higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE (VOCATIONAL)

ELECTRICAL PRINCIPLES AND PRACTICE
NQF LEVEL 3

(12041003)

8 December 2020 (Y-paper)
13:00–16:00

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

411Q1N2008

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.

QUESTION 1

1.1 Explain each of the following terms:

1.1.1 Free electrons

1.1.2 Potential difference

1.1.3 Electromotive force

(3 × 2) (6)

1.2 State the effect that temperature has on the resistance of carbon. (2)

1.3 Explain the term *low temperature coefficient of resistance*. (2)

1.4 Explain the relationship between *resistivity* and *resistance*. (2)

1.5 A coil of copper wire has a resistance of 15 Ω at 30 °C.

What will its resistance be at a temperature of 50 °C if the temperature coefficient of copper at 30 °C is $4,3 \times 10^{-3}$ per °C? (3)

[15]

QUESTION 2

2.1 Give TWO practical applications of each of the following electromagnets:

2.1.1 Bell

2.1.2 Lifting magnet

(2 × 2) (4)

2.2 Complete the following paragraph by writing only the missing word or words next to the question number (2.2.1–2.2.3) in the ANSWER BOOK.

Ampere is the amount of electrical current which, if maintained in two straight (2.2.1) … conductors of infinite length and negligible (2.2.2) … and placed one meter apart in a vacuum, produces a force of (2.2.3) … newton per metre length between the conductors. (3 × 1) (3)

2.3 A wire with a length of 12 cm is moved at right angles across a magnetic field at a constant velocity of 2 m/s. The flux density of the magnetic field is 5 Wb/m^2.

Calculate:

2.3.1 The emf induced in the wire

2.3.2 The force required to move this conductor if the emf results in a current flow of 10 A through an external circuit

(2 × 2) (4)

2.4 A coil with a length of 4 000 mm consists of 100 turns and the current flowing through it is 3 A.

Calculate:

2.4.1 The magnetomotive force (1)

2.4.2 The magnetic field strength (2)

2.5 Indicate whether the following statements are TRUE or FALSE by writing only 'True' or 'False' next to the question number (2.5.1–2.5.2) in the ANSWER BOOK.

2.5.1 The right-hand grip rule is used to work out the direction of the force on a wire carrying a current through a magnetic field.

2.5.2 Electromagnetic induction is the production of a potential difference (voltage) across a conductor when it is exposed to varying magnetic fields.

(2 × 1) (2)

2.6 Explain how to determine the relative direction of an induced emf using Fleming's right-hand rule. (4)

[20]

QUESTION 3

3.1

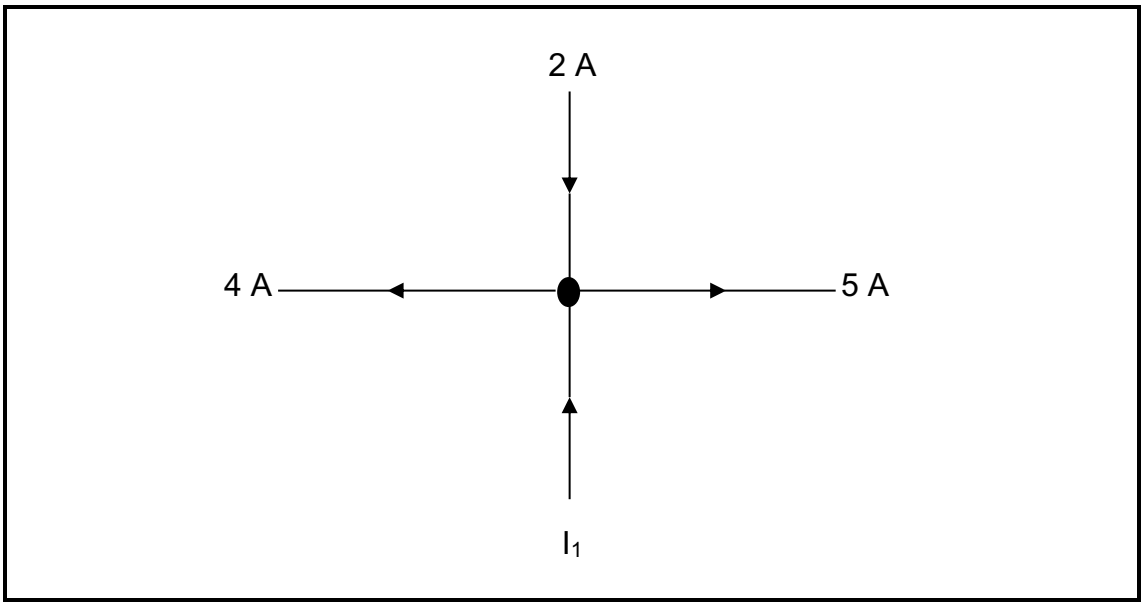

FIGURE 1

Apply Kirchhoff's law to determine the value of I_1 in FIGURE 1. (3)

3.2

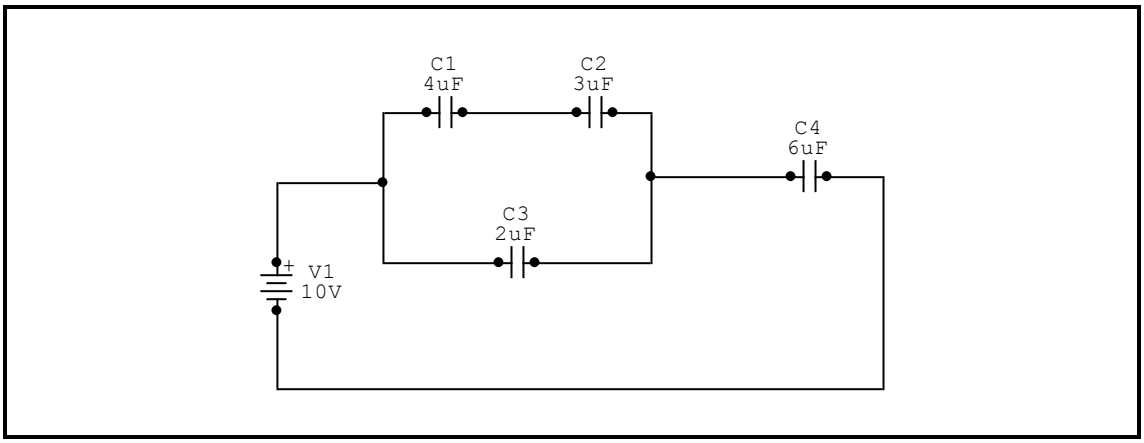

FIGURE 2

Refer to the circuit diagram in FIGURE 2 and calculate:

3.2.1 The total capacitance of the circuit (5)

3.2.2 The potential difference across capacitor C_4 (4)

3.3 Three resistors with the same values are connected in parallel across a DC supply.

If one of the resistors is removed, what will the effect on the total resistance and total current of the circuit be? (2)

3.4 A coil has 400 turns and a flux of 6 mWb linking with it when carrying a current of 5 A.

Calculate:

3.4.1 The inductance of the coil

3.4.2 The emf induced in the coil when the current collapses to zero in 0,04 s

(2 × 2) (4)

3.5 A 4 kW single-phase motor with a power factor of 0,9 lagging is connected to a supply voltage of 230 V.

Calculate the current drawn by the motor. (2)

3.6 List FOUR types of nonelectrolytic capacitors. (4)

3.7 A 100 kVA, 50 Hz, 2 400/240 V single-phase transformer supplies a certain load.

Ignore all volt drops and calculate the current flowing through each winding. (4)

3.8 Explain the term *line current*. (2)

[30]

QUESTION 4

4.1 Give THREE practical applications of a digital multimeter. (3)

4.2 List THREE methods to measure the power in a three-phase system. (3)

4.3 Give TWO advantages of a dynamometer-type instrument. (2)

4.4 The current flowing through a live conductor must be measured without disconnecting the circuit.

4.4.1 Which measuring instrument should be used to perform this task? (1)

4.4.2 Explain how to measure this current using the instrument in QUESTION 4.4.1. (3)

4.5 A moving-coil instrument with an internal resistance of 20 Ω gives full-scale deflection when 5 mA flows through it.

Calculate the value of a shunt resistor to be used with the instrument to measure a current of 4 A. (3)

[15]

QUESTION 5

5.1 Explain each of the following types of DC generators:

5.1.1 Series generator

5.1.2 Shunt generator

5.1.3 Compound generator

(3 × 2) (6)

5.2 State the purpose of a DC motor starter. (2)

5.3 Differentiate between *lap windings* and *wave windings* with regard to the commutator segments to which their ends are connected. (2 + 2) (4)

5.4 Briefly explain the working of a single-phase capacitor-start capacitor-run induction motor with regard to its torque and power factor during starting. (3)

5.5 Calculate the armature current of a DC motor if the terminal voltage is 400 V, the back emf is 380 V and the armature resistance is 5 Ω. (3)

5.6 Explain how a speed-voltage control is used to control the speed of a DC motor. (2)

[20]

TOTAL: 100

FORMULA SHEET

1. $cos\phi = \frac{R}{Z}$
2. $P = VIcos\phi$
3. $Q = VIsin\phi$
4. $\boldsymbol{S = V\ I}$
5. $V_1 = \left(\frac{R_1}{R_t}\right)V_T$
6. $I_1 = \left(\frac{R_2}{R_1 + R_2}\right)I_T$
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. $V_L\sqrt{3}Vph$
11. $E = V - I_aR_a$
12. $f = \frac{Np}{60}$
13. $S = \frac{N_s - N_r}{N_s}$
14. $R_{sh} = \frac{I_mR_m}{I_{sh}}$
15. $tan\phi = \sqrt{3}\left(\frac{W_1 - W_2}{W_1 + W_2}\right)$
16. $E = V + I_r$
17. $V = IR$
18. $R = \frac{p\ l}{A}$
19. $R_t = R_0(1 + \alpha t)$
20. $R_t = R_\theta[1 + \propto_\theta (t - \emptyset)]$
21. $P = VI$
22. $E = I^2Rt$
23. $\eta = \frac{P_0}{P_{in}} \times 100\eta$
24. $X_L = 2\pi fL$
25. $X_C = \frac{1}{2\pi fC}$
26. $Z = \sqrt{R^2 + (X_L - X_C)^2}$
27. $mmf = NI$
28. $H = \frac{mmf}{l}$

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

30. $F = BlI$

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

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

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

34. $Q = CV$

35. $F = 2 \times 10^{-7} \times \frac{I_1 I_2}{d}$

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. $E = Blv$

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. $Pf = \cos\theta$