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 2018 (X-Paper)
09:00–12:00

This question paper consists of 7 pages and a formula sheet of 2 pages.

NCV

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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. Write neatly and legibly.

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QUESTION 1

1.1 The resistance of a material is influenced by four properties.

Name any TWO of these properties. (2)

1.2 The following is an element as displayed on the periodic table:

64 Gd Gold 157

Indicate what each of the following pieces of information represent:

1.2.1 64

1.2.2 Gd

1.2.3 Gold

1.2.4 157

(4 × 1) (4)

1.3 The current flowing through a circuit is directly proportional to the potential difference of a circuit.

Define *potential difference*. (2)

1.4 A copper conductor with a length of 3 km has a cross-sectional area of 4 mm^2.

Calculate the resistance of the conductor, if copper has a resistivity of 0,0173 µΩm. (3)

1.5 A piece of copper wire has a resistance of 150 Ω at 10 °C.

What will its resistance be at 250 °C? Take $\alpha_0 = 4{,}3 \times 10^{-3}$/°C. (4)

[15]

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QUESTION 2

2.1 The operation of a generator is best explained using the laws of electro-magnetic induction.

State TWO such laws of electromagnetic induction which you are familiar with. (2)

2.2 State the right-handgrip rule which determines the direction of the magnetic field around a current-carrying coil. (3)

2.3 A force will be exerted on a current-carrying conductor placed inside a magnetic field.

State THREE factors that will influence the magnitude of this force. (3)

2.4 A conductor 20 cm long moves at a uniform velocity of 4 m/s at right angles to a uniform magnetic field having a flux density of 10 T.

Calculate the following:

2.4.1 The maximum EMF induced in a conductor

2.4.2 The instantaneous value of the induced EMF if the conductor has moved through 45° from zero

(2 × 2) (4)

2.5 Define the term *magnetic flux density* with reference to a magnetic circuit. (2)

2.6 Calculate the magnetic force in N/m length when two current-carrying conductors, each carrying a current of 500 A flowing in the same direction, and are placed 30 cm apart. (4)

2.7 Calculate the magnetomotive force of an electromagnet wound with 300 turns when it is energised with a current of 5 A. (2)

[20]

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QUESTION 3

3.1 Indicate whether the following statements are TRUE or FALSE. Choose the answer and write only 'true' or 'false' next to the question number (3.1.1–3.1.5) in the ANSWER BOOK.

3.1.1 A series circuit is one where there is only one path for the current to flow.

3.1.2 A parallel circuit is one which has two or more components connected across the same voltage source.

3.1.3 The total resistance of equal resistors in a parallel circuit is equal to the resistance of one resistor divided by the number of resistors.

3.1.4 Equivalent resistance is a term used to represent the total resistance of a combination of loads in a circuit.

3.1.5 Current divider rule is used to determine the current flowing through each section of a parallel circuit.

(5 × 1) (5)

3.2 A network junction of TWO currents of 6 A and I_1 are flowing toward a junction and TWO currents of 3 A and 1 A are flowing away from that same junction.

Determine the magnitude of I_1. (2)

3.3 Choose a practical application from COLUMN B that matches the cell in COLUMN A. Write only the letter (A–E) next to the question number (3.3.1–3.3.5) in the ANSWER BOOK.

COLUMN A		COLUMN B	
3.3.1	Mercury cell	A	car and motorbike batteries
3.3.2	Lead-acid cell	B	torch batteries, toys, portable radios
3.3.3	Carbon-zinc cell	C	miniature flat cells used in hearing aids and watches
3.3.4	Nickel-cadmium cell	D	lighting in railway carriages and industrial uses
3.3.5	Nickel-iron cell	E	portable power tools, power pack of laptops

(5 × 1) (5)

3.4 The current always lags the voltage in an inductive circuit.

State FOUR factors that influence the inductance of an inductor. (4)

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3.5 Three capacitors C_1 = 2 µF, C_2 = 6 µF and C_3 = 8 µF are connected in series.

Calculate the total capacitance of the circuit. (3)

3.6 A 20 kW, three-phase AC motor is connected in star through a supply voltage of 380 V. If the power factor is 0,65, calculate:

3.6.1 The phase voltage (2)

3.6.2 The phase current of the motor (5)

3.7 The reticulation network used in our country is a three-phase network.

Show, by means of a neat sketch, three single-phase transformers connected to produce a star-delta transformer. (4)
[30]

QUESTION 4

4.1 There are two types of moving-iron instruments, namely attraction and repulsion types.

Describe the operation of an attraction type moving-iron instrument. (3)

4.2 Digital multimeters are growing in popularity.

State THREE advantages of digital multimeters. (3)

4.3 You are expected to measure the terminal voltage of a lead-acid battery.

Explain in FOUR steps how you would affect such a measurement using a multimeter. (4)

4.4 An ammeter has an internal resistance of 8 ohms and gives a full-scale deflection when a current of 30 mA flows through it.

Calculate the value of the shunt resistor required for a 2 A current flow. (3)

4.5 The function of the controlling mechanism in any analogue type measuring instrument is to produce the controlling torque.

Name the TWO types of controlling devices used in these instruments. (2)
[15]

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QUESTION 5

5.1 Energy cannot be created or destroyed, but instead can be converted from one form into another.

Using this statement, explain the function of an electric motor. (2)

5.2 Single-phase motors are more expensive than three-phase motors.

Name THREE types of single-phase AC motors. (3)

5.3 A 230-volt shunt-wound generator has an armature resistance of 0,4 Ω.

Calculate the generated emf when it is delivering a load current of 10 A and the field current is 1 A. (4)

5.4 Large three-phase induction motors draw large currents from the supply.

Name TWO types of reduced voltage starters used to limit these high starting currents. (2)

5.5 Squirrel-cage motors are the most popular motors used in industry.

Name THREE disadvantages of a squirrel-cage motor. (3)

5.6 Electrical motors are very expensive and must therefore be protected against all possible fault conditions.

Explain what is understood by each of the following protective devices used in motor control:

5.6.1 No-volt release

5.6.2 Phase-failure relay

5.6.3 Phase-reversal relay

(3 × 2) (6)
[20]

TOTAL: 100

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FORMULA SHEET

1. $Q = I\,t$

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

3. $\boldsymbol{V = I\,R}$

4. $P = V\,I$

5. $E = Pt$

6. $R = \frac{p\,l}{A}$

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

8 $\frac{\boldsymbol{R_1}}{\boldsymbol{R_2}} = \frac{1+\boldsymbol{\alpha t_1}}{1+\boldsymbol{\alpha t_2}}$

9. $R_T = R_0\,[\,1 + \propto_0 (t - \theta)$

10. $R_T = R_1 + R_2 + R_3$

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

12. $\frac{1}{\boldsymbol{R_T}} = \frac{1}{\boldsymbol{R_1}} + \frac{1}{\boldsymbol{R_2}} + \frac{1}{\boldsymbol{R_3}}$

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

14. $I = \frac{Emf}{R_T + r_T}$

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

16. $C_T = C_1 + C_2 + C_3$

17. $\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

18. $E = -\,L\frac{\Delta\ I}{t}$

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

20. $L_T = L_1 + L_2 + L_3$

21. $\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}$

22. $L_T = L_1 + L_2 + L_3\ +\ L_n$

23 $\boldsymbol{P = V\ I\ Cos\phi}$

24. $S = VI$

25. $\boldsymbol{P = \sqrt{3}\ I_L}$ VL Cos θ

26. $\boldsymbol{S = \sqrt{3}\ I_L}$ VL

27. $\boldsymbol{I_L = \sqrt{3}\ I_p}$

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

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

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

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

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

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33. $R_{se} = \frac{V_t - R_m}{It}$

34. $E_{gen} = V + Ia\ R_a$

35. $I_{SH} = \frac{V_{Sh}}{R_{sh}}$

36. $Ia = I_{sh} + I$

37. $V = E_{gen} - I\ (Ra + R_{se})$

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

39. $E = V + I\ r$

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

41. $E = B\ l\ v$

42. $F = B\ I\ l$

43. $Mmf = N\ I$

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

50. $E = I^2\ R\ t$

51. $F = 2 \times 10^{-7} \times \frac{I1\ I2}{d}$

NCTV

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