higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T480**(E)**(A6)T
APRIL EXAMINATION

NATIONAL CERTIFICATE

ELECTROTECHNICS N5

(8080085)

6 April 2016 (X-Paper)
09:00–12:00

Calculators may be used.

This question paper consists of 5 pages and 1 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 State TWO methods of changing the direction of a DC machine. (2)

1.2 Where are the compensating windings situated and how are they connected? (2)

1.3. The number of series turns per pole required on a 355 kW long shunt compound generator must be determined to enable it to maintain a constant voltage at 580 V, between no-load and full-load. Without any series winding, it is found that the shunt current has to be 6 A on no-load and 7,5 A on full-load, to maintain the voltage constant at 580 V. Number of turns per pole on the shunt winding is 2 100.

1.3.1 Calculate the demagnetising and cross-magnetising ampere-turns per pole.

1.3.2 If the series coils were wound with 12 turns per pole and had a total resistance of 0,08 Ω, determine the value of diverter resistance that would be required to give level compounding.

(2 × 5) (10)

1.4 A 625 V, 35 kW, four-pole DC motor has a wave-wound armature with 900 conductors and the commutator has 180 segments. The full-load efficiency is 85% and the shunt current is 2,25 A. The brushes are shifted backwards through 1,5 segments from the geometrical neutral axis .

Calculate the demagnetising and cross-magnetising ampere-turns per pole. (6)

[20]

QUESTION 2

2.1 The voltage across a certain circuit element is v (t) = 800 sin (314 t + 30 º) V. The current flowing in this element is I (t) = 8 sin (314 t +30 º) A.

Determine :

2.1.1 The nature and magnitude of this element.

2.1.2 The time period of the waveform.

(2 × 3) (6)

2.2 A circuit consisting of a coil with an inductance of 140 μH and a resistance of 8,25 Ω is connected in parallel with a variable capacitor. This combination is then connected in series with a resistor of 7300 Ω across a 380 V supply having a frequency of 1 MHz.

Calculate :

2.2.1 The capacitance of the capacitor required to give resonance. (3)

2.2.2 The impedance of the parallel circuit. (2)

2.2.3 The current in each branch of the parallel circuit. (9)

[20]

QUESTION 3

3.1 Name THREE methods of reducing leakage flux in transformers. (3)

3.2 A 24 kVA, 3 200/800 V single-phase transformer , operating at no-load has the following resistances and leakage reactances.

Primary winding : Resistance 8,4 Ω Reactance 14,4 Ω
Secondary winding : Resistance 0,75 Ω Reactance 1,5 Ω

Calculate the secondary voltage at full-load , with a power factor of 0,8 lagging, when the primary voltage remains constant. (7)

3.3 Three similar inductors, with a resistance of 29 Ω each and an inductance of 0,038H are connected in delta to a three-phase, 535 V, 50 Hz sinusoidal supply.

Calculate :

3.3.1 The value of the line current. (6)

3.3.2 Power factor. (2)

3.3.3 Power input to the circuit. (2)
[20]

QUESTION 4

4.1 The input power to a 2 950 V three-phase delta-connected induction motor is 135 kW. The power factor of the motor is 0,85 lagging.

Calculate:

4.1.1 The line and phase currents (2)

4.1.2 Input power readings on the two watt-meters (4)

4.1.3 kVA rating of the motor (2)

4.2 A three-phase transmission line supplies a 1,73 MW star-connected load, having a power factor of 0,75 lagging at a line voltage of 35 kV.
The line has a resistance of 85 Ω per phase and an inductive reactance of 155 Ω per phase.

Calculate :

4.2.1 Voltage (line) at the sending end (5)

4.2.2 The per-unit regulation (2)

4.2.3 Efficiency of the line (5)
[20]

QUESTION 5

5.1 Briefly explain the term *hunting* or phase swinging with reference to synchronous motors. (2)

5.2 A three-phase slip-ring induction motor gives a reading of 95 V across the slip-rings on open circuit with normal stator voltage applied. The rotor is star-connected and has an impedance of 0,7 + j 9 Ω per phase.

Calculate the impedance:

5.2.1 At standstill with the slip-rings joined to a star-connected starter with a phase impedance of 4 + j 7 Ω. (4)

5.2.2 When running normally with 5 % slip. (2)

5.3 A three-phase induction motor with a star-connected rotor , has an induced EMF of 145 V between slip-rings at standstill on open circuit. The rotor resistance and reactance per phase at standstill is 1, 25 Ω and 6, 75 Ω respectively.

Calculate the following when the slip-rings are short-circuited :

5.3.1 The rotor starting current per phase. (4)

5.3.2 The power factor. (2)

5.4 A three-phase star-connected alternator, driven at 1 200 rev/min. is required to generate a line voltage of 885 V at 60 Hz. on open circuit. Assume full-pitched coils and the stator has 8 slots per pole per phase and 6 conductors per slot. (kd = 0,96)

Calculate :

5.4.1 The number of poles. (2)

5.4.2 The useful flux per pole. (4)

[20]

TOTAL: 100

ELECTROTECHNICS N5

FORMULA SHEET

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

$$E = V \pm I_a R_a$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

% Voltage regulation
% 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

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