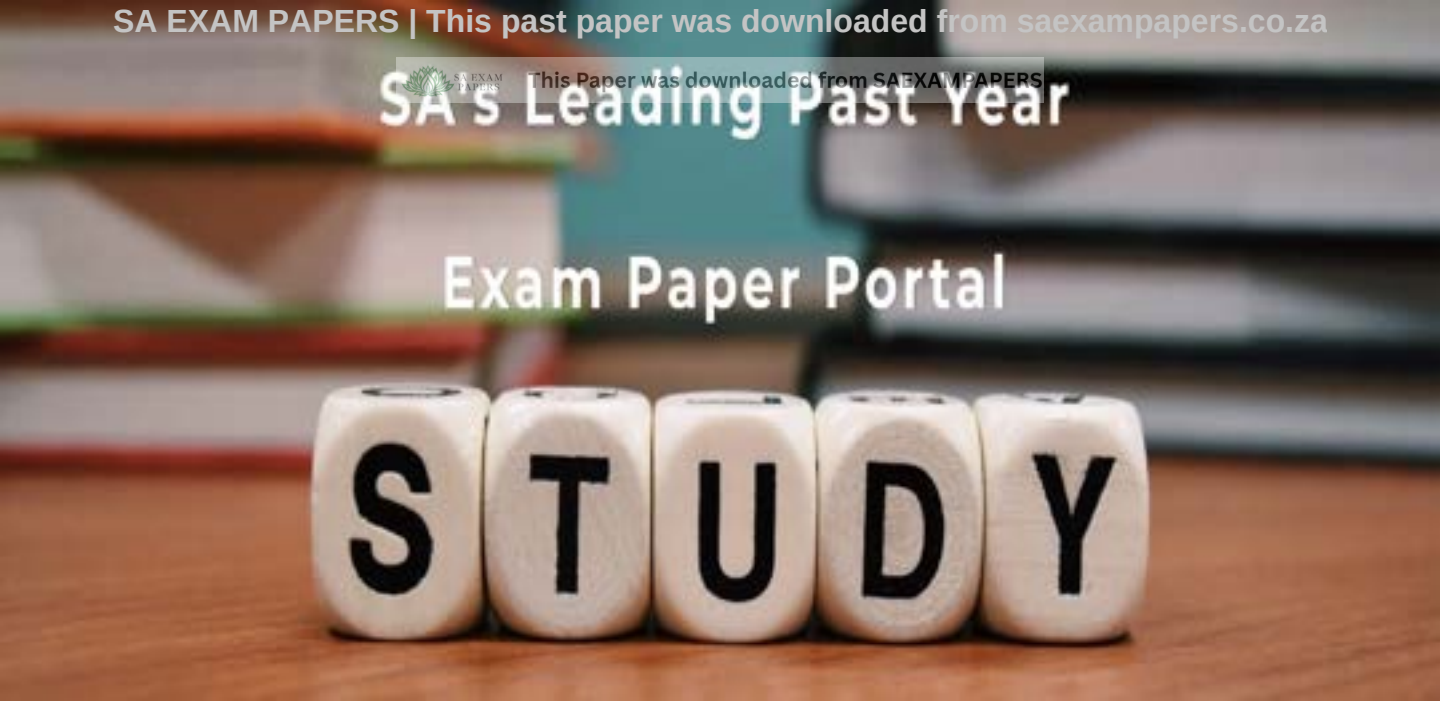

Province of the
EASTERN CAPE
EDUCATION

Iphondo leMpuma Kapa: Isebe leMfundo
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Porafensie Ya Kapa Botjhabela: Lefapha la Thuto

NATIONAL SENIOR CERTIFICATE

GRADE 12

SEPTEMBER 2025

ELECTRICAL TECHNOLOGY: ELECTRONICS

MARKS: **200**

TIME: **3 hours**

This question paper consists of 14 pages, including a 2-page answer sheet and a 1-page formula sheet.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of SIX questions.
2. Sketches and diagrams must be large, neat and fully labelled.
3. Show ALL calculations and round off answer correctly to TWO decimal places.
4. Number the answers correctly according to the numbering system used in this question paper.
5. You may use a non-programmable calculator.
6. Show the units for ALL answers of calculations.
7. A formula sheet is provided at the end of this question paper.
8. Write neatly and legible.

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are given as possible answers to the following questions. Choose the answer and write only the letter (A–D) next to the question numbers (1.1 to 1.15) in the ANSWER BOOK, for example 1.16 D.

1.1 The meaning of the term *risk* is …

A an incident that has already occurred.
B an injury or damaged that has previously occurred.
C the probability that no injury or damage will ever occur.
D the probability that injury or damage will occur. (1)

1.2 The reference of a phasor diagram for a series RLC circuit is current. The reason for this is …

A resistance in series divide the current and the voltage stays the same.
B resistance in series divide the voltage and the current stays the same.
C current is inversely proportional to the resistance.
D voltage is directly proportional to the resistance. (1)

1.3 In a pure inductive circuit, the inductive reactance will … if the frequency doubles.

A double
B half
C stay the same
D decrease (1)

1.4 Which ONE of the following is TRUE for a series RLC circuit at resonance?

A The capacitive reactance is not equal to the inductive reactance.
B The current is 0 A.
C The resistance of the circuit is equal to the impedance of the circuit.
D The phase angle is 90°. (1)

1.5 The term *transistor* refers to …

A a device which transfers voltage from a high resistance input circuit to a low resistance output circuit.
B a device which transfers current from a low resistance input circuit to a high resistance output circuit.
C a device which transfers current from a high resistance input circuit to a low resistance output circuit.
D a device which transfers voltage from a low resistance input circuit to a high resistance output circuit. (1)

1.6 Pin 2 of a 741 op amp is …

A inverting input.
B negative supply voltage.
C non-inverting input.
D offset null. (1)

1.7 Which ONE of the following is a characteristic of an ideal op amp?

A The ideal op amp has low gain.
B The input impedance of an ideal op amp is almost non existing low.
C The output impedance is extremely low, between 50 Ω and 100 Ω.
D The ideal op amp will have a very narrow bandwidth to amplify only signals of a predetermined frequency. (1)

1.8 A passive RC circuit with its resistor across the output terminals forms a differentiator circuit. It produces an output signal which is ...

A indirectly proportional to the rate of change of the input signal.
B indirectly proportional to the rate of change of the supply voltage.
C directly proportional to the rate of change of the supply voltage.
D directly proportional to the rate of change of the input signal. (1)

1.9 With reference to FIGURE 1.9 below, the function of the 1 kΩ resistor is …

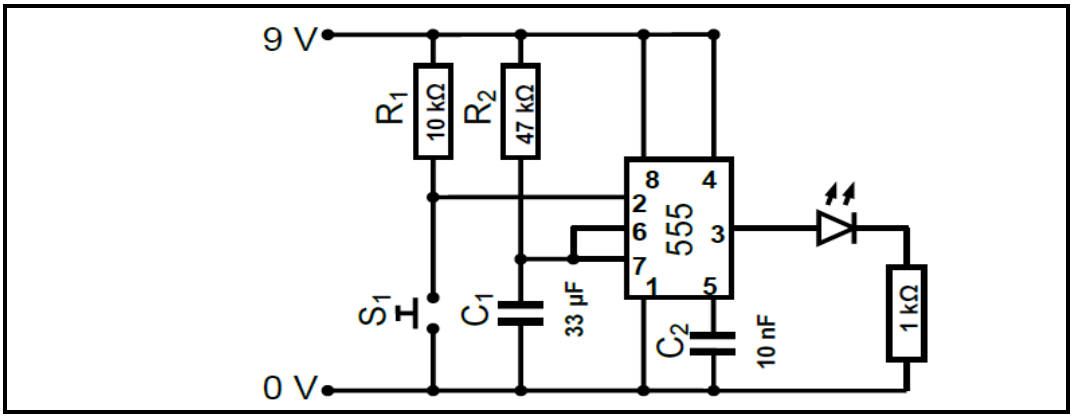


FIGURE 1.9

A to protect the LED from over current.
B to protect the 555 timer IC from over current.
C a pull-up resistor to prevent the voltage from floating.
D a pull-down resistor to prevent the voltage from floating. (1)

1.10 With reference to FIGURE 1.10 below, the function of Rf is to …

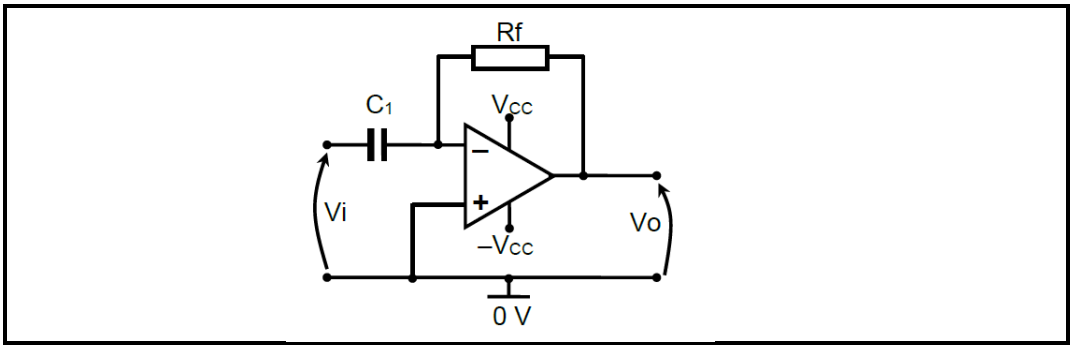


FIGURE 1.10

A feed the entire signal back to the input.
B feed back a small part of the signal to the input.
C allow the input signal to bypass the op amp entirely.
D allow the input signal to partially bypass the op amp. (1)

1.11 The maximum current the 555 timer IC can source or sink:

A 1 A
B 20 mA
C 100 mA
D 200 mA (1)

1.12 In class B biasing of an amplifier, the Q point is chosen to lie …

A right at the bottom of the load line right at the cut-off point.
B just within the active operating region of the amplifier.
C right down below the cut-off region of the amplifier.
D in the centre of the active region of the amplifier. (1)

1.13 With reference to the transformer coupling amplifier, it is referred to as acting as a buffer. This means that …

A it isolates the input and output stages to prevent feedback.
B it will correctly match two different impedances while at the same time separating their DC circuits.
C it will correctly match two different impedances while at the same time allow their DC circuits to pass.
D it combines the input and output signals to provide a very large, stable output. (1)

1.14 Which ONE of the following is an advantage of a RC coupled amplifier?

A Low voltage and power gain as the effective resistance is reduced.
B Not suitable for low-frequency amplification.
C Offers a varying gain over a specific frequency band.
D Cheap, economical and compact as it uses only resistors and capacitors. (1)

1.15 The output waveform generated by a RC phase-shift oscillator will be … wave.

A sawtooth
B sinusoidal
C triangular (1)
D square **[15]**

QUESTION 2: OCCUPATIONAL HEALTH AND SAFETY

2.1 Name ONE example of victimisation that is forbidden in a workplace. (1)

2.2 Poor lighting in a workshop is often said to be an unsafe condition. Explain why this is true. (2)

2.3 When we say something is safe, we mean it is free from any hazard. Explain what the term *hazard* means. (2)

2.4 Explain the importance of having human rights applied to a workplace. (3)

2.5 Name TWO steps that is included in the treatment of electrical shock. (2)

[10]

QUESTION 3: RLC CIRCUITS

3.1 Define the following terms with reference to RLC circuits:

3.1.1 *Inductive reactance* (2)

3.1.2 *Impedance* (2)

3.2 Explain the influence that a decrease in frequency in a RLC circuit will have on the capacitive reactance value of the circuit. Give a reason for your answer. (3)

3.3 Explain why the current drawn by a series RLC is at a maximum during resonance. (4)

3.4 A coil has an inductance of 2 H and is connected in series with a capacitor with a capacitive reactance of 12,67 Ω and a 30 Ω resistor. The circuit is connected to a 225 V alternating current supply with a variable frequency.

Calculate the:

3.4.1 Value of the capacitor in μF (3)

3.4.2 Impedance of the circuit (6)

3.4.3 Resonant frequency if the capacitor and resistor values remain unchanged but the inductor value is 7 mH at resonance (3)

3.4.4 Current drawn by the circuit during resonance (3)

3.5 A parallel RLC circuit has a resistor with a resistance of 470 Ω, an inductor with an inductive reactance of 264 Ω and a capacitor with a capacitive reactance of 310 Ω connected to a power source of 420 V; 60 Hz.

Calculate the:

3.5.1 Current drawn by the resistor (2)

3.5.2 Current drawn by the inductor (2)

3.5.3 Current drawn by the capacitor (2)

3.5.4 Value of the inductor (3)

[35]

QUESTION 4: SEMICONDUCTOR DEVICES

4.1 State what the abbreviation BJT stands for. (1)

4.2 Explain the difference in methods used to control the output current between a BJT and a FET. (2)

4.3 The cross-sectional view of an electronic component is shown in FIGURE 4.3. Answer the questions that follow.

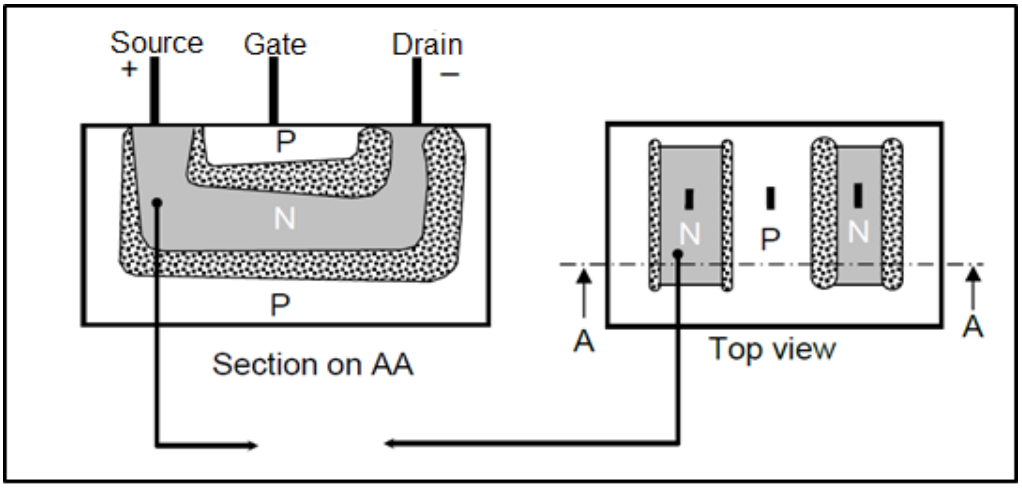


FIGURE 4.3

4.3.1 Identify the component in FIGURE 4.3. (1)

4.3.2 Draw the labelled symbol for the component in FIGURE 4.3. (4)

4.3.3 Explain the functional operation of the component in FIGURE 4.3. (9)

4.3.4 With reference to the component in FIGURE 4.3, explain the term *pinch-off point.* (3)

4.4 With reference to a 741 op amp, explain the function of the second high gain differential amplifier stage. (3)

4.5 A 741 op amp is connected as a non-inverting amplifier to provide an output voltage of 6,9 V_{AC}. The value of the input resistor is 120 Ω. Determine the value of the feedback resistor when the input voltage is 17 mV. (3)

4.6 Draw a fully labelled circuit diagram for a buffer amplifier. (3)

4.7 List ONE use for the 555 IC. (1)

4.8 Define the term *monolithic.* (2)

4.9 Discuss pin 6 (threshold) with reference to its purpose in a 555 IC. (3)

4.10 Discuss the operation of the 555 IC. (5)

4.11 Discuss the operation of the trigger pin, pin 2 of a 555 timer IC. (5)

[45]

QUESTION 5: SWITCHING CIRCUITS

5.1 Name THREE types of operation of multivibrators. (3)

5.2 Discuss a typical application of a 555 bistable multivibrator. (4)

5.3 Explain what determines the time period a monostable multivibrator output stays high for. (2)

5.4 Explain the principle of operation of an op amp monostable multivibrator. (6)

5.5 With reference to a 555 monostable multivibrator, explain why the input signal will go from a high to a low when triggered. (6)

5.6 With reference to an astable multivibrator, discuss the term *free running*. (4)

5.7 An inverting summing amplifier has three inputs. The inputs are 1 V; 1,6 V and 2,7 V respectively. The respective input resistors have the values of 2k2; 1k7 and 1k respectively. The output voltage is 320 mV.

5.7.1 Calculate the value of the feedback resistor. (4)

5.7.2 Calculate the gain for the input V_1 in this circuit. (3)

5.7.3 Draw a fully labeled circuit diagram for this circuit. (5)

5.7.4 Discuss why the output voltage will be 180 degrees out of phase. (2)

5.8 Name ONE practical application of a summing amplifier. (1)

5.9 $V_{out} = -(V_1 + V_2 + V_3)\,V$

Discuss under which conditions the formula above will be used to calculate the output voltage of a summing amplifier. (2)

5.10 Discuss how a comparator circuit can be practically used as a temperature sensor. (6)

5.11 Draw a fully labelled circuit diagram of a passive integrator. (2)

[50]

QUESTION 6: AMPLIFIERS

6.1 Compare *small signal amplifiers* and *power amplifiers* with each other with reference to the application of each. (4)

6.2 FIGURE 6.2 shows a transistor circuit diagram. Answer the questions that follow.

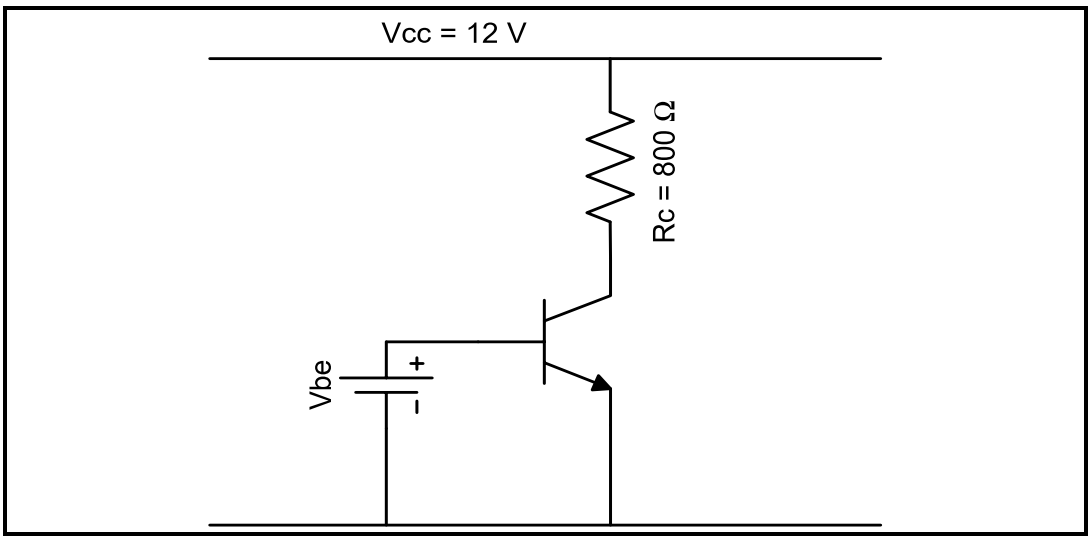


FIGURE 6.2: TRANSISTOR CIRCUIT

6.2.1 Calculate the maximum collector current that can be drawn by this circuit. (3)

6.2.2 Calculate the maximum voltage across the collector resistor. (2)

6.2.3 Draw the load line represented by the circuit shown in FIGURE 6.2 on the ANSWER SHEET for QUESTION 6.2.3. (5)

6.2.4 Explain what the effect on the load line will be if the supply voltage is increased by 3 V. Show ALL calculations to prove the answer. (8)

6.2.5 Draw the new load line on the ANSWER SHEET for QUESTION 6.2.5. (5)

6.3 Distinguish between *class A amplifiers* and *class B amplifiers* with reference to the following:

6.3.1 Conduction angle (4)

6.3.2 Efficiency (2)

6.4 Discuss TWO disadvantages of class B amplifiers. (4)

6.5 Analyse and discuss the term *half power point.* (4)

6.6 Discuss the difference between the oscillator circuits of a *Hartley oscillator* and a *Colpitts oscillator*. (4)

[45]

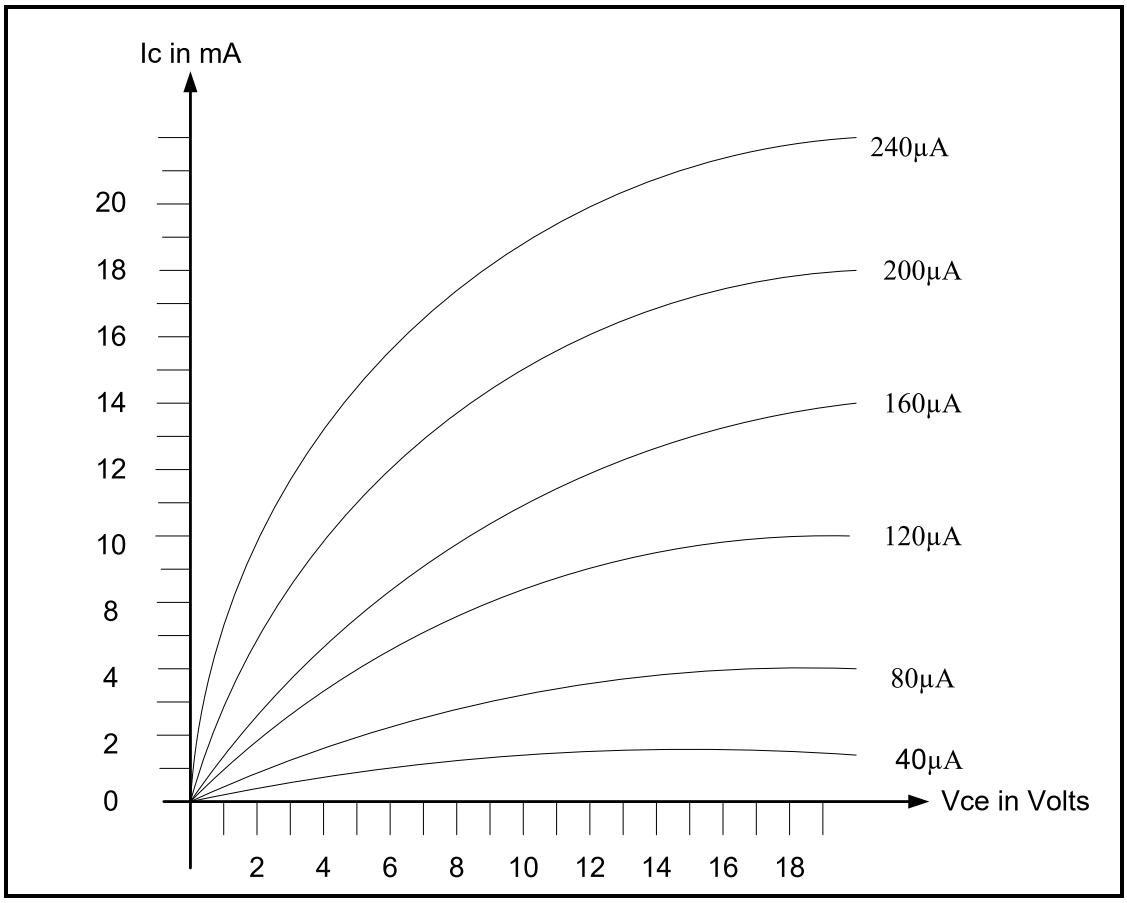
TOTAL: 200

LEARNER'S NAME: _____

QUESTION 6: AMPLIFIERS

ANSWER SHEET FOR QUESTION 6.2.3

6.2.3

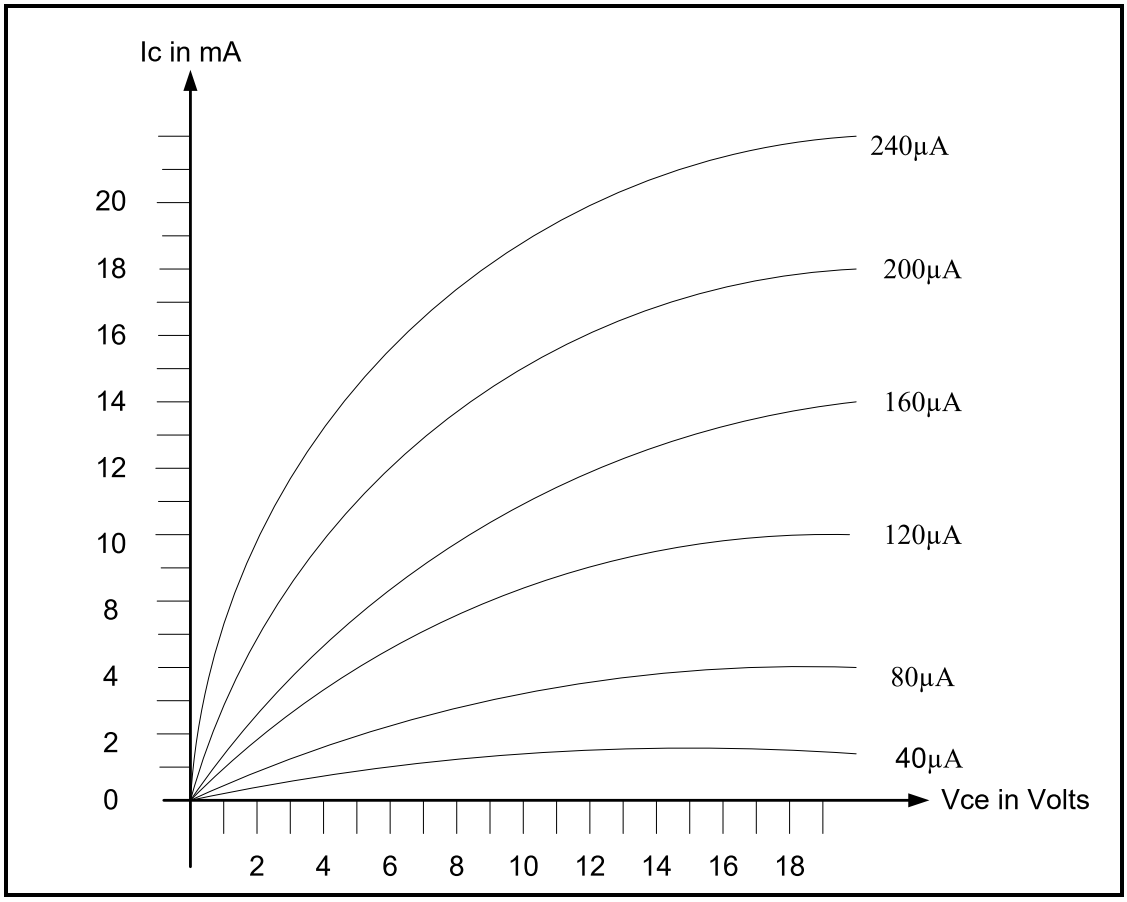


LEARNER'S NAME: _____

QUESTION 6: AMPLIFIERS

ANSWER SHEET FOR QUESTION 6.2.5

6.2.5



FORMULA SHEET

RLC CIRCUIT

$$XL = 2\pi FL \text{ and } XC = \frac{1}{2\pi FC}$$

SERIES

$$I_T = I_R = I_C = I_L$$

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

$$VT = \sqrt{V_R{}^2 + (V_L - V_C)^2}$$

$$VL = IX_L \text{ and } Vc = IX_C \text{ and } V_T = IZ$$

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

$$COS\theta = \frac{V_R}{V_T}$$

$$Q = \frac{X_L}{Z} = \frac{X_C}{Z} = \frac{V_L}{V_S} = \frac{V_C}{V_S} = \frac{1}{R}\sqrt{\frac{L}{C}}$$

PARALLEL

1. $VT = V_R = V_L = V_C$
2. $I_R = \frac{V}{R} = and\ I_L = \frac{V}{X_L} = I_C = \frac{V}{X_C}$
3. $I_T = \sqrt{I_R{}^2 + (I_L - I_C)^2}$
4. $COS\theta = \frac{I_R}{I_T}$
5. $Q = \frac{X_L}{Z} = \frac{X_C}{Z} = \frac{V_L}{V_S} = \frac{1}{R} = \sqrt{\frac{L}{C}}$

SEMI-CONDUCTORS DEVICES

$$A_V = \frac{Vout}{Vin} = \frac{R_F}{R_{IN}}$$

$$V_{OUT} = V_{IN} = (-\frac{R_F}{R_{IN}})$$

$$A_V = 1 + \frac{R_F}{R_{IN}}$$

$$V_{OUT} = V_{IN}\,(1 + \frac{R_F}{R_{IN}})$$

$$\beta_{super} = \beta_1 \times \beta_2$$

AMPLIFIERS

$$V_{CE} = V_{CC}$$

$$I_{Cmax} = \frac{V_{CC}}{R_C}$$

$$A' = \frac{A}{1+\beta A}$$

$$Power\ Gain\ A_P = log_{10}\left(\frac{P_{out}}{P_{in}}\right)$$

$$A_V = 20\ log_{10}\frac{E_{out}}{E_{in}}\ dB$$

$$A_I = 20\ log_{10}\frac{I_{out}}{I_{in}}$$

$$F_0 = \frac{1}{2\pi\sqrt{L_T C}}$$

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

$$F_O = \frac{1}{2\pi\sqrt{6\,RC}}$$

SWITCHING CIRCUITS

1. $\text{Gain } A_V = \frac{V_{OUT}}{V_{IN}} = -\left(\frac{R_f}{R_{in}}\right)$ inverting operational amplifier

2. $\text{Gain } A_V = \frac{V_{OUT}}{V_{IN}} = 1 + \left(\frac{R_f}{R_{in}}\right)$ non-inverting operational amplifier

3. $V_{OUT} = V_{IN} \times \left(-\frac{R_f}{R_{in}}\right)$ inverting amplifier

4. $V_{OUT} = -(V_1 + V_2 + V_3)$ summing up op amp

5. $f_r = \frac{1}{2\pi\sqrt{LC}}$

6. $f = \frac{1}{2\pi\sqrt{6RC}}$