EKURHULENI TECH

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PAST EXAM PAPER & MEMO N3

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Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T500**(E)**(A5)T
APRIL EXAMINATION

NATIONAL CERTIFICATE

ELECTRO-TECHNOLOGY N3

(11040343)

5 April 2016 (X-Paper)
09:00–12:00

This question paper consists of 7 pages and 1 formula sheet of 3 pages.

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. Number the answers according to the numbering system used in this question paper.
4 The correct information must be copied from the question paper and substituted for the correct symbol.
5. Keep the subsections of questions together.
6. Rule off after the completion of EACH question.
7. Sketches and diagrams must be done in pencil.
8. The sketches/diagrams must be neat, reasonably large and fully labelled.
9. The answers must be worked to THREE decimal places.
10. Use the correct units for answers.
11. Write neatly and legibly.

QUESTION 1

1.1 Choose the correct word(s) from those given in brackets. Write only the word(s) next to the question number (1.1.1–1.1.2) in the ANSWER BOOK.

1.1.1 The (field winding, yoke, pole shoes) is that part of the DC machine which protects the inner parts. (2)

1.1.2 (Field poles, pole shoes, carbon brushes) are used to increase the efficiency of the magnetic path. (2)

1.2 Briefly explain the following methods to minimise the effects of armature reaction.

1.2.1 Brush shifting (2)

1.2.2 Interpoles (2)

1.2.3 Increasing the field flux (2)
[10]

QUESTION 2

2.1 State FOUR factors which the magnitude of an induced EMF in a conductor depends on. (4)

2.2 Name TWO generators which are dependent on the excitation process in order to operate, and support your answer with two relevant sketches. (6)
[10]

QUESTION 3

3.1 State TWO important reasons for the decrease in terminal voltage of a separately excited generator. (2)

3.2 Name ONE purpose of the separately excited generator. (1)

3.3 Briefly state ONE application for each of the following types of generator.

3.3.1 Shunt generator (1)

3.3.2 Series generator (1)

3.4 Name TWO variable factors that the torque of a DC motor depends on. (2)

3.5 Name THREE applications of the series motors. (3)
[10]

QUESTION 4

A brake test was performed on a DC motor and the following information obtained:

The drum radius	=	300 mm
Drum speed	=	420 rev/min
Effective load	=	425 N.m
The supply voltage	=	0,21 kV
The current absorbed by the motor	=	33 000 mA

Determine the following:

4.1 Input power of the motor in kW (3)

4.2 Output power of the motor in kW (4)

4.3 The motor efficiency (3)
[10]

QUESTION 5

5.1 The following ordinate points were read from the full cycle of an alternating quantity.

$e_1 = 20$ V; $e_2 = 42$ V; $e_3 = 83$ V; $e_4 = 120$ V; $e_5 = 95$ V; $e_6 = 35$ V; $e_7 = 18$ V.

Determine the following from the above data:

5.1.1 What type of alternating quantity is mentioned above? (1)

5.1.2 Actual value (3)

5.1.3 Average value (3)

5.1.4 Form factor (1)

5.1.5 What type of wave form is deduced from the value of the crest factor, if crest factor is 1,414 and form factor as calculated in QUESTION 5.1.4? (1)

5.2 Define *maximum value.* (1)
[10]

QUESTION 6

An RLC circuit consists of a 400 mH inductor, a resistor of 10 Ω and a 50 mF capacitor. The circuit is connected in series across a 240 V/60 Hz supply.

Determine the following:

6.1 The impedance of the circuit (5)

6.2 The circuit current (2)

6.3 The phase angle and state whether it is leading or lagging (3)
[10]

QUESTION 7

7.1 State TWO advantages of a star connection. (2)

7.2 A 380 V, three-phase, star-connected motor is rated at 25 kW. The full load power factor is given as 0,8 and the efficiency as 85%.

Determine the following:

7.2.1 The line voltage for the motor when it runs at full load. (1)

7.2.2 The phase voltage for the motor when it runs at full load. (2)

7.2.3 The phase current for the motor when it runs at full load. (5)
[10]

QUESTION 8

8.1 What is the colour of silica gel after it absorbs moisture? (1)

8.2 Name TWO sources of losses that occur in a transformer. (2)

8.3 A single-phase transformer has 42 turns on the secondary winding and is connected to a 210V AC supply. The output voltage is 70V and the primary current is 218 mA.

Determine the following:

8.3.1 Primary number of turns (2)

8.3.2 Secondary current in amperes (2)

8.3.3 Secondary VA if ALL losses are ignored. (1)
[8]

QUESTION 9

9.1 Draw a neat labelled sketch of a dynamometer as an electrical measuring instrument. (7)

9.2 Name THREE basic mechanisms which are found in measuring instruments. (3)
[10]

QUESTION 10

10.1 Draw and label the following gates by its IEC symbols.

10.1.1 AND gate (2)

10.1.2 NOR gate (2)

10.2 Change the following decimal numbers to binary and show ALL necessary steps.

10.2.1 $10{,}5_{10}$. (2)

10.2.2 $14{,}25_{10}$. (2)

10.2.3 Subtract the answer of QUESTION 10.2.1 from QUESTION 10.2.2 and leave the answer in binary number. (2)

10.3 Briefly explain with the aid of a neat sketch the concept of forward bias. (2)
[12]

TOTAL: 100

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

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

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

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

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

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

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

10. E = Blv

11. $e = E_m \text{Sin} 2\text{ц}ft$

12. $i = I_m \text{Sin} 2\text{ц}ft$

13. $e_{ave/gem}$ or/of $i_{ave/gem}$ = 0,637 E_m or/of I_m

14. $e_{rms/wgk}$ or/of $i_{rms/wgk}$ = 0,707 E_m or/of I_m

15. $E_{ave/gem} = \frac{e_1 + e_2 + e_3 + e_4 + ... + e_n}{n}$

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

16. E $_{rms/wgk} = \sqrt{\dfrac{e_1{}^2 + e_2{}^2 + e_3{}^2 + ... + e_n{}^2}{n}}$

Or/of I $_{rms/wgk} = \sqrt{\dfrac{i_1{}^2 + i_2{}^2 + i_3{}^2 + ... + i_n{}^2}{n}}$

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

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

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

20. X $_L$ = 2цfL; i= $\dfrac{V}{X_L}$

21. X $_C$ = 2цfC; i= $\dfrac{V}{X_C}$

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

23. Tan $\theta = \dfrac{X_L}{R}$; Tan θ = $\dfrac{X_C}{R}$

24. V $_R$ = I x 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 = $\dfrac{X_L - X_C}{R}$; Tan θ = $\dfrac{X_C - X_L}{R}$

27. P = V x I; P = I $^2 R$; P = $\dfrac{V^2}{R}$

28. P = VICosθ

29. Cos θ = $\dfrac{R}{Z}$; Cos θ = $\dfrac{W or/of kW}{VA or/of kVA}$

30. I $_{active/aktief} = ICos\theta$; I $_{reactive/reaktief} = ISin\theta$

31. P = VI Cos θ

Q = VI Sin θ

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

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

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

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

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

37. Cos θ = $\dfrac{I_R}{I}$

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

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

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

44. $I_T = I_m + I_s$

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

MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL EXAMINATION

ELECTRO-TECHNOLOGY N3

5 APRIL 2016

This marking guideline consists of 11 pages.

QUESTION 1

1.1 1.1.1 Yoke ✓ (2)
1.1.2 Pole shoes ✓
(2)

1.2 1.2.1
- By moving brushes backwards in the motor. ✓
- By moving brushes forwards in the generator. ✓ (2)

1.2.2
- Interpoles are smaller poles placed between the main poles. ✓
- Connected in series with the armature and must have the same polarity as the main poles - passed in the motor – to ensure sparkless commutation. ✓ (2)

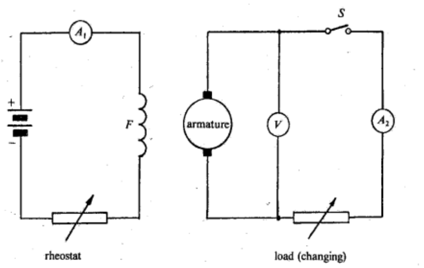
1.2.3
- By making use of series winding on the main field poles. ✓
- Varying the main field to the load condition. ✓ (2)

[10]

QUESTION 2

2.1
- The number of pairs of poles used. ✓
- The strength of the magnetic field or flux. ✓
- The rate at which the magnetic flux is cut by the moving conductor. ✓
- The number of active conductors connected in series. ✓ (4)

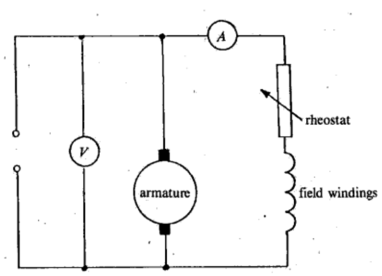
2.2 Separately excited generator. ✓ (1)



✓ ✓

For correct labelled sketch (2)

Self-excited generator ✓ (1)



✓ ✓

For correct labelled sketch (2)
[10]

QUESTION 3

3.1
- Effective field flux is reduced due to armature reaction as the load increases. ✓
- Voltage drop due to the armature circuit resistance. ✓ (2)

3.2 Used as the generator in the Ward-Leonard motor generator system. ✓ (1)

3.3 3.3.1 Shunt generator – it is used where a constant voltage is required. ✓ (1)

3.3.2 Series generator – as a booster on DC transmission line. ✓ (1)

3.4
- Flux (Φ) ✓
- Armature current (Ia) ✓ (2)

3.5
- Driving crane ✓
- Train ✓
- Hoists ✓
- Lifts
- Trolley buses
- Electric vehicle (Any 3 x 1) (3)

[10]

QUESTION 4

Given: R = 300 mm = 0,3 m; N = 420 r/min; effective load = 425 N.m
V = 0,21 kV = 210 V; I = 33 000 m A = 33A

4.1 Input Power [P] = IV
= 33 A x 210 V✓
= 6 930 W✓
= 6,93 kW✓ → Answer (3)

4.2 Output Power [P] = $\frac{2\ x\ \Pi NWr}{60}$

$= \frac{2 \times 3{,}142 \times 420 \times 425 \times 0{,}3}{60}$ ✓✓

= 5608,47 W✓
= 5,609 kW ✓Answer (4)

4.3 Efficiency = $\frac{Output}{Input} \times 100\%$

$= \frac{5{,}609\, kW}{6{,}93\, kW} \times 100\%$ ✓

= 0, 80938 x 100%✓
= 80,938 % ✓ → Answer (3)

[10]

QUESTION 5

Given: :- $e_1 = 20$ V; $e_2 = 42$ V; $e_3 = 83$ V; $e_4 = 120$ V; $e_5 = 95$ V; $e_6 = 35$ V; $e_7 = 18$ V.

5.1 5.1.1 Alternating voltage. ✓ (1)

5.1.2

$$\text{Actual } [E_{RMS}] = \sqrt{\frac{{e_1}^2 + {e_2}^2 + {e_3}^2 + {e_4}^2 + {e_5}^2 + {e_6}^2 + {e_7}^2}{n}}$$

$$= \sqrt{\frac{20^2 + 42^2 + 83^2 + 120^2 + 95^2 + 35^2 + 18^2}{7}} \checkmark$$

$$= \sqrt{\frac{34\,027}{7}} \checkmark$$

$$= \sqrt{4\,861}$$

= 69.721 V✓ ⟶ Answer (3)

5.1.3

$$\text{Average Value } [E_{AVE}] = e_1 + e_2 + e_3 + e_4 + e_5 + e_6 + e_7 / 7$$

$$= (20 + 42 + 83 + 120 + 95 + 35 + 18) / 7 \checkmark$$

$$= 413/7 \checkmark$$

= 59 V✓ ⟶ Answer (3)

5.1.4

$$\text{Form factor} = E_{RMS} / E_{AVE} = 69{,}721V / 59V$$

= 1,182 ⟶ Answer ✓ (1)

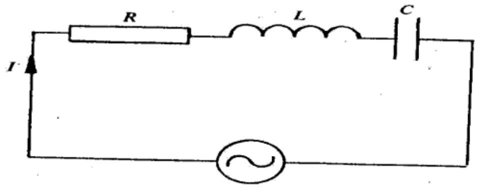
5.1.5

- Sine wave ✓
- Peak wave
- Sinusoidal wave (Any 1 x 1) (1)

5.2 Maximum value – is the maximum or peak value of an alternating voltage or current. ✓ (1)

[10]

QUESTION 6



6.1

$X_L = 2\Pi f L$

$= 2 \times 3{,}142 \times 60 \text{ Hz} \times 400 \times 10^{-3}$

$= 150{,}816\ \Omega$ ✓ → Answer

$X_C = \dfrac{1}{2\Pi f C}$

$= \dfrac{1}{2 \times 3{,}142 \times 60 \times 50 \times 10^{-6}}$

$= 53{,}045\ \Omega$ ✓ Answer →

Impedance of the circuit [Z] = $\sqrt{R^2 + (X_L - X_C)^2}$

$= \sqrt{10^2 + (150{,}816 - 53{,}045)^2}$ ✓

$= \sqrt{100 + 9559.168}$ ✓

$= 98{,}281\ \Omega$ ✓ → Answer (5)

6.2

Circuit current [I_t] = $\dfrac{V_t}{Z}$

$= \dfrac{240V}{98{,}281\Omega}$ ✓

$= 2{,}442$ A ✓ → Answer (2)

6.3

Phase angle: Tan θ = $\frac{X_L - X_C}{R}$

$= \dfrac{150{,}816 - 53{,}045}{10}$ ✓

θ = $\text{Tan}^{-1}\ 9{,}777$ ✓

= 84,160º lagging ✓ → Answer (3)

[10]

QUESTION 7

7.1
- With a star connection two voltages are available, namely V_L and V_{ph}.✓
- By earthing the neutral, earth leakage protection is simplified. ✓ (2)

7.2 7.2.1 V_L = 380 V ✓. (Given) (1)

7.2.2 $V_L = \sqrt{3}V_{PH}$

$$V_{ph} = \frac{380V}{\sqrt{3}} ✓$$

= 219,393 V✓ → Answer (2)

7.2.3

$$\text{Input power} = \frac{Output}{\eta}\times 100$$

$$= \frac{25\,000}{85}\times 100 ✓$$

= 29 411,765 W ✓ → Answer

Pin = $\sqrt{3}\times V_L\times I_L\times Cos\theta$

$$I_L = \frac{29\,411{,}765W}{\sqrt{3}\times 380\times 0.8} ✓$$

= 55,858 A → Answer ✓

Therefore $I_C = I_{ph}$ (In star connection)

I_{ph} = 55.858 A ✓ → Answer (5)

[10]

QUESTION 8

8.1 Pink ✓ (1)

8.2
- Winding ✓
- Core ✓

(2)

8.3 8.3.1

Primary number of turns[N_1] = $42 \times \frac{210V}{70V}$ ✓

= 126 turns ✓ → Answer

(2)

8.3.2

$$\frac{V_1}{V_2} = \frac{I_2}{I_1}$$

$$I_2 = \frac{210V \times 0{,}218A}{70V}$$ ✓

= 0,654 A ✓ → Answer

(2)

8.3.3 Secondary volt-ampere = VI

= 70 Volt x 0,654 A

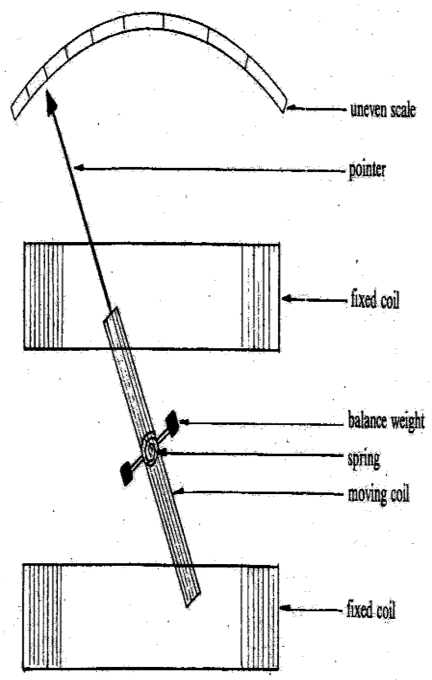
= 45,78 VA ✓ → Answer

(1)

[8]

QUESTION 9

9.1 FOUR marks for ANY RELEVANT correct labelling



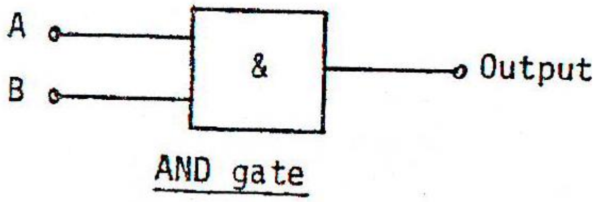
THREE marks for correct sketch. (7)

9.2
- A deflecting device ✓
- A controlling device ✓
- A damping device ✓ (3)

[10]

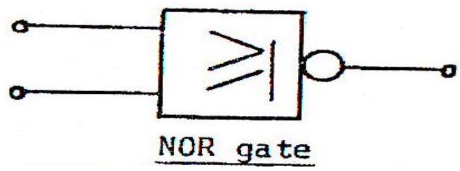
QUESTION 10

10.1 10.1.1



✓✓ for correct diagram and labelling (2)

10.1.2



✓ ✓ for correct diagram and labelling (2)

10.2 10.2.1

2	10		
2	5	remainder 0	0,5 x 2 = 1
2	2	remainder 1	
2	1	remainder 0	✓
		remainder 1	

$10,5_{10} = 1010,1_2$ ✓ ⟶ Answer (2)

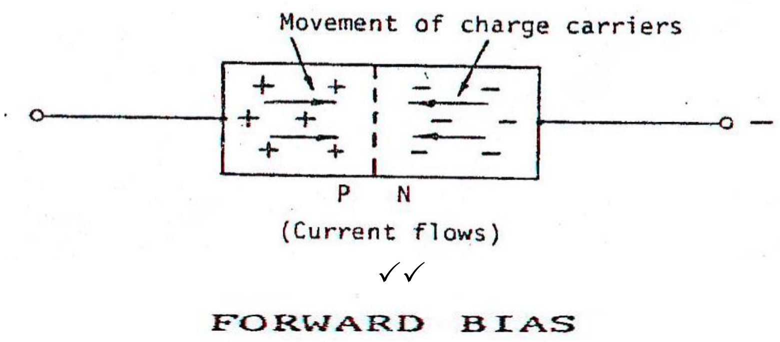
10.2.2

2	14		
2	7	remainder 0	0,25 x 2 = 0
2	3	remainder 1	0,5 x 2 = 1
2	1	remainder 1	
		remainder 1	✓

$14,25_{10} = 1110,01_2$ ✓ ⟶ Answer (2)

10.2.3 -1010,10
<u>1110,01</u>
<u>$0011,11_2$ ✓✓ ⟶ Answer</u> (2)

10.3



1 for correct sketch and 1 for labelling (2)

[12]

TOTAL: 100

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