higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ELECTRO-TECHNOLOGY N3

(11040343)

29 November 2022 (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.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ELECTRO-TECHNOLOGY N3
TIME: 3 HOURS
MARKS: 200

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 off all calculations to THREE decimal places.
6. Use the correct symbols and units.
7. Start each section on a new page.
8. Use only a black or blue pen.
9. Write neatly and legibly.

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QUESTION 1

Choose a term from COLUMN B that matches a description in COLUMN A. Write only the letter (A–L) next to the question number (1.1–1.10) in the ANSWER BOOK.

COLUMN A		COLUMN B	
1.1	They produce a very high starting and operating torque	A	copper losses
1.2	The ratio of output power to input power	B	Buchholz relay
1.3	Opposes current changes and in so doing, it causes the current to lag the voltage by 90°	C	eddy currents
1.4	The property of an electric circuit or coil that causes an EMF to be generated as a result of a changing magnetic flux	D	capacitive reactance
1.5	Mainly used in the industry where high currents have to be measured such as in motor starters and panels	E	series motors
1.6	It is used to protect large transformers against the harmful effects of overloads and short circuits	F	compound-wound generators
1.7	When the current flows in a DC machine there is power loss due to the resistance of all the current-carrying components	G	inductive reactance
1.8	They are induced in the metal core of the transformer by the alternating field in the core	H	capacitance
1.9	They have two field coils, namely a series field and a shunt field	I	moving-iron instruments
1.10	Opposes voltage changes and in so doing, it causes the current lead to the voltage by 90°	J	efficiency
		K	inductance
		L	shunt motors

(10 × 1) **[10]**

QUESTION 2

2.1 State THREE purposes of the yoke in a DC machine. (3)

2.2 Briefly explain commutation as applicable to a DC machine. (2)

2.3 A 440 V shunt-wound generator produces an armature current of 40A. The resistances of the shunt field and armature are 220 Ω and 0,25 Ω respectively.

Calculate the following:

2.3.1 The magnitude of the generated EMF (2)

2.3.2 The electrical power output of the machine in kW (3)

[10]

QUESTION 3

3.1 Explain the operating principle of a direct-current motor. (3)

3.2 Explain how a large DC motor can be started without damaging the motor or motor circuit. (2)

3.3 What is the other name for hysteresis losses? (1)

3.4 The torque of an eight-pole lap-wound DC motor is 320 N.m. If the armature current is 160 A and the number of armature conductors is 560, determine the useful flux per pole in mWb. (4)

[10]

QUESTION 4

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

Drum diameter	=	250 mm
Drum speed	=	13 r/s
Mass	=	31 kg
Spring-balance reading	=	100 N
Supply voltage	=	230 V
The current drawn from the supply	=	0,01 mA

Hint: Take g as 9,81 m/s^2

Calculate the following:

4.1 The effective load in N (2)

4.2 The output power of the motor in kW (4)

4.3 The input power of the motor in kW (2)

4.4 Efficiency of the motor (2)

[10]

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QUESTION 5

An AC supply is represented by the equation e = 230 sin (314,2t) V.

Calculate the following:

5.1	The average value	(2)
5.2	The supply frequency	(2)
5.3	The period	(1)
5.4	The instantaneous value of the EMF 4 milliseconds after zero while the waveform is increasing positively	(3)
5.5	The crest factor	(2)

[10]

QUESTION 6

A parallel circuit consists of THREE branches with the following components:

- Branch 1: Resistor of 50 Ω .
- Branch 2: Inductor of 40 mH and negligible resistance.
- Branch 3: Capacitor of 140 µF.

The circuit is connected across a 200 V, 60 Hz supply.

Determine the following:

6.1	Current through the resistor	(1)
6.2	Current through the inductor	(2)
6.3	Current through the capacitor	(2)
6.4	Total current flow in the circuit	(3)
6.5	The impedance	(2)

[10]

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QUESTION 7

7.1 State TWO advantages of three-phase systems. (2)

7.2 A three-phase star-connected motor draws 25 A from a 380 V supply at a lagging power factor of 0,86.

Calculate the:

7.2.1 Active power of the motor (2)

7.2.2 Reactive power of the motor (3)

7.2.3 Apparent power of the motor (2)

7.2.4 Phase current of the motor winding (1)

[10]

QUESTION 8

8.1 A 20 MVA 3-phase 132 kV/11 kV delta-star transformer has 100 turns on the secondary sideg. Calculate the following:

8.1.1 Turns ratio of the transformer (3)

8.1.2 The number of turns on the primary side of the transformer (2)

8.1.3 Output power at a power factor of 0,8 (3)

8.2 State TWO uses of transformers. (2)

[10]

QUESTION 9

9.1 A measuring instrument has an internal resistance of 15 Ω and gives a full-scale deflection at a current of 60 mA. Calculate the resistance required to enable the instrument to be used as a voltmeter, reading 0 to 12 V. (4)

9.2 Explain *mutual inductance* as applicable to a single-phase transformer. It is not necessary to make a sketch as part of the explanation. (4)

9.3 State TWO advantages of a damping mechanism. (2)

[10]

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QUESTION 10

10.1 Name the electronic logic gates represented by the diagrams in FIGURES 1 to 3 below. Write only the answer next to the question number (10.1.1–10.1.3) in the ANSWER BOOK.

10.1.1

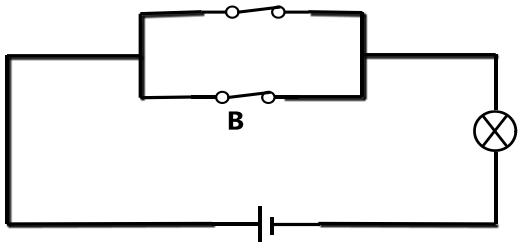

FIGURE 1 (1)

10.1.2

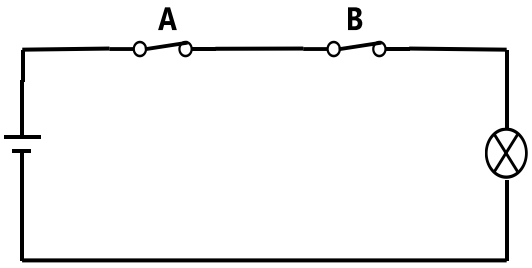

FIGURE 2 (1)

10.1.3

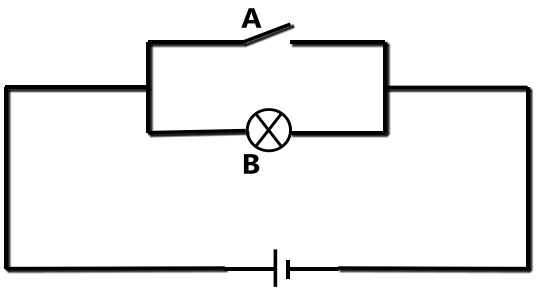

FIGURE 3 (1)

10.2 State TWO characteristics of a germanium transistor. (2)

10.3 Add the following binary numbers and convert the answer to a decimal number:

$1011,0101_2 + 1010,1100_2$ (5)

[10]

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

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

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

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

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

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

9. $E = Blv$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

22. Tan $\theta = \frac{X_L}{R}$; Tan $\theta = \frac{X_C}{R}$

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

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

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

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

27. $P = VI\cos\theta$

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

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

30. P = VI Cos θ

31. 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. P = $\sqrt{3}V_L I_L Cos\theta \times \eta$

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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