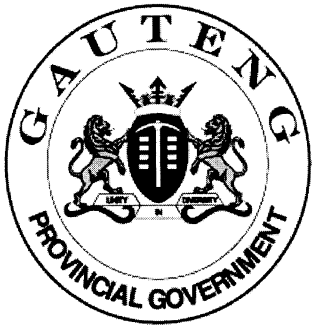
SENIOR CERTIFICATE EXAMINATION
SENIORSERTIFIKAAT-EKSAMEN



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2005

ELECTRICIANS WORK

ELEKTRISIËNSWERK

SG 703-2/0

ELECTRICIANS WORK SG

703 2 0 SG

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X05

GAUTENGSE DEPARTEMENT VAN ONDERWYS

SENIORSERTIFIKAAT-EKSAMEN

ELEKTRISIËNSWERK SG

TYD: 3 uur

PUNTE: 200

BENODIGHEDE:

- Tekeninstrumente en 'n goedgekeurde nieprogrammeerbare sakrekenaar.

INSTRUKSIES:

- Beantwoord AL die vrae.
- Trek 'n lyn dwarsoor die bladsy na beantwoording van elke vraag.
- Formules en berekeninge moet, waar van toepassing, getoon word.
- 'n Lys van formules word verskaf.

VRAAG 1
ELEKTRIESE STROOMTEORIE

1.1 'n Parallelkring bestaan uit 'n weerstand van 30 ohm, 'n induktor van 60 mH en 'n kapasitor van 150 mikrofarad. Die toevoerspanning is 150 V, 50 Hz.

1.1.1 Bereken die stroom deur elke komponent. (10)

1.1.2 Bereken die totale stroom. (3)

1.1.3 Bereken die impedansie. (2)

1.1.4 Bereken die fasehoek. (3)

1.1.5 Skets die fasordiagram met al die inligting aangedui (nie volgens skaal nie). (5)

1.2 Verduidelik die volgende terme:

1.2.1 Resonansie (3)

1.2.2 Impedansie (3)

1.2.3 Effektiewe waarde (3)

1.2.4 Vormfaktor (3)

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 after answering each question.
- Formulae and calculations, where applicable, must be shown.
- A list of formulae is provided.

QUESTION 1
ELECTRICAL CURRENT THEORY

1.1 A parallel circuit consists of a resistor of 30 ohms, an inductor of 60 mH and a capacitor of 150 microfarads. The supply voltage is 150 V, 50 Hz.

1.1.1 Calculate the current through each component. (10)

1.1.2 Calculate the total current. (3)

1.1.3 Calculate the impedance. (2)

1.1.4 Calculate the phase angle. (3)

1.1.5 Sketch (not to scale) the phasor diagram with all the necessary information. (5)

1.2 Explain the following terms:

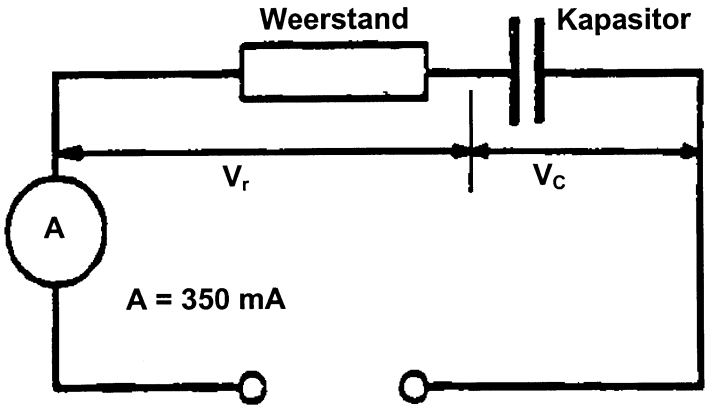
1.2.1 Resonance (3)

1.2.2 Impedance (3)

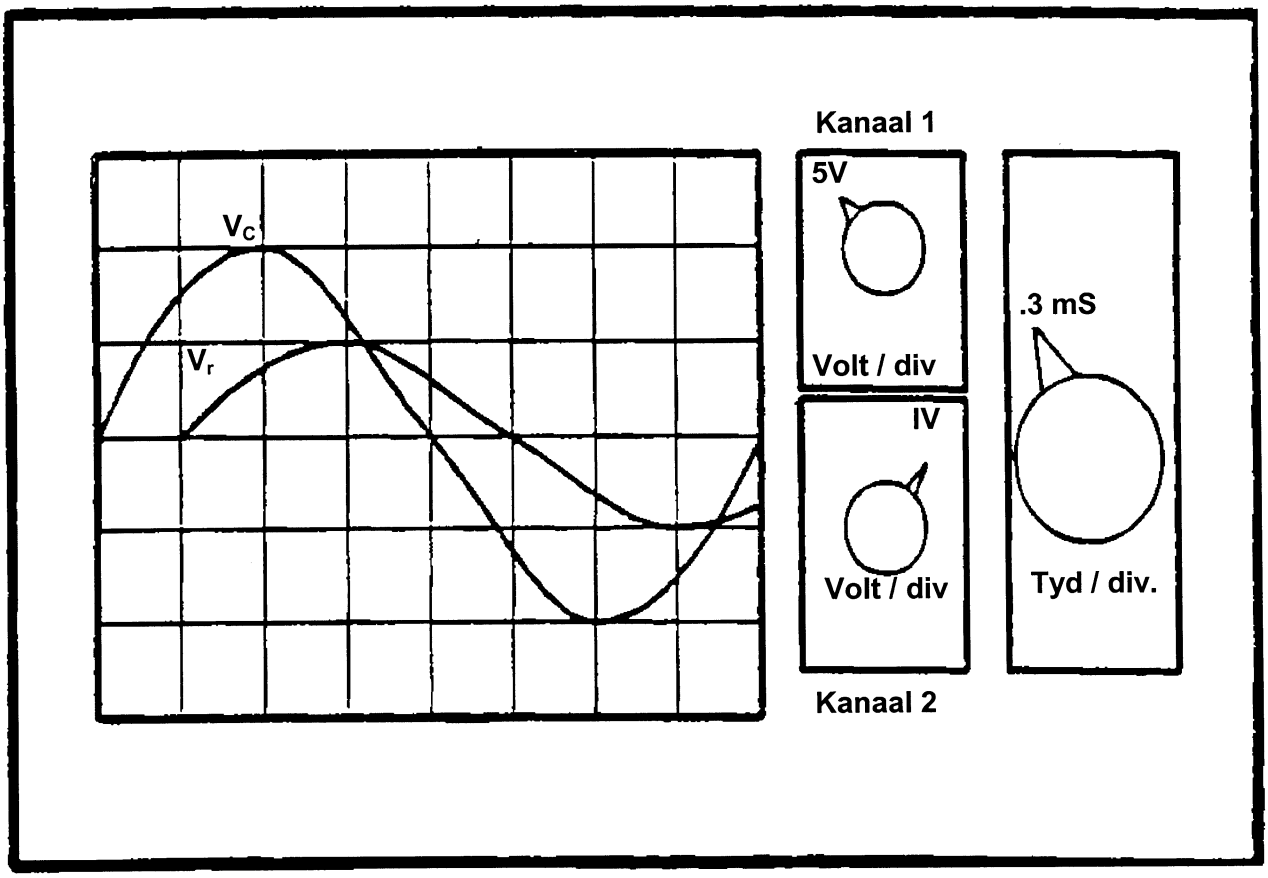
1.2.3 Effective value (3)

1.2.4 Form factor (3)

1.3 'n Onbekende weerstand en kapasitor word in serie met mekaar gekoppel. Die spanningwaardes word verkry deur die lesings op die ossiloskoop (**Figuur 2**). Die stroom se waarde word verkry van die meter wat in die kring gekoppel is (**Figuur 1**). Kanaal 1 meet die spanning oor die kapasitor en kanaal 2 die spanning oor die weerstand. Bereken die waarde van die weerstand en die kapasitor.



Figuur 1



Figuur 2

(18)

1.3 An unknown resistor and capacitor are connected in series with each other. The voltage values are obtained by the readings on the oscilloscope (**Figure 2**). The value of the current is obtained from the meter connected in the circuit (**Figure 1**). Channel 1 measures the voltage across the capacitor, and channel 2 the voltage across the resistor. Calculate the value of the resistor and the capacitor.

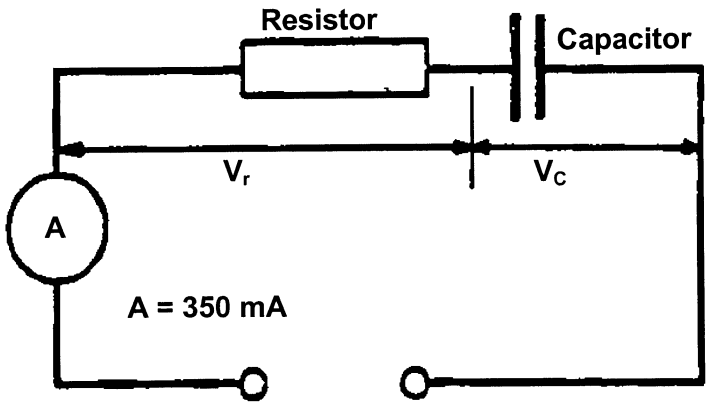


Figure 1

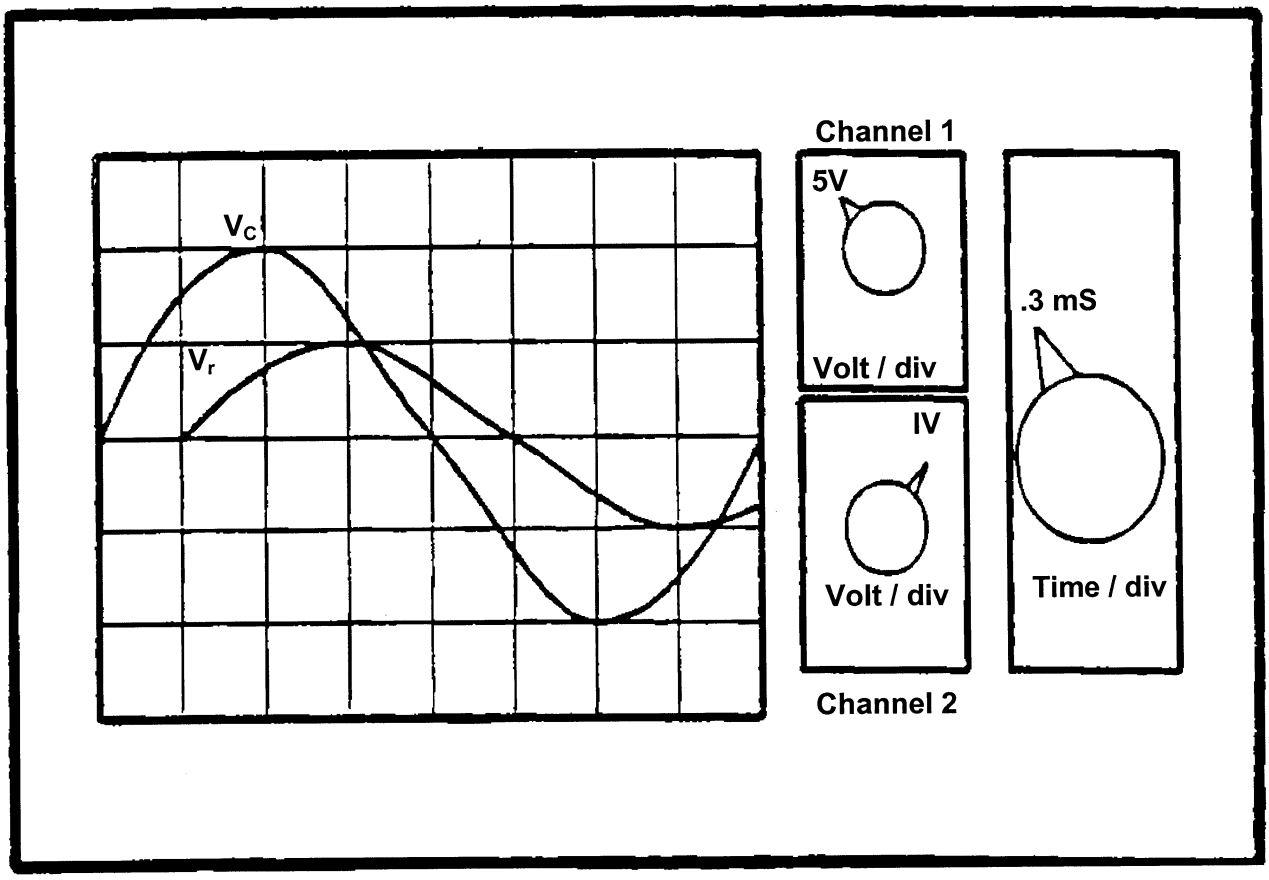


Figure 2

(18)

1.4 Die effektiewe waarde van 'n wisselstroom is 20 A. Bereken die maksimum waarde van die stroom. (3)

1.5 'n Wisselspanning word voorgestel deur die volgende vergelyking:

$$e = 200 \sin 628 t$$

Bereken die oombliklike waarde van die spanning 0,0003 sekondes nadat die kring aangeskakel is. (4)
[60]

VRAAG 2
INSTRUMENTE EN DRIEFASE-STELSELS

2.1 Maak 'n netjiese benoemde skets van 'n induksie-wattmeter. (10)

2.2 Watter voorsorgmaatreël moet getref word as 'n ammeter van 'n stroomtransformator verwyder word, en waarom is dit noodsaaklik dat hierdie voorsorg getref moet word? (4)

2.3 Maak 'n netjiese, benoemde skets om die golfvorms in 'n driefasige gebalanseerde wisselstroom-stelsel aan te toon. (6)

2.4 'n Driefasige delta-verbinde induksiemotor word aan 'n toevoerspanning van 380 V verbind en lewer 'n uitset van 10 kW. Die doeltreffendheid (rendement) van die motor is 80% met 'n drywingsfaktor van 0,9.

Bereken die

2.4.1 insetdrywing. (4)

2.4.2 lynstroom. (3)

2.4.3 fasestroom. (3)

2.4.4 fasespanning. (2)

2.5 'n 150 kW driefase-ster-verbinde motor werk vanaf 'n 3 000 V-toevoer. Die motor se rendement is 90% met 'n drywingsfaktor van 0,88. Bereken die lynstroom van die motor. (8)
[40]

1.4 The effective value of an alternating current is 20 A. Calculate the maximum value of the current. (3)

1.5 An alternating voltage is represented by the equation:

$$e = 200 \sin 628 t$$

Calculate the instantaneous value of the voltage 0,0003 seconds after the circuit has been switched on. (4)
[60]

QUESTION 2
INSTRUMENTS AND THREE-PHASE SYSTEMS

2.1 Make a neat, labelled sketch of an induction wattmeter. (10)

2.2 What precaution must be taken when an ammeter is removed from a current transformer, and why is it necessary to take this precaution? (4)

2.3 Draw a neat, labelled sketch to show the waveforms in a three-phase balanced alternating system. (6)

2.4 A three-phase induction motor, with its windings connected in delta, is connected to a 380 V supply and delivers an output of 10 kW. The efficiency of the motor is 80% at a power factor of 0,9.

Calculate the

2.4.1 input power. (4)

2.4.2 line current. (3)

2.4.3 phase current. (3)

2.4.4 phase voltage. (2)

2.5 A 150 kW three-phase star-connected motor is fed from a 3 000 V supply. The motor has an efficiency of 90% while the power factor is 0,88. Calculate the line current of the motor. (8)
[40]

VRAAG 3
TRANSFORMATORS

3.1 'n Driefase-verlagingstransformator het 'n vermoë van 400 kVA en die fasespanning oor die ster-verbinde sekondêre wikkeling is 220 volt.

Bereken

3.1.1 die sekondêre lynspanning. (2)

3.1.2 die maksimum toelaatbare sekondêre fasestroom. (5)

3.1.3 die maksimum lewering (uitset) as die arbeidsfaktor 0,85 is. (3)

3.1.4 die **primêre fasespanning** en die **primêre lynspanning** indien die primêre wikkeling van bogenoemde transformator in delta verbind is en die transformasieverhouding 10:1 is. (4)

3.2 Teken 'n netjiese, benoemde diagram van 'n enkelfase-outotransformator. (7)

3.3 Noem TWEE funksies van 'n Bucholz-relê. (4)

3.4 'n Driefasige transformator met 'n toevoerspanning van 15 kV is in 'n delta-ster-konfigurasie gekoppel en het 'n transformasieverhouding van 15:1.

Bereken

3.4.1 die sekondêre fasespanning. (4)

3.4.2 die sekondêre lynspanning. (4)

3.5 Noem TWEE verliese wat in transformators voorkom. (2)
[35]

QUESTION 3
TRANSFORMERS

3.1 A three-phase step-down transformer has a rating of 400 kVA and the phase voltage across the star-connected secondary winding is 220 volt.

Calculate

3.1.1 the secondary line voltage. (2)

3.1.2 the maximum permissible secondary phase current. (5)

3.1.3 the maximum output if the power factor is 0,85. (3)

3.1.4 the **primary phase voltage** and the **primary line voltage** if the primary windings of the above transformer are delta-connected and the transformation ratio is 10:1. (4)

3.2 Draw a neat, labelled diagram of a single-phase autotransformer. (7)

3.3 List TWO functions of the Bucholz relay. (4)

3.4 A three-phase transformer with a supply voltage of 15 kV is connected in a delta-star configuration and has a transformer ratio of 15:1.

Calculate

3.4.1 the secondary phase voltage. (4)

3.4.2 the secondary line voltage. (4)

3.5 State TWO losses that occur in transformers. (2)
[35]

VRAAG 4
WISSELSTROOM-MOTORE

4.1 Beskryf kortliks die verskil tussen sinchrone spoed en rotorspoed. (4)

4.2 Skets netjiese, benoemde diagramme van die volgende enkelfasige motors:

4.2.1 Kapasitor-aansitmotor (6)

4.2.2 Afgeskermdepool-motor (6)

4.3 Noem VIER voorbeelde van veiligheidstoestelle wat in die veiligheidskring van motoraansitters ingevoeg kan word. (4)

4.4 Skets 'n netjiese, benoemde diagram van 'n outomatiese ster-delta-aansitter. (15)
[35]

VRAAG 5
ELEKTRONIKA EN VEILIGHEID

5.1 Teken kringdiagramme om die volgende transistorkonfigurasies aan te toon:

5.1.1 Gemeenskaplike emitter (4)

5.1.2 Gemeenskaplike kollektor (4)

5.1.3 Gemeenskaplike basis (4)

5.2 Toon die basiese konstruksie van 'n voegvlak-diode aan die hand van 'n netjiese, benoemde skets. (8)

5.3 Noem DRIE nadele van halfgeleier-diodes, wanneer dit met buisdiodes vergelyk word. (6)

5.4 Verduidelik hoe Vigs van een persoon na 'n ander oorgedra kan word. (4)
[30]

TOTAAL: 200

QUESTION 4
ALTERNATING-CURRENT MOTORS

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

4.2 Sketch neat, labelled diagrams of the following single-phase motors:

4.2.1 Capacitor-start motor (6)

4.2.2 Shaded-pole motor (6)

4.3 Name FOUR examples of safety devices that could be included in the safety circuit of a motor starter. (4)

4.4 Sketch a neat, labelled diagram of an automatic star-delta starter. (15)
[35]

QUESTION 5
ELECTRONICS AND SAFETY

5.1 Draw circuit diagrams showing the following transistor configurations:

5.1.1 Common emitter (4)

5.1.2 Common collector (4)

5.1.3 Common base (4)

5.2 Show the basic construction of a junction diode by means of a neat, labelled sketch. (8)

5.3 Name THREE disadvantages of semiconductor diodes as compared to tube diodes. (6)

5.4 Explain how Aids can be spread from one person to another. (4)
[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*
$I_L = I_{ph}$
$V_L = \sqrt{3} \times V_{ph}$

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

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

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

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

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

END / *EINDE*