higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

ELECTROTECHNICS N5

(8080085)

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This question paper consists of 5 pages and a formula sheet of 2 pages.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
ELECTROTECHNICS N5
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 section on a new page.
5. Use only a black or blue pen.
6. Write neatly and legibly.

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QUESTION 1

1.1 Explain why the terminal voltage of a DC shunt-excited generator drops as the current supplied by the machine is increased. (2)

1.2 Explain the application of lap and wave windings with regard to DC machines. (2)

1.3 The approximate maximum and minimum values of armature current are 65 A and 40 A respectively. A 220 V, DC shunt motor has an armature resistance of 0,4 Ω.

Determine the number of studs required for a motor starter. (7)

1.4 A series-wound DC motor rotates at 900 r/min when taking 84 A at 240 V. The armature resistance is 0,46 Ω and the resistance of the field circuit is 0,34 Ω.

Calculate the value of the additional resistance required in series with the motor to reduce the speed to 770 r/min if the gross torque is proportional to the speed. (9)

[20]

QUESTION 2

2.1 A coil takes a current of 6,5 A and dissipates 1,4 kW when connected to a 230 V, 50 Hz sinusoidal supply. When another coil is connected in parallel with it, the total current taken from the supply is 18 A at a power factor of 0,87 lagging.

Determine the current flow and the overall power factor when the coils are connected in series across the same supply. (10)

2.2 An impedance of 3 + j4 Ω is connected in series with two impedances in parallel of 4 + j10 Ω and 8 – j3 Ω respectively. This combination is then connected across a 120 V alternating-current supply.

Calculate the:

2.2.1 Voltage across the series branch (7)

2.2.2 Voltage across the parallel branch (2)

2.2.3 Power factor (1)

[20]

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QUESTION 3

3.1 How can eddy current loss in a transformer be minimised? (1)

3.2 Give TWO methods of reducing leakage flux in a transformer. (2)

3.3 Two single-phase transformers of similar voltage ratios, but with the ratings and impedances shown below, are connected in parallel to supply a load of 1 500 kW at a power factor of 0,87 lagging.

Transformer 1	1 900 kVA	5 Ω resistance	8 Ω reactance
Transformer 2	2 300 kVA	3,8 Ω resistance	6 Ω reactance

Calculate the kVA in each transformer as well as its power factor. (10)

3.4 A 480/230 V single-phase transformer has an equivalent resistance of 0,43 Ω referred to the primary and an equivalent leakage reactance of 1,95 Ω referred to the primary side. The secondary is connected to a coil with a resistance of 90 Ω and reactance of 120 Ω.

Calculate the percentage voltage regulation. (6)

3.5 Briefly explain the term *voltage regulation* as it relates to transformers. (1)

[20]

QUESTION 4

4.1 Two wattmeters read -660 W and 4,4 kW when connected to measure the power taken by a balanced three-phase load.

Determine the power factor of this load. (4)

4.2 A load of 3,5 MVA at 13 kV and a power factor of 0,79 lagging is supplied by a three-phase transmission line having a resistance of 8 Ω per phase and inductive reactance of 12 Ω per phase.

Determine the:

4.2.1 Percentage regulation (7)

4.2.2 Efficiency of the line (4)

4.3 A three-phase overhead line of 30 km long has solid copper conductors of diameter 0,6 cm that are spaced on the corners of a triangle having sides of length 100 cm, 140 cm and 210 cm.

Calculate the:

4.3.1 Inductance per phase (3)

4.3.2 Capacitance per phase (2)

[20]

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QUESTION 5

5.1 Briefly explain each of the following terms:

5.1.1 Pitch factor

5.1.2 Distribution factor

5.1.3 Form factor

(3 × 2) (6)

5.2 A three-phase induction motor is wound with six poles and supplied from a 50 Hz supply.

Calculate the:

5.2.1 Synchronous speed (2)

5.2.2 Rotor speed when the slip is 6% (2)

5.2.3 Rotor frequency when the rotor runs at 600 r/min (3)

5.3 A three-phase star-connected alternator driven at 1 500 r/min is required to generate a line voltage of 415 V at 50 Hz on open circuit. The stator has eight slots per pole per phase and 16 conductors per slot.

Calculate the useful flux per pole if the distribution factor is 0,968. (7)

[20]

TOTAL: 100

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FORMULA SHEET

Armature ampere-turns/pole $= \frac{1}{2} \cdot \frac{I_a}{C} \cdot \frac{Z}{2P}$

$$E = V \pm I_a R_a$$

$$E = \frac{2pNZ\Phi}{60c}$$

$$T = 0{,}318 \ \frac{I_a}{c} \ ZP\Phi$$

$$k = n\sqrt{\frac{R_1}{r_m}}$$

$$r_1 = R_1\left[\frac{k-1}{k}\right]$$

$$r_1 = R_s \ \frac{1-y}{1-y^m}$$

$$R_1 = bR_1 \ (k-1) \times \frac{1-b^n}{1-b} + r_m$$

$$y = \frac{I_2}{I_1}$$

$$r_1 = bR_1 \ (k-1)$$

$$\frac{E_1}{E_2} = \frac{K\Phi_1 N_1}{K\Phi_2 N_2}$$

$$\frac{T_1}{T_2} = \frac{K\Phi_1 I_{a1}}{K\Phi_2 I_{a2}}$$

$$I_{ave} = \frac{i_1 + i_2 + i_3 + \ldots i_n}{n}$$

$$I_{rms} = \sqrt{\frac{i_1^2 + i_2^2 + i_3^2 + \ldots + i_n^2}{n}}$$

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

$$f = \frac{1}{2\pi L}\sqrt{\frac{L}{C} - R^2}$$

$$P = \sqrt{3} I_L V_L \cos\phi$$

$$P_1 = V_L I_L \cos(30 - \phi)$$

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$$P_2 = V_L I_L \cos(30 + \phi)$$

$$\tan\phi = \frac{\sqrt{3}\,(P_2 - P_1)}{(P_2 + P_1)}$$

% voltage regulation

$$= I_1 \frac{(R_e \cos\phi \pm X_e \sin\phi)}{v_1} \times \frac{100}{1}$$

$$Z_e = \sqrt{R_e^2 + X_e^2}$$

$$\%Z_e = \frac{I\,Z_e}{V} \times \frac{100}{1}$$

$$S_1 = S \frac{Z_2}{Z_1 + Z_2}$$

$$E = 2{,}222\ k_d k_p\ Z\Phi f$$

$$I_r = \frac{E_r}{Z_r}$$

$$E_o = V_p \frac{Z_r}{Z_s}$$

$$\cos\phi_r = \frac{R}{Z_r}$$

$$s = \frac{2\pi T(n_s - n_r)}{2\pi T\ n_s}$$

$$L = 0{,}05 + 0{,}2\ Lin\ \frac{d}{r}$$

$$C = \frac{1}{36 Lin \frac{d - r}{r}}$$

$$C = \frac{1}{18 Lin \frac{de}{r}}$$

% regulation

$$= \frac{V_s - V_R}{V_R} \times \frac{100}{1}$$

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