GAUTENG DEPARTMENT OF EDUCATION

SENIOR CERTIFICATE EXAMINATION

ELECTRICIANS WORK SG

TIME: 3 hours

OCTOBER / NOVEMBER 2005
OKTOBER / NOVEMBER 2005

MARKS: 200

REQUIREMENTS:

- Drawing instruments and an approved calculator

INSTRUCTIONS:

- Answer ALL the questions.
- Rule off after each question in your answer book.
- Where applicable, formulae and calculations must be shown.
- A list of formulae appears on the last page of the question paper.

QUESTION 1
ELECTRICAL CURRENT THEORY

1.1 A series circuit consists of a resistor of 100 ohms, an inductor of 0,12 henry and a 190 microfarad capacitor. The circuit is connected across a 180 V, 50 Hz supply.

Calculate:

1.1.1 The impedance (6)

1.1.2 The current (3)

1.1.3 The phase angle (3)

1.1.4 The voltage drop across each component (9)

1.2 What is generally considered to be a good power factor? (2)

1.3 What is a **phasor**? (3)

1.4 What is the effect of capacitance on an alternating current circuit? (2)

1.5 An alternating voltage with the equation e = 50 sin (314 t) is connected across a 75 ohm resistor.

1.5.1 Determine the current through the resistor as measured by an ammeter. (5)

1.5.2 What is the frequency of the alternating voltage? (3)

1.5.3 Calculate the instantaneous value of the voltage 3 milli-seconds after it has been switched on. (6)

1.6 A parallel circuit consists of a resistor of 40 ohms, a coil with an inductance of 70 mH and a capacitor with a capacitance of 120 microfarads. If the supply is 200 V, 50 Hz, calculate

1.6.1 the total current in the circuit. (12)

1.6.2 the power factor of the circuit. (4)

1.7 Of which TWO components does the current drawn from a line consist? (2)
[60]

QUESTION 2
INSTRUMENTS AND THREE-PHASE ALTERNATING-CURRENT SYSTEMS

2.1 Sketch a labelled diagram of a single-phase, induction type wattmeter. (13)

2.2 The full-load output of a 500 volt, three-phase motor is 15 kW. Calculate the efficiency of the motor if the input line current at full load is 20 amperes at a power factor of 0,9. (6)

2.3 A wattmeter used to measure the power in an AC circuit reads 2 500 watts, while an ammeter and a voltmeter connected in the same circuit read 12 amperes and 220 volts, respectively.

Calculate:

2.3.1 The power factor of the circuit (4)

2.3.2 The active component of the current (3)

2.3.3 The reactive component of the current (4)

2.4 Draw a labelled diagram of a power-factor meter and indicate how it is connected in a circuit. (10)
[40]

QUESTION 3
TRANSFORMERS

3.1 Sketch the diagram of a three-phase transformer consisting of three single-phase transformers in which the windings are connected in delta-star. (9)

3.2 State the losses that occur in a transformer. (2)

3.3 A three-phase transformer is connected in delta-star to an 11 kV line. The transformer has 4 000 primary windings and takes a full-load line current of 5 amps on the same side. The secondary line voltage is 380 volts with a lagging power factor of 0,8.

Calculate:

3.3.1 The secondary phase voltage (4)

3.3.2 The transformation ratio (4)

3.3.3 The number of secondary windings (4)

3.3.4 The primary phase current (4)

3.3.5 The output power of the transformer (4)

3.4 Name TWO types of instrument transformers. (4)
[35]

QUESTION 4
ALTERNATING-CURRENT MOTORS

4.1 Draw a neat, labelled diagram of a shaded-pole induction motor. (9)

4.2 Briefly explain how the direction of rotation of a three-phase induction motor can be changed. (2)

4.3 A three-phase induction motor can supply a maximum power of 15 kW to a machine. Calculate the current value on which the overload unit must be set if a 9% overload is permitted. The supply voltage to the motor is 380 V, with a lagging power factor of 0,8. The efficiency of the motor is 85%. (10)

4.4 Sketch a labelled diagram of a direct-on-line starter as it is used to control a single-phase induction motor. The connection to the motor must be shown. (12)

4.5 Which TWO factors determine the efficiency of a machine? (2)
[35]

QUESTION 5
ELECTRONICS AND OCCUPATIONAL SAFETY

5.1 Indicate, with the aid of diagrammatic sketches, what is understood by the terms **forward bias** and **reverse bias**. The depletion-region effect must be shown clearly. (10)

5.2 Sketch a labelled diagram of a rectifier circuit which makes use of a transformer with a centre-tapped secondary winding. (6)

5.3 Draw a labelled sketch of a cathode ray tube. (9)

5.4 Explain how Aids can be spread from one person to another. (5)
[30]

TOTAL: 200

FORMULA SHEET ***FORMULEBLAD***

$Z = \sqrt{R^2 + (X_L \approx X_c)^2}$ $V_R = I_T \times R$ $I_T = \frac{V_T}{Z}$

$Z = \sqrt{R^2 + X_L^{\,2}}$

$Z = \sqrt{R^2 + X_c^{\,2}}$

$V_L = I_T \times X_L$ $V_c = I_T \times X_c$

$I_T = \sqrt{I_R^{\,2} + (I_c \approx I_L)^2}$ $I_R = \frac{V_R}{R}$; $I_L = \frac{V_L}{X_L}$; $I_C = \frac{V_c}{X_c}$; $Cos\theta = \frac{I_R}{I_T}$

$X_L = 2\pi fL$ $X_c = \frac{1}{2\pi fC}$

$P = V \times I \times \cos\theta$ $\cos\theta = \frac{R}{Z}$ $\tan\theta = \frac{X_L - X_c}{R}$; $\cos\theta = \frac{P}{VA}$

$P = I^2R$

$I_{act} = I \times \cos\theta$ $I_{react} = I \times \sin\theta$

Star/*ster*	Delta / *delta*
$I_L = I_{ph}$	$I_L = \sqrt{3} \times I_{ph}$
$V_L = \sqrt{3} \times V_{ph}$	$V_L = V_{ph}$

$F = \frac{pN}{60}$ $S = \frac{N_s - N_R}{N_S} \times 100\%$ $N_R = \frac{f}{p}(1-s)$

$P = \sqrt{3} \times V_L \times I_L \times \cos\theta$

$S = \sqrt{3} \times V_L \times I_L$; $\frac{V_p}{V_s} = \frac{N_P}{N_s} = \frac{I_s}{I_p}$ or / of $\frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{I_2}{I_1}$

Efficiency = $\frac{\textbf{Output}}{\textbf{Input}}$ *Rendement* = $\frac{Afvoer}{Invoer}$

END / ***EINDE***