basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

SENIOR CERTIFICATE EXAMINATION / NATIONAL SENIOR CERTIFICATE EXAMINATION

ELECTRICAL TECHNOLOGY: ELECTRONICS

2021

POINTS: 200

TIME: 3 hours

This question paper consists of 22 pages, a 1-page formula sheet and 4 answer sheets.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of FIVE questions.

2. Answer ALL the questions.

3. Answer the following questions on the attached ANSWER SHEETS:

   QUESTIONS 4.2.4, 4.7.1 and 4.7.2
   QUESTIONS 5.9.3 and 5.10.6

4. Write your CENTER NUMBER and EXAMINATION NUMBER on each ANSWER SHEET and submit it with your ANSWER BOOK, even if you have not used it.

5. Sketches and diagrams must be large, neat and COMPLETELY NOMINATED.

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 the following:

   9.1. Formulas and manipulations where necessary

   9.2 Correct replacement of values

   9.3 Correct answers and relevant units where applicable

10. A formula sheet is attached at the end of this question paper.

11. Write neatly and legibly.

QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY

1.1 Define the term *safe* with reference to the Occupational Health and Safety Act, 1993 (Act 85 of 1993). (1)

1.2 Name TWO characteristics or moral principles that are related to work ethic. (2)

1.3 Name ONE category / example of a dangerous practice in a workshop. (1)

1.4 Explain why poor ventilation is an unsafe condition in a workshop. (2)

1.5 Name TWO general duties of employees in the workplace. (2)

1.6 Explain the need for human rights in the workplace. (2)
[10]

QUESTION 2: RLC CIRCUITS

2.1 Define the following terms with reference to RLC circuits:

2.1.1 Phase angle (2)

2.1.2 Capacitance (1)

2.2 Explain the effect that Lenz's law has on an inductor connected in an RLC circuit across an alternating supply voltage. (2)

2.3 The RLC series circuit in FIGURE 2.3 below consists of a resistor with a resistance of 30 Ω, an inductor with an inductance of 300 mH and a capacitor with a capacitive reactance of 30.32 Ω. The components are all connected across the supply voltage of 80 V / 60 Hz-WS with a total current of 2.55 A flowing through the circuit. Answer the questions that follow.

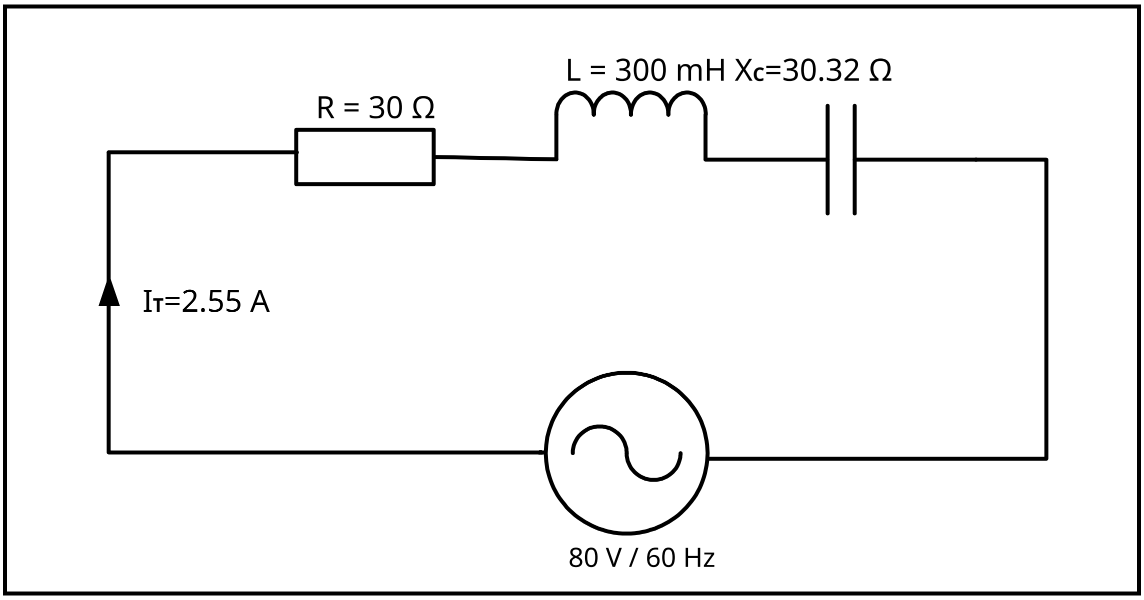


FIGURE 2.3: RLC SERIES CIRCLE

Gave:

R = 30 Ω
L = 300 mH
X_C = 30.32 Ω
I_T = 2.55 A
V_T = 80 V
f = 60 Hz

2.3.1 Calculate the inductive reactance of the circuit. (3)

2.3.2 Calculate the total impedance of the circuit. (3)

2.3.3 State whether the circuit is capacitive or inductive. Give a reason to motivate your answer. (2)

2.4 FIGURE 2.4 below shows a parallel RLC circuit consisting of a 75 Ω resistor, an inductor with unknown inductance value and a capacitor with a capacitive reactance of 50 Ω which are all connected across a 300 V-AC supply voltage is. The current flow through the resistor is 4 A and the current flow through the inductor is 3 A. Answer the questions that follow.

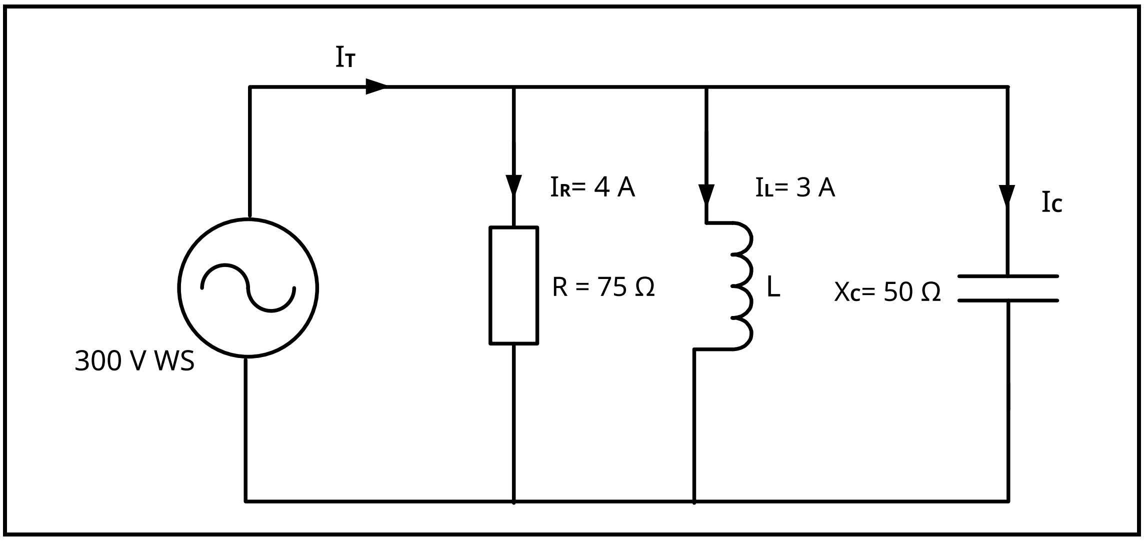


FIGURE 2.4: PARALLEL RLC CIRCUIT

Gave:

V_T = 300 V-WS
X_C = 50 Ω
R = 75 Ω
I_R = 4 A
I_L = 3 A

2.4.1 Calculate the value of the current through the capacitor. (3)

2.4.2 Calculate the value of the inductive reactance. (3)

2.4.3 Calculate the value of the total current. (3)

2.4.4 Calculate the phase angle. (3)

2.5 Refer to FIGURE 2.5 below and answer the questions that follow.

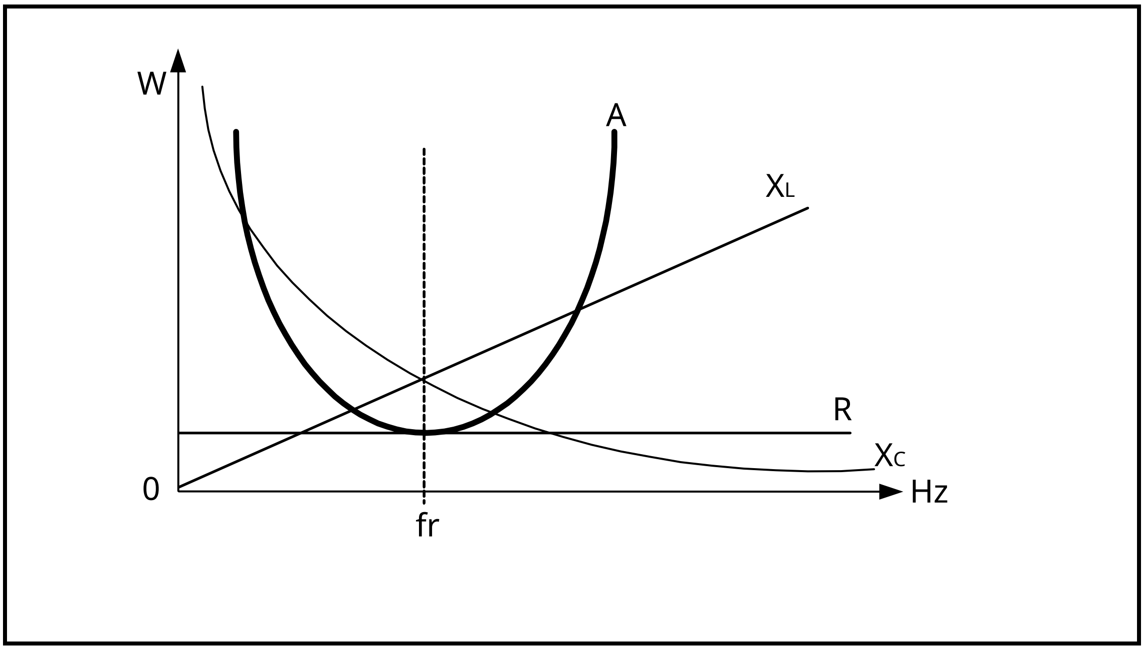


FIGURE 2.5: RESONANCE RELEASE CURVES

2.5.1 Name the version week curve used by **A** proposed. (1)

2.5.2 Compare the magnitude of the reactance values (X_L and X_C) below the resonant frequency. (2)

2.5.3 Explain why the inductive reactance in FIGURE 2.5 is represented by a straight line and the capacitive reactance is represented by a curved line. (2)

2.5.4 Calculate the resonant frequency of an RLC series circuit with the following component values: a resistor with a resistance of 20 Ω, a capacitor with a capacitance of 1.47 μF and an inductor with an inductance of 2.12 H which An AC supply is connected.

Gave:

R = 20 Ω
C = 1.47 μF
L = 2.12 H (3)

2.5.5 Name ONE application of the circuit in QUESTION 2.5.4. (1)

2.6 Refer to FIGURE 2.6 below and answer the questions that follow.

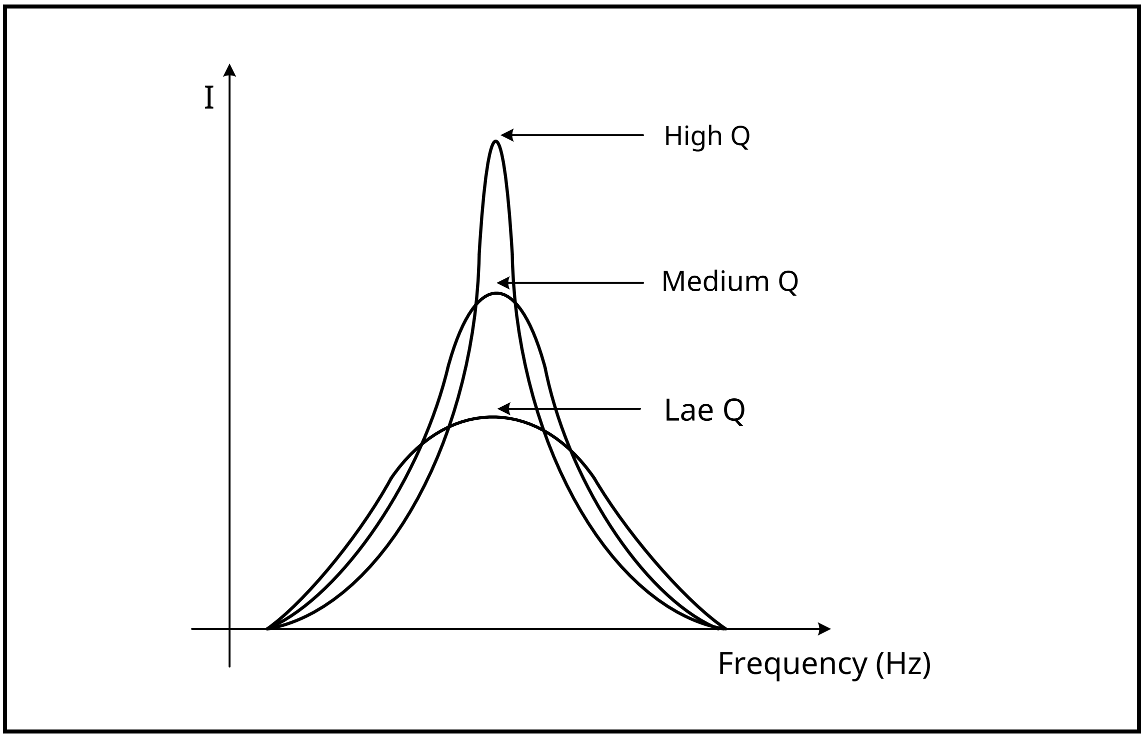


FIGURE 2.6: FREQUENCY VERSION CURVES

2.6.1 Explain how the value of the Q factor affects the value of the current. (1)

2.6.2 Define the term *half power points*. (1)

2.6.3 When selecting a component, name TWO factors that determine the quality factor of the circuit. (2)

2.6.4 Describe what happens to the selectivity and bandpass frequencies as the Q factor is reduced in FIGURE 2.6. (2)

[40]

QUESTION 3: SEMICONDUCTOR DEVICES

3.1 Name ONE type of field effect transistor (VET). (1)

3.2 Refer to FIGURE 3.2 below and answer the questions that follow.

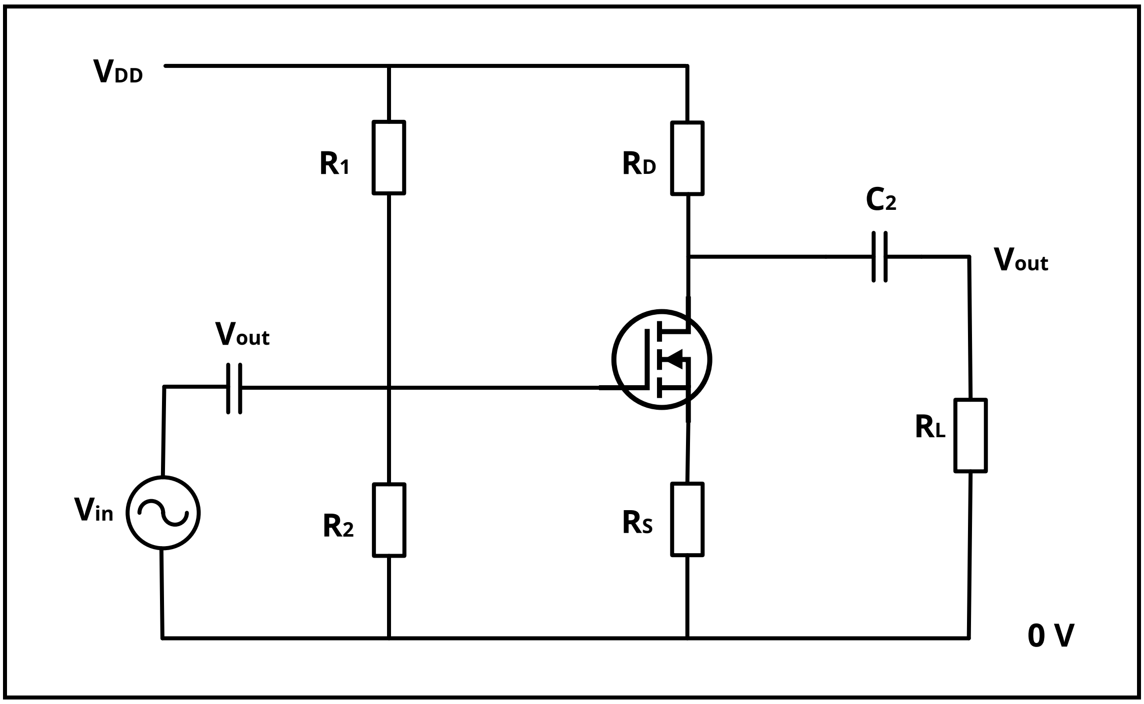


FIGURE 3.2: FAT AS AN AMPLIFIER

3.2.1 Identify the type of MOSVET used in this circuit. (2)

3.2.2 Name ONE application of a MOSVET other than an amplifier. (1)

3.3 FIGURE 3.3 below shows the incomplete characteristic curve of a single-junction transistor (EVT). Answer the questions that follow.

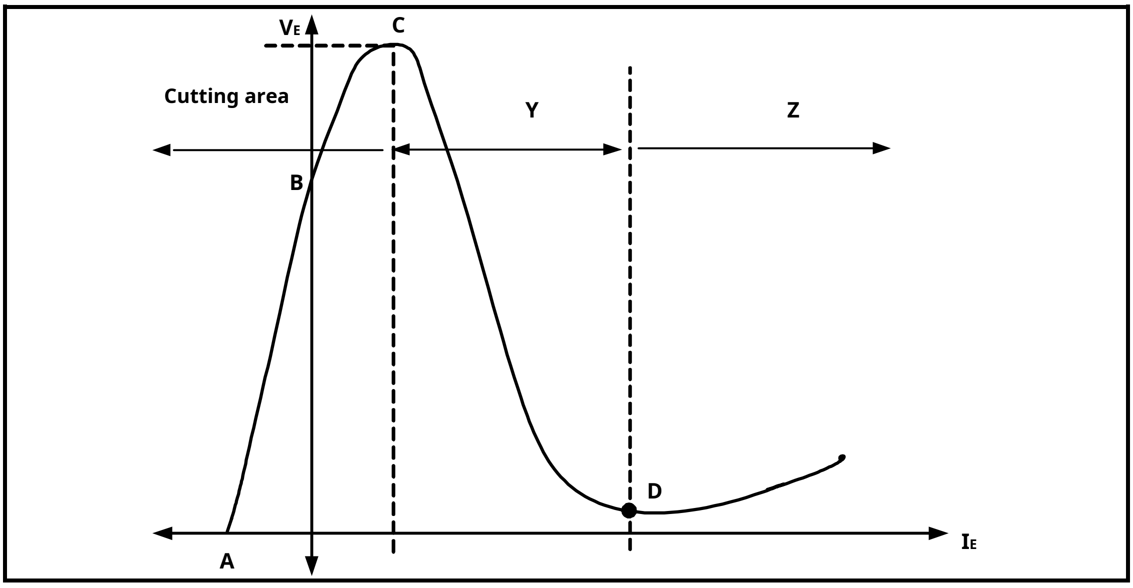


FIGURE 3.3: EVT CHARACTERISTICS

3.3.1 Name areas**Y**and**Z**. (2)

3.3.2 Name point**D**. (1)

3.3.3 With reference to counter-leakage current, explain what at cut-off point**B** happen. (3)

3.4 Name FOUR characteristics of an ideal operational amplifier. (4)

3.5 FIGURE 3.5 below shows the on-amplifier as a non-inverting amplifier. Answer the questions that follow.

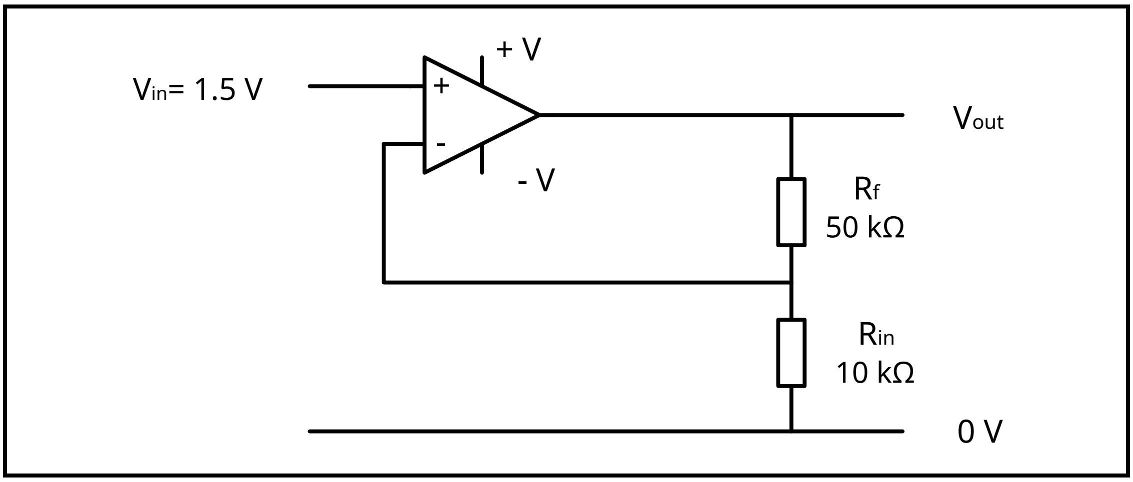


FIGURE 3.5: NON-REVERSE AMPLIFIER

Gave:

V_{IN} = 1.5 V
R_F = 50 kΩ
R_{IN} = 10 kΩ

3.5.1 Calculate the voltage gain in FIGURE 3.5. (3)

3.5.2 Calculate the output voltage. (3)

3.5.3 Describe the effects of feedback resistance reduction. (2)

3.6 FIGURE 3.6 below shows a 555 timer IC ('IC'). Answer the questions that follow.

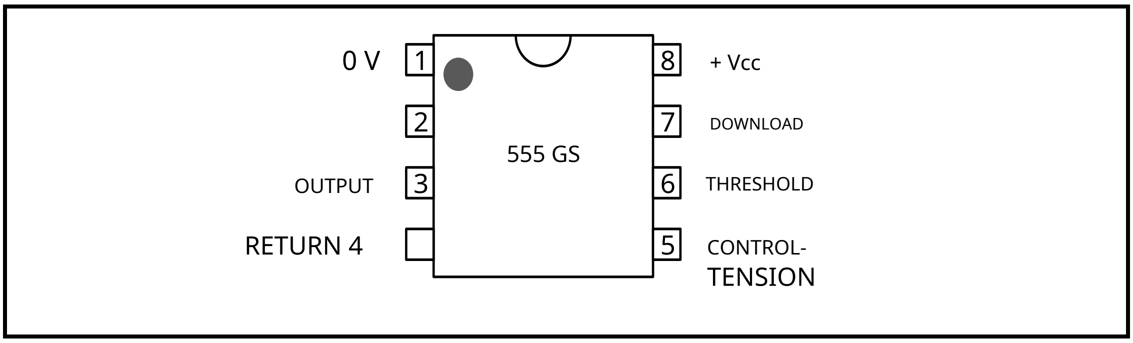


FIGURE 3.6: 555 TIMER GS ('IC')

3.6.1 Identify pen **2**. (1)

3.6.2 Explain the function of pin 6 (threshold) on a 555 GS ('IC'). (3)

3.6.3 Name the voltage range within which a 555 timer GS ('IC') can operate. (2)

3.6.4 Explain the unstable mode of a 555 timer. (2)
[30]

QUESTION 4: CIRCUITS

4.1 Refer to FIGURE 4.1 below and answer the questions that follow.

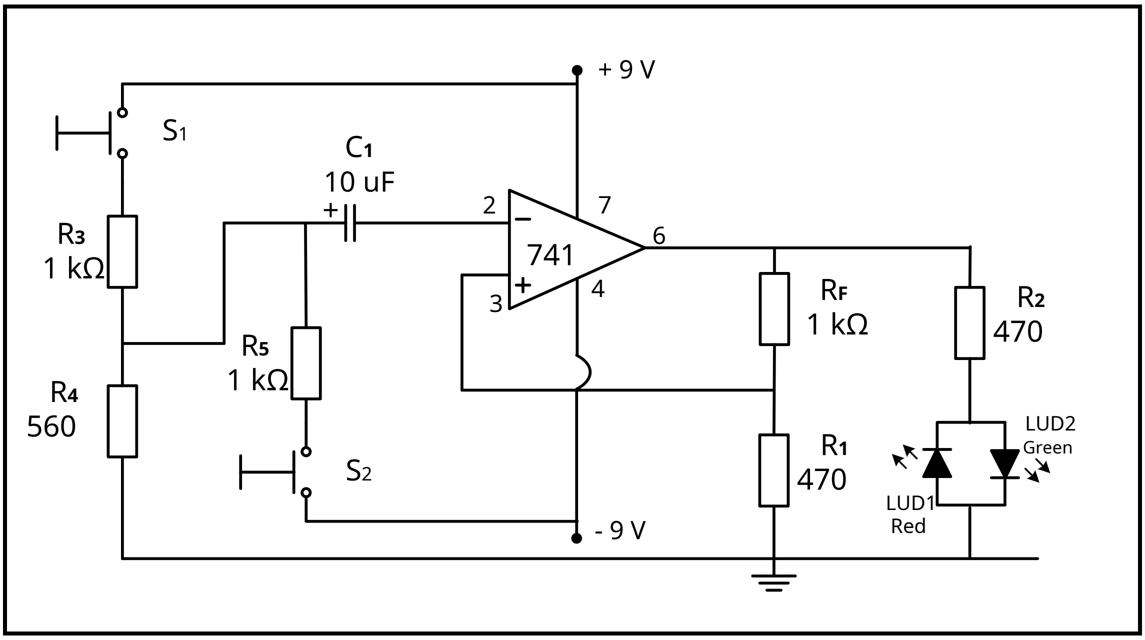


FIGURE 4.1: MULTIVIBRATOR

4.1.1 Identify the multivibrator in FIGURE 4.1. (1)

4.1.2 State the polarity of the pulse provided on the inverter input when switch S_1 printed. (1)

4.1.3 Name TWO functions of the 741-on amplifier in the circuit. (2)

4.1.4 Which LUD will be biased when switch S_1 be printed? (1)

4.1.5 Name the polarity of the voltage present on pin 3 after switch S_2 printed. (1)

4.2 FIGURE 4.2 below shows a 741-on-amplifier monostable multivibrator. Answer the questions that follow.

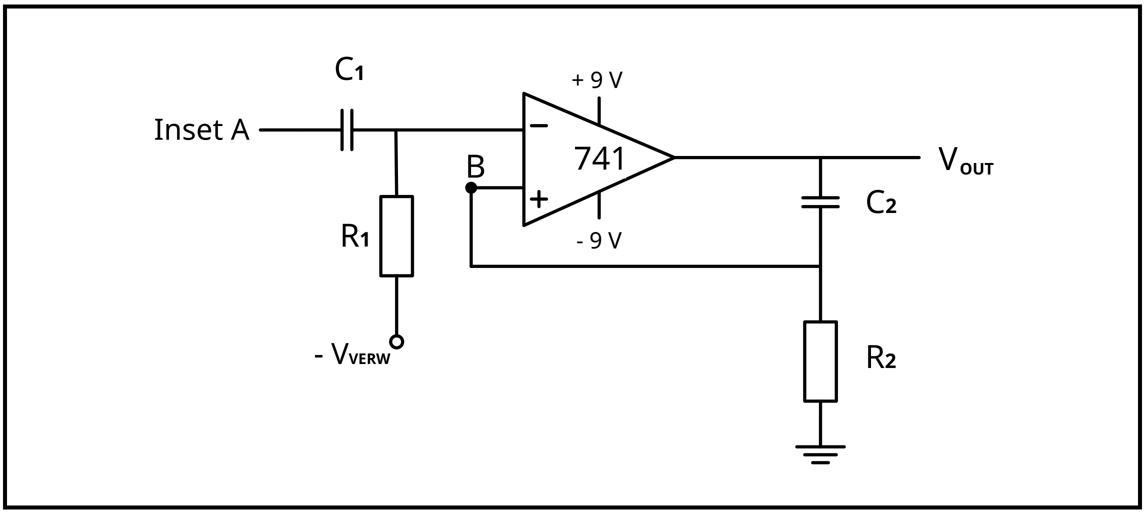


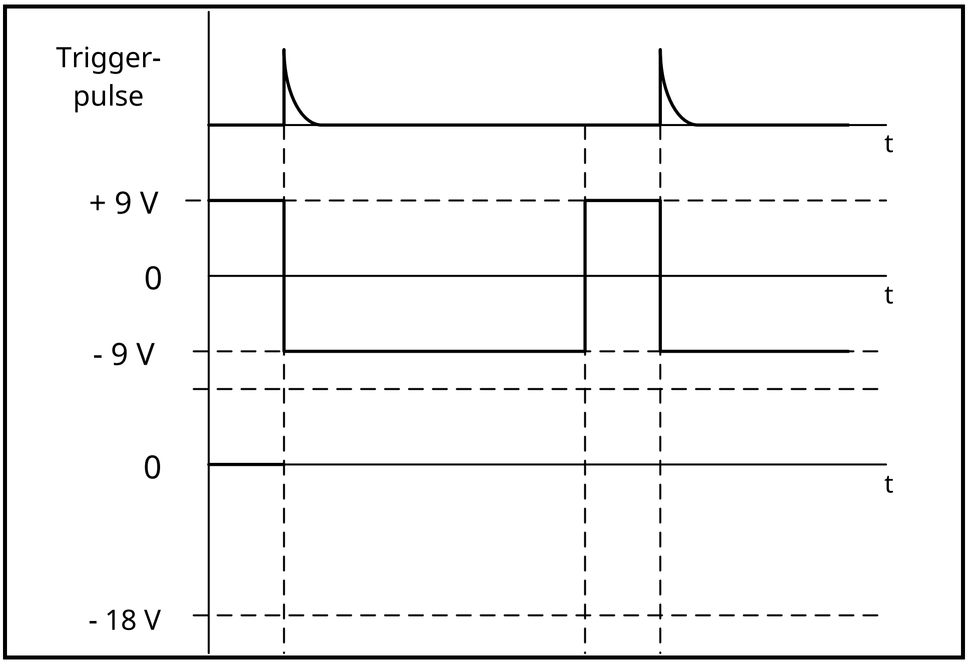
FIGURE 4.2: 741-OP-AMPLIFIER MONOSTABLE MULTIVIBRATOR

4.2.1 Write the value of the voltage across capacitor C_2 down when the circle is in its natural resting position. (1)

4.2.2 Write the voltage at point **B**down when the circuit is in the recovery state. (1)

4.2.3 Explain when the circuit output will change state. (2)

4.2.4 On the ANSWER SHEET for QUESTION 4.2.4, draw the voltage at point**B**if the input signal below is applied to the input of the circuit.



(4)

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

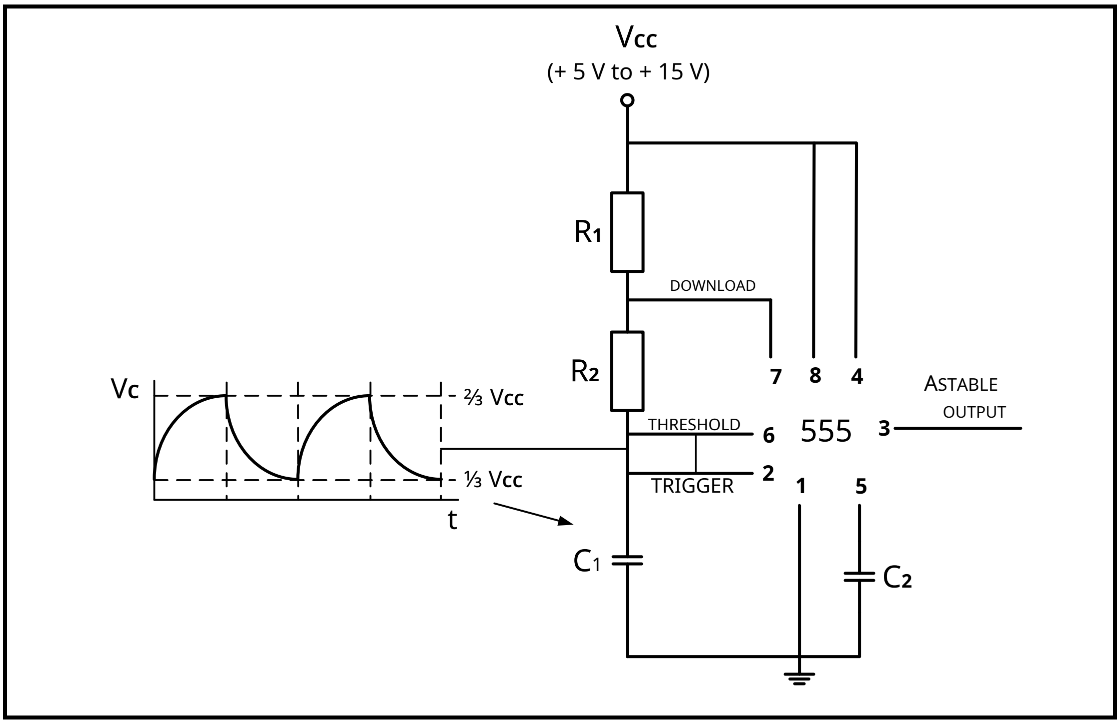


FIGURE 4.3: ASTABLE MULTIVIBRATOR

4.3.1 Identify the components used for charging capacitor C_1 responsible. (1)

4.3.2 Explain why the output will continuously oscillate between high and low conditions. (2)

4.3.3 Draw a fully labeled 741-DC-on-amplifier equivalent of the circuit in FIGURE 4.3. (6)

4.4 Explain the operation of the circuit in FIGURE 4.4 below.

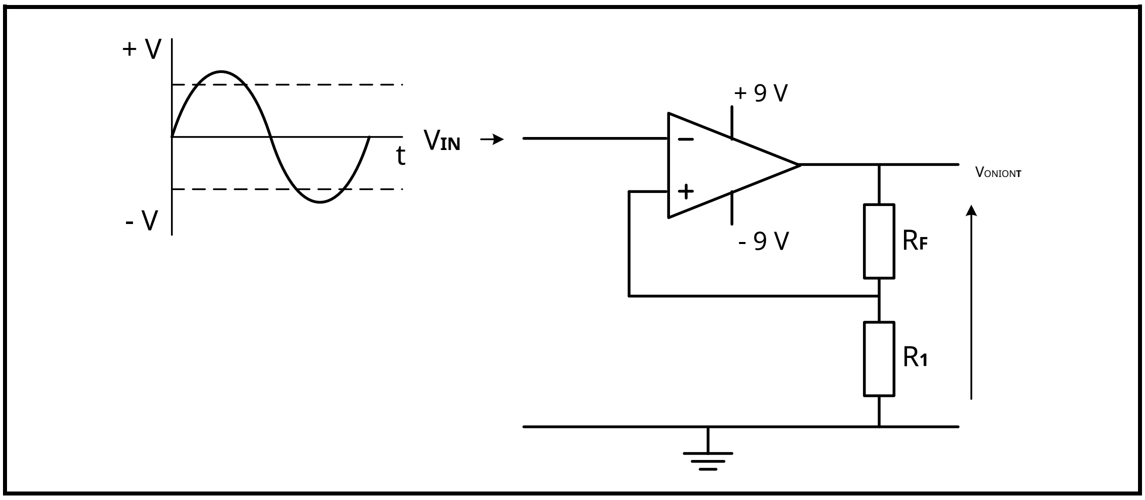


FIGURE 4.4: SCHMITT FAST (6)

4.5 FIGURE 4.5 and TABLE 4.5 below show the resistance values, output voltages and gain of a summing amplifier. Refer to FIGURE 4.5 and study TABLE 4.5 to answer the following questions.

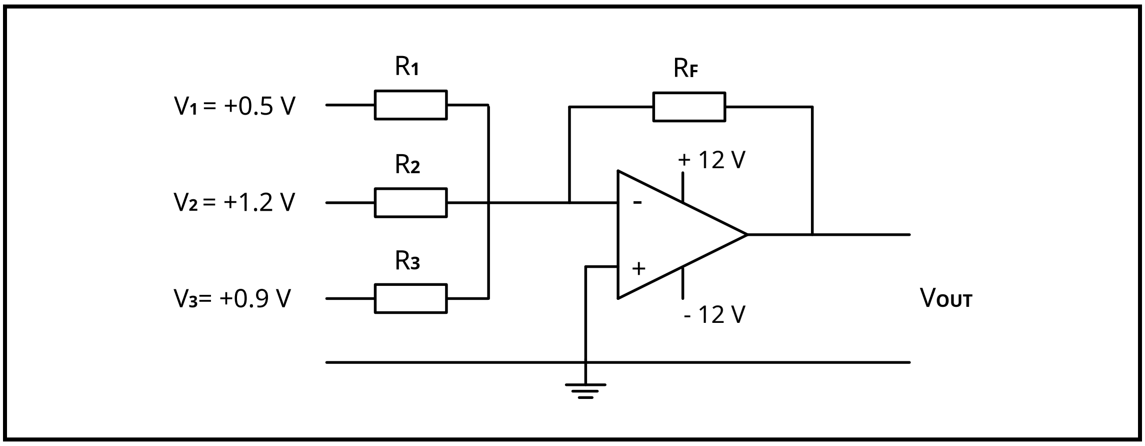


FIGURE 4.5: SUMMER AMPLIFIER

RESISTANCE VALUES				**OUTPUT**	**PROFIT**
R_1	**R_2**	**R_3**	**R_F**	**V_{OUT}**	**β (A_V)**
20 kΩ	20 kΩ	20 kΩ	20 kΩ	**B**	1
20 kΩ	20 kΩ	20 kΩ	40 kΩ	+ 5.2 V	**D**
5 kΩ	10 kΩ	20 kΩ	40 kΩ	**C**	4.08
20 kΩ	20 kΩ	20 kΩ	**A**	+ 10.4 V	4

TABLE 4.5

4.5.1 Name the function of a summing amplifier. (2)

4.5.2 Calculate the output voltage at**B**. (3)

4.5.3 Calculate the output voltage at**C**. (3)

4.5.4 Calculate the value of the feedback at**A**. (3)

4.5.5 Calculate the total profit at**D**. (3)

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

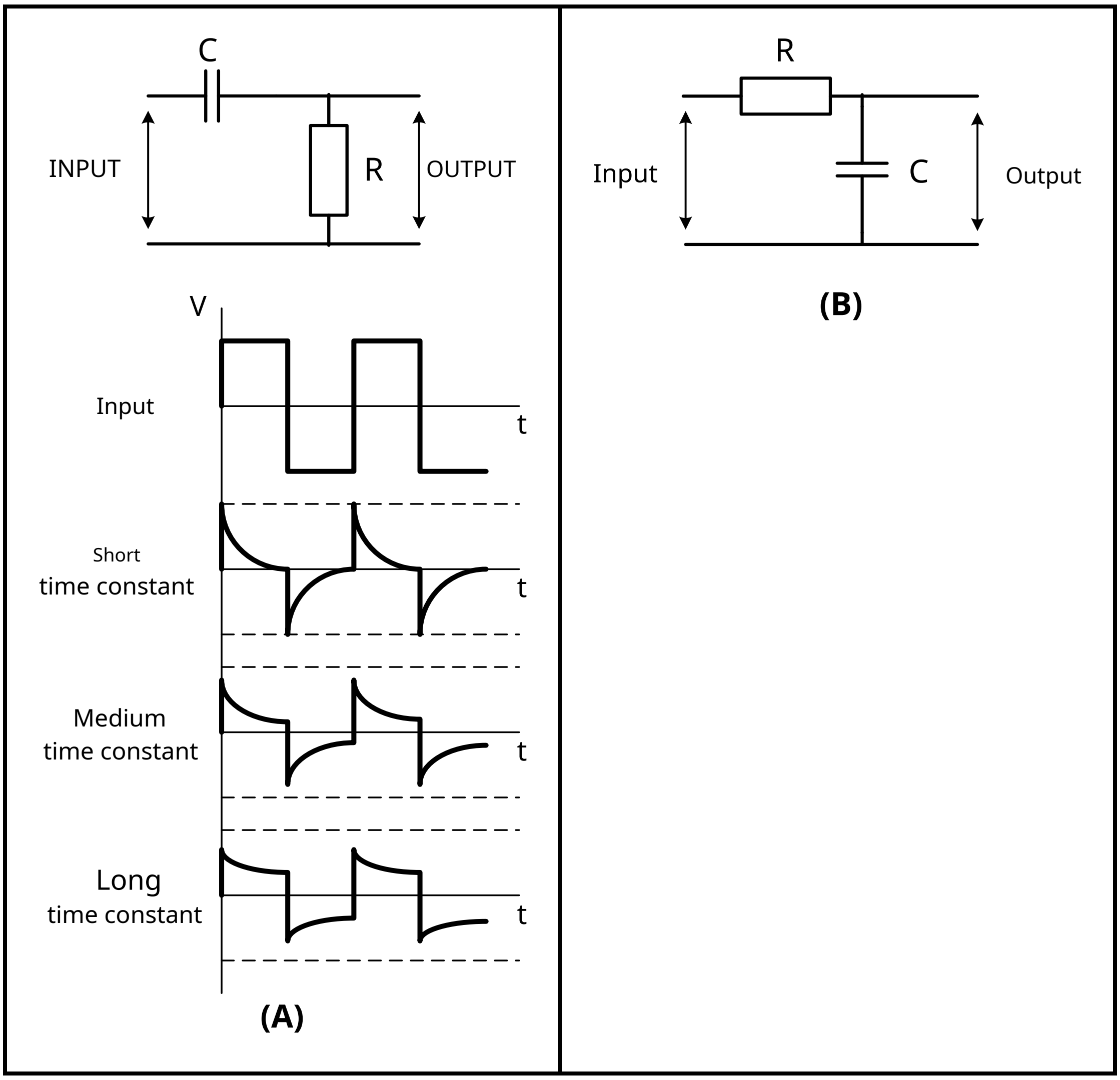


FIGURE 4.6

4.6.1	Identify the circuits in FIGURE 4.6 (A) and (B).	(2)
4.6.2	Explain the influence that a long time constant will have on the operation of the circuit in FIGURE 4.6 (A).	(3)
4.6.3	Explain the function of the circuit in FIGURE 4.6 (B).	(2)

4.7 Refer to FIGURE 4.7 below and answer the questions that follow.

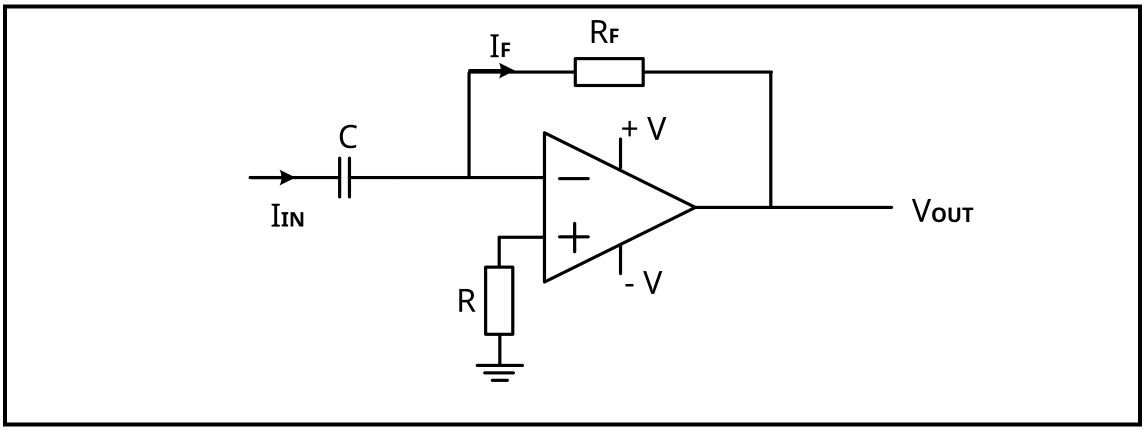
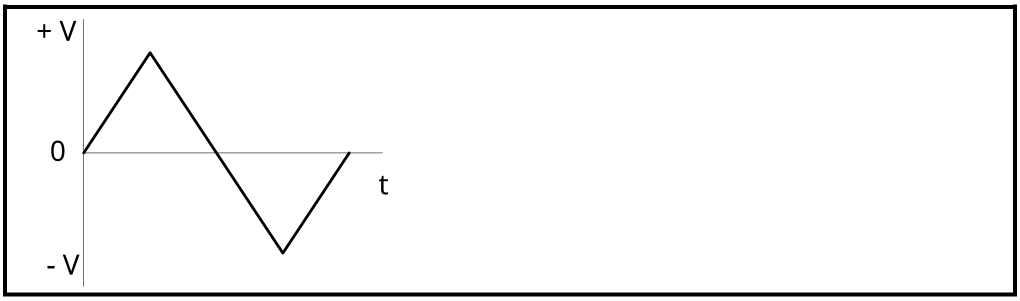


FIGURE 4.7: OP-AMPLIFIER-DIFFERENTIATOR

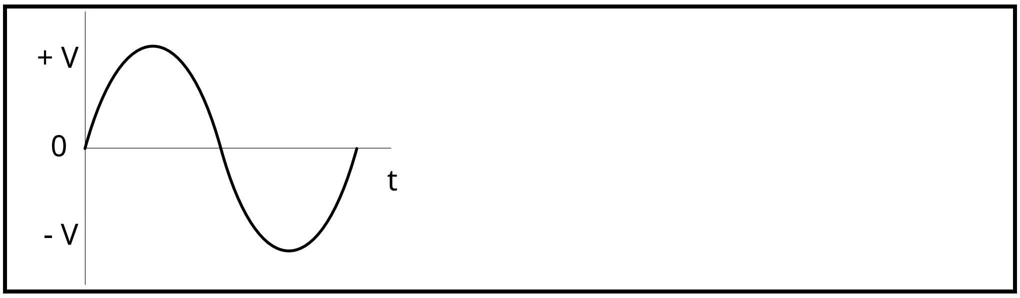
On the ANSWER SHEET for QUESTION 4.7.1 and QUESTION 4.7.2, draw the output waveform if the following inputs are applied to the circuit.

4.7.1



(3)

4.7.2



(5)

4.7.3 Name TWO improvements that the op-amplifier contributes to the operation of the circuit in FIGURE 4.7. (2)

[60]

QUESTION 5: AMPLIFIERS

5.1 Define the following terms with reference to amplifier circuits:

5.1.1 Weakening (2)

5.1.2 High-pass filter (2)

5.2 Explain the following categories of transistor amplifiers:

5.2.1 A small signal amplifier (2)

5.2.2 A power amplifier (2)

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

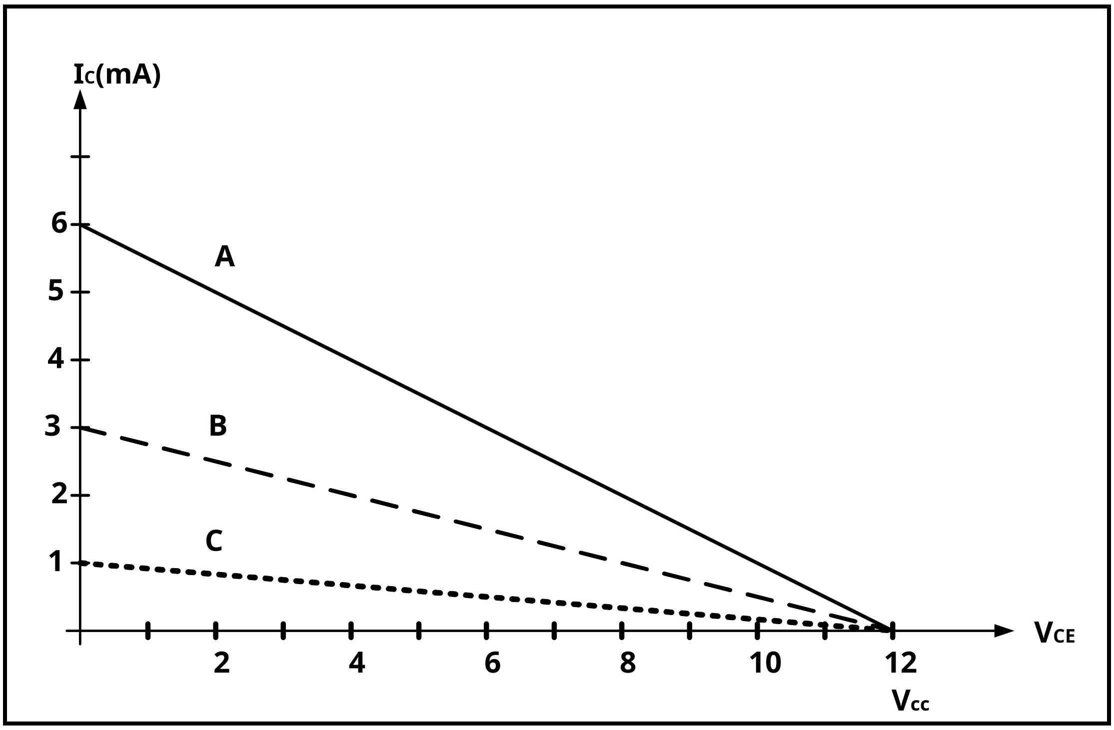


FIGURE 5.3: GS WELDING LINES

5.3.1 Name ONE purpose of a DC load line. (1)

5.3.2 Explain why there is a difference in the slopes of DC load lines **A**, **B** and**C**is. (3)

5.3.3 Calculate the value of the collector resistance of the DC load line passing through line **B**be represented. (3)

5.4 Refer to FIGURE 5.4 below and explain why the amplifier class A is biased.

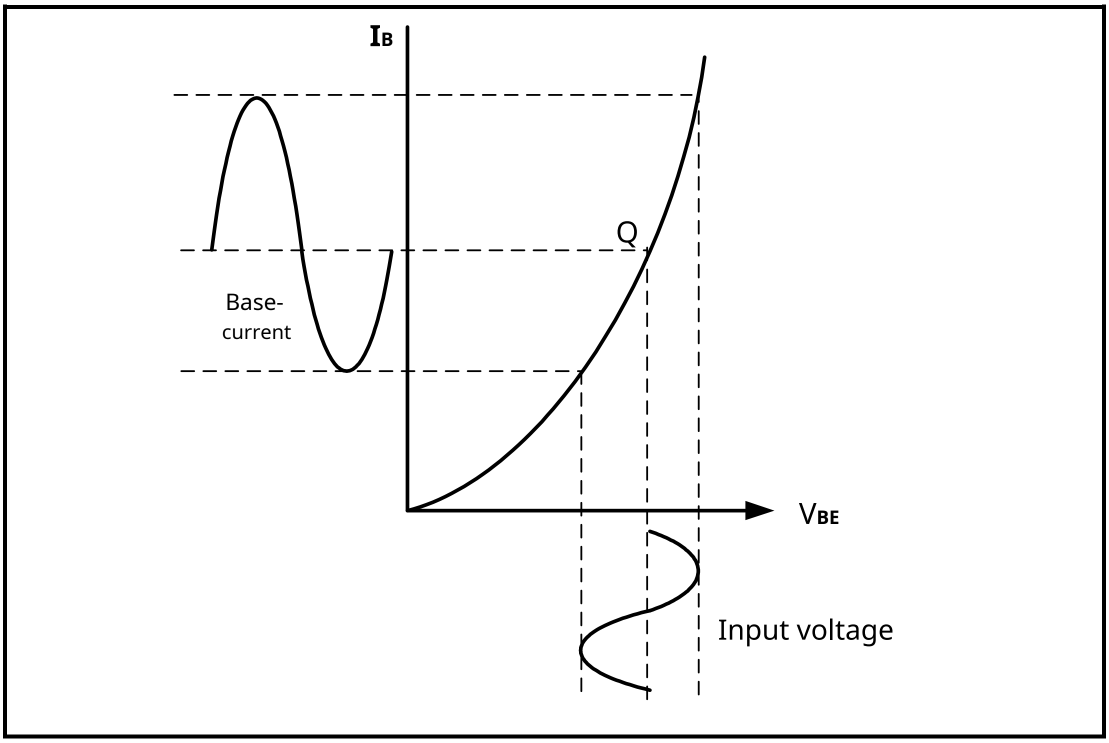


FIGURE 5.4: FEATURES OF A CLASS A AMPLIFIER

5.5 Explain the term *infinite bandwidth* with reference to the frequency response curves of an amplifier circuit. (1)

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

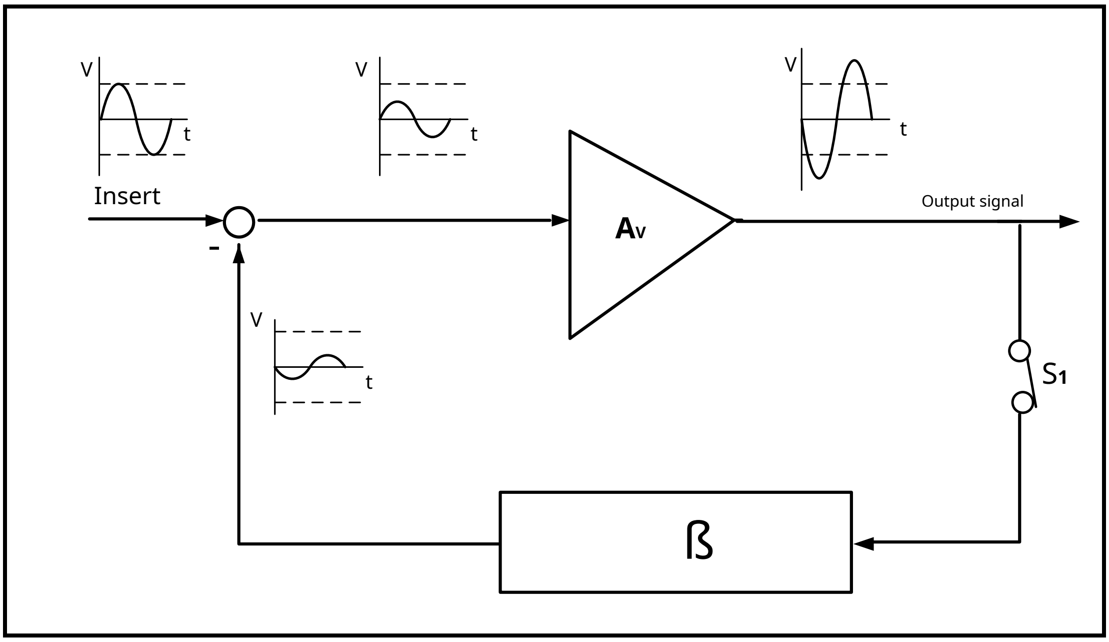


FIGURE 5.6: BLOCK DIAGRAM

5.6.1 Identify the block diagram in FIGURE 5.6. (1)

5.6.2 Name THREE conditions that will occur if switch S_1 is open. (3)

5.7 Refer to FIGURE 5.7 below and answer the questions that follow.

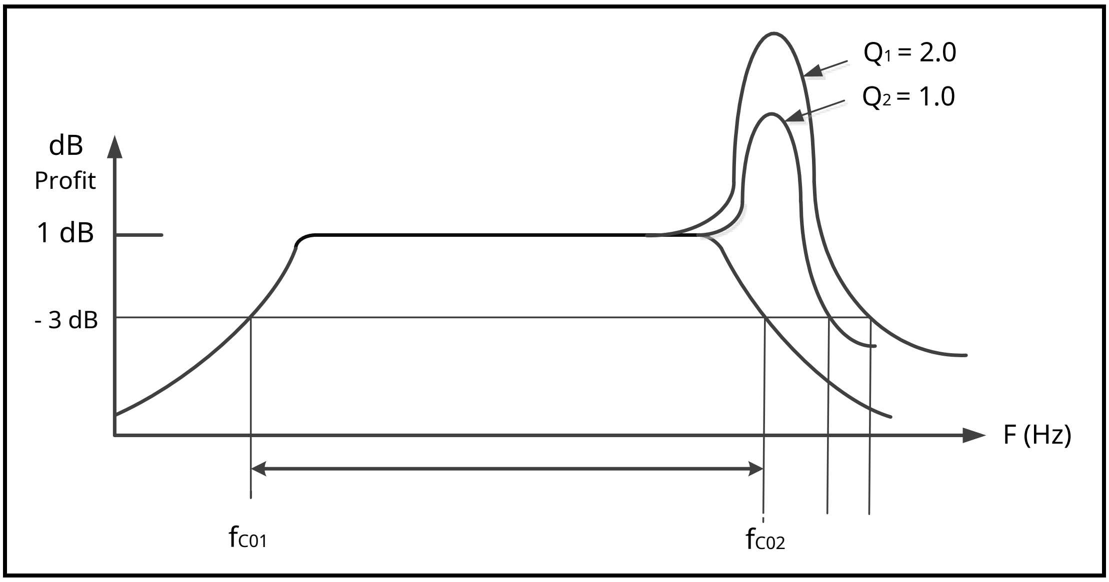


FIGURE 5.7: FREQUENCY CURVES

5.7.1 Identify the amplifier circuit from which the frequency curve in FIGURE 5.7 is derived. (1)

5.7.2 Describe how the frequency affects the gain. (4)

5.8 Refer to FIGURE 5.8A below and FIGURE 5.8B on the next page and answer the questions that follow.

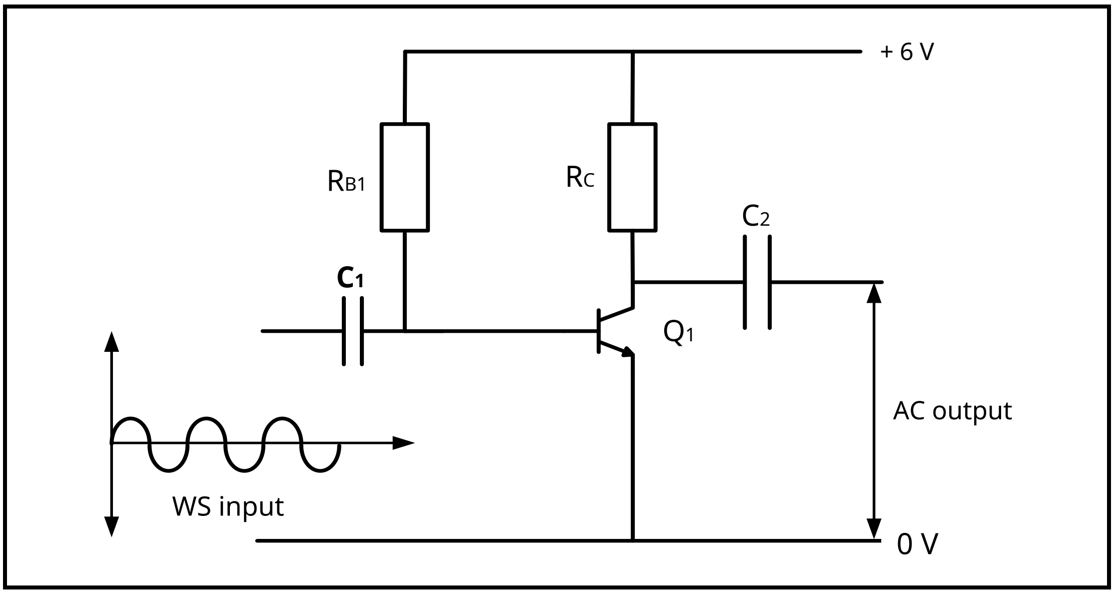


FIGURE 5.8A: COMMON EMITTER AMPLIFIER CIRCUIT

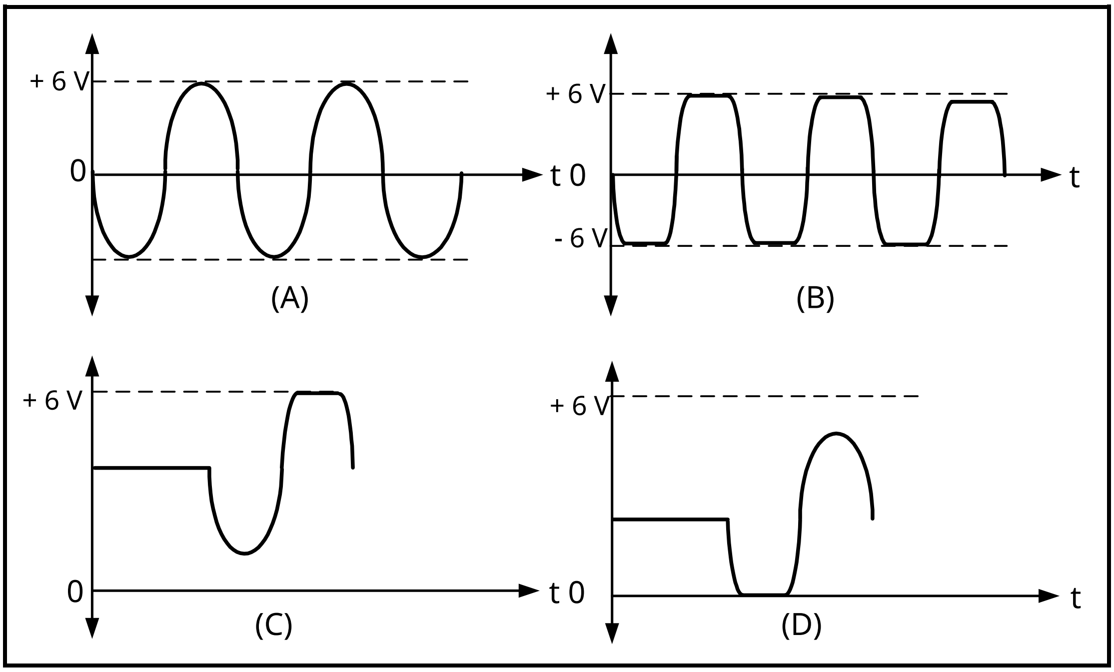


FIGURE 5.8B: OUTPUT WAVE FORMS

Identify the waveform in FIGURE 5.8B that represents the output of the circuit diagram in FIGURE 5.8A for the following conditions:

5.8.1 The transistor is biased at the center of the DC load line (1)

5.8.2 The value of the base R_{B1} is reduced (1)

5.8.3 The base current is reduced (1)

5.8.4 Input overloads the amplifier (1)

5.9 FIGURE 5.9 below shows a balance amplifier using Class B NPN and PNP transistors. Answer the questions that follow.

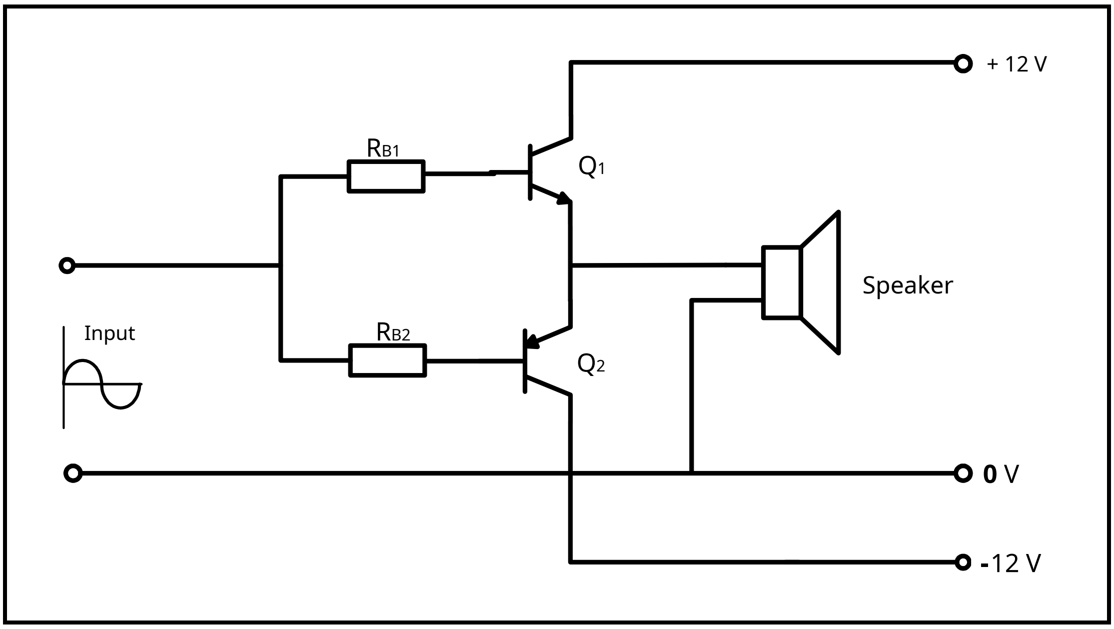


FIGURE 5.9: AMPLIFIER WHICH COMPLEMENTARY TRANSISTORS USE

5.9.1 Explain why the circuit in FIGURE 5.9 uses a DC power supply and an AC signal at the input. (2)

5.9.2 Name the type of distortion that can be found in this circuit. (1)

5.9.3 On the ANSWER SHEET for QUESTION 5.9.3, draw the output waveform that will be delivered to the speaker if there is distortion. (4)

5.9.4 Explain the operation of the circuit in FIGURE 5.9. (5)

5.10 Refer to FIGURE 5.10 below and answer the questions that follow.

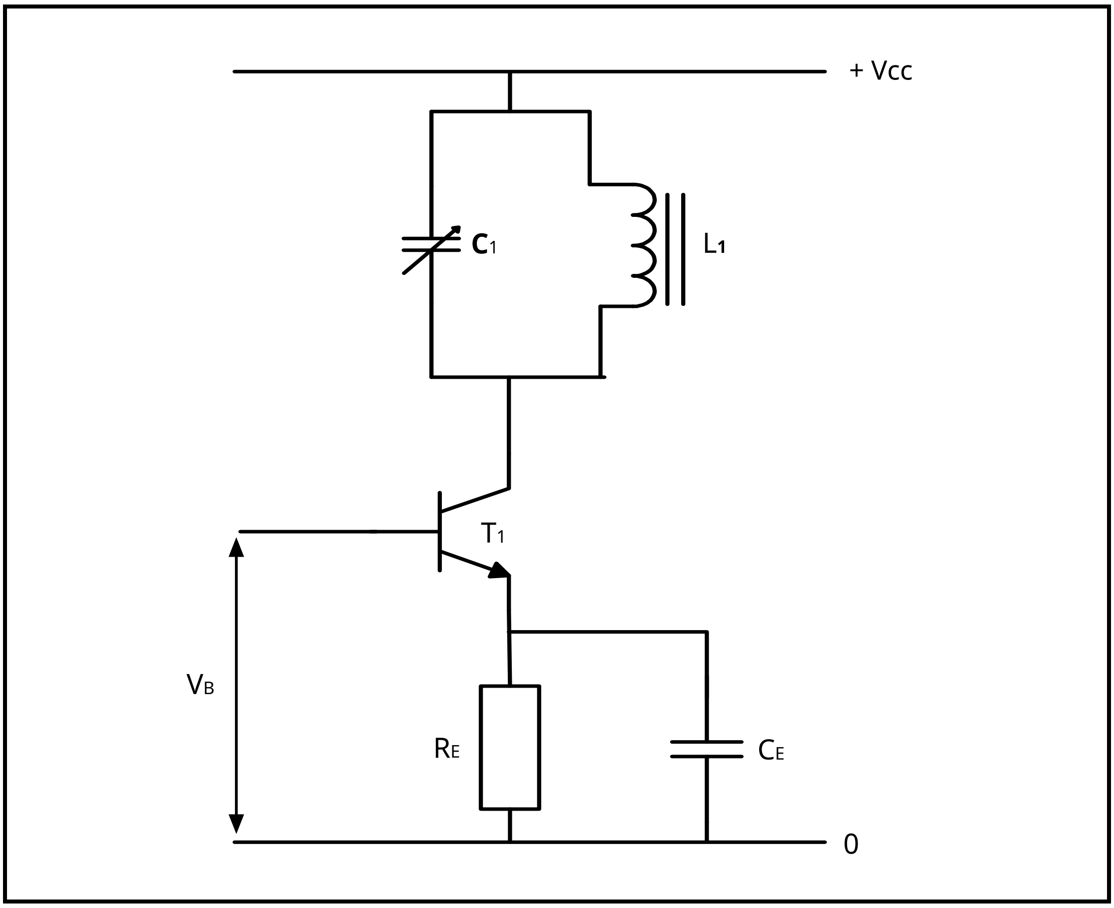


FIGURE 5.10: LC RESONANCE CIRCLE

5.10.1 Name the class of reinforcement used in FIGURE 5.10. (1)

5.10.2 Describe a radio frequency amplifier. (3)

5.10.3 Explain the term *unwanted frequencies* with reference to the operation of radio frequency amplifiers. (1)

5.10.4 Explain the purpose of the tuned LC circuit. (2)

5.10.5 Describe how the resonant frequency of the circuit can be changed. (2)

5.10.6 Draw a labeled frequency curve of the radio frequency amplifier. (4)

5.11 Refer to FIGURE 5.11 below and explain the operation of the Hartley oscillator tank circuit, as shown in block **A** showed.

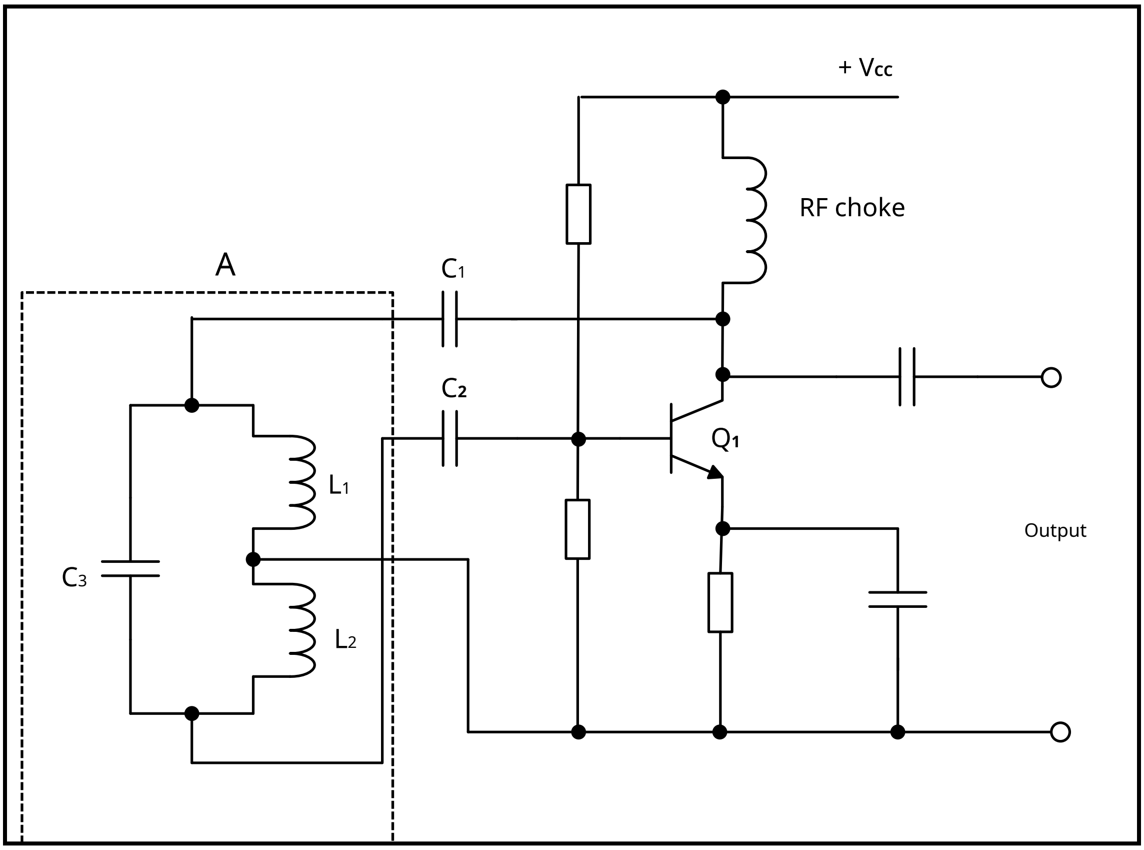


FIGURE 5.11: HARTLEY OSSILLATOR CIRCUIT (4)

[60]

TOTAL: 200

FORMULA SHEET

RLC CIRCUITS

$P - VI\text{-}\cos\theta$

$X_L - 2 - \ fL$

$X_C - \dfrac{1}{2 - fC}$

$f_r - \dfrac{1}{2 - \sqrt{LC}}$ OR $f_r - \dfrac{f_2 - f_1}{2}$

$BW - \dfrac{f_r}{Q}$ OR $BW - f_2 - f_1$

Series

$V_R - IR$

$V_L - IX_L$

$V_C - IX_C$

$I_T - \dfrac{V_T}{Z}$ OR $I_T - I_R - I_C - I_L$

$Z - \sqrt{R^2 - -X_L - X_C -^{2}}$

$V_T - \sqrt{V_R^2 - -V_L - V - _C^{2}}$ OR $V_T - IZ$

$\cos\theta - \dfrac{R}{Z}$ OF $\cos\theta - \dfrac{V_R}{V_T}$

$Q - \dfrac{X_L -}{R} \quad \dfrac{X_C -}{R} \quad \dfrac{V_L -}{V_T} \quad \dfrac{V_C}{V_T} - \dfrac{1}{R}\sqrt{\dfrac{L}{C}}$

Parallel

$V_T - V_R - V_L - V_C$

$I_R - \dfrac{V_T}{R}$

$I_C - \dfrac{V_T}{X_C}$

$I_L - \dfrac{V_T}{X_L}$

$I_T - \sqrt{I_R^2 - -I_L - I - _C^{2}}$

$Z - \dfrac{V_T}{I_T}$

$\cos\theta - \dfrac{I_R}{I_T}$

$Q - \dfrac{R}{X_L} - \dfrac{R}{X_C} - \dfrac{I_L}{I_T} - \dfrac{I_C}{I_T} - \dfrac{1}{R}\sqrt{\dfrac{L}{C}}$

SEMICONDUCTOR DEVICES

Wins $A_V - \dfrac{V_{OUT}}{V_{IN}} - - \dfrac{R_F}{R_{IN}}$ $\quad A_V - 1 - \dfrac{R_F}{R_{IN}}$

$V_{OUT} - V_{IN} - - - - \dfrac{R_F -}{R_{IN} -}$

$V_{OUT} - V_{IN} - - - 1 - \dfrac{R_F}{R_{IN} -}$

SWITCHES

$V_{OUT} - - - - V_1 \dfrac{R_F}{R_1} - V_2 \dfrac{R_F}{R_2} - \ldots V_A \dfrac{R_F}{R_A} -$

Wins $A_V - \dfrac{V_{OUT} -}{V_{IN}} \quad \dfrac{V_{OUT}}{-V_1 - V_2 - \ldots V_A -}$

$V_{OUT} - - \ (V_1 - V_2 - \ldots V_A)$

AMPLIFIERS

$I_C - \dfrac{V_C}{R_C}$

$V_{CC} - V_{CE} - I_C R_C$

$V_B - V_{BE} - \ V_{RE}$

$A_V - \dfrac{V_{OUT}}{V_{IN}}$

$A_I - \dfrac{I_{OUT}}{I_{IN}}$

$A_P - \dfrac{P_{OUT}}{P_{IN}}$ OR $A_P - A_V - A_I$

$A = \beta_1 \times \beta_2$ OR $A_V - A_{V1} - A_{V2} - A_{V3}$

$P_{IN} - I^2 - Z_{IN}$ AND $P_{OUT} - I^2 - Z_{OUT}$

PROFIT IN DECIDE

$A_I - \ 20\log_{10} \dfrac{I_{OUT}}{I_{IN}}$

$A_V - 20\log_{10} \dfrac{V_{OUT}}{V_{IN}}$

$A_P - 10\log_{10} \dfrac{P_{OUT}}{P_{IN}}$

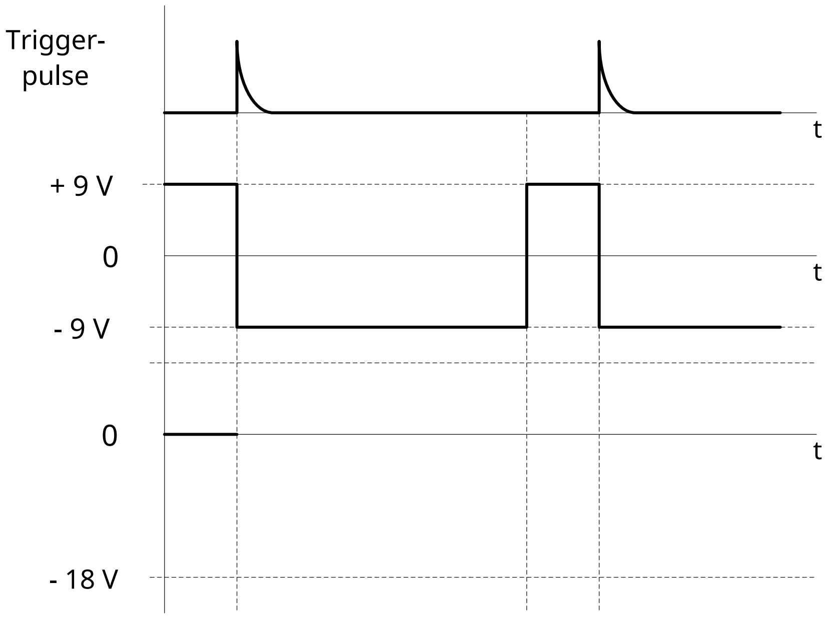
CENTER NUMBER:							

EXAM NUMBER:													

ANSWER SHEET

QUESTION 4: CIRCUITS

4.2.4



Transfer points to
answer book about

MOD

(4)

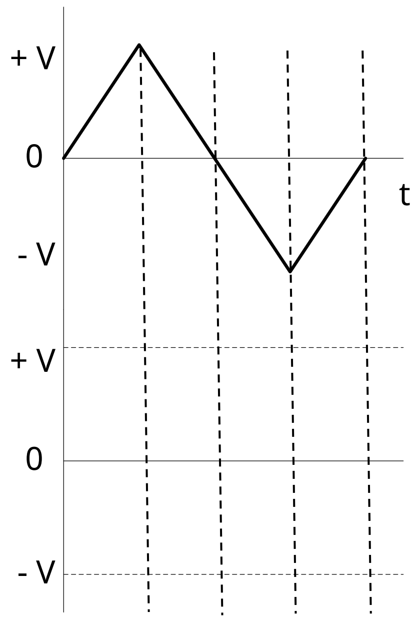
FIGURE 4.2.4

CENTER NUMBER:

EXAM NUMBER:

ANSWER SHEET

4.7.1



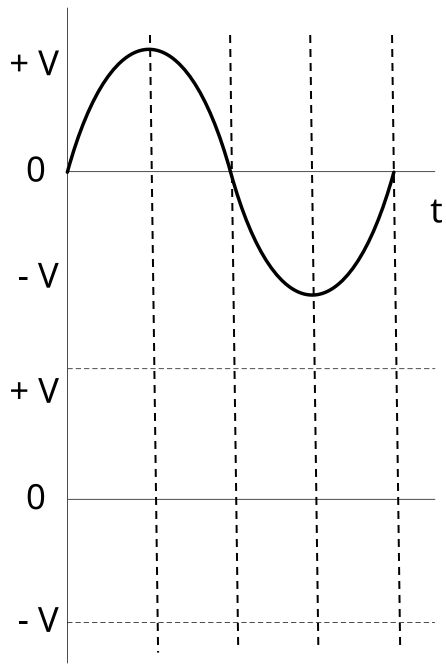
Transfer points to answer book about

MOD

(3)

FIGURE 4.7.1

4.7.2



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(5)

FIGURE 4.7.2

CENTER NUMBER:							

EXAM NUMBER:													

ANSWER SHEET

QUESTION 5: AMPLIFIERS

5.9.3

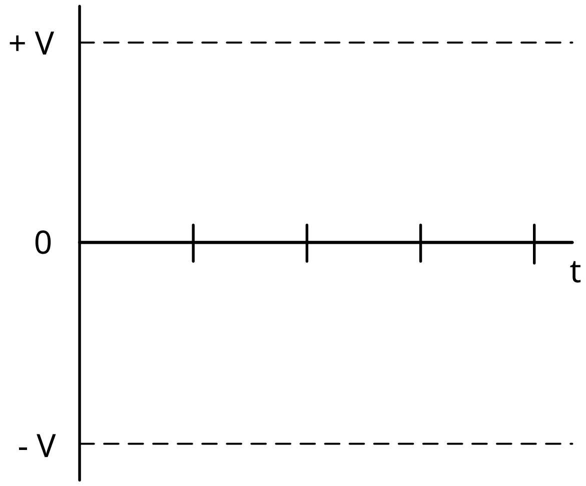

FIGURE 5.9.3

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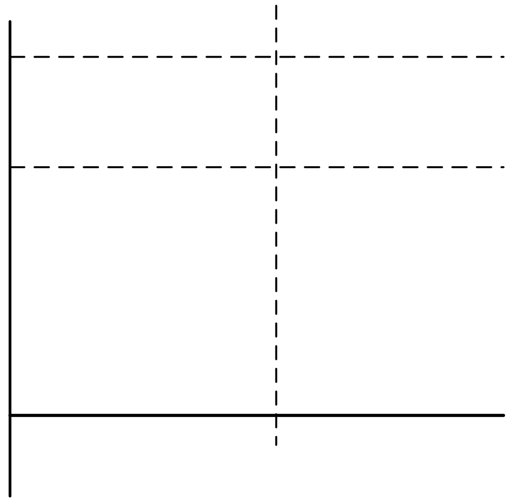
CENTER NUMBER:

EXAM NUMBER:

ANSWER SHEET

5.10.6



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answer book about

MOD

(4)

FIGURE 5.10.6