GAUTENG DEPARTMENT OF EDUCATION

SENIOR CERTIFICATE EXAMINATION

ELECTRICIANS WORK SG

TIME: 3 hours

MARKS: 200

REQUIREMENTS:

- Drawing instruments and an approved non-programmable calculator

INSTRUCTIONS:

- Answer ALL the questions.
- Draw a line across the page in your answer book upon completion of each question.
- Formulae and calculations, where applicable, must be shown.
- A list of formulae is provided.

QUESTION 1
ELECTRICAL CURRENT THEORY

1.1 An alternating voltage with the equation 3 = 60 sin (314 t) is connected across a 45 ohm resistor.

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

1.1.2 Calculate the frequency of the alternating voltage. (3)

1.1.3 Calculate the instantaneous value of the voltage 3 milliseconds after it has been switched on. (6)

1.2 The instantaneous value of a current with a sinusoidal wave form is 5 amperes after 5 milliseconds. Calculate the maximum value which the current will reach if the period of the cycle is 20 milliseconds. (7)

1.3 Explain the meaning of the term impedance with regards to ac circuits. (3)

1.4 A series circuit consists of a resistor of 55 ohms, an inductor of 0,4 henry and a capacitor of 160 microfarad. If the supply voltage is 150 V / 100 Hz, calculate the

1.4.1 current in the circuit. (12)

1.4.2 phase angle between the current and the voltage. (3)

1.4.3 power factor. (2)

1.4.4 active current in the circuit. (3)

1.4.5 reactive current in the circuit. (3)

1.5 Name THREE disadvantages of a low power factor. (3)
[50]

QUESTION 2
INSTRUMENTS

2.1 Sketch a neat, labelled diagram of a single-phase induction-type wattmeter. The connections of the meter to the supply and the load must be clearly shown. (13)

2.2 Discuss the vibrating-reed frequency meter under the following headings:

2.2.1 Construction (3)

2.2.2 Operation (4)
[20]

QUESTION 3
THREE-PHASE ALTERNATING-CURRENT SYSTEMS

3.1 Three pure resistances of 40 ohms each are connected to a balanced 380 V three-phase supply.

Calculate the

3.1.1 phase voltage, current, line current and power when these resistances are connected in star. (10)

3.1.2 phase voltage, current, line current and power when these resistances are connected in delta. (9)

3.2 A 200 kW three-phrase, delta-connected motor is connected to a 500 V supply. The power factor is 0,9 and the efficiency is 90%.

Calculate the

3.2.1 line current of the motor. (8)

3.2.2 phase current of the motor. (3)
[30]

QUESTION 4
TRANSFORMERS

4.1 Name TWO functions of the Bucholz relay. (2)

4.2 A single-phase 120 kVA transformer with a supply of 2 000 volt / 50 hertz has an output of 400 volt. The secondary winding has 150 turns.

Calculate the

4.2.1 number of primary turns. (4)

4.2.2 primary current. (3)

4.2.3 secondary current. (3)

4.3 A three-phase transformer with 3 000 turns on the primary is connected in delta-star to a supply voltage of 6 000 V. The full load line current on the primary is 25 A when the secondary line voltage is 380 V and the power factor is 0,9.

Calculate the

4.3.1 secondary phase voltage. (4)

4.3.2 transformation (turns) ratio. (4)

4.3.3 number of secondary turns. (4)

4.3.4 primary phase current. (4)

4.4 State TWO losses that occur in transformers. (2)
[30]

QUESTION 5
ALTERNATING-CURRENT MOTORS

5.1 Explain briefly the difference between synchronous speed and rotor speed. (4)

5.2 Name THREE tests that must be performed on the windings of a new electric motor before it is put into operation. (3)

5.3 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 7% overload is permitted. The supply voltage to the motor is 380 V, with a lagging power factor of 0,9. The efficiency of the motor is 95%. (10)

5.4 Draw a neat, labelled drawing of the starting circuit of a slipring-motor-starter. (15)

5.5 Name FOUR disadvantages of synchronous motors, when compared with ordinary induction motors. (4)

5.6 Mention the TWO factors which determine the speed of an induction-type alternating-current motor. (2)

5.7 Explain how the direction of a rotation can be changed in a three-phase motor. (2)
[40]

QUESTION 6
ELECTRONICS

6.1 Draw a neat, labelled sketch of a cathode-ray tube. (9)

6.2 What are the characteristics of a transistor with a common-emitter configuration? (3)

6.3 Under which biasing conditions will the NPN transistor function correctly? (4)

6.4 What is the function of a Zener diode? (2)

6.5 How can maximum deflection on a cathode-ray tube be obtained? (2)
[20]

QUESTION 7
SAFETY

7.1 Explain what you would do if you noticed that a learner in the workshop was being shocked by an electrical supply. (5)

7.2 State the FIVE basic causes of accidents. (5)
[10]

TOTAL: 200

FORMULA SHEET — ***FORMULEBLAD***

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

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

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

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

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

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

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

$P = I^2R$

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

Star/*ster*

$I_L = I_{ph}$

$V_L = \sqrt{3} \times V_{ph}$

Delta / *delta*

$I_L = \sqrt{3} \times I_{ph}$

$V_L = V_{ph}$

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

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

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

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

END / *EINDE*