GAUTENG DEPARTMENT OF EDUCATION

SENIOR CERTIFICATE EXAMINATION

TECHNIKA (ELECTRICAL) SG

TIME: **3 hours**

MARKS: **200**

REQUIREMENTS:

- An approved calculator and drawing instruments.

INSTRUCTIONS:

- Answer ALL the questions.
- Sketches and diagrams should be neat and clear.
- Formulae and calculations must be clear.
- Formulae and calculations must be shown, where applicable.
- A list of formulae, which must be used where applicable, is given on the last page of this examination paper.

QUESTION 1
ELECTRICAL CURRENT THEORY

1.1 A circuit consists of a coil with a resistance of 40 Ohms and an inductance of 0,14 H, connected in series with a capacitor of 49 micro-Farads, across a source of 220 V, 60 Hz. Calculate the

1.1.1	impedance of the circuit.	(9)
1.1.2	total current flow.	(3)
1.1.3	phase angle of the current, relative to the applied voltage.	(4)
1.1.4	voltage drop across the coil.	(6)

1.2 Calculate the Q factor of a series resonant RLC circuit, where R = 42 Ω and L = 120 μH, with a supply frequency of 325 kHz. (6)

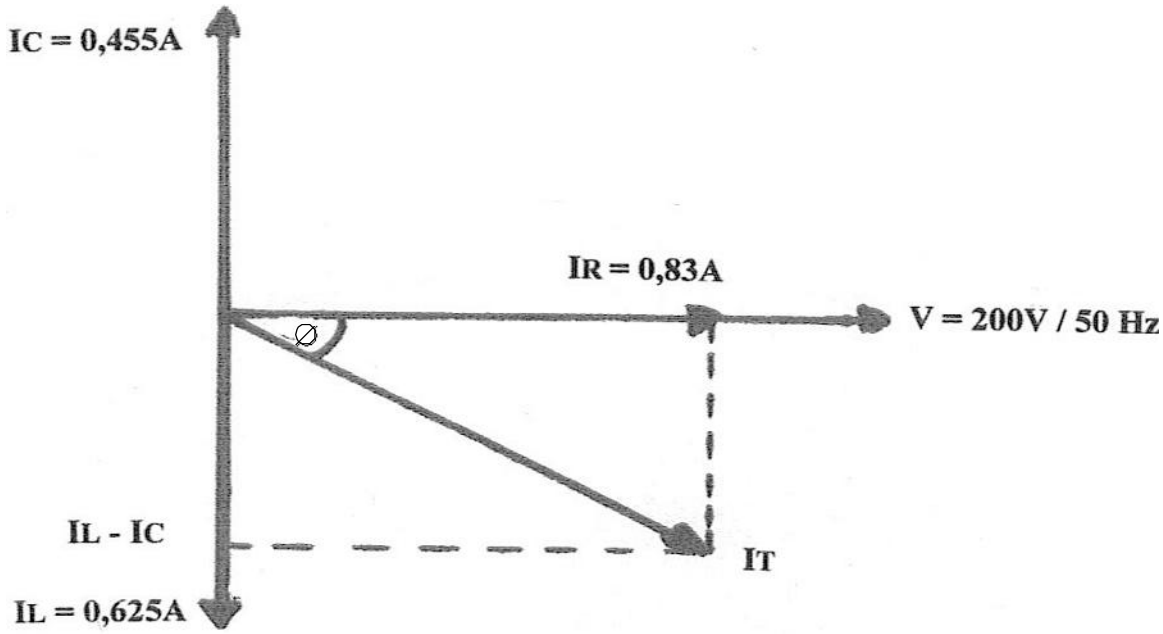

Figure 1.1

1.3 From the phasor diagram in **Figure 1.1** calculate:

1.3.1 The total current flow (3)
1.3.2 The phase angle (4)
1.3.3 The inductance of the coil in the circuit (6)

1.4 What effect will an increase in frequency have on the current flowing through an inductor in a parallel RLC circuit, with reference to the impedance of the circuit? (2)

1.5 In a parallel RLC circuit, when will the total current flow be equal to the current through the resistor? (2)

[45]

QUESTION 2
SINGLE AND THREE-PHASE SYSTEMS

2.1 The meter readings in a certain single-phase system are:
V= 250 V, I = 20 A and power factor = 0,8 leading.

2.1.1 Calculate the apparent power of the circuit. (3)
2.1.2 Calculate the effective power of the circuit. (3)
2.1.3 Calculate the phase angle between the current and the voltage. (2)

2.2 State ONE advantage of a three-phase alternating current system when compared to that of a single-phase alternating current system. (2)

[10]

QUESTION 3
TRANSFORMERS

3.1 What is the purpose of silica gel in the breather of a transformer? (2)

3.2 Large transformers are used for the distribution of power. The transformers are immersed in a specific oil. Give ONE reason for the use of this specific oil in transformers. (2)

3.3 A three-phase alternator supplies a three-phase delta-star connected transformer with power. The alternator's line voltage and current is 11 kV and 5A. The transformer has 5000 primary windings. The secondary line voltage is 500 Volts with a lagging power factor of 0,6. Calculate the

3.3.1 secondary phase voltage. (2)
3.3.2 transformation ratio. (3)
3.3.3 number of secondary windings. (3)
3.3.4 primary phase current. (2)
3.3.5 secondary phase current. (3)
3.3.6 output power. (3)

[20]

QUESTION 4
ALTERNATING CURRENT MOTORS

4.1 Briefly explain the difference between the synchronous speed and the rotor speed of an alternating current motor. (2)

4.2 The supply to a 50 kW three-phase motor is 380 Volts. Calculate the current that the motor will take from the line, if the efficiency of the motor is 80% at a power factor of 0,85. (6)

4.3 State TWO possible causes of overheating of an electric motor on load. (2)

4.4 Determine the slip, in percentage, of a four-pole three-phase induction motor. The supply to the motor is 500 Volts, 50 Hertz with a rotor speed of 1425 r/min. (6)

4.5 Draw a neat, labelled circuit diagram of a capacitor-starter motor. (4)

4.6 Give ONE use of the shaded-pole motor. (2)

4.7 What is the purpose of the second capacitor in the capacitor start-and-run motor? (3)

[25]

QUESTION 5
SEMICONDUCTORS

5.1 Draw the symbols of the following components:

5.1.1 NPN transistor (2)
5.1.2 Diac (2)

5.2 Under which biasing conditions will a bipolar transistor (NPN) function correctly? (4)

5.3 Name ONE difference between a Zener diode and a junction diode. (2)
[10]

QUESTION 6
AMPLIFIERS

6.1 Draw a neat, labelled circuit diagram of a push-pull amplifier. (8)

6.2 Which class of amplification is used in this push-pull amplifier? (2)

6.3 With the aid of a circuit diagram, explain how a single transistor can be used to amplify a sine wave. Show the input and output wave forms. (8)

6.4 State TWO disadvantages of a transformer-coupled amplifier. (2)
[20]

QUESTION 7
SWITCHING AND CONTROL CIRCUITS

7.1 What does the term **regulated power supply** mean? (2)

7.2 Explain, with the aid of a labelled circuit diagram, how an SCR (Silicon Controlled Rectifier) can be used to control the speed of an electric motor. (10)

7.3 Name TWO safety precautions that should be kept in mind when working with power supplies. (2)

7.4 Name ONE method used to switch off an SCR. (2)

7.5 Draw a simple circuit of a Zener regulated power supply. (4)
[20]

QUESTION 8
OPERATIONAL AMPLIFIERS

8.1 Sketch a neat, labelled circuit diagram of a differentiator circuit which makes use of an operational amplifier. Illustrate all relevant wave forms. **[10]**

QUESTION 9
OSCILLATORS

9.1 Describe the following terms as applied to oscillators:

9.1.1 Positive feedback (2)
9.1.2 Tank circuit (2)
9.1.3 Piezo-electricity (2)

9.2 Explain the purpose of the crystal in a Hartley crystal-controlled oscillator. (2)

9.3 What is the purpose of an oscillator circuit in a capacitance meter? (2)
[10]

QUESTION 10
COMPUTER PRINCIPLES

10.1 A learner is approached to design a circuit consisting of three switches, A, B and C, which will allow the current to flow under the following conditions:

- Switches A and C open and B closed
- Switches B and C open and A closed
- Switches A and C closed and B open
- All three switches closed

10.1.1 Draw up a truth table for the circuit. (8)
10.1.2 Derive a logical expression for the circuit. (4)

10.2 Prove with the aid of truth tables that:

$$A + B = A.B$$ (6)

10.3 Draw the symbol of a NAND gate. (2)
[20]

QUESTION 11
MEASURING INSTRUMENTS

11.1 Draw a neat, labelled sketch of a power-factor meter. (6)

11.2 Name TWO uses of the oscilloscope. (2)

11.3 Give ONE method used to obtain deflection in a cathode ray tube. (2)

[10]

TOTAL: 200

FORMULA SHEET/ FORMULELYS

$X_L = 2 \pi f L$

$X_C = \frac{1}{2\pi fC}$

$Z = \sqrt{R^2 + (X_L - X_C)^2}$

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

$f = \frac{\omega}{2\pi}$

$t = R.C$

Star/Ster

$V_L = V_P.\sqrt{3}$

$I_L = I_P$

Delta

$V_L = V_P$

$I_L = I_P.\sqrt{3}$

$I_r = I \sin\theta$

$Ia = I \cos\theta$

$P = \sqrt{3}.V_L.I_L.Cos\theta$

$Cos\theta = \frac{P}{P_{apparant/skynbaar}}$

Efficiency / Rendement = $\frac{Output / Uitset}{Input / Inset}$

$N_s = \frac{f}{P}$

$\cos\theta = \frac{R}{Z}$

$Z = \frac{V}{I}$

$Z = \frac{L}{CR}$

$F_r = \frac{1}{2\pi}\sqrt{\frac{1}{LC} - \frac{R^2}{L^2}}$

$Q = \frac{X_L}{R}$

$f = \frac{1}{T}$

$VR = I.R$

$V_L = I.X_L$

$V_C = I.X_C$

$\frac{N_P}{N_S} = \frac{V_P}{V_S} = \frac{I_S}{I_P}$

$t = R.C$

$I_E = I_B + I_C$

$I_C = \frac{V_{CE}}{R_L}$

$S = \frac{N_s - N_r}{N_s}$

$\beta = \frac{I_C}{I_B}$

END