higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T60**(E)**(A6)T

NATIONAL CERTIFICATE

ARMATURE WINDING THEORY N2

(11020042)

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09:00–12:00

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. ALL diagrams must be neat and in proportion.
5. Use the value of π as 3,142.
6. Write neatly and legibly.

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QUESTION 1

1.1 A sinusoidal wave has a peak voltage of 100 volts connected to a frequency of 50 Hz.

Calculate the:

1.1.1 Average value of the wave

1.1.2 RMS value

1.1.3 Form factor

(3 × 2) (6)

1.2 Define the term *slip* as applicable to AC machines. (2)

1.3 Make a neat schematic diagram of a three-phase induction motor with a slip-ring rotor. (5)

1.4 What is the biggest disadvantage of a single-layer winding (hairpin winding)? (2)

1.5 Calculate the power of a delta-connected motor supplied with 525 V at a power factor of 0,8 and drawing a current of 11 A. (3)

[18]

QUESTION 2

2.1 Name TWO winding forms used in DC armatures. (2)

2.2 Make a neat diagram of a waveform-balanced three-phase system. (4)

2.3 What is the main function of a centrifugal switch in a split-phase motor? (2)

2.4 List, in sequence, SEVEN basic steps when rewinding a motor. (7)

2.5 Draw a neat, labelled diagram of the connections of a mixed-pole split-phase motor. (6)

[21]

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QUESTION 3

3.1 Draw a neat diagram of a capacitor under test. (3)

3.2 Briefly describe the construction of an oil-filled capacitor. (2)

3.3 Calculate the total capacitance when three capacitors of 2,4 µf, 4,1 µf and 8,3 µf respectively are connected in parallel. (2)

3.4 How is the direction of rotation of a shaded motor reversed? (2)

3.5 Show with a sketch how to control a universal motor using a resistance method. (3)

3.6 Indicate by means of a diagram how to take a line out on straight or skewed slots. (4)

[16]

QUESTION 4

4.1 The input to a three-phase delta-connected motor was measured by the two-wattmeter method. The readings were 10,4 kW and -3,4 kW respectively and the line voltage was 450 V.

Calculate the:

4.1.1 Total power (2)

4.1.2 Power factor (5)

4.2 Name THREE methods of testing direct-current machines. (3)

4.3 Make a neat diagram to indicate Hopkinson's back-to-back method. (6)

4.4 Make a neat diagram showing how to take dope (winding data) on a single-phase motor. (7)

[23]

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QUESTION 5

5.1 Explain the term *forced oil water cooled*. (2)

5.2 During a brake test performed on a DC motor, the effective load was 226 N and the scale was 180 N at a drum speed of 960 r/min.

If the effective radius of the drum was 22,5 cm and the input to the motor was 28 A at 230 V, calculate the:



5.2.1 Output power

5.2.2 Efficiency of the motor

(2 × 3) (6)

5.3 A 400 kVA transformer is connected in delta-star and the winding ratio is 15:1. The secondary line voltage is 380 V.

Calculate the:

5.3.1 Supply-line voltage



5.3.2 Load-line current

(2 × 2) (4)

5.4 Draw a neat, labelled sketch of a voltage stabiliser. (3)

5.5 A bridge rectifier has been identified and found to be faulty on one of the diodes.

How can it be repaired to achieve the same results of full-wave rectification? Diagrams may be used. (3)



5.6 Name TWO defects that are mostly found in LEDs. (2)

5.7 Explain the term *Class 1 machine*. (2)

[22]

TOTAL: 100

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FORMULA SHEET

e = EMsinØ

Average value $= \frac{i_1 + i_2 + in}{n}$

RMS value $= \sqrt{\left(\frac{i_1^2 + i_2^2 + in^2}{n}\right)}$

1. $Z = \sqrt{R^2 + (XL - XC)^2}$
2. $Z = \sqrt{R^2 + XL^2}$
3. $Z = \sqrt{R^2 + Xc_2}$
4. $I = \frac{V}{Z}$

$P = I^2R$

P = VA × power factor

Sinusoidal

Average value = 0,637 × max value

Form factor $= \frac{RMS\ value}{Ave\ value}$
= 1.11 for sine wave

$n = \frac{f}{p}$

Commutator pitch $= \frac{\text{No. of bars}}{\text{No. of pairs of poles}}$

er = EMsinØ

et = er + ey + eb

Reactive VA = VA × sinØ

it = $i_1 + i_2 + i_3$

PF $= \frac{\text{input power}}{\text{output power}}$
$= \frac{\text{wattmeter reading}}{\text{voltmeter reading \& ammeter reading}}$

Percentage slip $= \frac{slip\ frequency}{synchronous\ frequency \times 100\%}$

$= \frac{synchronous\ frequency - rotor\ frequency \times 100\%}{synchronous\ frequency}$

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P = VIcosØ

XL = 2πfL

$$XC = \frac{1}{2\,\pi\,fc}$$

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

Total current 1 = $\sqrt{(\text{active current})^2 + (\text{reactive current})^2}$

Resonant frequency:

$$xL = xc$$

$$2II\ fl = \frac{1}{2\,\pi\ fc}$$

$$f^2 = \frac{i_1}{(Z)_2\ \pi^2\ LC}$$

$$f = \frac{1}{2\,\pi\,\sqrt{LC}}$$

$$NL = \sqrt{3}\ vp$$

IL = Ip

Ic = 1,732 × phase

$$Vp = V\ell$$

$$Ip = \frac{Ip}{\sqrt{3}} \times \cos\phi$$

$$P = 3 \times Vp \times Ip \cos\phi$$

$$P_{input} = \sqrt{3}\ V\ell\ I\ell \cos\phi$$

$$P_{output} = \sqrt{3}\ V\ell\ I\ell \cos\phi \times eff$$

$$\text{Tanø} = \frac{\sqrt{3}\ W_1 - (-W_2)}{W_1 + (-W_2)}$$

Constant loss

Pc = input with no load – I2 R loss in stator winding

$$\frac{IP}{IS} = \frac{NS}{Np} = \frac{VS}{Vp}$$

$$KVA_1 = \frac{KVA_2}{n}$$

$$\text{Input power} = \frac{KVA^2 \times \cos\phi}{n}$$

$$V_1\ \phi = \frac{V_1\ L}{\sqrt{3}}$$

Output power of M = n × input power to M

Output power of G = n × input power to G

$$\eta = \frac{2\ II\ N\ (F_1 - F_2)\ R}{60\ VI}$$

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$$\frac{I_1\ L}{I_2\ L} = \frac{V_2\ L}{V_1\ L}$$

Primary line current = $\frac{secondary\ line\ current}{transformation\ ratio}$

KVA rating = Power rating with unit power factor

Efficiency = $\frac{Work\ done}{Energy\ consumed} = \frac{Output}{Input} <$

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

Constant losses = VIs + VIa (no load)

Load current = Ia – Is

Variable loss = PV = Ia2 Ra

Friction loss = Pa = VIa (unloaded)

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