education

Department:
Education
REPUBLIC OF SOUTH AFRICA

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NATIONAL CERTIFICATE

ELECTROTECHNICS N5

(8080085)

30 March (X-Paper)
09:00 – 12:00

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

DEPARTMENT OF EDUCATION
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 correctly according to the numbering system used in this question paper.
4. Write neatly and legibly.

QUESTION 1

1.1 Name THREE methods of improving commutation. (3)

1.2 A 400 V, 40 kW, DC motor has to start on full-load and the starting current must not exceed 1,5 times the normal full-load value. If the armature resistance is 0,08 ohms and the starter has 10 elements, calculate the resistance of the first three elements. The full-load efficiency of the motor is 73 per cent. (9)

1.3 A generator with eight poles has a lap-connected armature with 600 conductors. The ratio of pole arc to pole pitch is 0,8. Calculate the ampere-turns per pole of a compensating winding, to give uniform air gap density, when the total armature current is 500 A. (4)

1.4 A shunt generator has to be converted to a level-compounded generator by adding a series field winding. From a test, on the machine with shunt excitation only, it is found that the shunt current is 4,5 A to give 520 V on no-load and 6,5 A to give the same voltage when the machine is supplying its full-load of 280 A. The shunt winding has 1 000 turns per pole.

Calculate the number of series turns required per pole. (4)

[20]

QUESTION 2

2.1 Two circuits are connected in parallel to a 250 V, 50 Hz supply. The total current taken by the combination is 22 A, at unity power factor. Circuit A consists of a 9,8 ohms resistor and a 205 microfarad capacitor connected in series. Circuit B consists of a resistor and an inductive reactance in series.

Calculate the following for circuit B :

2.1.1 The current (4)

2.1.2 The power factor (2)

2.1.3 The impedance (2)

2.1.4 The reactance (1)

2.1.5 The resistance (1)

2.2 A constant voltage at a frequency of 1,8 MHz is applied across a circuit consisting of an inductor in series with a variable capacitor. When the capacitor is set to 350 pf., the current is at its maximum value. When the capacitance is reduced to 320 pf., the current is 0,707 of its maximum value.

Find the inductance and the resistance of the inductor. (10)

[20]

QUESTION 3

3.1 Three similar inductors, with resistances of 18 ohms and inductances of 0,03 H each are delta connected to a three-phase, 480 V, 50 Hz sinusoidal supply.

Calculate the following:

3.1.1 Value of the line current (6)

3.1.2 The power factor (2)

3.1.3 The power input to the circuit (2)

3.2 A single-phase transformer has a supply voltage of 200 V. It has an equivalent resistance of 0,5 ohms and an equivalent leakage reactance of 0,9 ohms referred to the primary. The secondary is connected to a coil with a resistance of 280 ohms and a reactance of 170 ohms. The secondary winding has 6 times as many turns as the primary.

Calculate the secondary terminal voltage. (10)

[20]

QUESTION 4

4.1 Two wattmeters are used to measure the input power to a balanced three-phase load, which has a unity power factor. Each meter indicates 20 kW. If the power factor drops to 0,7 lagging but the power remains unchanged, calculate the readings of the wattmeters. (8)

4.2 The two-wattmeter method is applied to a three-phase wire, 150 V system. With the meters connected to lines R and B, WR = 1 200 watts and WB = 650 watts. Find the impedance of the balanced delta connected load. (5)

4.3 The load taken by a three-phase induction motor was measured by the two-wattmeter method, and the readings were 920 W and 295 W.
Calculate the power taken by the motor and the power factor. (5)

[18]

QUESTION 5

5.1 A three-phase star-connected alternator supplies a 600 kW, 4,2 kV delta-connected induction motor with an efficiency of 85% and a full-load power factor of 0,8. Calculate the KVA output of the alternator and the value of the current in the alternator and motor windings. (8)

5.2 A three-phase, 50 Hz induction motor has 4 poles and runs at a speed of 1 400 r/min when the total torque developed by the rotor is 160 Nm.

Calculate the following:

5.2.1 The total input power to the rotor (5)

5.2.2 The rotor copper loss in watts (3)

5.3 Determine the number of stator conductors per slot for a three-phase, 50 Hz alternator if the winding is star connected and has to supply a line voltage of 25 kV when the machine is on an open circuit. The flux per pole is 0, 2 wb. Assume full-pitch coils and the stator to have three slots per pole per phase. The speed is 300 r/min and the distribution factor is 0,96. (6)

[22]

TOTAL: 100

ELECTROTECHNICS N5

FORMULA SHEET

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

$$E = V \pm I_a R_a$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

PTO

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

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

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

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

% Voltage regulation
% Spanningsreëling

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

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

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

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

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

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

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

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

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

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

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

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

% Regulation
% Regulering

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