higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

ELECTRICAL PRINCIPLES AND PRACTICE
NQF LEVEL 3

(12041003)

26 February 2020 (X-paper)
09:00–12:00

This question paper consists of 6 pages and a formula sheet of 2 pages.

047Q1S2026

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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. Use only a black or blue pen.
6. Write neatly and legibly.

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QUESTION 1

1.1 Germanium has an atomic number of 32. State how many electrons are in the:

1.1.1 First shell (1)

1.1.2 Second shell (1)

1.1.3 Third shell (1)

1.1.4 Fourth shell (1)

1.1.5 Valency shell (1)

1.2 Complete the following sentences by writing only the missing word or words next to the question number (1.2.1–1.2.5) in the ANSWER BOOK.

1.2.1 The number of protons in the nucleus of an atom is called …

1.2.2 The voltage measured across an open circuit is called …

1.2.3 If the cross-sectional area of a conductor is halved and the length stays the same, its resistance will be …

1.2.4 The particles that make up an atom are held together by …

1.2.5 A/An … is an electron that has been removed from a valency shell.

(5 × 1) (5)

1.3 Calculate the resistance of a copper conductor with a length of 1 000 m and a cross-sectional area of 35 mm^2. The resistivity of copper is 17,3 nΩm. (3)

1.4 What effect does an increase in temperature have on the resistance of insulating materials? (2)

[15]

QUESTION 2

2.1 Explain the term *magnetomotive force*. (2)

2.2 Calculate the magnitude of flux produced by a coil when the flux density is 180 T and the area of the magnetic circuit is 400 mm^2. (3)

2.3 State *Lenz's law*. (2)

2.4 Explain the principle of *electromagnetic induction*. (2)

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2.5 A coil with an effective length of 250 mm moves through a magnetic field of 0,008 Wb/m^2 at a velocity of 50 m/s.

Calculate:

2.5.1 The maximum emf in the coil

2.5.2 The instantaneous value of the induced emf if the coil has moved through 45° from zero

(2 × 2) (4)

2.6 Explain the operation of an electric bell. (4)

2.7 State the *screw rule* that applies to magnetic circuits. (3)

[20]

QUESTION 3

3.1 Two resistors of 2 Ω and 3 Ω are connected in parallel. This combination is then connected in series with an unknown resistor Rx. The circuit is connected across a 12 V DC supply and a current of 2 A is drawn from the supply.

Calculate:

3.1.1 The unknown resistance Rx (5)

3.1.2 The current flowing through the 2 Ω resistor (4)

3.2 If the 2 Ω resistor in QUESTION 3.1 is open circuit, how will it affect the total resistance and the total current of the circuit? (2)

3.3 A coil is wound with 500 turns. When a current of 4 A flows through the coil, the total flux threading the coil is found to be 60 µWb.

Calculate the inductance of the coil. (2)

3.4 Calculate the total capacitance when three capacitors of 0,1 µF, 0,2 µF and 0,4 µF respectively are arranged in:

3.4.1 Series (3)

3.4.2 Parallel (2)

3.4.3 What can you conclude from the above results? (1)

3.5 State TWO ways in which cells can be grouped to form a battery. (2)

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3.6

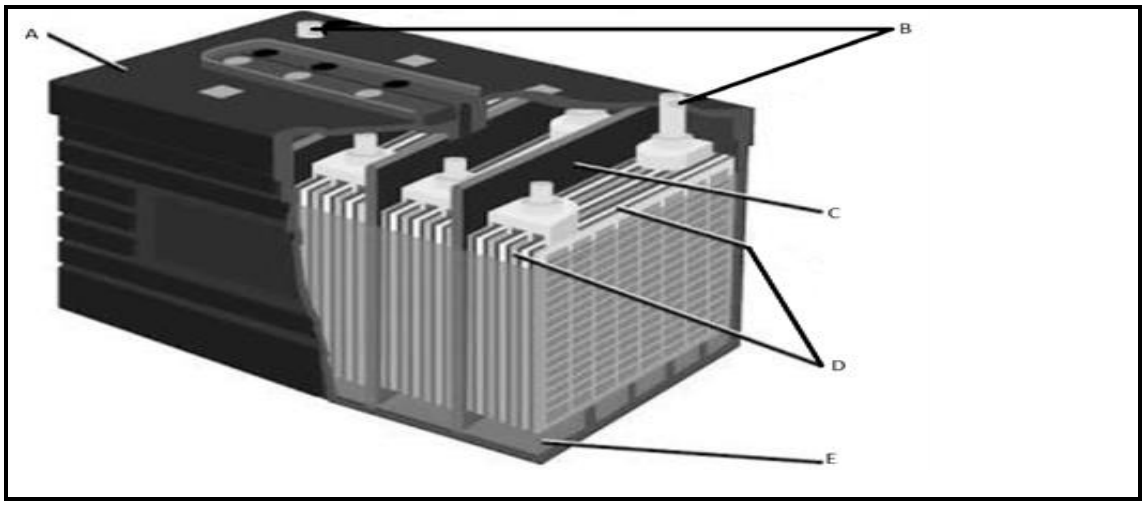


FIGURE 1

Label the parts in FIGURE 1 by writing only the answer next to the letter (A–E) in the ANSWER BOOK. (5 × 1) (5)

3.7 A single-phase load draws a current of 3 A from a 220 V supply at a power factor of 0,75.

Determine the real power drawn by the load. (2)

3.8 Explain each of the following terms relating to a three-phase system:

3.8.1 Line voltage

3.8.2 Phase voltage

(2 × 1) (2)
[30]

QUESTION 4

4.1 Explain the working of a *deflecting device.* (2)

4.2 Give THREE disadvantages of a dynamometer-type instrument. (3)

4.3 Explain how to measure the resistance of a resistor in a circuit using a digital multimeter. List the details of each step clearly. (5)

4.4 A moving-coil instrument has a resistance of 10 Ω and it takes 25 mA to produce full-scale deflection.

Calculate the values of the resistors to be used with the instrument so that it will be able to measure a:

4.4.1 Voltage up to 150 V (2)

4.4.2 Current of 20 A (3)
[15]

QUESTION 5

5.1 Refer to FIGURE 2 and answer the questions.

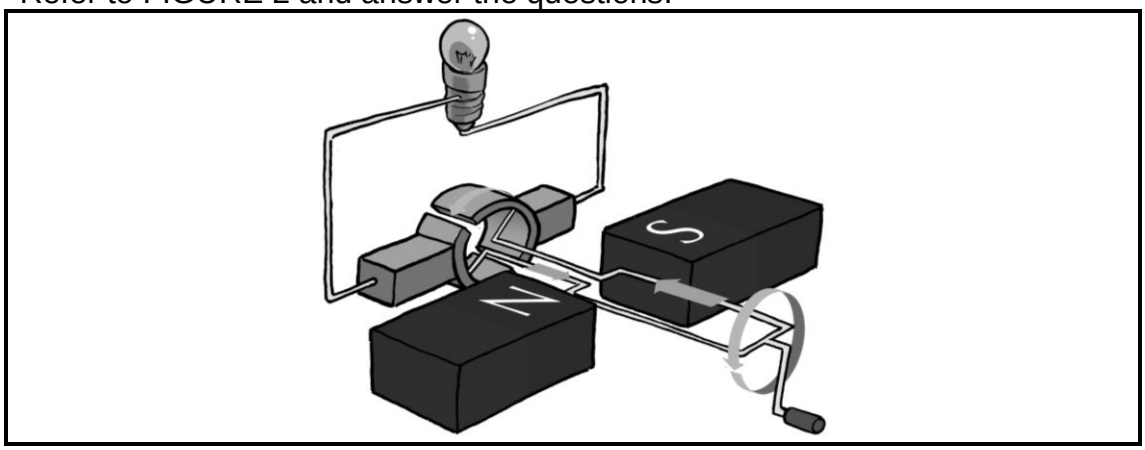


FIGURE 2

5.1.1 Identify FIGURE 2. (1)

5.1.2 Explain the energy conversion taking place in FIGURE 2. (2)

5.2 Explain the term *wave winding* as applicable to DC machines. (2)

5.3 Briefly explain each of the following components found in a DC machine:

5.3.1 Frame (1)

5.3.2 Stator (1)

5.3.3 Armature core (2)

5.4 DC motors are classified as series, shunt and compound depending on the connections of the field windings with the armature and supply.

5.4.1 State TWO characteristics of a series motor. (2)

5.4.2 Give TWO applications of a compound wound motor. (2)

5.5 Explain a *self-excited generator.* (2)

5.6 The full-load armature current of a DC motor is 40 A and the armature resistance is 0,185 Ω.

Calculate the back emf induced in the armature if the supply voltage is 220 V. (2)

5.7 A series-wound generator delivers 30 A at 330 V to the load.

If the series field and armature resistances are 0,15 Ω and 0,05 Ω respectively, calculate the magnitude of the generated emf. (3)

[20]

TOTAL: 100

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FORMULA SHEET

1. $\boldsymbol{Cos\,\phi = \frac{R}{Z}}$

2. $\boldsymbol{P = V\ I\ Cos\,\phi}$

3. $Q = V\ I\ Sin\phi$

4. $\boldsymbol{S = V\ I}$

5. $V_1 = \left(\frac{R_1}{R_t}\right) V_T$

6. $\boldsymbol{I_1 = \left(\frac{R_2}{R_1 + R_2}\right) I_T}$

7. $R_T = R_1 + R_2 + R_3 + \cdots + R_n$

8. $\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots + \frac{1}{R_n}$

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

10. $V_L = \sqrt{3}\, V\ p\ h$

11. $\boldsymbol{E = V - I_a R_a}$

12. $\boldsymbol{f = \frac{Np}{60}}$

13. $S = \frac{N_s - N_r}{N_s}$

14. $\boldsymbol{R_{sh} = \frac{I_m R_m}{I_{sh}}}$

15. $\tan\boldsymbol{\phi} = \sqrt{3}\left(\frac{\boldsymbol{W_1 - W_2}}{\boldsymbol{W_1 + W_2}}\right)$

16. $E = V + I\,r$

17. $\boldsymbol{V = I\ R}$

18. $R = \frac{p\ l}{A}$

19. $\boldsymbol{R_t = R_0(1 + \alpha t)}$

20. $R_t = R_0[1 + \propto_0 (t - \emptyset)]$

21. $P = V\ I$

22. $E = I^2\ R\,t$

23. $\boldsymbol{\eta = \frac{P_0}{P_{in}} \times 100}$

24. $\boldsymbol{X_L = 2\pi\ f\ L}$

25. $X_C = \frac{1}{2\pi\ f\ C}$

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

27. $Mmf = N\ I$

28. $H = \frac{Mmf}{l}$

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29. $R_{se} = \frac{V_t}{I_t} - R_m$

30. $F = B\ I\ l$

31. $E = -L\frac{di}{dt}$

32. $A = \frac{\pi\ d^2}{4}$

33. $E = \frac{1}{2}\ C\ V^2$

34. $Q = C\ V$

35. $F = 2\times10^{-7} \times \frac{I_1\ I_2}{d}$

36. $I = \frac{Emf}{R + r_T}$

37. $L = N\frac{\Delta\ \phi}{\Delta\ I}$

38. $E = V + R_a I_a$

39. $P = \sqrt{3}\ V_L I_L\ cos\theta$

40. $S = \sqrt{3}\ V_L I_L$

41. $B = \frac{\Phi}{A}$

42. $E = B\ l\ v$

43. $E = -N\ \frac{d\emptyset}{dt}$

44. $E = \frac{V}{d}$

45. $E = \frac{1}{2}LI^2$

46. $Q = It$

47. $C_T = C_1 + C_2 + C_3 + \cdots + C_n$

48. $\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots + \frac{1}{C_n}$

49. $L_T = L_1 + L_2 + L_3 + \cdots + L_n$

50. $\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \cdots + \frac{1}{L_n}$

51. $Q = \sqrt{3}\ V_L I_L\ sin\theta$

52. $Pf = cos\theta$

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