higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T540**(E)**(A12)T

NATIONAL CERTIFICATE

ELECTROTECHNICS N5

(8080085)

12 August 2019 (X-Paper)
09:00–12:00

Calculators may be used.

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. Write neatly and legibly.

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QUESTION 1

1.1 State TWO functions of commutators. (2)

1.2 The armature of a four-pole motor is lap-wound with 2 050 conductors and runs at 980 r/min, taking an armature current of 45 A from a 480 V, DC supply. The resistance of the armature circuit is 0,36 ohms.

Calculate the following:

1.2.1 The useful flux per pole in milliweber

1.2.2 The torque developed by the armature

(2 × 3) (6)

1.3 A 500 V, DC shunt motor has an armature resistance of 0,25 ohms. When operating at full load, the armature takes 110 A.

What resistance should be inserted in the armature circuit to obtain a 25% speed reduction when the motor is developing 80% of full load torque? (10)

1.4 State TWO characteristics of shunt motors. (2)
[20]

QUESTION 2

2.1 The voltage across a certain element is V(t) = 844 Sin (314t + 45°) volts and the current flowing in the element is i(t) = 12 Cos (314t – 45°) amperes.

Calculate the following:

2.1.1 The nature and magnitude of this element (3)

2.1.2 The frequency and the period of these waveforms (2)

2.2 Circuit A is connected in parallel with circuit B and this parallel circuit is connected across a 220 V, 50 Hz supply. The total power of the combination is 3 300 W at a unity power factor. Circuit B consists of a 5 ohm resistor and a 145 microfarad capacitor connected in series. Circuit A consists of a resistor and an inductive reactance in series.

Calculate the following for circuit A:

2.2.1 The reactance of an inductor and the resistance (13)

2.2.2 The power factor (2)
[20]

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QUESTION 3

3.1 State FOUR conditions that will be satisfied when two or more transformers are connected in parallel. (4)

3.2 Does a transformer draw any current when its secondary side is open-circuited? Explain your answer. (2)

3.3 Two single-phase transformers of the same polarity operate in parallel to feed a load of 1,2 MW at a power factor of 0,85 lagging. The ratings and the impedances of the two transformers are as follows:

Transformer 1	1 400 kVA	2,5 ohms resistance	5,5 ohms reactance
Transformer 2	1 800 kVA	1,6 ohms resistance	3,5 ohms reactance

Calculate the kVA load and power factor of each of the following:

3.3.1 Transformer 1 (8)

3.3.2 Transformer 2 (6)

[20]

QUESTION 4

4.1 A delta-connected, three-phase, 415 V, 50 Hz sinusoidal supply has three similar coils. Each has a resistance of 12 Ω and an inductance of 0,04 H.

Calculate the following:

4.1.1 The value of the line current (6)

4.1.2 The power factor (1)

4.1.3 The input power of the circuit (2)

4.2 A star-connected load of 3 MVA at 12 kV and a power factor of 0,78 lagging is supplied by a three-phase transmission line with a resistance of 5 ohms per phase and an inductive reactance of 10 ohms per phase.

Calculate the following:

4.2.1 The percentage regulation (8)

4.2.2 The efficiency of the line (3)

[20]

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QUESTION 5

5.1 Briefly explain the term *hunting.* (2)

5.2 A three-phase induction motor has four-pole pairs and is supplied from a 50 Hz supply.

Calculate the rotor speed when the percentage slip is 4%. (4)

5.3 Two similar three-phase star-connected alternators are connected in parallel. Each machine has a synchronous impedance of 0,2 + j4,5 ohms per phase. The machines are excited so that their EMFs are 1 910 V and 1 800 V per phase and the latter is retarded by a load angle of 30° electrical.

Calculate the following:

5.3.1 The circulating current between the machines (5)

5.3.2 The terminal voltage (3)

5.4 A three-phase induction motor with a star-connected rotor has an induced EMF of 110 volts between slip rings at standstill on open circuit. The rotor resistance and reactance per phase at standstill is 2,6 ohms and 7,5 ohms respectively. The slip rings are short-circuited.

Calculate the following:

5.4.1 The rotor starting current per phase (4)

5.4.2 The power factor (2)

[20]

TOTAL: 100

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ELECTROTECHNICS N5

FORMULA SHEET

Armature ampere-turns/pole
Ankerampèrewindings/pool

$$= \frac{1}{2} \cdot \frac{I_a}{C} \cdot \frac{Z}{2P}$$

$$E = V \pm I_a R_a$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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$$P = \sqrt{3} I_L V_L \, Cos \, \phi$$

$$P_1 = V_L I_L \, Cos \, (30 - \phi)$$

$$P_2 = V_L I_L \, Cos \, (30 + \phi)$$

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

% Voltage regulation
% Spanningsreëling

$$= I_1 \frac{(R_e \, Cos\phi \pm X_e \, Sin\phi)}{v_1} \times \frac{100}{1}$$

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

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

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

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

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

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

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

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

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

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

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

% Regulation
% Regulering

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

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