESTION 4

4.1 A sinusoidal AC supply has a maximum value of 282,885 V and a periodic time of 50 milliseconds.

Calculate the following:

4.1.1 The RMS value of the voltage

4.1.2 The average value of the voltage

4.1.3 The frequency

4.1.4 The instantaneous value of 7,5 milliseconds after the commencement of the cycle (5)

4.2 A 36 kVA, 3 600/180 V, 60 Hz single-phase transformer has 1 000 turns on the primary winding.

Calculate the following:

4.2.1 Turns ratio

4.2.2 Number of secondary turns

4.2.3 Secondary full-load current

4.2.4 Maximum value of the core flux (7)

4.3 In a certain circuit having THREE parallel branches, the instantaneous branch circuits are represented by:

$$i_1 = 30Sin(wt + \frac{\pi}{4})$$

$$i_2 = 45Sin(wt - \frac{\pi}{4})$$

4.3.1 Calculate the total current and write it in the form:

$$i = I_{max}Sin(wt + \theta)$$

(5)

4.3.2 Represent these currents by drawing a phasor diagram. (3)

**[20]**

$$f = \frac{Np}{60}$$

$$\omega = 2\pi f$$

$$Z_L = R + j\omega L$$

$$Z_c = R - j\frac{1}{\omega C}$$

$$pf = \cos\phi = \frac{R}{Z}$$

$$S = VI$$

$$P = V.I\cos\phi = I^2R$$

$$Q = V.I\sin\phi$$

4. *Transformers*

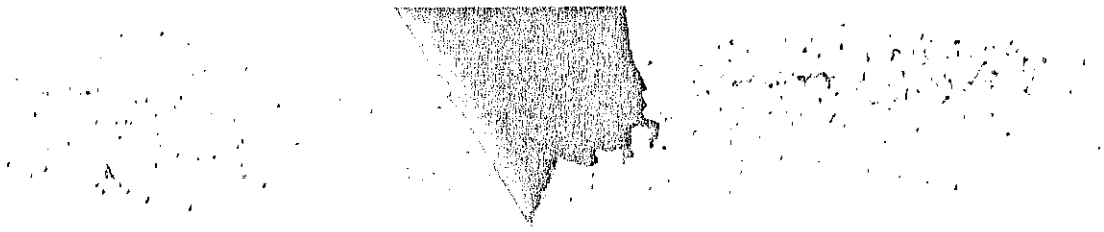
$$E = 4{,}44\ f\ \Phi_m\ N$$

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

5. *Measuring instruments*

$$R_{SH} = \frac{i_m\ R_m}{I_{sh}}$$

$$R_{se} = \frac{V}{i_m} - R_m$$



# ELECTROTECHNICS N4

## FORMULA SHEET

Any applicable formula may also be used.

### 1. *Principles of electricity*

$$E = V + Ir$$

$$V = IR$$

$$R_{se} = R_1 + R_2 + \dots R_n$$

$$R_p = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \dots \frac{1}{R_n}}$$

$$R = \rho \frac{\ell}{a}$$

$$\frac{R_1}{R_2} = \frac{1 + \alpha_o T_1}{1 + \alpha_o T_2}$$

$$R_t = R_\theta \left[1 + \alpha_\theta \left(t - \theta\right)\right]$$

$$P = VI = I^2R = \frac{V^2}{R}$$

$$\Phi = \frac{mmf}{S} = \frac{IN}{S}$$

$$H = \frac{IN}{\ell}$$

$$F = B\ell I$$

$$E = \frac{\Delta\Phi}{\Delta t} . N$$

$$E = B\ell v$$

$$E = \frac{L\Delta I}{\Delta t}$$

$$L = \frac{\Delta\Phi}{\Delta I} . N$$

$$Q = VC$$

$$Q_{se} = Q_t = Q_1 = Q_2 \dots = Q_n$$

$$C_{se} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \dots \frac{1}{C_n}}$$

$$Q_p = Q_1 + Q_2 + \dots Q_n$$

$$C_p = C_1 + C_2 + \dots C_n$$

### 2. *Direct-current machines*

$$E = \frac{2Z}{c} . \frac{Np}{60} . \Phi$$

$$c = 2a$$

$$E_{gen} = V + I_a R_a$$

$$E_{mot} = V - I_a R_a$$

$$R_{start} = \frac{(V - E)}{I_a} - R_a$$

### 3. *Alternating-current machines*

$$E_m = 2\pi BANn$$

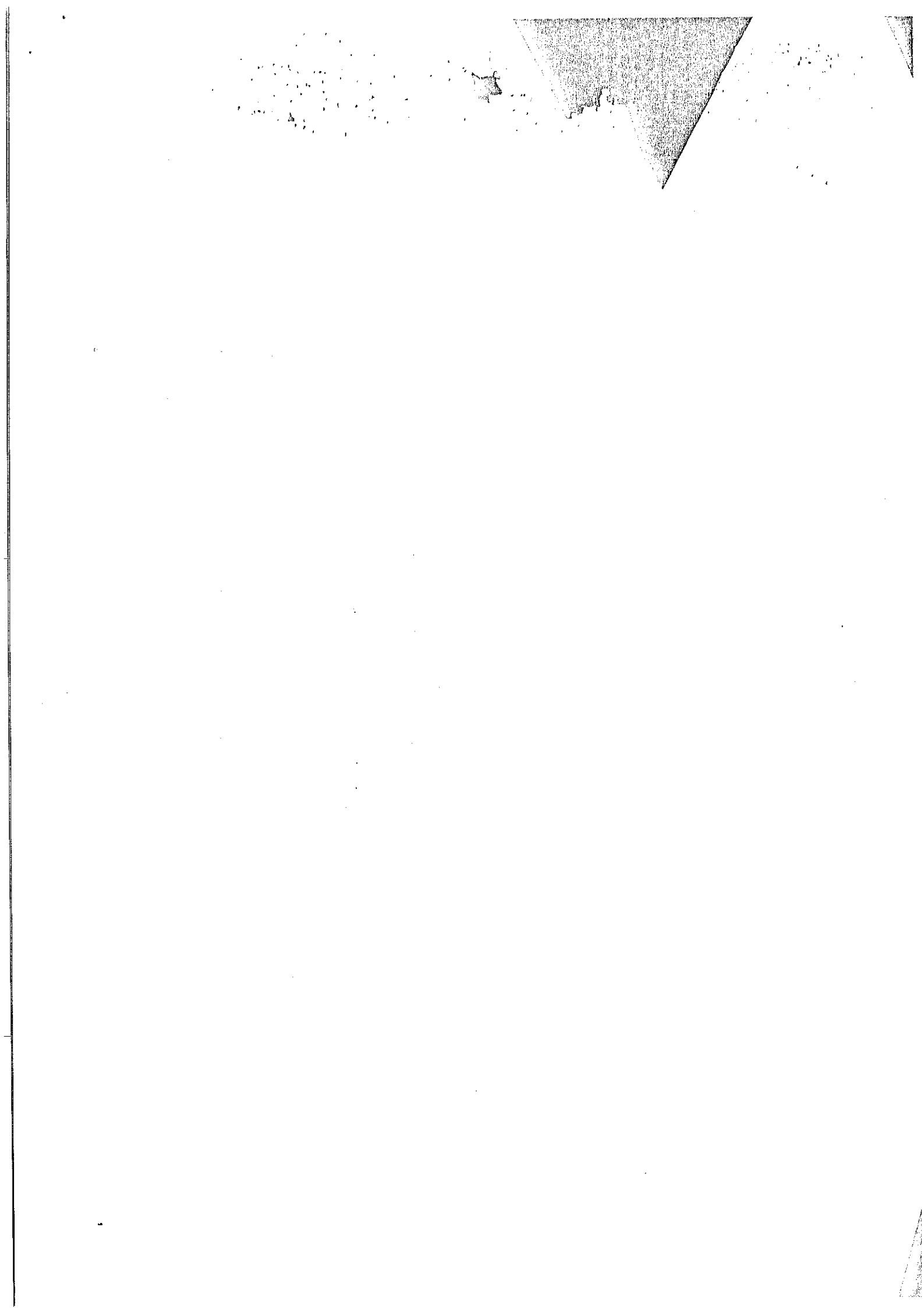
$$e = E_m \sin\left(2\pi f . t \times 57{,}3\right)^\circ$$

$$E_{ave} = 0{,}637\ E_m$$

$$E_{rms} = 0{,}707\ E_m$$

$$T = \frac{1}{f}$$

PTO



...ust a SIX pole alternator be driven, to produce an EMF ...ving a frequency of 60 Hz? (2)

What motor is superior in efficiency and the most extensively used of ALL types of electric motors? (2)

5.3 An impedance of 60 L 45° ohms and an impedance of 60 L -45° ohms are connected in parallel to a 600 volt, 50 Hz supply.

Determine the following:

5.3.1 The total impedance

5.3.2 The current in each branch

5.3.3 The current flowing in the circuit

5.3.4 The overall power factor

5.3.5 Draw the phasor diagram to represent the current in the circuit (10)

5.4 A milli-ammeter with a 6 ohms coil resistances, indicates a full-scale deflection when a current of 600 mA flows through it.

Calculate the value of the series resistance required to enable the instrument to be used as a:

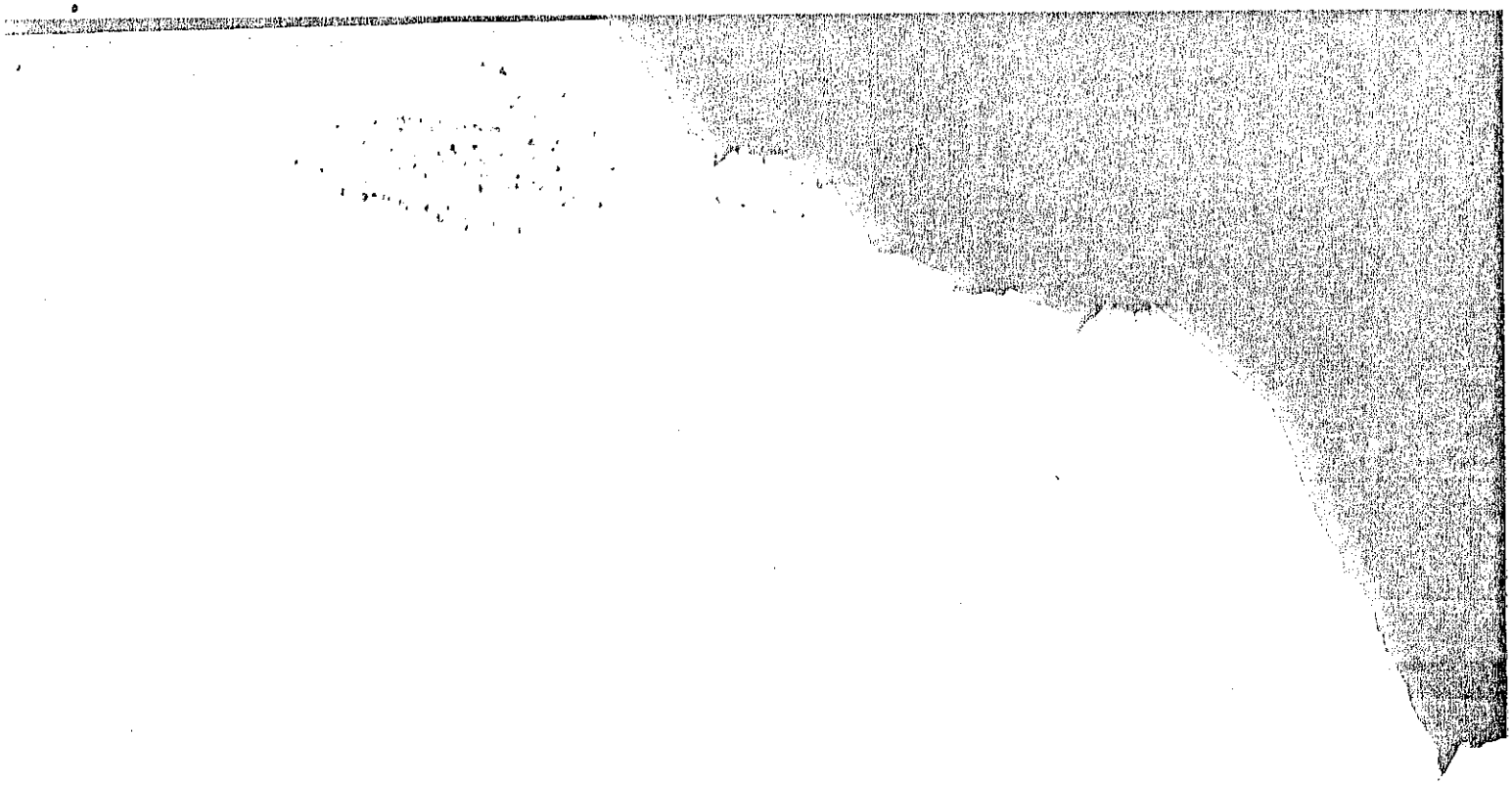
5.4.1 6 V voltmeter (2)

5.4.2 1 A ammeter (2)

5.5 Why are coal fired power stations normally built far away from the main load points? (2)

**[20]**

**TOTAL: 100**



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# ELECTRO-TECHNOLOGY N3

(11040343)

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10. Use the correct units for answers.
11. Write neatly and legibly.

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## QUESTION 1

1.1 Describe the following terms as applied in direct current machines:

1.1.1 Armature reaction (2)
1.1.2 Commutation (2)

1.2 Briefly explain the effects of the following armature reactions that are used for minimisation:

1.2.1 Brush shifting (2)
1.2.2 Interpoles (2)
1.2.3 Increasing the field flux (2)
**[10]**

## QUESTION 2

2.1 Briefly describe the term *cumulative compounded* and support the answer with a suitable sketch. (4)

2.2 Which law in electrotechnology is associated with back EMF? (1)

2.3 Draw a neat sketch which explains the basic principles of a generator and shows the different component's relative directions. (5)
**[10]**

## QUESTION 3

3.1 Name ONE use (application) of the following types of direct current machines:

3.1.1 Compound generator (1)
3.1.2 Differentially compounded generator (1)

3.2 Draw a circuit diagram of the following terms in direct current machine and clearly show ALL directions of the different components:

3.2.1 A short shunt compounded motor (3)
3.2.2 A long shunt compounded motor (3)

A 380 volts DC generator has an armature resistance of 0,2 ohms. Determine the generated EMF when armature current is 25 A. (2)
**[10]**

## QUESTION 4

4.1 State TWO factors which the speed of an electric direct-current motor depends upon. (2)

4.2 Briefly name and explain TWO safety devices applications in the face plate starter. (4)

4.3 Briefly explain the operation of oil dashpot type mechanisms. (4)

**[10]**

## QUESTION 5

During a test on TWO similar 440 V and 198 kW generators the current between the machines is equal to the full-load current and in addition 60 A are taken from the supply.

Determine the following:

5.1 The load current of the generator in amperes (2)

5.2 The approximate efficiency of each generator (5)

5.3 Briefly name THREE types of losses which occur in a DC machine. (3)

**[10]**

## QUESTION 6

The following ordinates points are read from the even wave of an alternating quantity:

$i_1$ = 12 A; $i_2$ = 34 A; $i_3$ = 54 A; $i_4$ = 75 A; $i_5$ = 94 A; $i_6$ = 112 A; $i_7$ = 100 A; $i_8$ = 87 A; $i_9$ = 68 A; $i_{10}$ = 48 A; $i_{11}$ = 27 A; $i_{12}$ = 10 A.

Determine the following:

6.1 Average value (3)

6.2 RMS value (4)

6.3 The maximum value of the alternating quantity (1)

6.4 Form factor (1)

6.5 Crest factor (1)

**[10]**

**QUESTION 10**

10.1 Give THREE configurations of a transistor. (3)

10.2 Briefly explain what is a *positive ion*. (2)

10.3 Name TWO uses of the cathode ray oscilloscope. (2)

10.4 Determine the number of possibilities for the following:

10.4.1 A four input gate (1)
10.4.2 An eight input gate (1)
10.4.3 A three input gate (1)
**[10]**

**TOTAL: 100**

31. $P = VI \text{ Cos } \theta$

$Q = VI \text{ Sin } \theta$

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

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

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

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

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

37. $Cos\ \theta = \frac{I_R}{I}$

38. $V_L = V_P$ ; $I_L = \sqrt{3}\, Ip$

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

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. $KVA = \frac{\sqrt{3}\, V_L I_L}{1\,000}$

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

44. $I_T = I_m + I_s$

45. $I_T = \frac{V_T}{R_T}$

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

or/of $I_{rms\ wgk} = \sqrt{\frac{i_1^2 + i_2^2 + i_3^2 + \ldots + i_n^2}{n}}$

17. $Form\ factor/Vormfaktor = \frac{E_{rms\ wgk}}{E_{ave\ gem}}\ or/of\ \frac{I_{rms\ wgk}}{I_{ave\ gem}}$

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

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

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

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

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

28. $P = VI \text{ Cos } \theta$

29. $\text{Cos } \theta = \frac{R}{Z}\ ;\ Cos\ \theta = \frac{W\ or/of\ KW}{VA\ or/of\ KVA}$

30. $I_{active\ aktief} = I \cos \theta$

$I_{reactive/reaktief} = I \sin \theta$

# ELECTRO-TECHNOLOGY N3

## FORMULA SHEET

Any applicable formula may also be used.

1. $E = V - I_a R_a$

2. $E = V + I_a R_a$

3. $E = 2p\Phi \dfrac{ZN}{60C}$

4. $N = \dfrac{V}{K\Phi}$

5. $T = \dfrac{0.318\, I_a\, Zp\, \Phi}{C}$

6. $Efficiency/Rendement = \dfrac{VI}{VI + Ia^2 Ra + IsV + C} \times 100$

7. $Efficiency/Rendement = \dfrac{VI - (Ia^2 Ra + IsV + C) \times 100}{VI}$

8. $Efficiency/Rendement = \dfrac{2\pi N(W - S) \times r}{60\, VI} \times 100$

9. $Efficiency/Rendement = \sqrt{\dfrac{I_1}{I_1 + I_2}} \times 100$

10. $E = Blv$

11. $e = E_m Sin2\pi ft$

12. $i = I_m Sin2\pi ft$

13. $e_{ave\ gem}$ *of/or* $i_{ave\ gem} = 0.637\ Em$ *or/of* $Im$

14. $e_{rms\ vgk}$ *or/fr* $i_{rms\ vgk} = 0,707\ Em$ *or/of* $Im$

15. $E_{aver\,gem.} = \dfrac{e_1 + e_2 + e_3 + \ldots + e_n}{n}$

or/of $I_{ave/gem.} = \dfrac{i_1 + i_2 + i_3 + \ldots + i_n}{n}$