GAUTENG DEPARTMENT OF EDUCATION

SENIOR CERTIFICATE EXAMINATION

TECHNIKA (ELECTRICAL) HG

TIME: 3 hours

MARKS: 300

REQUIREMENTS:

Drawing instruments and an approved calculator

INSTRUCTIONS:

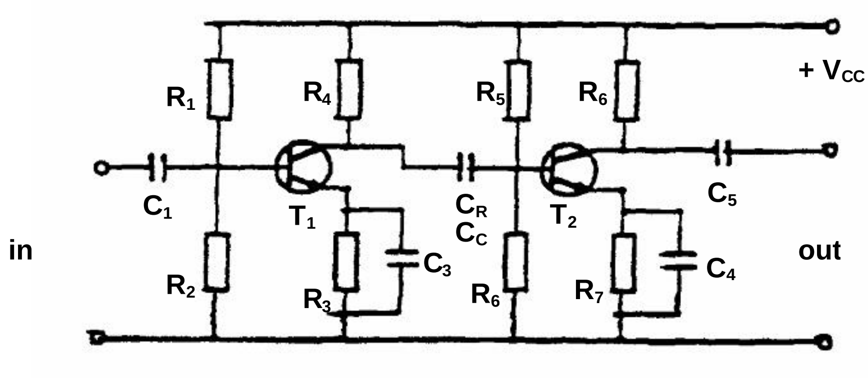
- Answer ALL the questions.
- Sketches and diagrams must be clear and writing must be legible.
- Formulae and calculations must, where applicable, be indicated.
- A list of formulae, which may be used when applicable, is given on the last page of the question paper.

QUESTION 1

1.1 Briefly describe the safety precautions which must be complied with, before a portable electric appliance can be used. (5)

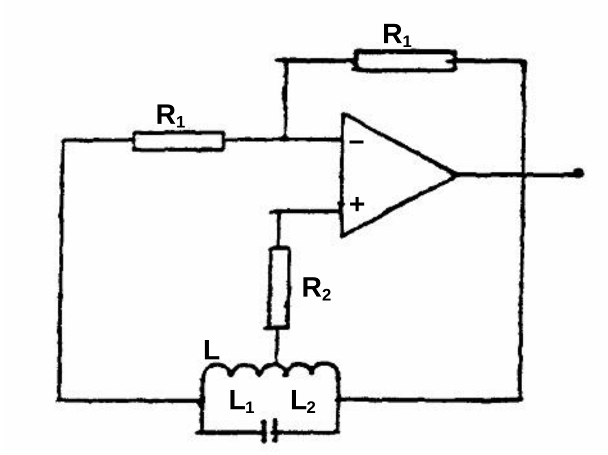
1.2 Identify the following diagrams / devices:

1.2.1



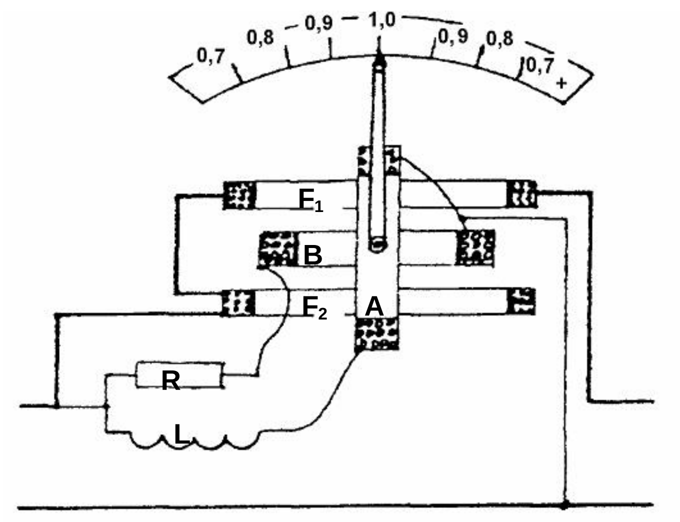
(1)

1.2.2



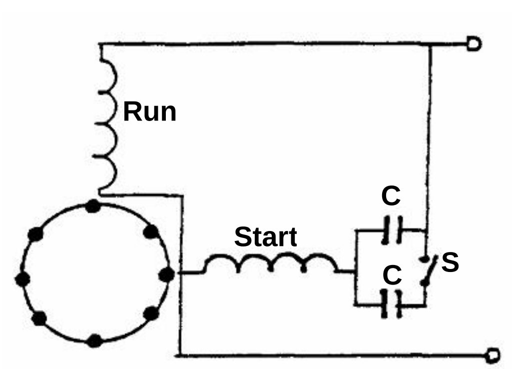
(1)

1.2.3



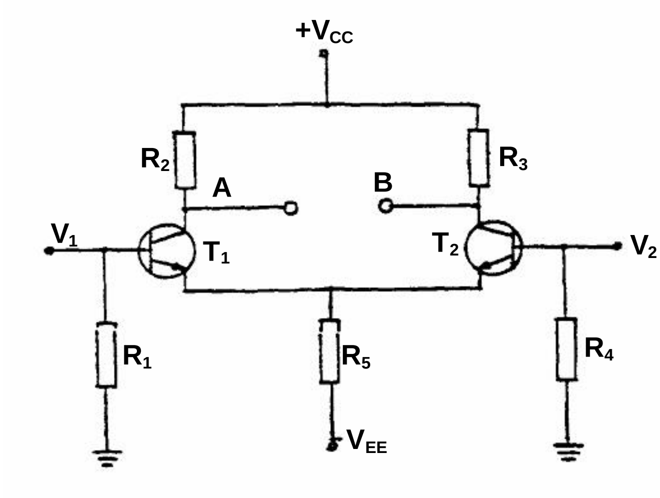
(1)

1.2.4



(1)

1.2.5



(1)
[10]

QUESTION 2

2.1 A resistance of 10 Ohms, an inductance of 200 milliHenry and a capacitor of 100 microFarads are connected in series across a 250 V / 50 Hz supply.

Calculate

2.1.1 the circuit impedance. (9)

2.1.2 the circuit power factor. (3)

2.1.3 the reactive component of the current. (7)

2.1.4 Draw the phasor diagram of the circuit. (4)

2.2 A parallel circuit consists of a resistance of 12 Ohms, an inductance of 0,12 Henrys and a capacitor 100 microFarads. The circuit is connected across a 100 V / 50 Hz supply.

2.2.1 Draw a diagram of the circuit and show all the detail. (3)

2.2.2 Calculate the current through each component. (10)

2.2.3 Calculate the total current in the circuit. (3)

2.2.4 Draw a phasor diagram, not according to scale, but in good proportion, of the circuit. (3)

2.3 Define the following terms:

2.3.1 The Ampére (5)

2.3.2 Frequency (2)

2.3.3 Phasor (2)

2.3.4 Period (2)

2.4 Describe the meaning of each of the following concepts:

2.4.1 Q factor (2)

2.4.2 Active component of alternating current (2)

2.4.3 Efficiency (3)

2.4.4 Resonant frequency (2)
[62]

QUESTION 3

3.1 Name FIVE advantages of three-phase alternating-current systems over that of single-phase systems. (5)

3.2 What is the phase-sequence of a three-phase, three-wire, alternating-current supply? (3)

3.3 Three identical coils are connected in star to a 400 V / 50 Hz three-phase supply. The total power used by the coils is 1,5 kW at a power factor of 0,2.

Determine the resistance and the inductance of each coil. (23)
[31]

QUESTION 4

4.1 Three single-phase transformers are connected in delta to a 3 kV supply. The secondaries of the transformers are connected in star and supply 415 V line voltage to a balanced load. The power in the load is 150 kW at a power factor of 0,8 lagging. The primary is wound at 4 V per turn. Assume 100% efficiency.

4.1.1 Draw a neat, labelled diagram to show the connection of the transformers. (4)

4.1.2 Calculate the number of primary turns. (4)

4.1.3 Calculate the number of secondary turns. (5)

4.1.4 Calculate all the current values in the circuit. (12)

4.2 The winding of an auto-transformer consists of 600 turns, and is used to transform 220 Volt to 20 Volt.

4.2.1 State the disadvantage of an auto-transformer. (2)

4.2.2 Sketch a labelled diagrammatic representation of the transformer. (5)

4.2.3 Calculate the position of the tap on the winding where the 20 Volts are obtained. (4)

[36]

QUESTION 5

5.1 5.1.1 What is meant by the term **rotor speed** of an electric motor? (2)

5.1.2 A four-pole three-phase induction motor is connected to a 380 V / 50 Hz supply. Calculate the synchronous speed. (4)

5.2 Sketch a neat, labelled diagram to show the internal connections of a capacitor-start motor. (7)

5.3 How can the direction of rotation of a three-phase motor be altered? (2)

5.4 A four-pole, three-phase squirrel-cage induction motor is connected to a 380 V alternating current supply with a periodic time of 0,02 seconds. The motor slip is calculated to be 0,04%.

Calculate the

5.4.1 supply frequency. (3)

5.4.2 rotor speed. (6)

5.5 Briefly describe TWO safety devices for motor starters that are in use. (6)

[30]

QUESTION 6

6.1 Describe, by means of a circuit diagram, how a transistor can be used as a switch. Also name the conditions to be satisfied for switching on a transistor. (7)

6.2 Explain by means of a neat, labelled sketch and a brief description, the functional OPERATION of a silicon controlled rectifier (SCR). (7)

[14]

QUESTION 7

7.1 A common-emitter amplifier is connected to a load resistor of 4 kilo-Ohms. The voltage supply to the circuit is 12 V.

7.1.1 Calculate the DC load line coordinates of the amplifier. (4)

7.1.2 Draw typical input and output characteristic curves for the amplifier on the same axis as the load line. Assume the amplifier operates in the class A mode with a sinus-wave input. (6)

7.2

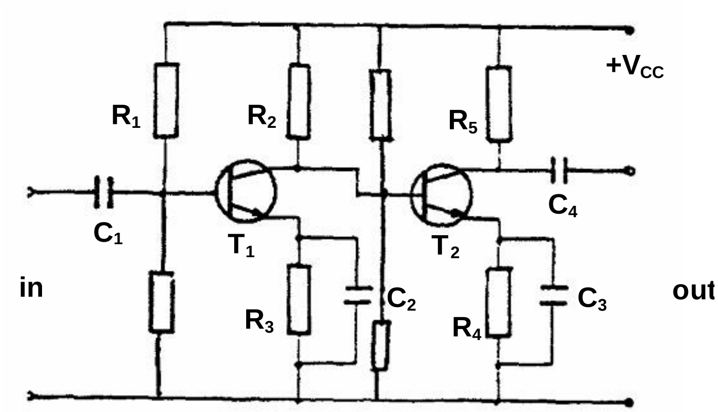


Figure 7.1

With reference to **Figure 7.1** answer the following questions:

7.2.1 Identify the purpose of **T1** in the above circuit. (1)

7.2.2 Which method is used to connect the amplification steps? (1)

7.2.3 Sketch the frequency-response curve of the circuit. (6)

7.2.4 Which bias voltage method is used in this circuit? (1)

7.2.5 Which transistor configuration is used in this circuit? (1)

7.3 The output power of an amplifier is 100 mW at a frequency of 10 kHz. When the frequency increases to 20 kHz, the power drops to 50 mW. Calculate the power loss in decibels. (4)

7.4 Describe the concept **positive feedback**. (2)

7.5 Draw a diagram of a Darlington amplifier with NPN transistors. (5)

[31]

QUESTION 8

8.1 Briefly explain the concept **regulated power supply**. (3)

8.2

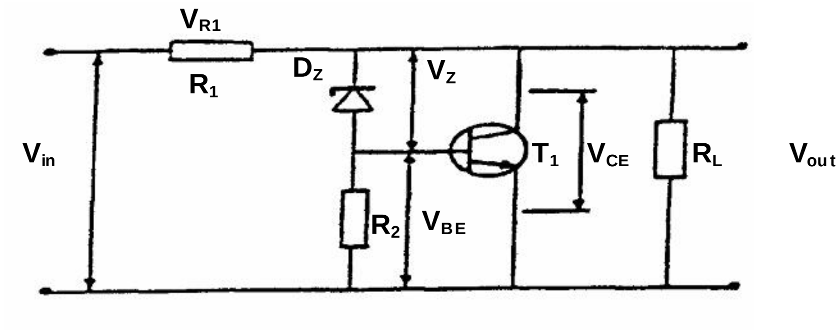


Figure 8.1

8.2.1 Identify the circuit in **Figure 8.1**. (1)

8.2.2 Fully describe how the circuit will compensate for a reduction in the value of R_L. (10)

8.3 Explain, with the aid of a circuit diagram and a brief description, how full wave lamp dimming can be obtained in an ac circuit. (10)

[24]

QUESTION 9

9.1

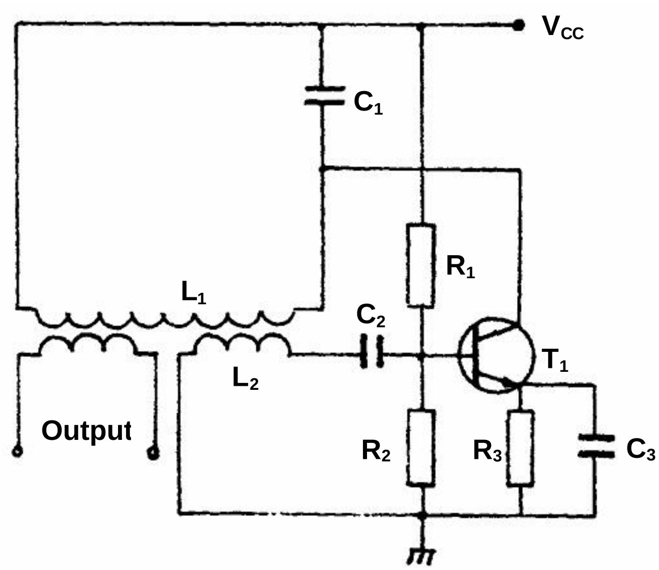


Figure 9.1

9.1.1 Identify the circuit illustrated in **Figure 9.1**. (1)

9.1.2 Identify the components which determine the frequency of the output signal. (2)

9.1.3 Which component is responsible for the amplification in the circuit? (1)

9.1.4 Describe, step-by-step, the principle of operation of the circuit. (5)

9.2 What is the function of the crystal in the crystal-controlled Hartley oscillator? (2)

9.3 Explain the following terms with reference to oscillators:

9.3.1 Positive feedback (2)

9.3.2 Piezo-electricity (2)
[15]

QUESTION 10

10.1

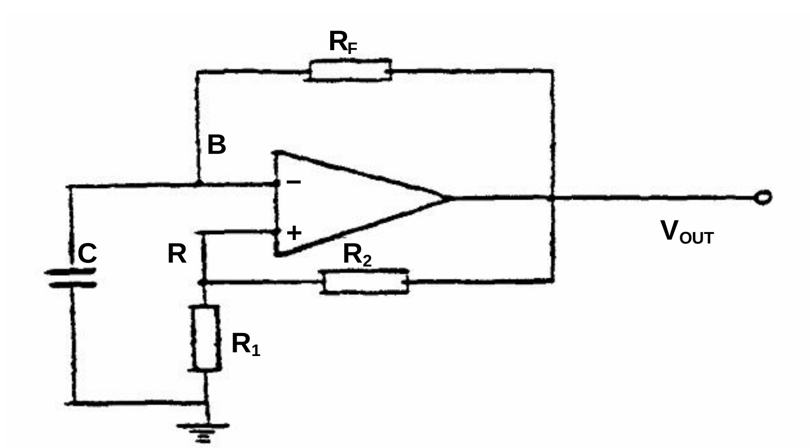


Figure 10.1

10.1.1 Identify the circuit in **Figure 10.1**. (1)

10.1.2 What is the function of $\mathbf{R_1}$? (1)

10.1.3 What is the function of $\mathbf{R_2}$? (1)

10.1.4 What is the function of $\mathbf{R_f}$? (2)

10.1.5 What is the function of **C**? (2)

10.1.6 Draw a typical output waveform for the circuit. (4)

10.2 Name TWO characteristics of an operational amplifier. (2)
[13]

QUESTION 11

11.1 Give the Boolean expression for an exclusive OR-gate. (2)

11.2 Draw the logic diagram of a half adder (use only TWO gates) and give the truth table. (8)

11.3 An electronics engineer 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

11.3.1 Draw up a truth table for the circuit. (8)

11.3.2 Simplify the Boolean expression that was derived from the truth table into its simplest form. (7)

11.3.3 Sketch a logic circuit of the simplified Boolean expression. (4)

[29]

QUESTION 12

12.1

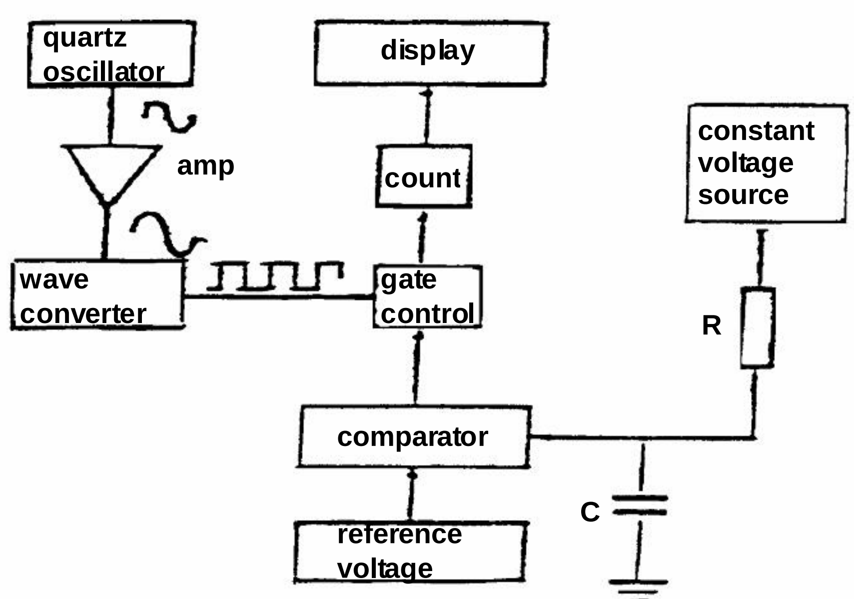


Figure 12.1

12.1.1 Identify the circuit in **Figure 12.1**. (1)

12.1.2 What is the function of the **wave converter**? (2)

12.1.3 What is the function of the **quartz oscillator**? (2)

[5]

TOTAL: 300

P.T.O.

FORMULES / FORMULAE

$X_L = 2\pi LF$

$X_C = \dfrac{1}{2\pi FC}$

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

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

$F_R = \dfrac{1}{2\pi}\sqrt{\dfrac{1}{LC} - \dfrac{R^2}{L^2}}$

$I_C = V \cdot \sqrt{\dfrac{C}{L}}$

$f = \dfrac{W}{2\pi}$

$t = R.C$

$V_R = IR$

$V_L = I.X_L$

$V_C = I.X_C$

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

$\text{Cos}\,\theta = \dfrac{R}{Z}$

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

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

$Z = \dfrac{L}{C.R}$

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

$P = I \times V \times \text{Cos}\,\theta$

Iwgk/rms = Imax x 0,707

$Q = \text{Cos}^{-1} \dfrac{VR}{VT}$

$P = I \times V$

$Vt^2 = V_R^{\,2} + V_L^{\,2}$

$kVA = I \times V$

$Ns = \dfrac{f}{p}$

Ster/Star

$V_L = V_P . \sqrt{3}$

$I_L = I_P$

Delta

$I_L = I_P . \sqrt{3}$

$V_L = V_P$

$Ir = I \sin\theta$

$Ia = I \cos\theta$

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

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

$\text{Cos}\,\theta = \dfrac{P}{P_{\text{Skynbaar/Apparent}}}$

$N_r = N_s - S$

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

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

$Ns = \dfrac{f}{P}$

$I_E = I_B + I_C$

$\dfrac{N_P}{N_S} = \sqrt{\dfrac{Z_P}{Z_S}}$

$I = \dfrac{Vcc}{R_L}$

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

$N = 10 \text{ Log } \dfrac{P_2}{P_1}$

END / *EINDE*