higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T560(**E**)(A10)T

NATIONAL CERTIFICATE

ELECTROTECHNICS N5

(8080085)

10 April 2017 (X-Paper)
09:00–12:00

Calculators may be used.

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

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.

QUESTION 1

1.1 Explain *armature reaction* in DC machines. (2)

1.2 1.2.1 Determine the number of series turns per pole needed on a compound generator to maintain a constant voltage at 618 V between a no-load and a full load of 395 kW. With no series winding, it is found that the shunt current has to be 4 A on no-load and 5,5 A on full load to maintain the voltage constant at 618 V. The number of turns per pole on the shunt winding is 2700. (5)

1.2.2 Calculate the value of the diverter resistance required to give level compounding if the series coils were wound with 8 turns per pole and had a total resistance of 0,08 Ω. (5)

1.3 A 33,5 kW, 488 V four-pole DC motor has a wave-wound armature with 1500 conductors. The commutator has 150 segments. The full-load efficiency is 85% and the shunt current is 1,6 A. The brushes are shifted backwards through 1,4 segments from the geometric neutral.

Calculate the demagnetising and cross-magnetising ampere-turns per pole. (8)
[20]

QUESTION 2

2.1 An impedance of 8,5 + j 9,5 is connected in series with two impedances in parallel, one of 10,5 + j 16,5 Ω and the other of 14 – j 7 Ω. This combination is then connected across a 140 V alternating-current supply

Calculate the following :

2.1.1 Total impedance (6)

2.1.2 Total current (2)

2.1.3 Power factor (2)

2.2 A coil with a resistance of 28 Ω and an inductance of 0,07 H is connected in parallel with a circuit consisting of a 140 μF capacitor in series with a 22 Ω resistor. The supply is 250 V, 50 Hz.

Calculate the following:

2.2.1 Total supply current and current in each branch (8)

2.2.2 Power and power factor (2)
[20]

QUESTION 3

3.1 A 265 kVA transformer has 490 turns on the primary and 160 turns on the secondary. The primary and secondary resistances are 0,85 Ω and 0,05 Ω and the leakage reactance is 1,9 Ω and 0,08 Ω respectively. The supply voltage is 2770 V.

Calculate the following:

3.1.1 The equivalent impedance referred to the primary circuit (3)

3.1.2 Voltage regulation and secondary terminal voltage on full load for a power factor of 0,8 lagging as well as for a power factor of 0,8 leading (11)

3.2 A three-phase transformer has 630 turns on the primary winding and 90 turns on the secondary winding. The supply voltage is 3260 V.

Calculate the secondary line voltage on no-load when the transformer is connected in each of the following:

3.2.1 Star/delta

3.2.2 Input power

(2 × 3) (6)
[20]

QUESTION 4

4.1 Two wattmeters are connected to measure the input to a balanced three-phase circuit. The readings are 735 W and 3400 W respectively.

Calculate the power factor of the circuit in each of the following situations:

4.1.1 Both the readings are positive.

4.1.2 The former/latter reading is obtained after reversing the connections to the current coil of one instrument.

(2 × 4) (8)

4.2 Calculate the inductance and capacitance per phase of 40 km of three-phase, overhead line having solid copper conductors with a diameter of 1,5 cm when the overhead line is spaced in each of the following ways:

4.2.1 75 cm between adjacent centres in flat regular spacing

4.2.2 On the corners of a triangle having sides of length 70 cm : 90 cm : 110 cm

(2 × 5) (10)

4.3 Calculate the inductance per phase of a 150 km, three-phase transmission line having an equilateral conductor spacing of 10 m and a conductor diameter of 60 mm. (2)
[20]

QUESTION 5

5.1 A three-phase, four-pole 50 Hz induction motor with a star-connected rotor has a rotor resistance of 0,75 ohms per phase. At standstill the reactance is 4,5 ohms. The EMF between the slip-rings is 265 V. Full-load speed is 1440 r/min.

Calculate the following:

5.1.1 Fractional slip (3)

5.1.2 EMF induced in each phase of the rotor (2)

5.1.3 Rotor reactance per phase (1)

5.1.4 Rotor current and power factor (if slip-rings are short circuited) (3)

5.1.5 Rotor frequency (1)

5.2 5.2.1 What is meant by the term *slip* with reference to induction motors? (2)

5.2.2 Explain why an induction motor needs slip to operate. (2)

5.3 A three-phase, 50 Hz eight-pole induction motor has a slip of 0,08 per unit when the output is 37,5 kW. The frictional loss is 305 W.

Calculate the following:

5.3.1 Rotor speed (2)

5.3.2 Rotor copper loss (4)
[20]

TOTAL: 100

ELECTROTECHNICS N5

FORMULA SHEET

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

$$E = V \pm I_a R_a$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

% voltage regulation

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

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

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

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

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

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

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

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

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

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

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

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

% regulation

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