T610(E)(J22)T
AUGUST 2009
NATIONAL CERTIFICATE
ELECTROTECHNICS N4
(8080074)
22 July (X-Paper)
09:00 – 12:00

REQUIREMENTS: Graph paper

Calculators may be used.

This question paper consists of 5 pages and a 2-page formula sheet.
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 A coil having 500 turns of conductor with a cross-sectional area of 50 mm² and a mean length per turn of 50 mm, has an inductance of 1 henry.

Calculate the following:

1.1.1 The resistance of the winding if the specific resistance of the conductor is 2 micro-ohm metres

1.1.2 The average value of the EMF induced in the coil when a current of 10 A is reversed in 20 seconds (5)
QUESTION 3

3.1 The open-circuit characteristics of a shunt-excited DC machine is as follows:

<table>
<thead>
<tr>
<th>Terminal voltage (V)</th>
<th>10</th>
<th>20</th>
<th>25</th>
<th>29</th>
<th>30,5</th>
<th>31</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field current (A)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>6,5</td>
<td>7,5</td>
</tr>
</tbody>
</table>

Plot the graph and determine the following:

3.1.1 The voltage to which the machine will excite on no-load when shunt-connected if the total field resistance is 5 ohms

3.1.2 The critical resistance

(10)

3.2 A long-shunt compound-wound DC-machine has an armature resistance of 0,2 ohms, a series field resistance of 0,06 ohms and a shunt field resistance of 60 ohms. The machine draws a current of 58 A from a 360 V-DC-supply when run as a motor.

Calculate the EMF generated in the armature.

(5)

3.3 What is the purpose of a pole shoe in a DC machine?

(2)

3.4 Make a neat sketch to illustrate magnetic fringing, leakage flux and useful flux.

(3)

[20]

QUESTION 4

4.1 What can be done to improve the power factor?

(2)

4.2 A 60 Hz sinusoidal voltage has an RMS value of 212,1 V. If the initial instantaneous voltage is zero and rising positively, find the time for the voltage to reach a value of 150 V from zero for the first time. Draw the phasor diagram and show the waveform for the voltage.

(6)

4.3 A coil with a resistance of 150 ohms and an inductance of 0,63662 henry is connected in series with a 10,61033 microfarad capacitor. This circuit is connected across a 360,556 V, 50 Hz supply.

Calculate the voltage drop across the following:

4.3.1 The coil
4.3.2 The capacitor

(8)

Draw the phasor diagram to represent the distribution of the voltage and the current in the circuit.

(4)

[20]
ELECTROTECHNICS N4

FORMULA SHEET

Any applicable formula may also be used.

1. *Principles of electricity*

\[ E = V + Ir \]
\[ V = IR \]
\[ R_{se} = R_1 + R_2 + \ldots + R_n \]
\[ R_p = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_n}} \]
\[ R = \rho \frac{\ell}{a} \]
\[ \frac{R_1}{R_2} = \frac{1 + \alpha_oT_1}{1 + \alpha_oT_2} \]

\[ R_i = R_a [1 + \alpha_o (t - \theta)] \]
\[ P = VI = I^2R = \frac{V^2}{R} \]
\[ \Phi = \frac{mmf}{S} = \frac{IN}{S} \]
\[ H = \frac{IN}{\ell} \]
\[ F = B\ell I \]
\[ E = \frac{\Delta\Phi}{\Delta t} \cdot N \]
\[ E = B\ell v \]
\[ E = \frac{L\Delta I}{\Delta t} \]
\[ L = \frac{\Delta\Phi}{\Delta I} \cdot N \]

\[ Q = VC \]
\[ Q_{se} = Q_t = Q_1 = Q_2 \ldots = Q_n \]
\[ C_{se} = \frac{1}{\frac{1}{C_1} + \frac{1}{C_2} + \ldots + \frac{1}{C_n}} \]
\[ Q_p = Q_1 + Q_2 + \ldots + Q_n \]
\[ C_p = C_1 + C_2 + \ldots + C_n \]

2. *Direct-current machines*

\[ E = \frac{2Z}{c} \cdot \frac{Np}{60} \cdot \Phi \]
\[ c = 2a \]
\[ E_{gen} = V + I_a R_a \]
\[ E_{mot} = V - I_a R_a \]
\[ R_{start} = \frac{(V - E)}{I_a} - R_a \]

3. *Alternating-current machines*

\[ E_m = 2\pi BANn \]
\[ e = E_m \sin (2\pi f \cdot t \times 57,3)^o \]
\[ E_{ave} = 0,637 \cdot E_m \]
\[ E_{rms} = 0,707 \cdot E_m \]
\[ T = \frac{1}{f} \]
\[ f = \frac{Np}{60} \]
\[ \omega = 2\pi f \]
\[ Z_L = R + j\omega L \]
\[ Z_c = R - j \frac{1}{\omega C} \]
\[ pf = \cos \phi = \frac{R}{Z} \]
\[ S = VI \]
\[ P = V \cdot I \cos \phi = I^2 R \]
\[ Q = V \cdot I \sin \phi \]

4. Transformers

\[ E = 4.44 f \Phi_m N \]
\[ k_t = \frac{N_1}{N_2} = \frac{V_1}{V_2} - \frac{I_2}{I_1} \]

5. Measuring instruments

\[ R_{SH} = \frac{i_m R_m}{I_{sh}} \]
\[ R_{se} = \frac{V}{i_m} - R_m \]