higher education & training

Department:
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REPUBLIC OF SOUTH AFRICA

T560**(E)**(A6)T

NATIONAL CERTIFICATE

ELECTRO-TECHNOLOGY N3

(11040343)

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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: 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. 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 Explain the term *torque*. (2)

1.2 Two types of bearings are used in a DC machine, namely ball bearings and roller bearings.

State TWO functions of these bearings. (2)

1.3 A lap winding is also known as a parallel winding and a wave winding as a series winding.

Make neat, fully labelled sketches of these windings. (4)

1.4 Brushes are used to make electrical connections between a stationary circuit and a rotating commutator.

Explain *bedding of brushes*. (2)
[10]

QUESTION 2

2.1 State Faraday's law of electromagnetic induction. (3)

2.2 Interpoles are used to reduce sparking and improve commutation.

2.2.1 State exactly where interpoles are located. (1)

2.2.2 Name the current that flows through interpoles. (1)

2.3 A 400 V shunt-wound generator produces an armature current of 30A. The resistances of the shunt field and armature are 180 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]

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QUESTION 3

3.1 Show by means of fully labelled circuit diagrams TWO methods used to reverse the rotation direction of a shunt-wound motor. First draw a circuit diagram to show the original rotation direction of the motor. The diagrams must show the direction of current flow. (2 × 3) (6)

3.2 A 400 V, six-pole DC series motor has a wave-wound armature with 740 conductors. The armature and series field resistances are 0,15 Ω and 0,2 Ω respectively.

Calculate the speed at which the motor operates if the armature current is 35 A and the useful flux per pole is 33 mWb. (4)
[10]

QUESTION 4

4.1 Explain each of the following terms:

4.1.1 Friction losses

4.1.2 Windage losses

(2 × 2) (4)

4.2 The Hopkinson's back-to-back test is used to test two identical 300 V, 22 kW shunt-connected generators. The current drawn from the mains is 12 A.

Calculate the efficiency of each machine, assuming the current circulating between the machines to be the normal full-load current. (4)

4.3 A compound-wound motor combines the advantage of a shunt motor with the advantage of a series motor.

Explain a *differential compound motor*. (2)
[10]

QUESTION 5

5.1 Indicating-type instruments measure the effective or root mean square (rms) values of current and voltage.

Explain *rms value*. (3)

5.2 Explain the term *period of a wave* as it relates to a sinusoidal wave. (2)

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5.3 The following are mid-ordinates of an irregular wave taken over half a cycle:

e_1 = 32 V
e_2 = 41 V
e_3 = 47 V
e_4 = 65 V
e_5 = 56 V
e_6 = 29 V

Determine the following:

5.3.1 The average value of the wave (2)

5.3.2 The rms value of the wave (2)

5.3.3 The form factor of the wave (1)
[10]

QUESTION 6

6.1 A 3 kW load operating at unity power factor is supplied with 240V, 50Hz.

Calculate the resistance of the load. (2)

6.2 A choke (coil) is connected in series with the load mentioned in QUESTION 6.1 and the combination is supplied with 400 V, 50 Hz.

Calculate the inductance of the choke if its resistance is assumed to be negligible. (5)

6.3 Calculate the new power factor of the circuit and state the nature of this power factor. (3)
[10]

QUESTION 7

A series circuit consisting of a 65 Ω resistor, an inductor of 200 mH and a capacitor of 125 µF are connected across a 150 V, 50 Hz supply.

7.1 Calculate the following:

7.1.1 The total impedance of the circuit (3)

7.1.2 The total current flowing through the circuit (2)

7.1.3 The frequency at which the circuit will resonate (2)

7.2 Draw a vector diagram to show the distribution of the voltage and current vectors. (3)
[10]

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QUESTION 8

8.1 Name TWO types of iron losses that occur in a transformer. (2)

8.2 A three-phase transformer has 600 turns on the primary side and 120 turns on the secondary side.

Calculate the secondary line voltage on no-load if the transformer is supplied with 2,2kV and connected in:

8.2.1 Star-delta

8.2.2 Delta-star

(2 × 4) (8)
[10]

QUESTION 9

9.1 The measurement of high voltages and high currents is both dangerous and impractical because measuring instruments are not designed for such functions.

State the range of each of the following instruments normally used in conjunction with instrument transformers:

9.1.1 Ammeters

9.1.2 Voltmeters

(2 × 1) (2)

9.2 A galvanometer with an internal resistance of 70Ω gives full-scale deflection when a current of 30mA flows through it.

Calculate, by means of neat circuit diagrams, the values of a shunt and multiplier resistors required to enable the instrument to be used as:

9.2.1 An ammeter, reading 0 ─ 7 A

9.2.2 A voltmeter, reading 0 ─ 150 V

(2 × 4) (8)
[10]

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QUESTION 10

10.1 Draw the IEC symbol for an NPN transistor and label the THREE terminals. (4)

10.2 Give TWO uses of silicon-controlled rectifiers. (2)

10.3 Add the following binary numbers using the rules for binary addition:

110_2 and 110_2 (4)

[10]

TOTAL: 100

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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. $T = \frac{0{,}318 I_a Z p \Phi}{C}$

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

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

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

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

28. $P = VI\cos\theta$

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

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

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31. $P = VI \cos \theta$

    $Q = VI \sin \theta$

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

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

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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