higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ARMATURE WINDING THEORY N2

(11020042)

1 December 2023 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 5 pages and a formula sheet of 3 pages.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

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 the value of π as 3,142.
5. Make sketches neatly and large enough to show the required detail.
6. Sketches may be done in pencil.
7. Start each section on a new page.
8. Round off answers to THREE decimal places.
9. Use only a black or blue pen.
10. Write neatly and legibly.

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QUESTION 1

1.1 List THREE methods to reduce commutation. (3)

1.2 Draw a neat diagram of a four-pole retrogressive winding with a 1 to 12 commutator pitch. (5)

1.3 List FOUR types of self-excited DC machines. (4)

1.4 Draw the load characteristic curve of a shunt-wound generator. (4)

1.5 A six-pole wave-wound armature has 72 slots and 143 commutator segments.

Calculate the:

1.5.1 Coil span

1.5.2 Commutator pitch

(2 × 2) (4)

[20]

QUESTION 2

2.1 Draw a neat diagram of a shunt-pole generator with interpoles. (6)

2.2 List THREE methods used for slot closures. (3)

2.3 An eight-pole lap-wound armature is rotated at 200 r/min and is required to deliver 450 V. The flux per pole is 0,0444 Wb. The armature has 76 slots and draws a current of 110 A.

Calculate:

2.3.1 The number of conductors per slot (4)

2.3.2 The torque developed by the windings (3)

2.4 The armature current of a DC shunt machine is 10 A. The motor is operating at a terminal voltage of 220 V when the resistance is 1,8 Ω.

Calculate the emf when the motor is connected in each of the following configurations:

2.4.1 Generator

2.4.2 Motor

(2 × 2) (4)

[20]

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QUESTION 3

3.1 State FIVE requirements that an armature must comply with after rewind. (5)

3.2 List FOUR tests that can be done on an armature after rewinding. (4)

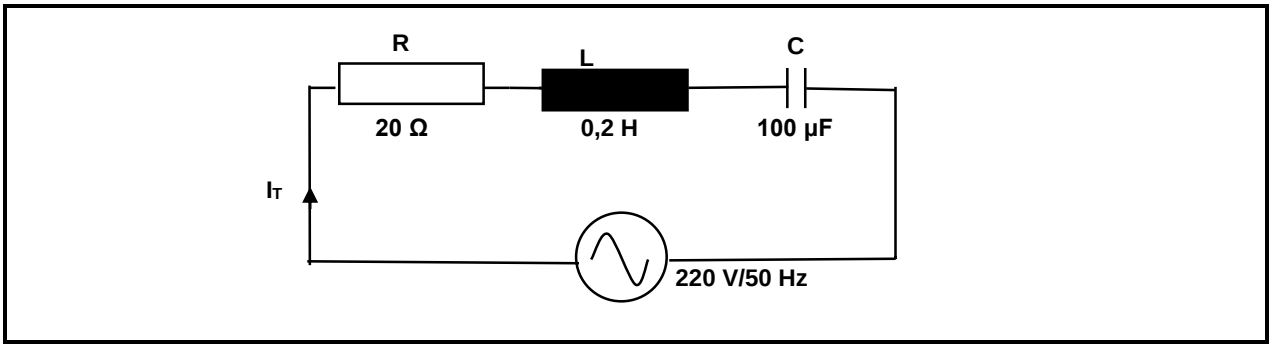
3.3 State THREE electrical defects that would cause start failure in a DC machine. (3)

3.4 Show, by means of a diagram, how to conduct a voltage drop test. (5)

3.5 Draw a neat diagram of an armature with three labels. (3)

[20]

QUESTION 4



4.1 Calculate:

4.1.1 The total impedance of the circuit (6)

4.1.2 The current flowing in the circuit (2)

4.1.3 The voltage drop across the inductor (2)

4.1.4 The voltage drop across the capacitor (2)

4.1.5 The phase angle between the voltage and current (2)

4.2 Name TWO types of AC rotors. (2)

4.3 What is the purpose of the centrifugal switch in a split-phase motor? (2)

4.4 Give TWO methods of reversing the direction of rotation of a DC motor. (2)

[20]

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QUESTION 5

5.1 List FOUR types of three-phase transformer connections. (4)

5.2 Draw a basic diagram of a shell-type transformer. (4)

5.3 Name TWO types of iron losses that occur in a transformer. (2)

5.4 How can the direction of rotation of a three-phase slip-ring motor be reversed? (2)

5.5 A single-phase transformer has 600 turns on the primary winding supplied from 220 V AC.

Determine the:

5.5.1 Number of turns on the secondary winding if it is required to supply a secondary voltage of 16 V

5.5.2 Primary current if the secondary current is 5 A

5.5.3 Rating of the transformer in VA

5.5.4 Transformer ratio

(4 × 2) (8)

[20]

100

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FORMULA SHEET

$$Coil\ span = \frac{Total\ number\ of\ slots + 1}{Total\ number\ of\ poles}$$

$$Commutator\ pitch = \frac{Number\ of\ segments \pm 1}{Number\ of\ pairs\ of\ poles}$$

$$E = \frac{Total\ flux\ of\ pole}{Time\ of\ one\ revolution}$$

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

$$= \frac{2\,\phi NP}{60} volt$$

$$= \frac{2\ ZNP\ \varphi}{C \times 60}$$

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

$$Mechanical\ power = \frac{Force \times distance}{Time\ in\ seconds}$$

$$= 2\ \pi\ metres$$

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

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

$E = V + Ia\ Ra$ **OR** $E = V - Ia\ Ra$

$V = E + Ia\ Ra$

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Summary

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

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

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

$$E = V + Ia\ Ra$$

$$Amax = \frac{Ia}{Jmin}$$

$$Ia = I + If$$

$$Amin = \frac{Ia}{J\ max}$$

$$P = EIa$$

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

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

$$Rectangual\,conductors: R = \frac{\rho\ell}{A}$$

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

$$Amax = \frac{Ia}{Jmin}$$

$$Amin = \frac{Ia}{J\ max}$$

$$n = f/p$$

$$QV^2 = QR^2 + QL^2$$

$$\frac{VP}{VS} = \frac{NP}{NS} = \frac{IS}{IP}$$

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

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

$$XL = 2\ \pi FL$$

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

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

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

$$I = \frac{V}{Z}$$

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

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

$$\cos\phi = \frac{R}{Z}$$

$$Ip\ Np = Is\ Ns$$

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

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

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

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