higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ARMATURE WINDING THEORY N2

(11020042)

5 August 2021 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 6 pages and a formula sheet of 3 pages.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
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NATIONAL CERTIFICATE
ARMATURE WINDING THEORY N2
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. Use 3,142 as the value of π.
5. Sketches must be neat, labelled and large enough to show the required detail.
6. Answers must be given to THREE decimals.
7. Write neatly and legibly.

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QUESTION 1

1.1 Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–C) next to the question number (1.1.1–1.1.3) in the ANSWER BOOK.

1.1.1 How many parallel paths are in a lap winding?

A 1p, depending on the poles of the machine
B 4p, depending on the poles of the machine
C 2p, depending on the poles of the machine

1.1.2 What is the purpose of the overload coil in a DC starter?

A To allow current to overflow to the NVR (no-volt release) coil and produce sufficient current
B To short-circuit the NVR coil and cause the starter arm to fly back to the off position
C To smoothen the overload current flowing to the NVR coil

1.1.3 What is meant by bedding of brushes?

A The accurate replacement of brushes' contact face to commutator
B The accurate selection of brush type to slipring or commutator
C The accurate placing of brushes in position with the commutator, turning the whole armature until the brushes have the same arc as the commutator

(3 × 2) (6)

1.2 Draw a neat diagram of a 4-pole retrogressive winding with a 1 to 12 commutator pitch. (4)

1.3 Explain Faraday's law of electromagnetic induction. (3)

1.4 What commutator pitch is found in an armature winding? (3)

1.5 A direct-current machine is connected to a 220 V supply and has an armature resistance of 0,34 Ω.

Calculate the back EMF in the following situations:

1.5.1 The machine runs as a motor taking 65 A.

1.5.2 The machine delivers 75 A as a generator.

(2 × 2) (4)

[20]

QUESTION 2

2.1 Define *torque.* (2)

2.2 What types of brushes are widely used for high surface speeds? (2)

2.3 The following information is reflected on a motor nameplate:

V = 240 V
R = 115 Ω

Calculate the following:

2.3.1 The full load current in the motor

2.3.2 The power of the motor

(2 × 2) (4)

2.4 Draw a neat diagram of a faceplate starter for a series motor. (5)

2.5 A 6-pole wave-wound armature is rotated at 600 r/min and is required to deliver 380 V. The flux per pole is 0,0212 Wb. The armature has 76 slots and draws a current of 100 A.

Calculate the following:

2.5.1 Conductors per slot (4)

2.5.2 The torque developed by the winding (3)

[20]

QUESTION 3

3.1 Show, by means of a diagram, how you would conduct a volt-drop test. (5)

3.2 Name THREE faults that may develop in an armature winding. (3)

3.3 Make a neat drawing showing the various shapes of armature slots. (5)

3.4 When coil taping, TWO points must be remembered as the taping proceeds.

Briefly explain those TWO points. (2)

3.5 Probably the first condition that causes an excessively high temperature on DC machines is overload.

List THREE other conditions that may cause an abnormal temperature increase on DC machines. (3)

3.6 Explain the term *precision former-wound coil*. (2)

[20]

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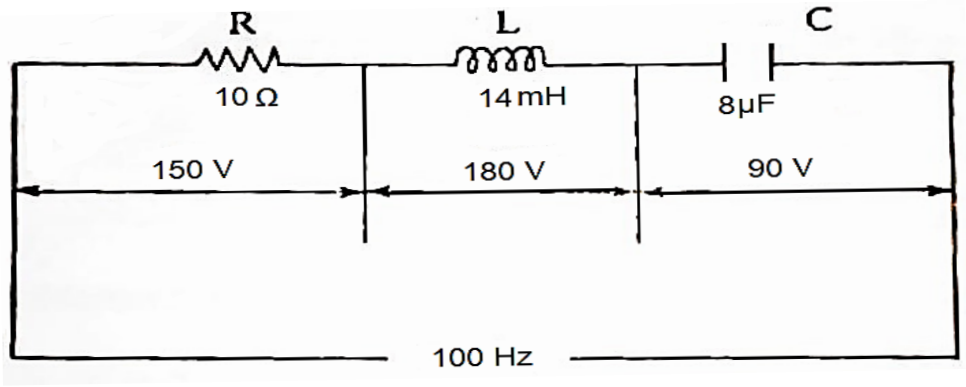
QUESTION 4

4.1 Name the SEVEN most important operations when rewinding a split-phase motor. (7)

4.2 Name any TWO types of AC rotors known to you. (2)

4.3 Refer to the diagram below and calculate the supply voltage.



(1)

4.4 Use the information in QUESTION 4.3 to calculate the following:

4.4.1 The inductive reactance of the circuit

4.4.2 The capacitive reactance of the circuit

4.4.3 The impedance of the circuit

4.4.4 The current in the circuit

4.4.5 The phase angle between the current and the voltage

(5 × 2) (10)
[20]

QUESTION 5

5.1 Define the following machine groups:

5.1.1 Class I

5.1.2 Class II

(2 × 2) (4)

5.2 Draw a neat diagram of a direct-switching contactor starter.

NOTE: Do NOT include the control circuit. (6)

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5.3 An 11 kV/220 V single-phase transformer has 3 600 primary turns.

Calculate the following:

5.3.1 The secondary turns

5.3.2 The primary current if 200 A is drawn from the secondary (2 × 2) (4)

5.4 Make a neat, labelled sketch of an armature and label at least FOUR parts. (4)

5.5 Name any TWO transformers known to you. (2)
[20]

TOTAL: 100

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ARMATURE WINDING THEORY N2

FORMULA SHEET

1. $\dfrac{Total\ number\ of\ slots + 1}{Total\ number\ of\ poles}$ = *COIL SPAN*

2. *COMMUTATOR PITCH* = $\dfrac{Number\ of\ segments \pm 1}{Number\ of\ pairs\ of\ poles}$

3. *E* = $\dfrac{Total\ flux\ of\ pole}{Time\ of\ one\ revolution}$

$= 2p\ \phi \div \dfrac{60}{N}$

$= \dfrac{2\phi NP}{60}$ *volt*

MECHANICAL POWER = $\dfrac{Force \times distance}{Time\ in\ seconds}$

$= 2\ \pi$ *metres*

$\therefore\ P = F \times 2\pi\ R \times \dfrac{N}{60}$

$= \dfrac{2\pi\ NT}{60}$ *watts*

SUMMARY

E = $\dfrac{2\ ZNP\phi}{C \times 60}$

T = $\dfrac{ZP\phi Ia}{C \times \pi}$

A = $\dfrac{I}{J}$

E = *V + Ia Ra* *A max* = $\dfrac{Ia}{J\ \min}$

Ia = *I + If* *A min* = $\dfrac{Ia}{J\ \max}$

P = *EIa*

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$$Lt = Z \times \frac{Length\ per\ turn}{2}$$

$$Ra = Zx\ \underline{Length\ per\ turn \times Resistance\ per\ unit\ x}\ \frac{1}{C^2}$$

RECTANGULAR CONDUCTORS $R = \frac{\rho \ell}{A}$

$$Ra = \frac{1t \times resistance\ per\ unit\ length}{C^2}$$

$$A\ max = \frac{Ia}{J\ \min}$$

$$A\ min = \frac{Ia}{J\ \max}$$

$$n = f/p$$

$$QV^2 = QR^2 + QL^2 \qquad \frac{VP}{VS} = \frac{NP}{NS} = \frac{IS}{IP}$$

$$V^2 = (IR)^2 + (I \times L)^2$$

$$V = I\sqrt{R^2 \times L^2}$$

$$\frac{V}{I} = \sqrt{R^2 \times L^2}$$

$$XL = 2\pi FL \qquad I = \frac{V}{2}$$

$$Z = \sqrt{R^2 + XL^2}$$

$$C = \frac{Q}{V}$$

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$$X_C = \frac{1}{2\pi fc}$$

$$XC = \frac{V}{I} = \frac{1}{2\,\pi} FC$$

$$C = \frac{1}{2\,\pi} FXc$$

$$Z = \sqrt{R^2 + (XC \quad XL)^2}$$

$$Cos\,\phi = \frac{R}{Z}$$

Ip Np = Is Ns

$$\frac{Ip}{Is} = \frac{Ns}{Np}$$

$$Current = \frac{Apparent\ power\ .\ Ps}{Potential\ difference.V}$$

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