basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATIONS/ NATIONAL SENIOR CERTIFICATE EXAMINATIONS

ELECTRICAL TECHNOLOGY: ELECTRONICS

MAY/JUNE 2026

MARKS: 200

TIME: 3 hours

This question paper consists of 23 pages, a 2-page formula sheet and a 6-page answer sheet.

Copyright reserved

INSTRUCTIONS AND INFORMATION

1. This question paper consists of SIX questions.
2. Answer ALL the questions.
3. Answer the following questions on the attached ANSWER SHEETS:

   QUESTIONS 4.5.2 and 4.6.2
   QUESTIONS 5.3.3, 5.5.2, 5.6.2 and 5.8.2
   QUESTIONS 6.2.3 and 6.8.3

4. Write your centre number and examination number on every ANSWER SHEET and hand them in with your ANSWER BOOK, whether you have used them or not.
5. Sketches and diagrams must be large, neat and FULLY LABELLED.
6. Show ALL calculations and round off answers correctly to TWO decimal places.
7. Number the answers correctly according to the numbering system used in this question paper.
8. You may use a non-programmable calculator.
9. Calculations MUST include:

   9.1 Formulae and manipulations where needed

   9.2 Correct replacement of values

   9.3 Correct answer and relevant units where applicable

10. A formula sheet is attached at the end of this question paper.
11. Write neatly and legibly.

Copyright reserved

QUESTION 1: MULTIPLE-CHOICE QUESTIONS

Various options are provided 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, e.g. 1.16 D.

1.1 An employee with a well-developed sense of teamwork …

A works well independently without any distractions.
B encourages open communication and collaboration with others.
C enjoys having a strict leader who makes all the decisions. (1)

1.2 The inductive reactance of an inductor … with an increase in frequency.

A increases linearly
B decreases linearly
C increases exponentially
D decreases exponentially (1)

1.3 The ratio of the resistance to the impedance in an RLC series circuit is known as the …

A apparent power.
B Q-factor.
C power factor.
D real power. (1)

1.4 The bandwidth of a resonant circuit will … with an increase in the Q-factor.

A decrease
B increase
C remain unchanged
D sum to zero (1)

1.5 The field-effect transistor …

A is a current-controlled device.
B uses a magnetic field to control the current flow.
C relies on the creation of an electric field within to control current flow.
D has a high power loss when compared to a BJT. (1)

1.6 The characteristic curve of a/an … is divided into three operating regions, namely cut-off, negative resistance and saturation.

A UJT
B Darlington pair
C FET
D MOSFET (1)

1.7 The concept of feedback in an op-amp circuit is to take a portion of the … and feed it back to one of the input terminals.

A output voltage
B output impedance
C output frequency
D B and C (1)

1.8 The pin that activates the 555 IC is known as a … pin.

A threshold
B trigger
C discharge
D control voltage (1)

1.9 A monostable multivibrator can … in electronic circuits.

A be used as a free running oscillator
B vary the time in both its stable states
C eliminate switch bounce
D amplify a small audio input signal to a large output signal (1)

1.10 A circuit used in an audio mixer to individually amplify or attenuate each input signal is the ...

A comparator.
B Schmitt trigger.
C inverting op-amp.
D summing amplifier. (1)

1.11 A basic op-amp comparator is a circuit with ....

A no feedback.
B a positive feedback loop.
C a negative feedback loop.
D None of the above-mentioned (1)

1.12 When the input receives a positive-going voltage waveform, the current flowing into the inverting terminal of the op-amp differentiator circuit is …

A equal to the rate of change of the input current.
B inversely proportional to the input current.
C directly proportional to the input current.
D zero. (1)

1.13 The purpose of biasing the transistor amplifier circuit is to …

A increase the gain of the transistor.
B decrease the noise in the transistor.
C establish an operating point for the transistor.
D filter out unwanted frequencies. (1)

1.14 The process of connecting two or more amplifier stages is called …

A attenuation.
B modulating.
C coupling.
D impedance matching. (1)

1.15 … is not widely used for audio amplifier purposes because of the non-linear distortion it causes.

A Class A
B Class B
C Class AB
D All of the above-mentioned (1)
[15]

QUESTION 2: OCCUPATIONAL HEALTH AND SAFETY

2.1 State whether it is an *unsafe act* or a *condition* when a person neglects to wear safety goggles while working with a pedestal drill. (1)

2.2 Define the term *employer* with reference to the Occupational Health and Safety Act, 1993 (Act 85 of 1993). (2)

2.3 Explain *quantitative risk analysis*. (2)

2.4 Explain the purpose of human rights in the workplace. (2)

2.5 An employee who has a sense of responsibility displays good work ethics. State how it can help the company achieve the production goals. (3)
[10]

QUESTION 3: RLC CIRCUITS

3.1 Explain the following with reference to RLC circuits:

3.1.1 Impedance (2)

3.1.2 Resonant frequency (2)

3.1.3 The status of current and impedance at resonance in a parallel circuit (2)

3.2 FIGURE 3.2 below shows an RLC circuit series connected to an AC supply with voltmeter readings across the inductor and capacitor.

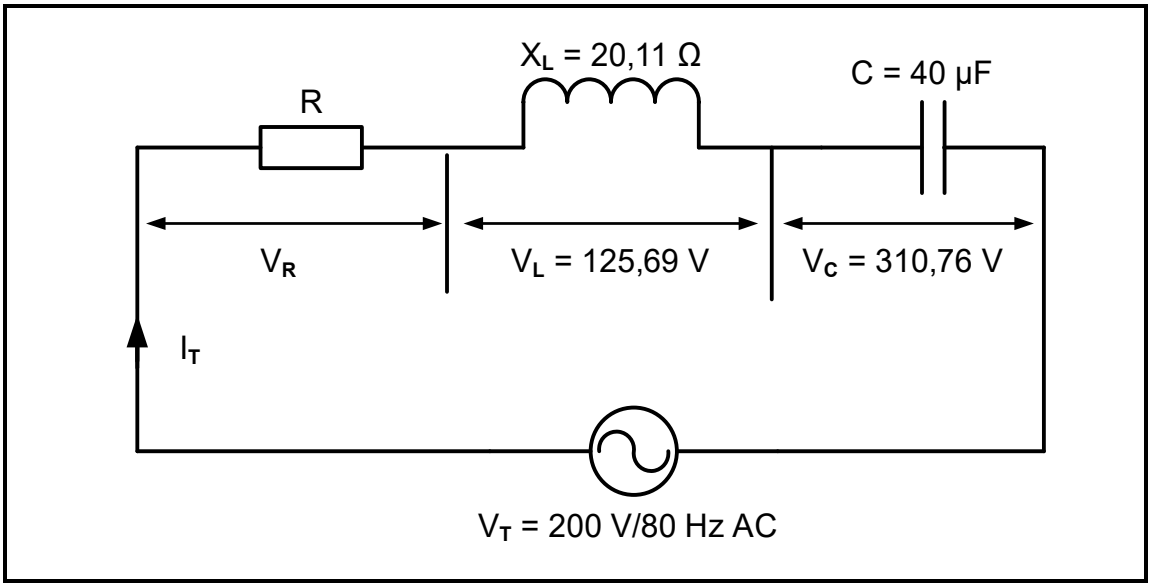


FIGURE 3.2: RLC SERIES CIRCUIT

Given:

X_L = 20,11 Ω
Z = 31,98 Ω
C = 40 µF
V_T = 200 V
V_L = 125,69 V
V_C = 310,76 V
f = 80 Hz

3.2.1 State whether the current through the inductor leads or lags the voltage across it. (1)

Calculate the following:

3.2.2 The capacitive reactance (3)

3.2.3 The value of the inductor (3)

3.2.4 The value of the resistor if the impedance is 31,98 ohms (3)

3.2.5 The total current (I_T) through the circuit (3)

3.2.6 The resonant frequency (3)

3.3 Refer to QUESTION 3.2 on the previous page to redraw and complete the voltage phasor diagram in FIGURE 3.3 below in your ANSWER BOOK.

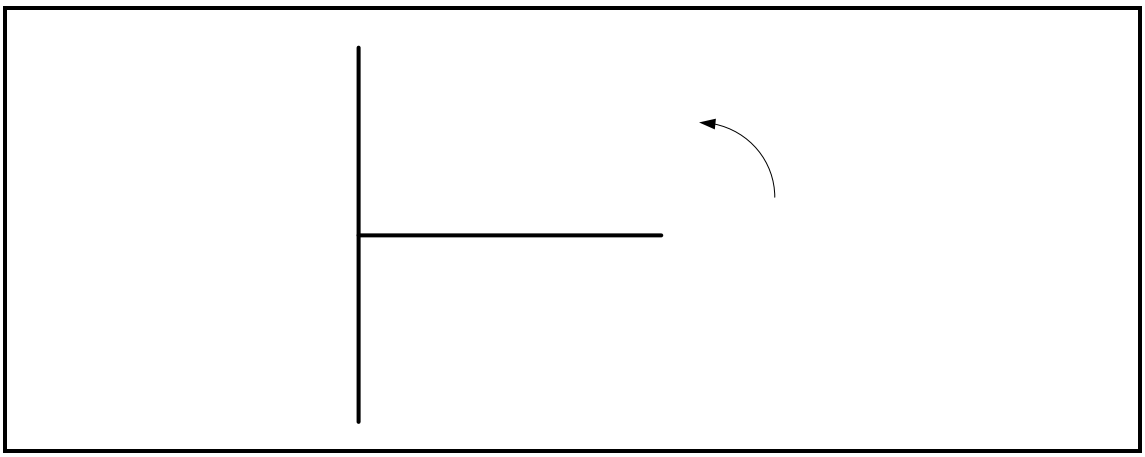


FIGURE 3.3: INCOMPLETE PHASOR DIAGRAM (4)

3.4 FIGURE 3.4 below shows a phasor diagram with the current flowing through the components of an RLC parallel circuit connected to an AC supply. Answer the questions that follow.

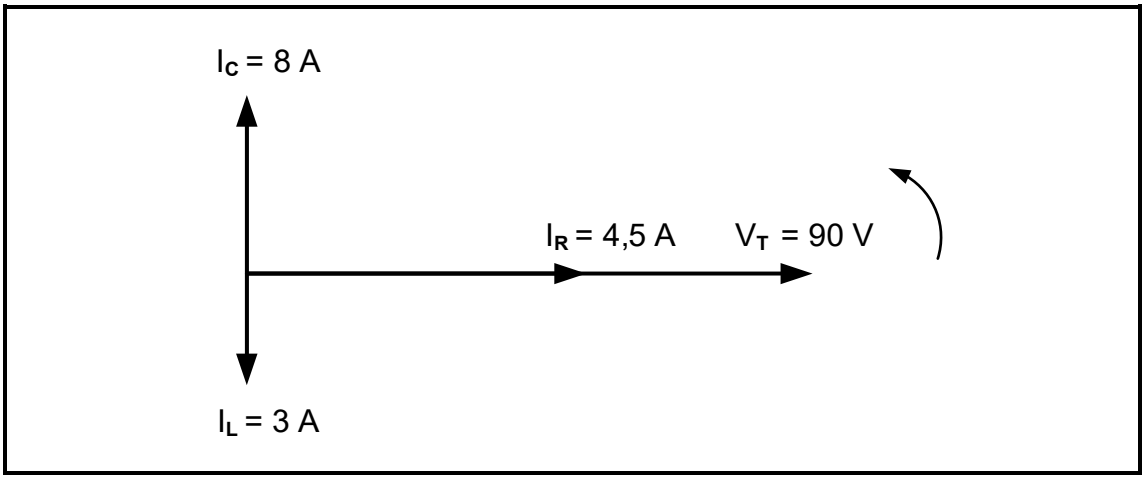


FIGURE 3.4: RLC PARALLEL CIRCUIT PHASOR DIAGRAM

Given:

I_C = 8 A
I_L = 3 A
I_R = 4,5 A
V_T = 90 V
X_C = 11,25 Ω
fr = 150 Hz

Calculate the following:

3.4.1 Inductive reactance (3)

3.4.2 The value of the capacitor if the capacitive reactance is 11,25 Ω (3)

3.4.3 The total current in the circuit (3)

[35]

QUESTION 4: SEMICONDUCTOR DEVICES

4.1 Identify the symbol of the transistor in FIGURE 4.1 below.

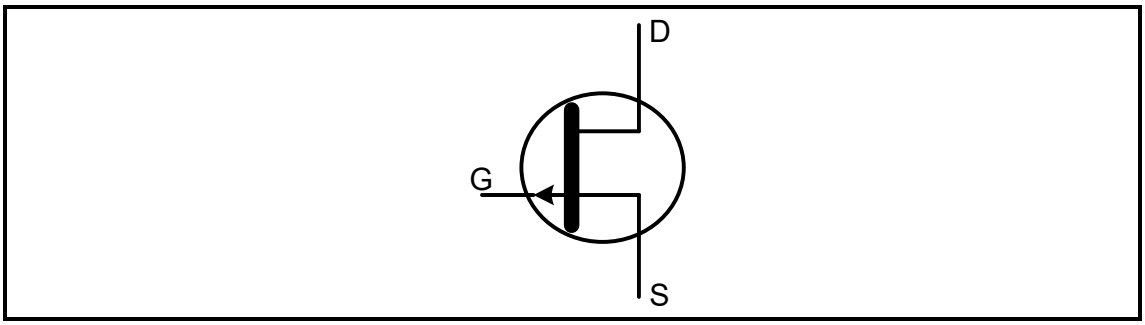


FIGURE 4.1 (2)

4.2 Describe the disadvantage of the JFET construction when comparing it to a MOSFET. (3)

4.3 Refer to FIGURE 4.3 below and answer the questions that follow.

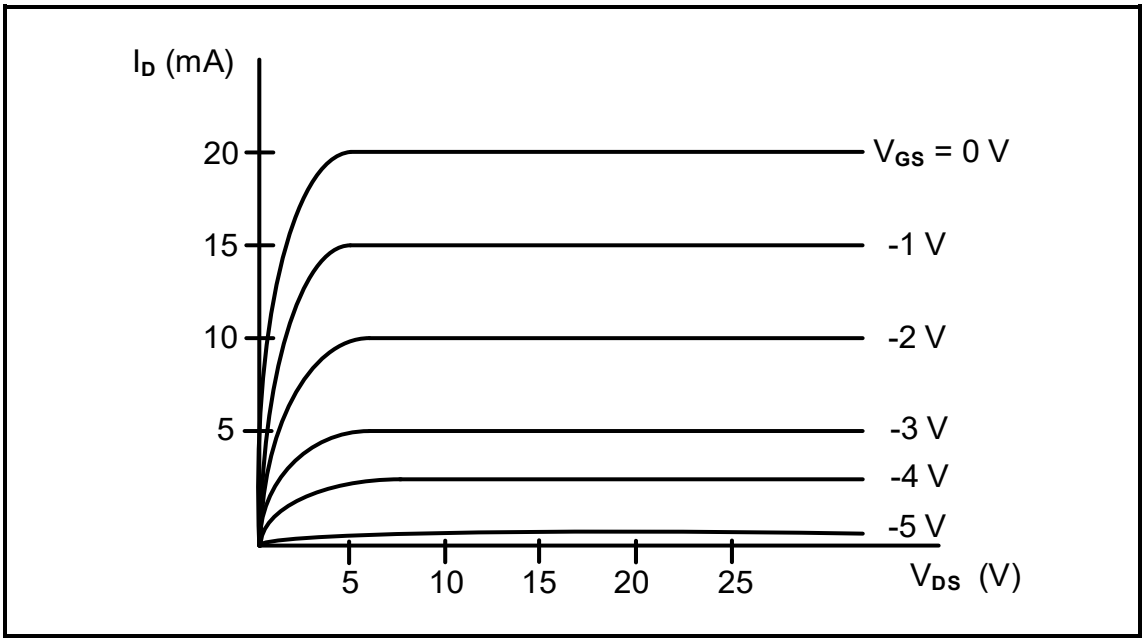


FIGURE 4.3: CHARACTERISTIC CURVE

4.3.1 Identify the characteristic curve in FIGURE 4.3 above. (1)

4.3.2 Explain how the drain current (I_D) will be affected if the gate-source voltage (V_{GS}) is set to -1 V and the drain-source voltage (V_{DS}) is gradually increased to 25 volts. (3)

4.4 State how a very high drain-source voltage (V_{DS}) affects the following:

4.4.1 Channel of the component (1)

4.4.2 Drain current (I_D) (1)

4.5 FIGURE 4.5 below shows an incomplete circuit diagram of an amplifier using a MOSFET. Answer the questions that follow.

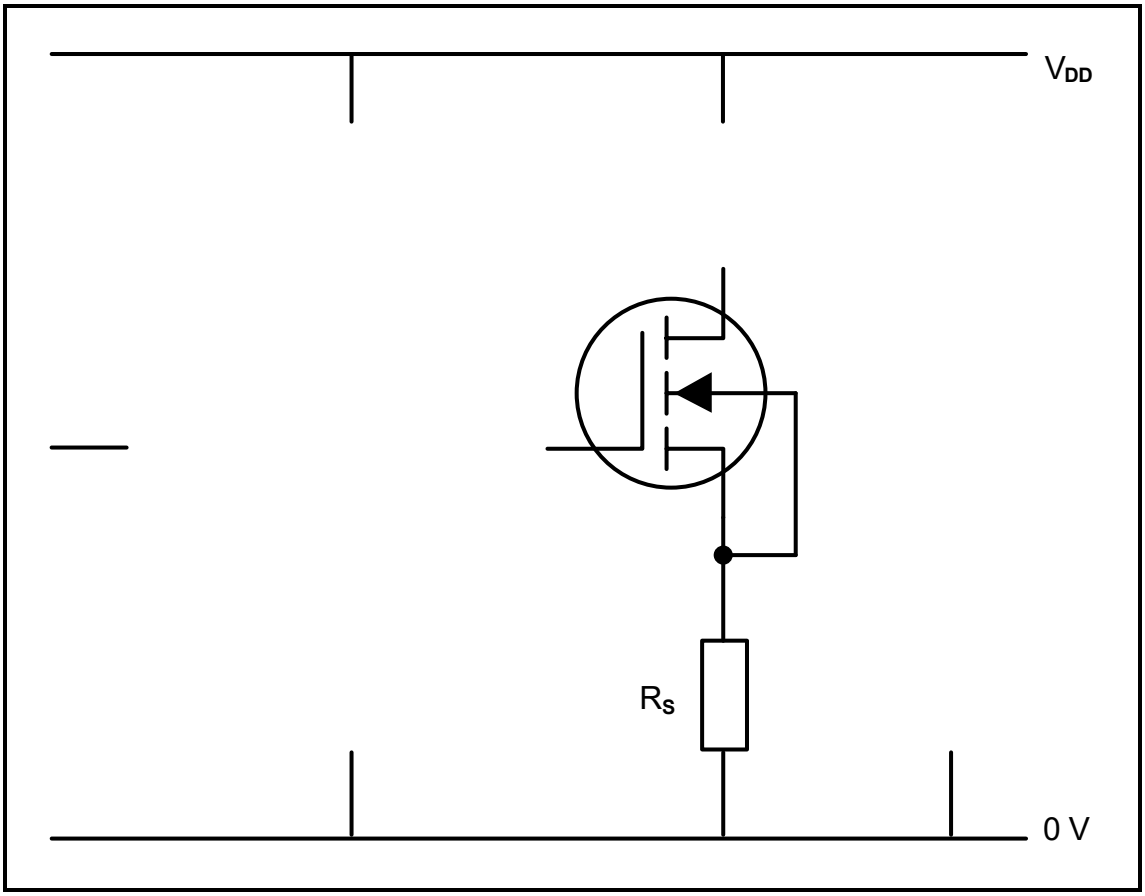


FIGURE 4.5: INCOMPLETE CIRCUIT OF A MOSFET AS AN AMPLIFIER

4.5.1 State TWO modes of operation of the MOSFET. (2)

4.5.2 Complete and fully label the MOSFET amplifier in FIGURE 4.5 above on the ANSWER SHEET for QUESTION 4.5.2. (6)

4.6 Refer to FIGURE 4.6 below and answer the questions that follow.

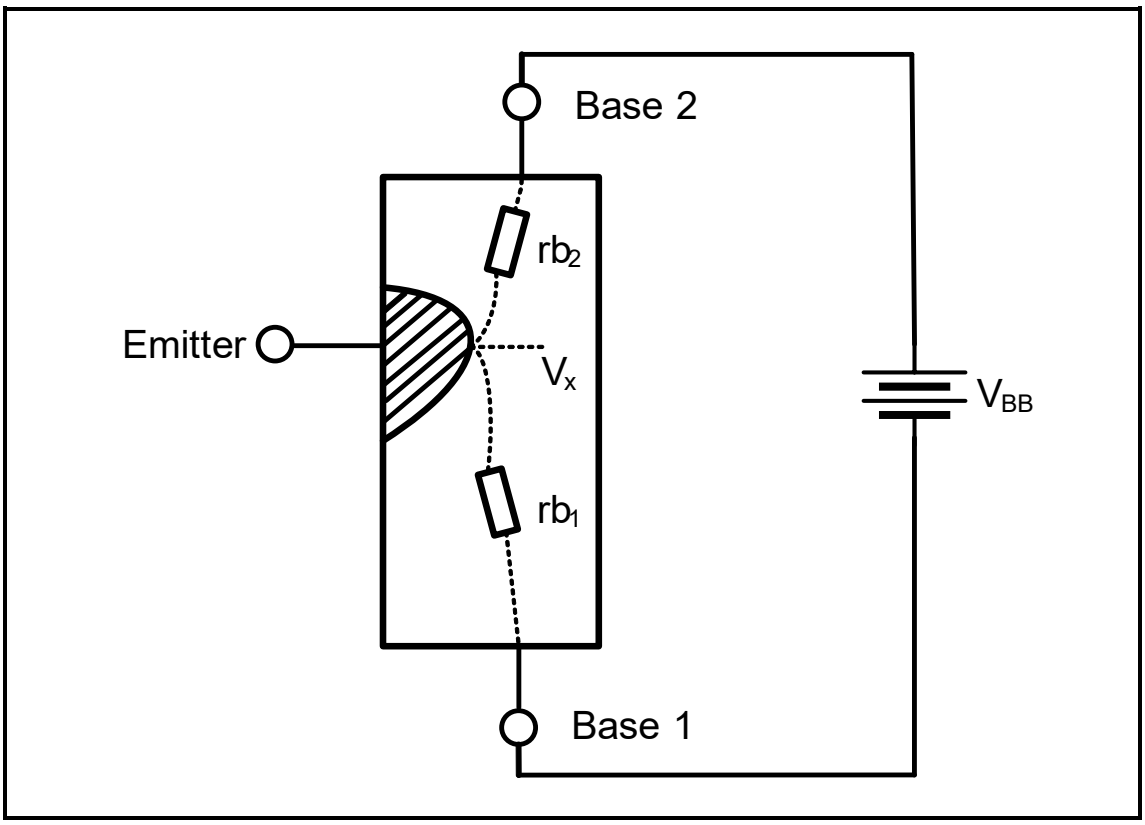


FIGURE 4.6: EQUIVALENT CIRCUIT OF THE UJT

4.6.1 State the purpose of rb_1 and rb_2. (1)

4.6.2 Complete a fully labelled UJT characteristic curve which shows the electrical events that take place at the emitter terminal in FIGURE 4.6 above on the ANSWER SHEET for QUESTION 4.6.2. (5)

4.7 Explain *common-mode rejection ratio* with reference to a 741 op amp. (2)

4.8 Refer to FIGURE 4.8 below and answer the questions that follow.

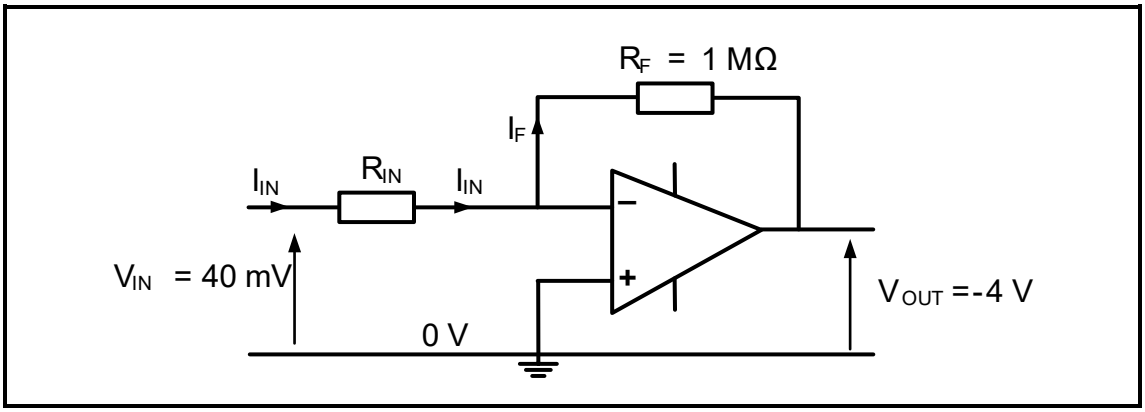


FIGURE 4.8: INVERTING OPERATIONAL AMPLIFIER

Given:

V_{IN} = 40 mV
V_{OUT} = -4 V
R_F = 1 MΩ

4.8.1 Calculate the value of the input resistor (R_{IN}). (3)

4.8.2 State why there is no current flow into the inverting input terminal of the op amp in FIGURE 4.8 above. (1)

4.9 FIGURE 4.9 below shows a non-inverting op amp. Answer the questions that follow.

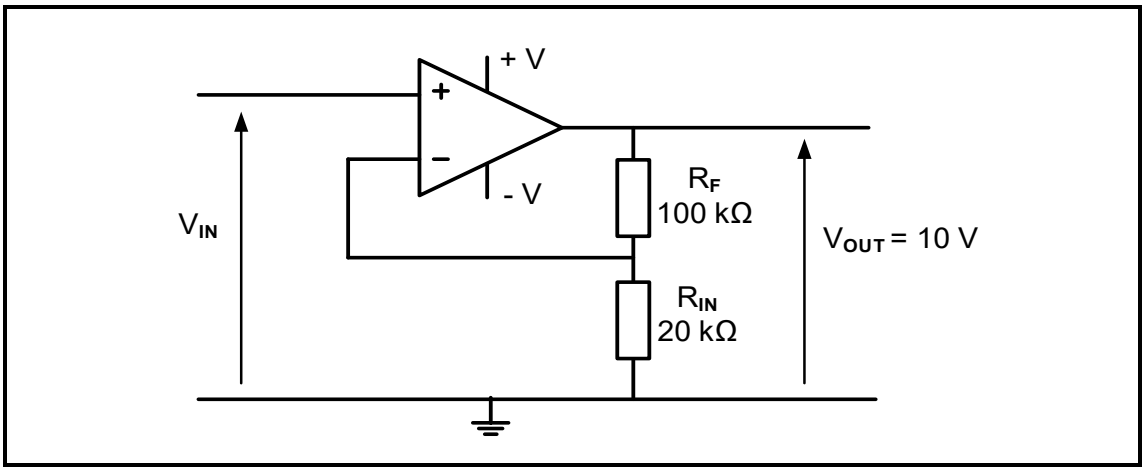


FIGURE 4.9: NON-INVERTING OP AMP

Given:

V_{OUT} = 10 V
R_F = 100 kΩ
R_{IN} = 20 kΩ

4.9.1 Name the component that can be connected between the non-inverting input terminal and the ground in FIGURE 4.9 to maintain DC stability on the op amp. (1)

4.9.2 Calculate the input voltage. (3)

4.10 FIGURE 4.10 below shows the construction layout of a 555 IC. Answer the questions that follow.

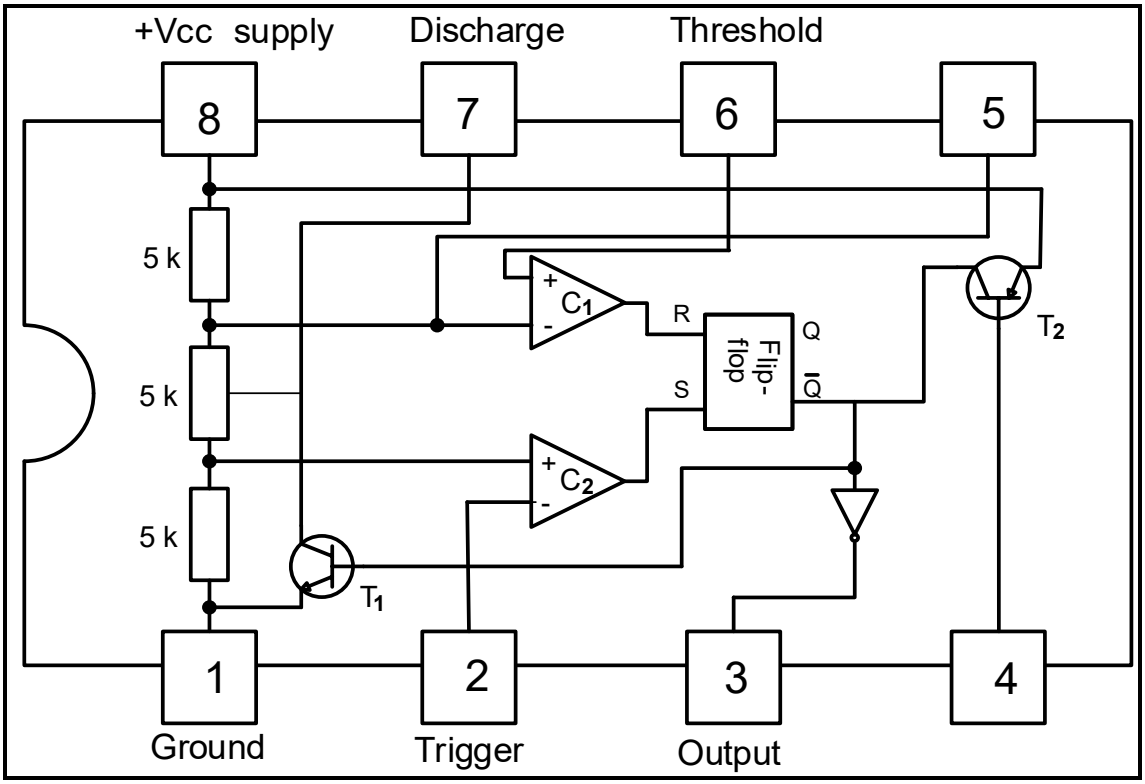


FIGURE 4.10: 555 IC

4.10.1 Label pins **4** and **5**. (2)

4.10.2 Name TWO primary building elements (blocks) of the 555 IC in FIGURE 4.10 above. (2)

4.10.3 State ONE basic application of the 555 IC other than the industrial applications, like temperature measurement and the positioning of servo devices. (1)

4.10.4 Explain the function of transistor T_1 in FIGURE 4.10 above. (2)

4.10.5 Determine the state of the outputs of the following components in FIGURE 4.10 above when the threshold voltage is greater than 2/3 V_{cc} and the trigger voltage is greater than 1/3 V_{cc}:

(a) The comparator C_1 (1)

(b) The comparator C_2 (1)

(c) $\overline{Q}$ of the RS flip-flop (1)

[45]

QUESTION 5: SWITCHING CIRCUITS

5.1 Explain the term *dual voltage supply* with reference to operational amplifiers. (2)

5.2 FIGURE 5.2 below shows a bistable multivibrator using a 555 IC. Answer the questions that follow.

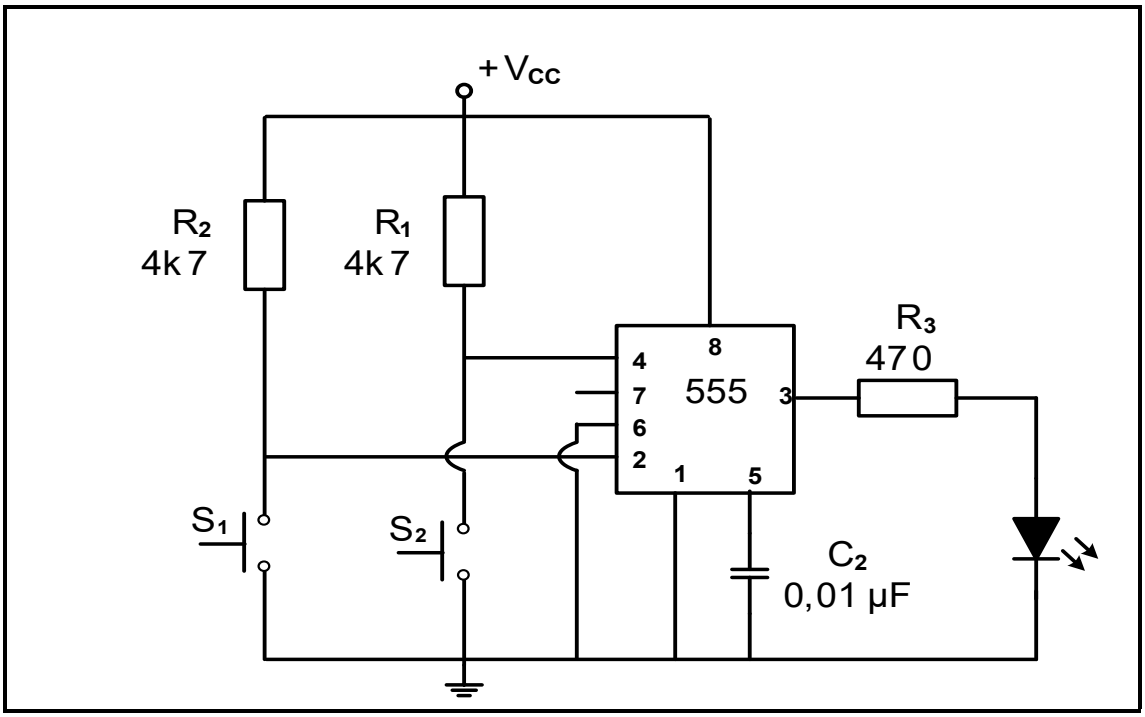


FIGURE 5.2: BISTABLE MULTIVIBRATOR

5.2.1 State the purpose of capacitor C_2. (1)

5.2.2 Explain the operation of the circuit in FIGURE 5.2 above when:

(a) S_1 is pressed (3)

(b) S_2 is pressed while S_1 remains closed (2)

5.2.3 Explain why the output of the circuit remains in a stable state once any of the switches is pressed. (2)

5.3 Refer to FIGURE 5.3 below and answer the questions that follow.

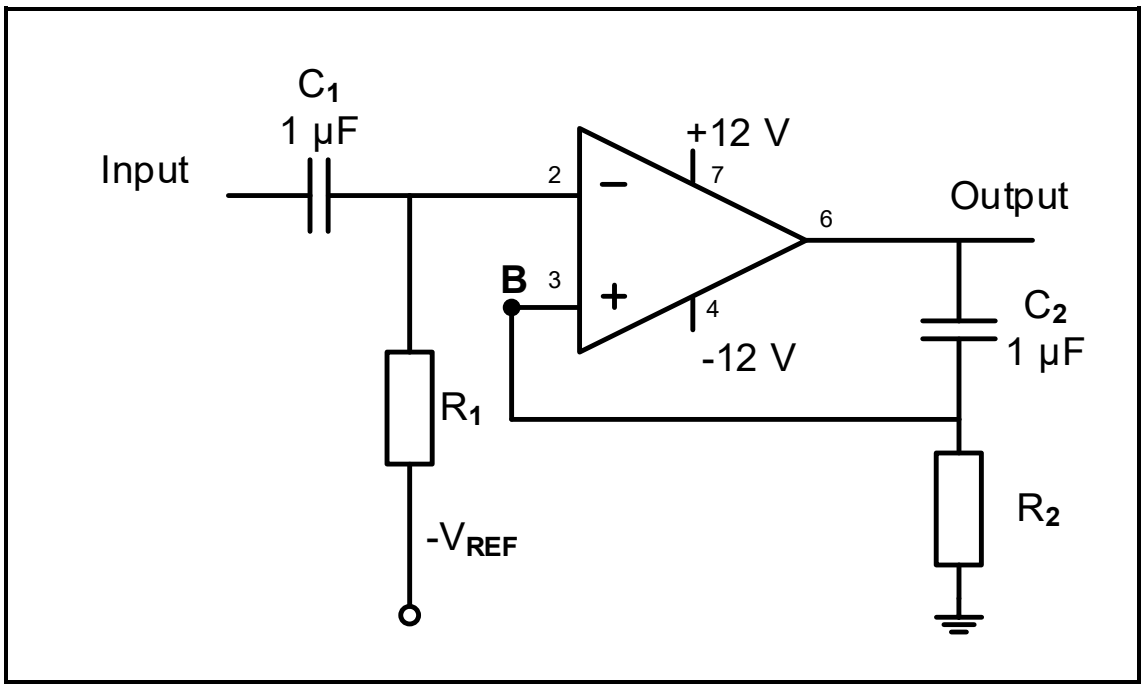


FIGURE 5.3: OP-AMP MONOSTABLE MULTIVIBRATOR CIRCUIT

5.3.1 State the purpose of $-V_{REF}$ in the inverting input during its natural resting condition. (2)

5.3.2 State what the voltage at point **B** will be when capacitor C_2 is fully charged. Motivate your answer. (2)

5.3.3 Refer to FIGURE 5.3.3 below and draw the output on the ANSWER SHEET for QUESTION 5.3.3.

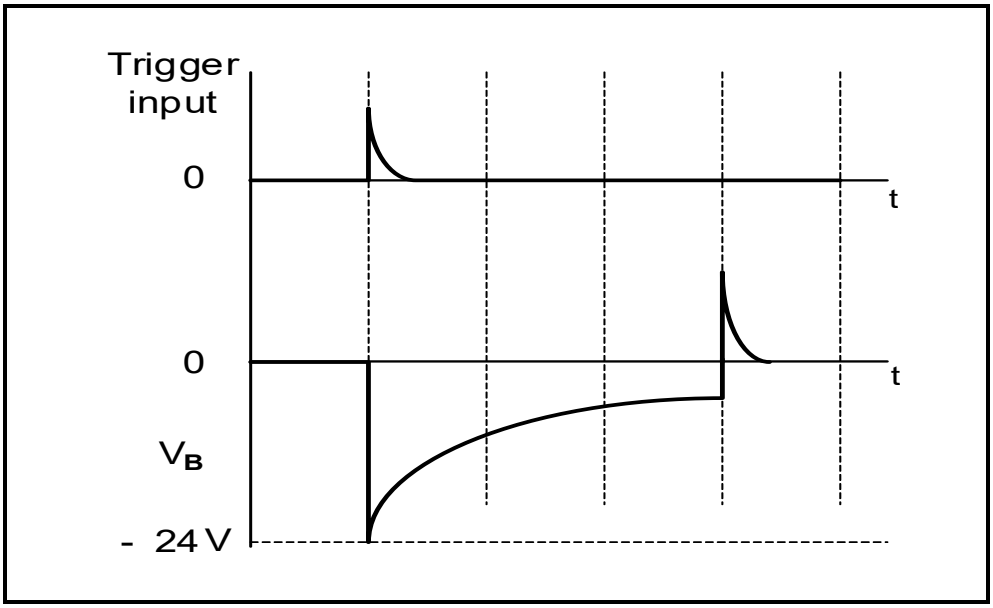


FIGURE 5.3.3: INPUT SIGNALS (4)

5.4 Explain the difference in operation between a 555 *monostable multivibrator* and a 555 *astable multivibrator*. (4)

5.5 FIGURE 5.5 below shows the input and output of a Schmitt trigger. Answer the questions that follow.

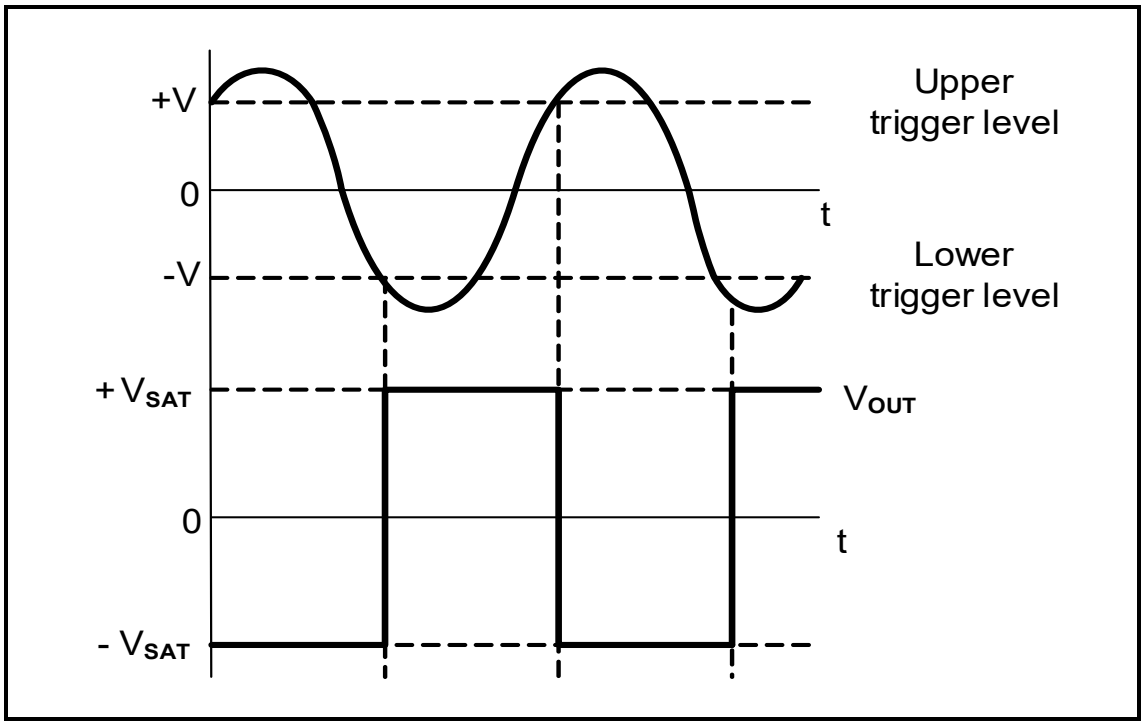


FIGURE 5.5: SCHMITT TRIGGER INPUT AND OUTPUT

5.5.1 State whether the signals provided in FIGURE 5.5 above represent an inverting or non-inverting Schmitt trigger. Motivate your answer. (3)

5.5.2 Complete the circuit diagram of a Schmitt trigger in FIGURE 5.5.2 below on the ANSWER SHEET for QUESTION 5.5.2.

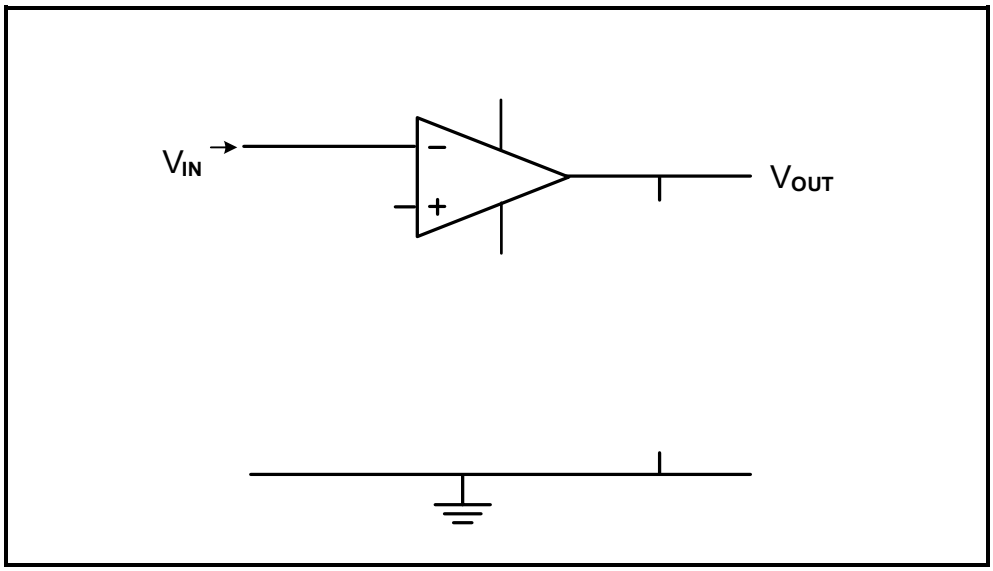


FIGURE 5.5.2: INCOMPLETE SCHMITT TRIGGER CIRCUIT DIAGRAM (5)

5.6 Refer to FIGURE 5.6 below and answer the questions that follow.

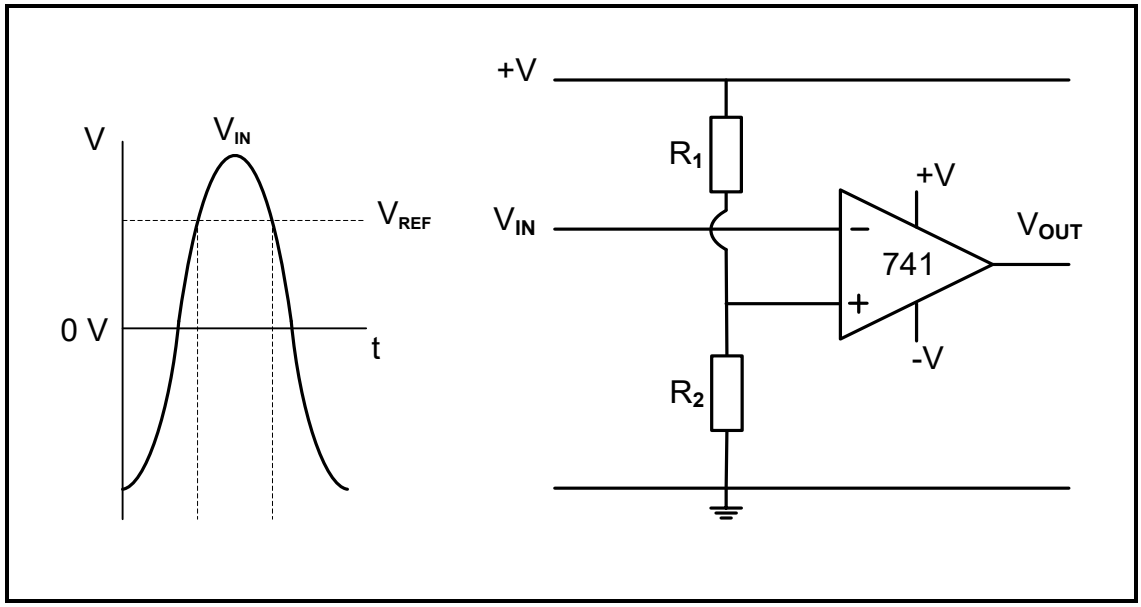


FIGURE 5.6: OP-AMP COMPARATOR

5.6.1 Explain the function of R_1 and R_2 with reference to the input voltage. (2)

5.6.2 Draw the output for the circuit in FIGURE 5.6 above on the ANSWER SHEET for QUESTION 5.6.2. (3)

5.7 Refer to FIGURE 5.7 below where V_2 is 180º out of phase with V_1 and V_3. Answer the questions that follow.

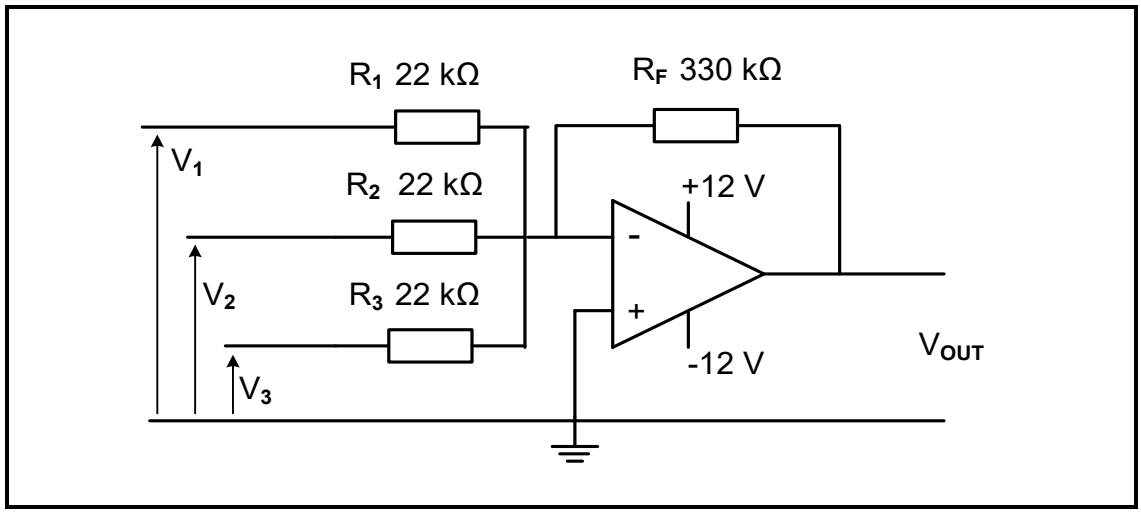


FIGURE 5.7: SUMMING AMPLIFIER

Given:

R_1, R_2, R_3 = 22 kΩ
R_F = 330 kΩ
V_1 = 0,1 V
V_2 = -0,2 V
V_3 = 0,3 V

Calculate the:

5.7.1 Gain of the amplifier (3)

5.7.2 Output voltage (3)

5.7.3 Output voltage if V_2 is changed to be in phase with V_1 and V_3 (3)

5.8 Refer to FIGURE 5.8 below and answer the questions that follow.

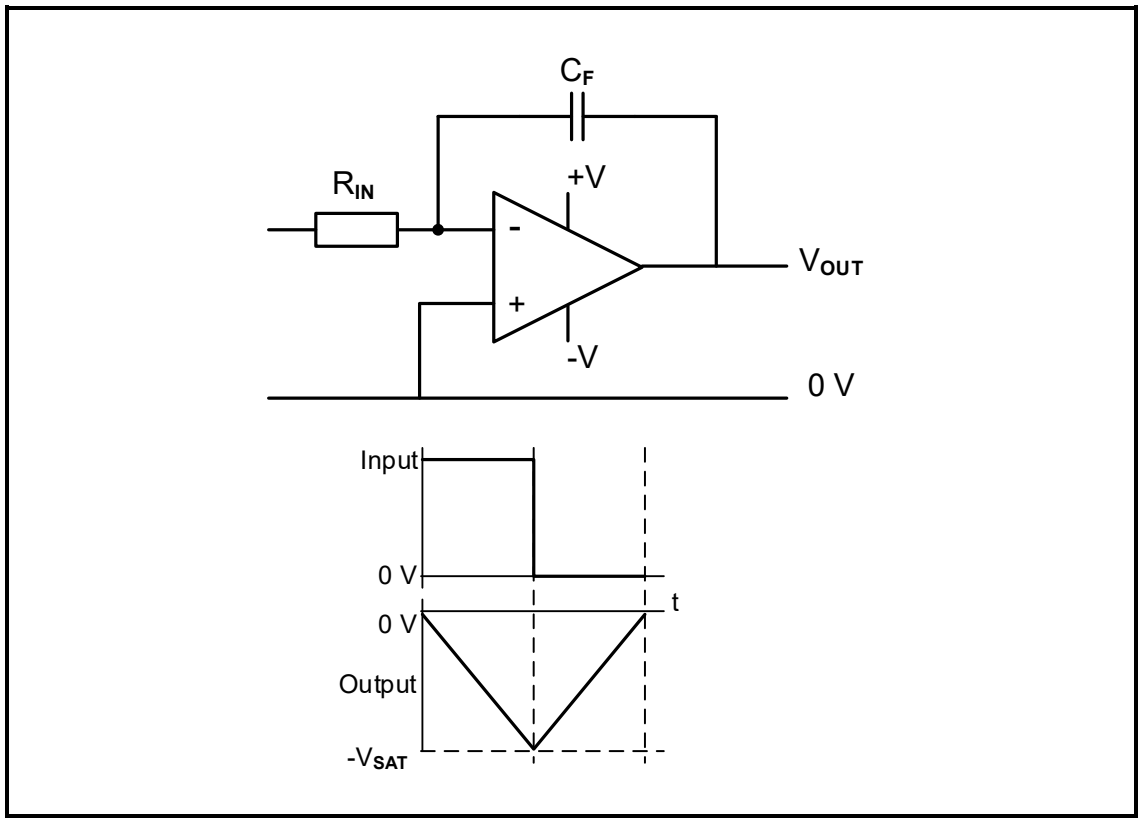


FIGURE 5.8: OP-AMP INTEGRATOR CIRCUIT

5.8.1 Name TWO key operating principles of the op-amp integrator circuit in FIGURE 5.8 above when a square wave is applied. (2)

5.8.2 Draw the output signal on the ANSWER SHEET for QUESTION 5.8.2 if the RC time constant is made shorter. (4)
[50]

QUESTION 6: AMPLIFIERS

6.1 Name ONE broad category of transistor amplifiers. (1)

6.2 Refer to FIGURE 6.2 below and answer the questions that follow.

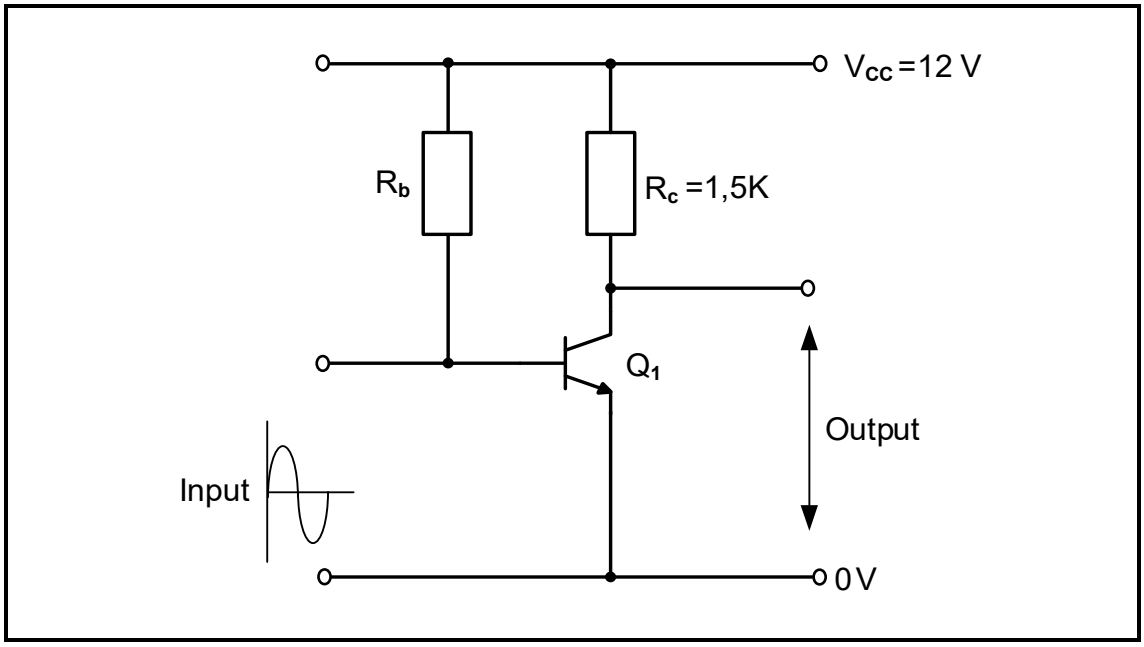


FIGURE 6.2: TRANSISTOR BIASING

6.2.1 Name the region at which transistor Q_1 operates as an amplifier in FIGURE 6.2 above. (1)

6.2.2 Calculate the value of the maximum collector current (I_{Cmax}) when the transistor is biased to its extreme ON state in FIGURE 6.2 and the supply voltage (V_{cc}) is reduced from 12 V to 8 V. (3)

6.2.3 Draw the output waveform for FIGURE 6.2 above on the ANSWER SHEET for QUESTION 6.2.3. (3)

6.3 Refer to FIGURE 6.3 below and answer the questions that follow.

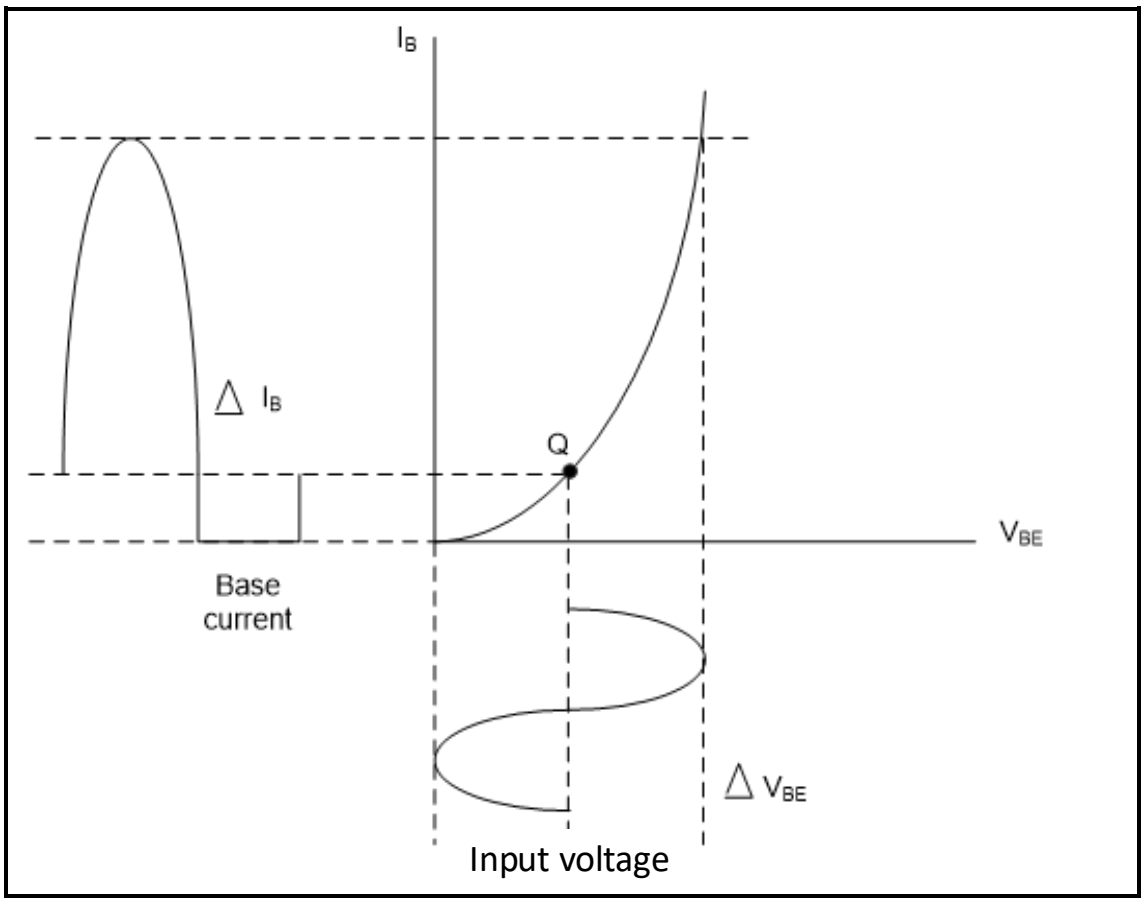


FIGURE 6.3: CHARACTERISTIC CURVE

6.3.1 Name the class of amplification represented in FIGURE 6.3 above. (1)

6.3.2 State whether FIGURE 6.3 above represents the input or the output characteristic curve. Motivate your answer. (3)

6.4 Name TWO advantages of negative feedback applied in amplifiers. (2)

6.5 Explain the term *negative feedback* with reference to amplifiers. (2)

6.6 The signal to a TV receiver is 150 mV, but to create a high contrast picture it needs to produce a 15 V signal. Calculate the receiver's voltage gain in decibels. (3)

6.7 Refer to FIGURE 6.7 below and answer the questions that follow.

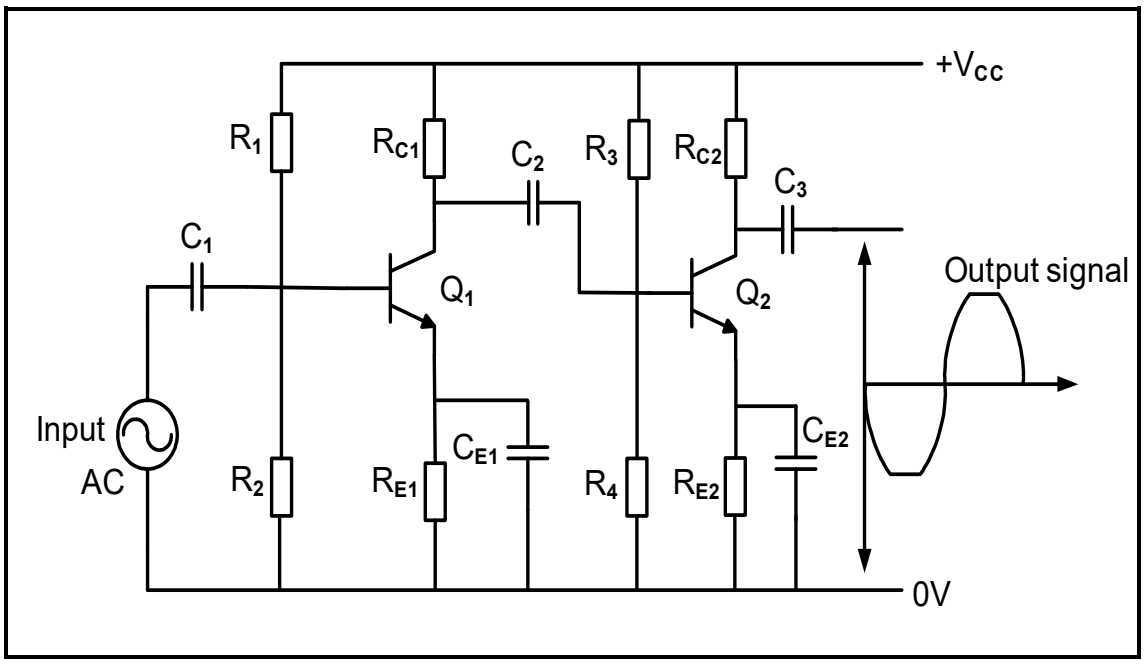


FIGURE 6.7: TWO-STAGE RC-COUPLED AMPLIFIER

6.7.1 Name TWO factors that caused distortion at the output signal. (2)

6.7.2 Explain why a transistor connected in common emitter configuration is commonly used as an amplifier. (3)

6.7.3 State TWO functions of the collector resistors (R_{C1} and R_{C2}) in FIGURE 6.7 above. (2)

6.8 FIGURE 6.8 below shows the circuit of a radio-frequency amplifier. Answer the questions that follow.

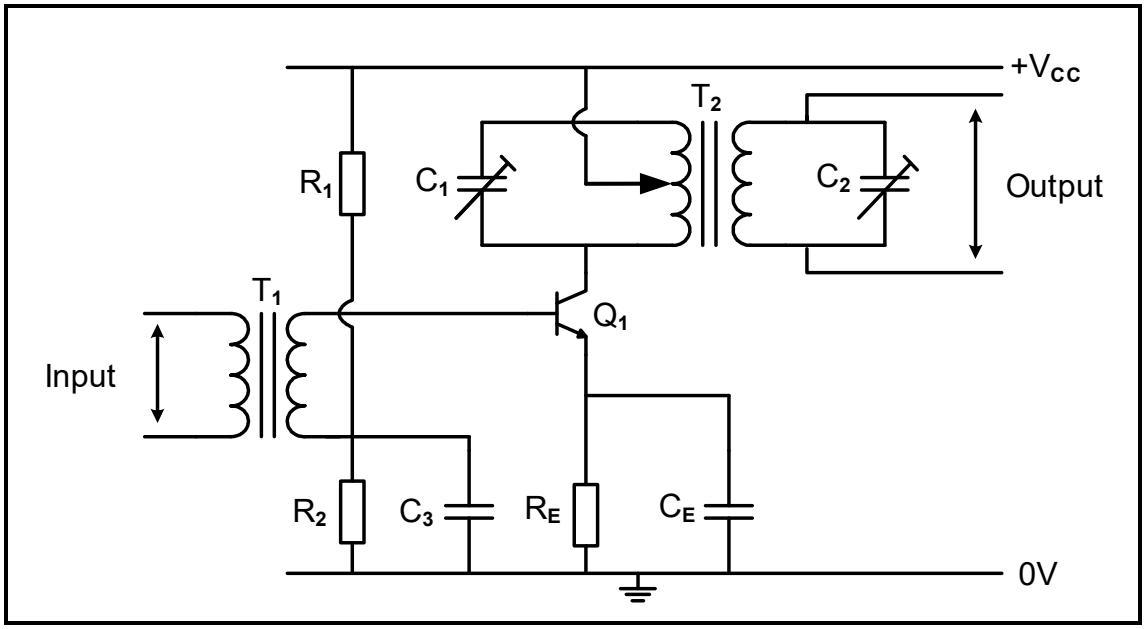


FIGURE 6.8: RADIO-FREQUENCY AMPLIFIER

6.8.1 State the function of capacitors C_1 and C_2, and transformer T_2 in FIGURE 6.8 above. (1)

6.8.2 Explain the purpose of capacitor C_E in FIGURE 6.8 above. (1)

6.8.3 Draw a fully labelled frequency response curve of a radio-frequency amplifier on the ANSWER SHEET for QUESTION 6.8.3. (4)

6.9 Refer to FIGURE 6.9 below and answer the questions that follow.

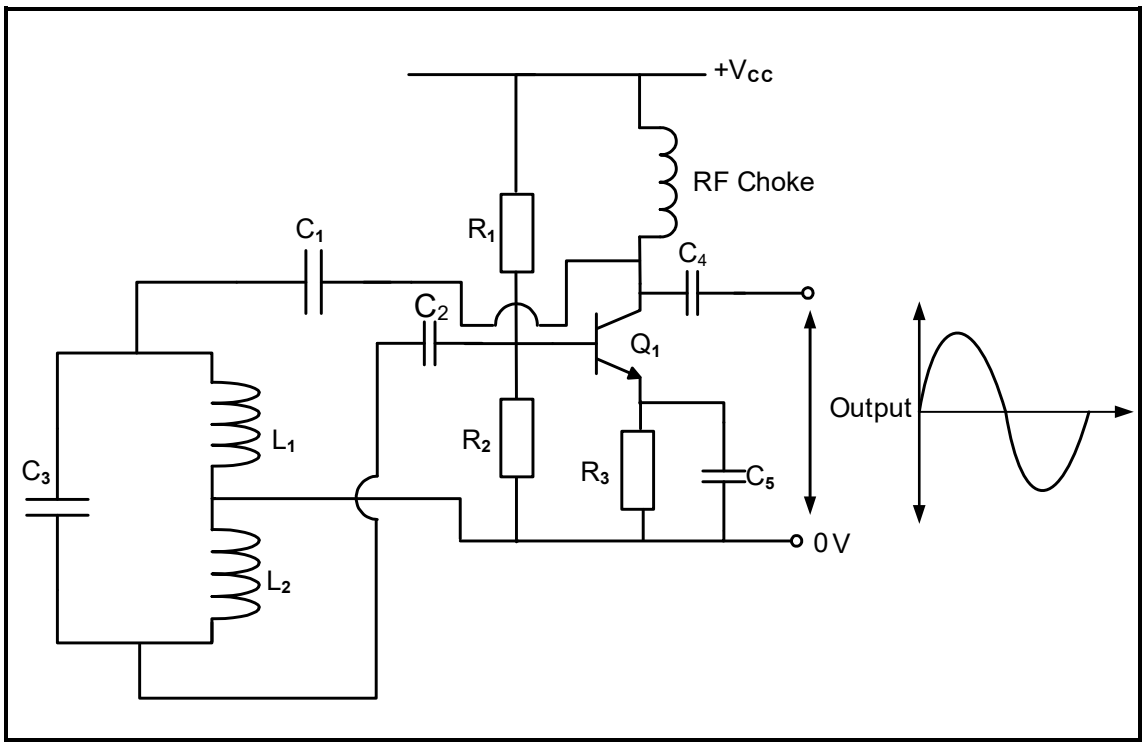


FIGURE 6.9: HARTLEY OSCILLATOR

6.9.1 Explain why the collector resistor was replaced by a radio-frequency choke in FIGURE 6.9 above. (1)

6.9.2 Describe how the Hartley oscillator provides feedback to sustain oscillation. (3)

6.10 FIGURE 6.10 below shows the circuit of a RC phase-shift oscillator. Answer the questions that follow.

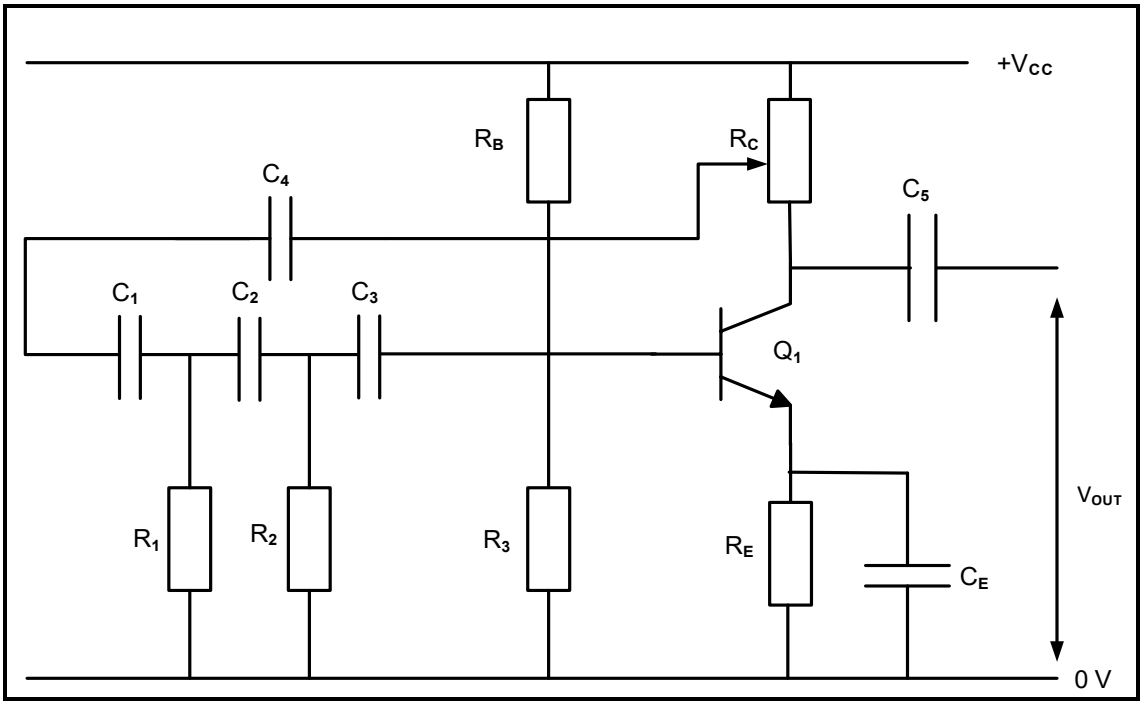


FIGURE 6.10: RC PHASE-SHIFT OSCILLATOR

6.10.1 Name ONE application of the RC phase-shift oscillator. (1)

6.10.2 Briefly explain the operation of the RC phase-shift oscillator in FIGURE 6.10 above. (6)

6.10.3 Explain how the RC phase-shift oscillator differs from the Colpitts oscillator with reference to their feedback circuit. (2)
[45]

TOTAL: 200

Copyright reserved

FORMULA SHEET

RLC CIRCUITS

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

$X_L = 2\pi fL$

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

$$f_r = \frac{1}{2\pi\sqrt{LC}} \quad \textbf{OR} \quad f_r = \frac{f_2 + f_1}{2}$$

$$BW = \frac{f_r}{Q} \quad \textbf{OR} \quad BW = f_2 - f_1$$

SERIES

$V_R = I R$

$V_L = I X_L$

$V_C = I X_C$

$$I_T = \frac{V_T}{Z} \quad \textbf{OR} \quad I_T = I_R = I_C = I_L$$

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

$$V_T = \sqrt{V_R{}^2 + (V_L - V_C)^2} \quad \textbf{OR} \quad V_T = I Z$$

$$\text{Cos}\ \theta = \frac{R}{Z} \ \textbf{OR}\ \text{Cos}\ \theta = \frac{V_R}{V_T} \ \textbf{OR}\ \text{Tan}\ \theta = \frac{V_L - V_C}{V_R}$$

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

PARALLEL

$V_T = V_R = V_L = V_C$

$$I_R = \frac{V_T}{R}$$

$$I_C = \frac{V_T}{X_C}$$

SEMICONDUCTOR DEVICES

$$\text{Gain}\ A_V = \frac{V_{OUT}}{V_{IN}} = -\frac{R_F}{R_{IN}} \quad \textbf{OR} \quad A_V = 1 + \frac{R_F}{R_{IN}}$$

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

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

SWITCHING CIRCUITS

$$V_{OUT} = -\left(V_1\frac{R_F}{R_1} + V_2\frac{R_F}{R_2} + \ldots V_N\frac{R_F}{R_N}\right)$$

$$\text{Gain}\ A_V = \frac{V_{OUT}}{V_{IN}} = \frac{V_{OUT}}{(V_1 + V_2 + \ldots V_N)}$$

$$V_{OUT} = -\ (V_1 + V_2 + \ldots V_N)$$

$$V_{FB} = V_{SAT} \times \frac{R_2}{R_1 + R_2}$$

$$V_{TRIG} = V_{OUT} \times \frac{R_2}{R_1 + R_2}$$

AMPLIFIERS

$$I_C = \frac{V_C}{R_C} \qquad V_{CC} = V_{CE} + I_C R_C$$

$V_B = V_{BE} + V_{RE}$

$$A_V = \frac{V_{OUT}}{V_{IN}}$$

$$A_I = \frac{I_{OUT}}{I_{IN}}$$

$$A_P = \frac{P_{OUT}}{P_{IN}} \quad \textbf{OR} \quad A_P = A_V \times A_I$$

$\beta_T = \beta_1 \times \beta_2$ **OR**

$$A_{VT} = A_{V1} \times A_{V2} \times A_{V3} \times \ldots A_{Vn}$$

$$P_{IN} = I^2 \times Z_{IN} \quad \textbf{AND} \quad P_{OUT} = I^2 \times Z_{OUT}$$

$$V_1 = \frac{R_1}{R_1 + R_2} \times V_{CC} \qquad V_2 = \frac{R_2}{R_1 + R_2} \times V_{CC}$$

Copyright reserved

$$I_L = \frac{V_T}{X_L}$$

$$I_T = \sqrt{I_R^2 + (I_C - I_L)^2}$$

$$Z = \frac{V_T}{I_T}$$

$$\text{Cos } \theta = \frac{I_R}{I_T}$$

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

OSCILLATION FREQUENCY

$$f_o = \frac{1}{2 \times \pi \sqrt{LC_T}} \quad \textbf{OF} \quad f_o = \frac{1}{2 \times \pi \sqrt{6} RC}$$

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

GAIN IN DECIBELS

$$A_I = 20\log_{10} \frac{I_{OUT}}{I_{IN}}$$

$$A_V = 20\log_{10} \frac{V_{OUT}}{V_{IN}} \quad \textbf{OR} \quad A_V = 20\log_{10} A_{VT}$$

$$A_P = 10\log_{10} \frac{P_{OUT}}{P_{IN}} \quad \textbf{OR} \quad A_P = 10\log_{10} \frac{P_2}{P_1}$$

Copyright reserved

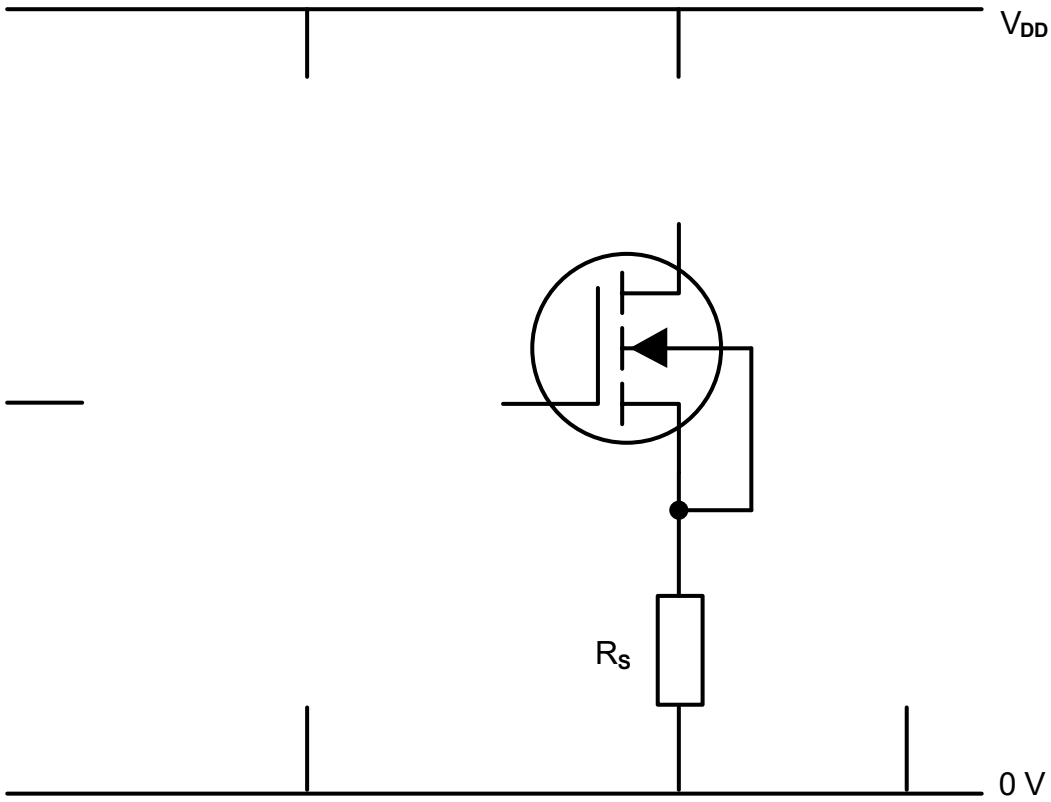
CENTRE NUMBER:							

EXAMINATION NUMBER:													

ANSWER SHEET

QUESTION 4: SEMICONDUCTOR DEVICES

4.5.2



Transfer mark to answer book

MOD

FIGURE 4.5.2 (6)

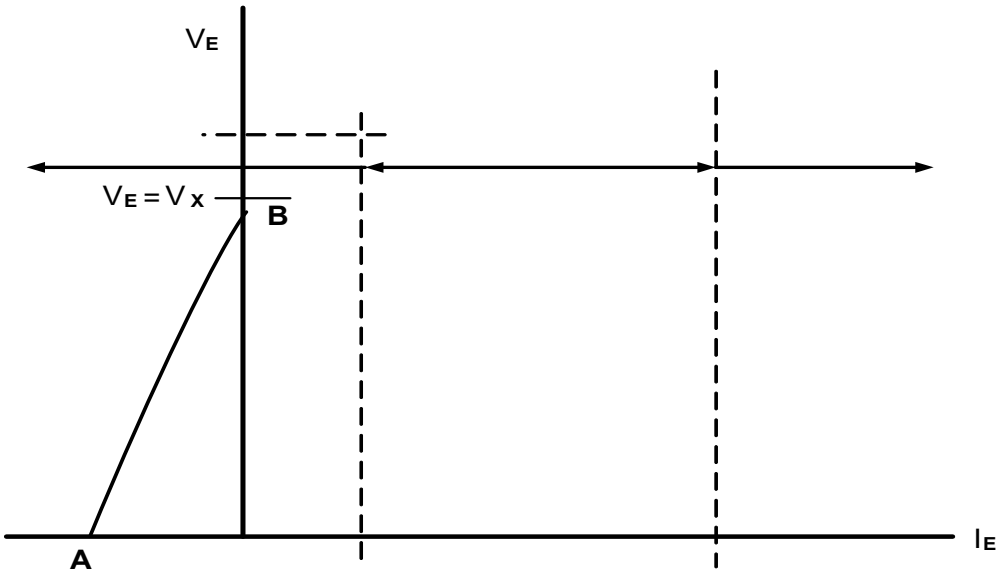
Copyright reserved

CENTRE NUMBER:							

EXAMINATION NUMBER:													

ANSWER SHEET

4.6.2



Transfer mark to answer book

MOD

FIGURE 4.6.2 (5)

Copyright reserved

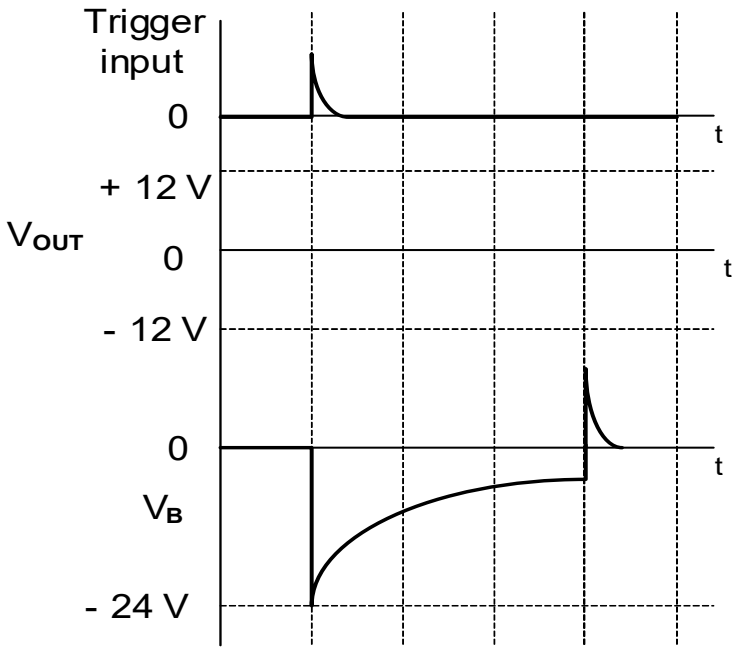
CENTRE NUMBER:							

EXAMINATION NUMBER:													

ANSWER SHEET

QUESTION 5: SWITCHING CIRCUITS

5.3.3

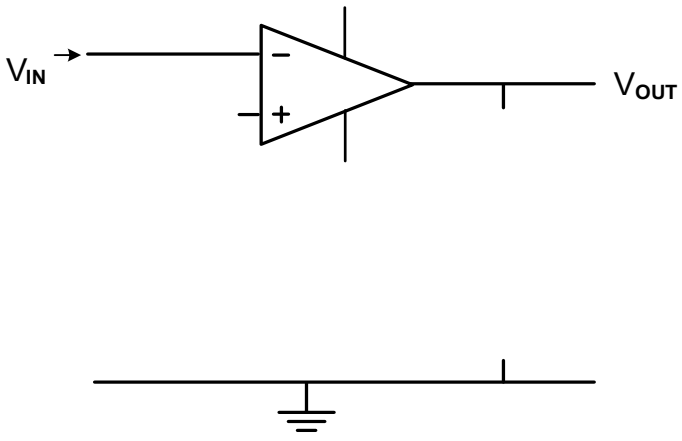


Transfer mark to answer book

MOD

FIGURE 5.3.3 (4)

5.5.2



Transfer mark to answer book

MOD

FIGURE 5.5.2 (5)

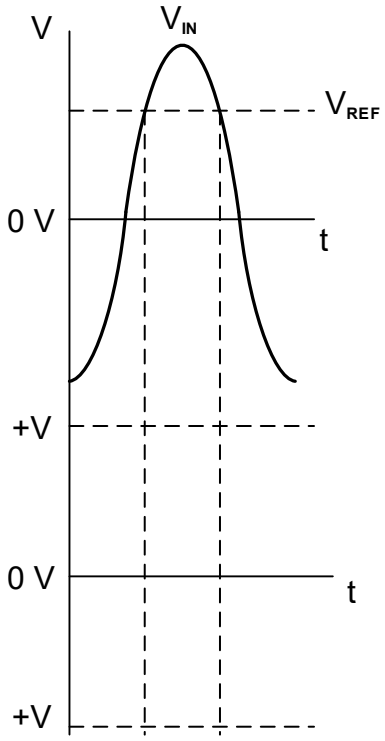
Copyright reserved

CENTRE NUMBER:							

EXAMINATION NUMBER:													

ANSWER SHEET

5.6.2

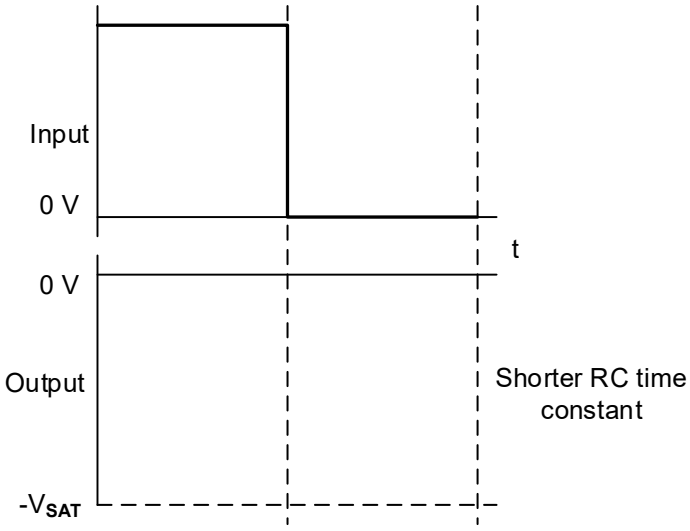


Transfer mark to answer book

MOD

FIGURE 5.6.2 (3)

5.8.2



Transfer mark to answer book

MOD

FIGURE 5.8.2 (4)

Copyright reserved

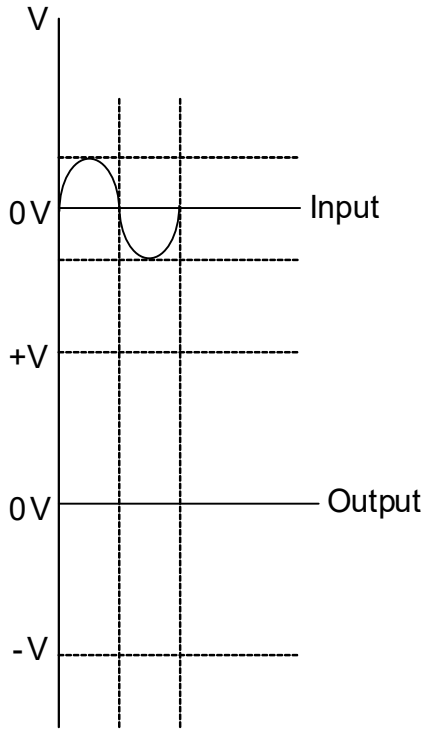
CENTRE NUMBER:							

EXAMINATION NUMBER:													

ANSWER SHEET

QUESTION 6: AMPLIFIERS

6.2.3



Transfer mark to answer book

MOD

FIGURE 6.2.3 (3)

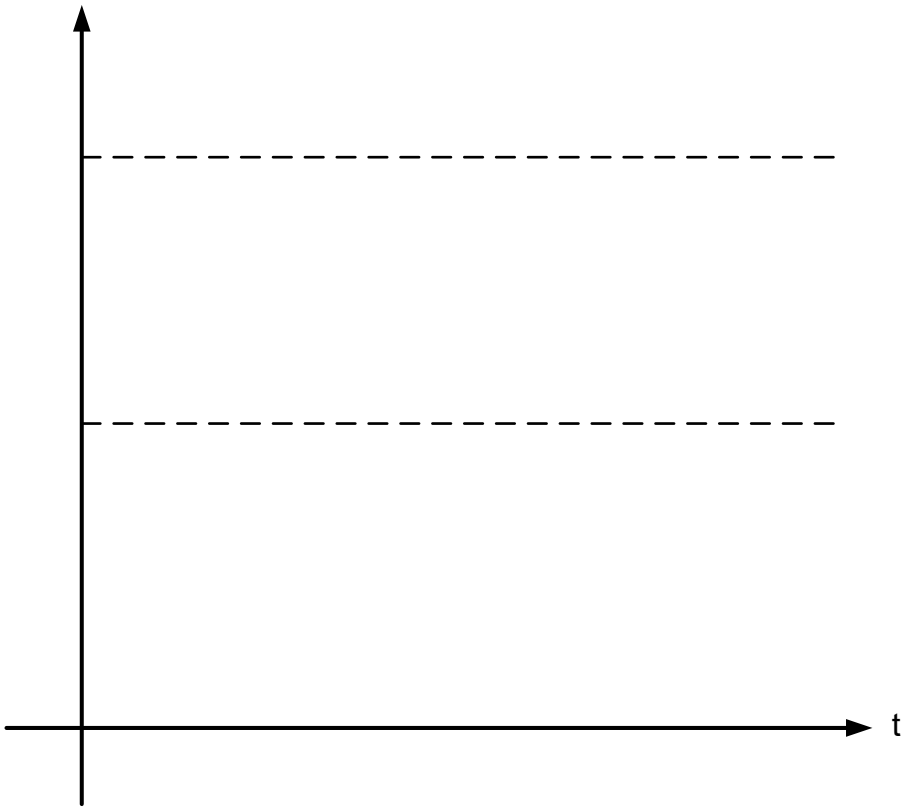
Copyright reserved

CENTRE NUMBER:							

EXAMINATION NUMBER:													

ANSWER SHEET

6.8.3



Transfer mark to answer book

MOD

FIGURE 6.8.3 (4)

Copyright reserved