higher education & training

Department:
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REPUBLIC OF SOUTH AFRICA

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

NATIONAL CERTIFICATE

ELECTRO-TECHNOLOGY N3

(11040343)

11 April 2019 (X-Paper)
09:00–12:00

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

QUESTION 1

1.1 Brushes used in DC machines are placed in rectangular brush-holder boxes.

Why must these brushes be spring loaded? (2)

1.2 The armature assembly of a DC machine is also known as the rotor.

Name FIVE components that make up the armature assembly. (5)

1.3 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'True' or 'False' next to the question number (1.3.1–1.3.2) in the ANSWER BOOK. Correct the statement if it is FALSE.

1.3.1 The direction of distortion of the flux in a motor is opposite to that in a generator. (1)

1.3.2 Graphite brushes are mechanically strong. (2)

[10]

QUESTION 2

2.1 The functioning of a DC generator is dependent on the excitation of its field coils.

Name TWO types of excitation methods associated with DC generators. (2)

2.2 Draw the characteristics curve of a series-wound generator showing terminal voltage against field current.

Clearly show the EMF generated as a result of residual flux and also where the point of saturation of the field coils is likely to occur. (3)

2.3 A load requiring 15 kW of power at a terminal voltage of 440 V is to be supplied by a shunt-wound generator. The resistances of the armature and shunt field of the generator are 0,22 Ω and 200 Ω respectively.

Calculate:

2.3.1 The magnitude of the armature current (3)

2.3.2 The magnitude of the generated EMF (2)

[10]

QUESTION 3

3.1 Electrical machines are used to convert one form of energy into another form of energy.

Use this statement and state the function of a DC motor. (2)

3.2 Shunt-wound motors are low-torque constant-speed motors.

Give THREE applications of these motors. (3)

3.3 The following data is known about a certain DC series-wound motor:

Number of poles:	4
Torque:	380 Nm
Current drawn from the supply:	55 A
Useful flux per pole:	42 mWb
5 conductors per slot	
Wave-wound armature	

Calculate the total number of slots in the armature core. (4)

3.4 A copper graphite brush is one type of brush used in a DC machine.

Why is copper mixed with graphite? (1)
[10]

QUESTION 4

4.1 A 22 kW, DC shunt-wound generator supplies a certain load at a terminal voltage of 320 V. The armature and shunt field resistances are 0,25 Ω and 200 Ω respectively.

Calculate:

4.1.1 The armature current (3)

4.1.2 The armature copper loss (2)

4.1.3 The shunt field copper loss (1)

4.1.4 The percentage efficiency of the machine if the iron, friction and windage losses amount to 400 W (2)

4.2 Iron, friction and windage losses are constant losses that occur in all DC machines.

Name TWO places in a DC machine where friction losses occur. (2)
[10]

QUESTION 5

5.1 The output voltage of an alternator is represented by a sinusoidal waveform.

Explain each of the following terms relating to a sinusoidal waveform:

5.1.1 Instantaneous value

5.1.2 Period

(2 × 2) (4)

5.2 An alternating emf is described by the expression e = 525sin (942,478t).

Determine:

5.2.1 The frequency of this EMF

5.2.2 The effective (rms) value of this wave

5.2.3 The instantaneous value of this EMF 1ms after the commencement of a cycle

(3 × 2) (6)
[10]

QUESTION 6

A 2,8 kW inductive load is supplied from a 220 V, 50 Hz, single-phase voltage source. The load operates at a power factor of 0,9 lagging.

6.1 Calculate the magnitude of the phase angle. (1)

6.2 Calculate the magnitude of the current drawn by the load. (2)

6.3 Determine the reactive power of the circuit. (2)

6.4 Calculate the impedance of the load. (2)

6.5 Draw a suitable vector diagram to show the voltage and current vectors as well as the phase angle. (3)
[10]

QUESTION 7

7.1 An alternating current circuit has three types of power associated with it.

Name the THREE types of power and write the formula for calculating each. (3 × 2) (6)

7.2 Large induction motors are started while connected in star and run in delta.

Show by means of a neat, fully labelled circuit diagram how the six terminals of this motor are connected in delta and to the supply. (3)

7.3 In a three-phase system, there is line voltage and phase voltage.

State the relationship between these two voltages in a delta-connected system. (1)

[10]

QUESTION 8

8.1 Three single-phase transformers can be electrically connected to produce four different three-phase transformer configurations.

Name FOUR transformer configurations. (4)

8.2 A 50 kVA, delta-star connected transformer has a turn ratio of 15:1. The transformer supplies a load at 400 V.

Calculate:

8.2.1 The primary line voltage

8.2.2 The secondary phase current

8.2.3 The primary phase current

(3 × 2) (6)

[10]

QUESTION 9

9.1 Eddy current damping, also known as electromagnetic damping, is one method used to minimise oscillations in analogue-type measuring instruments.

Make a neat, fully labelled sketch to show how eddy current damping is achieved. (5)

9.2 A galvanometer with an internal resistance of 65 Ω gives full-scale deflection when a current of 20 mA flows through it.

Calculate, by means of a neat circuit diagram, the value of a suitable resistor required to enable the instrument to be used as an ammeter with reading 0–5,5 A. (4)

9.3 The function of the controlling mechanism is to produce controlling torque.

Name ONE method of achieving controlling torque in an analogue-type measuring instrument. (1)

[10]

QUESTION 10

10.1 A rectifier circuit is used to convert AC into DC.

Make a neat, fully labelled sketch of a full-wave bridge rectifier circuit. The sketch must include the input and output waveforms. (6)

10.2 A binary number system is one of four different number systems used by computers and digital systems.

Convert 197_{10} to its binary equivalent. (4)

[10]

TOTAL: 100

FORMULA SHEET

Any applicable formula may 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. $\text{Efficiency} = \dfrac{VI}{VI + I_a{}^2 R_a + I_s V + C} \times 100\%$

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

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

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

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

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

17. Form factor = $\frac{E_{rms}}{E_{ave}}$ or $\frac{I_{rms}}{i_{ave}}$

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

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

28. P = VIcosθ

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

30. $I_{active} = I\cos\theta$; $I_{reactive} = I\sin\theta$

31. P = VIcosθ

Q = VIsinθ

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

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

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

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

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

37. $\cos\theta = \dfrac{I_R}{I}$

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. $\text{kVA} = \dfrac{\sqrt{3} V_L I_L}{1\,000}$

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

44. $I_T = I_m + I_s$

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