higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ARMATURE WINDING THEORY N2

(11020042)

24 November 2022 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 5 pages and 3 formula sheets.

185Q1E2224

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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. Answers must be given to THREE decimals.
6. Use only a blue or black pen.
7. Diagrams must be neat, labelled and large enough to show the required detail.
8. Diagrams may be done in pencil.
9. Write neatly and legibly.

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QUESTION 1

1.1 Name TWO main classifications of direct current windings. (2)

1.2 Define *commutation*. (2)

1.3 What is the purpose of mica between the commutator segments? (2)

1.4 State *Fleming's right-hand rule* for generators. (3)

1.5 How many parallel paths are in a lap winding? (1)

1.6 A six-pole wave-wound armature has 112 slots and 360 segments with a single-turn coil.

Calculate the following:

1.6.1 The coil span

1.6.2 Suitable commutator pitch

(2 × 3) (6)

1.7 A direct-current machine is connected to a 110 V supply and has an armature resistance of 0,62 Ω.

Calculate the back EMF if:

1.7.1 The machine runs as a motor taking 65 A

1.7.2 The machine delivers 75 A as a generator

(2 × 2) (4)

[20]

QUESTION 2

2.1 2.1.1 Explain the difference between a cumulatively compound-wound m and a differentially compound-wound motor. (2)

2.1.2 Draw a diagram of each one to support the explanation. (2 × 3) (6)

2.2 A SIX-pole lap-wound armature is rotated at 800 r/min and is required to deliver 380 V. The flux per pole is 41,4 mWb. The armature has 110 slots and draws a current of 80 A.

Calculate:

2.2.1 Number of conductors per slot (4)

2.2.2 Torque developed by the windings (3)

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2.3 Why are equalising windings installed? (4)

2.4 Name ONE type of a carbon brush. (1)
[20]

QUESTION 3

3.1 Why is it important to make sure that the load current of a DC machine does not link with the magnetic circuit formed by the shaft and the bedplates of a machine? (3)

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

3.3 Draw a neat diagram to show how a coil is tested using a transformer test. (4)

3.4 Draw a neat diagram of a sleeve bearing mounted on a bedplate. (4)

3.5 State THREE mechanical defects that would cause a DC machine to fail to start. (3)

3.6 State THREE methods of closing slots after windings have been inserted. (3)
[20]

QUESTION 4

A series circuit comprises a coil with a resistance of 28 Ω, an inductive reactance of 64 Ω and a capacitive reactance of 94 Ω. The circuit is connected across a 220 V, 50 Hz supply.

4.1 Determine the following:

4.1.1 Inductance of the coil in mH (2)

4.1.2 Capacitance of the capacitor in µF (2)

4.1.3 Impedance of the circuit (3)

4.1.4 Total current flowing in the circuit (2)

4.1.5 Voltage drop across each component (3)

4.1.6 Draw a phasor diagram of the circuit showing the relationship between the voltages. (3)

4.2 Draw a neat, labelled diagram of an armature. (5)
[20]

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QUESTION 5

5.1 Name THREE losses that are found in transformers. (3)

5.2 Name THREE methods that can be used to cool a transformer. (3)

5.3 State FOUR ways in which the armature reaction can be minimised. (4)

5.4 A 150 kVA, 1 000 V/400 V single-phase transformer, has 125 turns on the secondary winding. Ignore ALL losses.

Calculate:

5.4.1 The number of primary turns

5.4.2 The maximum allowable secondary current

5.4.3 The primary current

5.4.4 The maximum power if the power factor is 0,866 lagging

5.4.5 The transformation ratio

(5 × 2) (10)
[20]

TOTAL: 100

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ARMATURE WINDING THEORY N2

FORMULA SHEET

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

   $\dfrac{Totale\ aantal\ \ gleuwe + 1}{Totale\ aantal\ \ pole}$ $= SPOELSPAN$

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

   $KOMMUTATORSTEEK = \dfrac{Hoeveelheid\ \ segmente \pm 1}{Hoeveelheid\ \ poolpare}$

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

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

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

   $E = \dfrac{Totale\ vloed\ van\ pole}{Duur\ van\ een\ omwenteling}$

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

   $Z = \dfrac{EXC \times 60}{2\ NP\ \varphi}$

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

   $MEGANIESE\ DRYWING = \dfrac{Krag \times afstand}{Tyd\ \ in\ sekondes}$

   $= 2\ \pi\ metres$

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

   $= \dfrac{2\ \pi\ NT}{60}\ watt$

   $E = V + Ia\ Ra\ or/of\ E = V - Ia\ Ra$

   $V = E + Ia\ Ra$

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SUMMARY

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

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

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

$$E = V + Ia\,Ra \quad A\ max/maks = \frac{Ia}{J\ \min}$$

$$Ia = I + If \quad A\ min = \frac{Ia}{J\ max/maks}$$

$$P = EIa$$

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

$$Lt = Z \times \frac{Lengte\ per\ draai}{2}$$

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

$$Ra = Zx\ \underline{Lengte\ per\ draai \times Weerstand\ per\ eenheid\ x}\ \frac{1}{C^2}$$

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

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

$$Ra = \frac{1t \times weerstand\ \ per\ eenheidlengte}{C^2}$$

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

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

$$n = f/p$$

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

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

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

$$XL = 2\,\pi FL$$

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

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

$$I = \frac{V}{Z} \qquad C = \frac{1}{2\,\pi}\,FXc$$

$$Z = \sqrt{R^2 + (XC - XL)^2} \qquad Cos\,\phi = \frac{R}{Z}$$

$$Ip\ Np = Is\ Ns$$

$$\frac{Ip}{Is} = \frac{Ns}{Np} \qquad \frac{IP}{IS} = \frac{Ns}{Np} = \frac{Vs}{Vp}$$

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

$$Stroom = \frac{Skyndrywing\ .\ Ps}{Potensiaalverskil\ .\ V}$$

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