

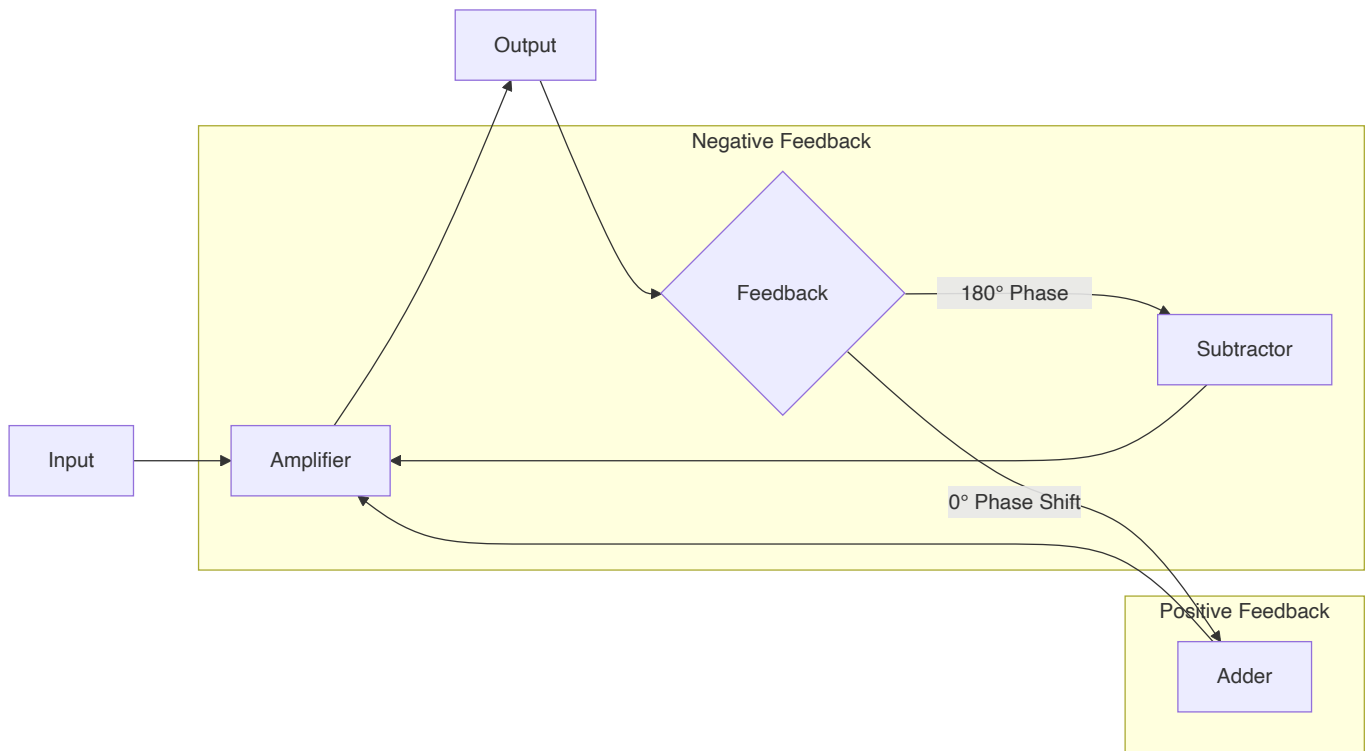
## Question 1(a) [3 marks]

State and explain the difference between positive and negative feedback with diagram.

Answer:

Parameter	Negative Feedback	Positive Feedback
Signal	Output signal is fed back to input with opposite phase	Output signal is fed back to input with same phase
Gain	Decreases	Increases
Stability	Improves	Reduces
Applications	Amplifiers	Oscillators

Diagram:



- **Phase relationship:** In negative feedback, signal is  $180^\circ$  out of phase while in positive feedback, signal is in phase
- **Purpose:** Negative feedback stabilizes system while positive feedback creates oscillations

**Mnemonic:** "Negative Needs Stability, Positive Produces Oscillations"

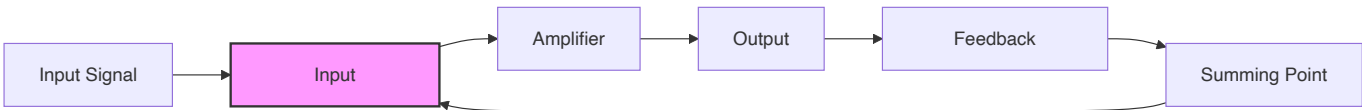
## Question 1(b) [4 marks]

Explain the effect of negative feedback on input impedance of the Amplifier.

Answer:

Type of Feedback	Effect on Input Impedance	Formula
Voltage Series	Increases	$Z(in-f) = Z(in)(1+A\beta)$
Current Series	Increases	$Z(in-f) = Z(in)(1+A\beta)$
Voltage Shunt	Decreases	$Z(in-f) = Z(in)/(1+A\beta)$
Current Shunt	Decreases	$Z(in-f) = Z(in)/(1+A\beta)$

Diagram:



- **Series feedback:** When feedback signal is in series with input, input impedance increases
- **Shunt feedback:** When feedback signal is in parallel with input, input impedance decreases
- **Magnitude:** Change is proportional to  $(1+A\beta)$  where A is gain and  $\beta$  is feedback factor

Mnemonic: "Series Soars, Shunt Shrinks"

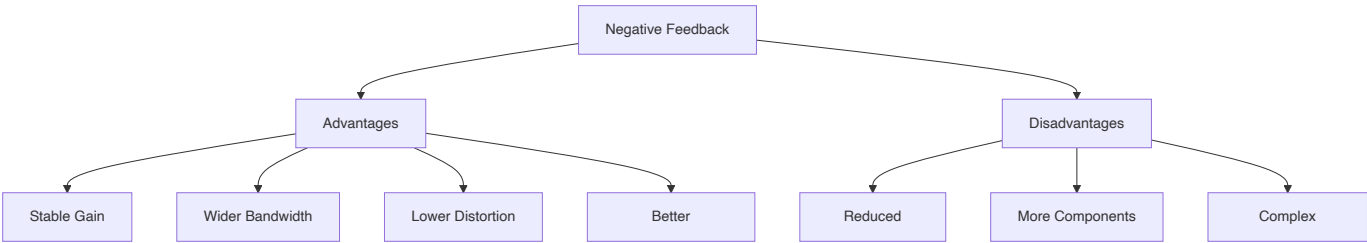
## Question 1(c) [7 marks]

List the advantages and Disadvantages of negative feedback.

Answer:

Advantages	Disadvantages
Stabilizes gain	Reduces overall gain
Increases bandwidth	Requires additional components
Reduces distortion	May cause oscillation if improperly designed
Reduces noise	Requires careful phase compensation
Improves input/output impedance	Increases power consumption
Reduces temperature sensitivity	Makes circuit more complex
Controls frequency response	May reduce signal-to-noise ratio in some cases

Diagram:



- **Performance tradeoff:** Sacrifices gain to achieve better stability and linearity
- **Frequency considerations:** May require compensation to prevent oscillations at high frequencies
- **Design complexity:** More complex to design properly but offers better long-term performance

Mnemonic: "Stability Grows As Gain Drops"

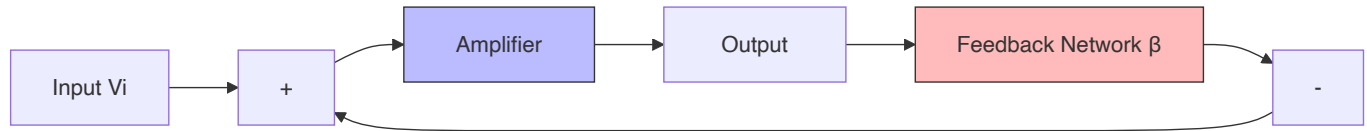
## Question 1(c) OR [7 marks]

Explain Voltage series feedback amplifier in detail with block diagram and draw the Practical voltage series feedback circuit.

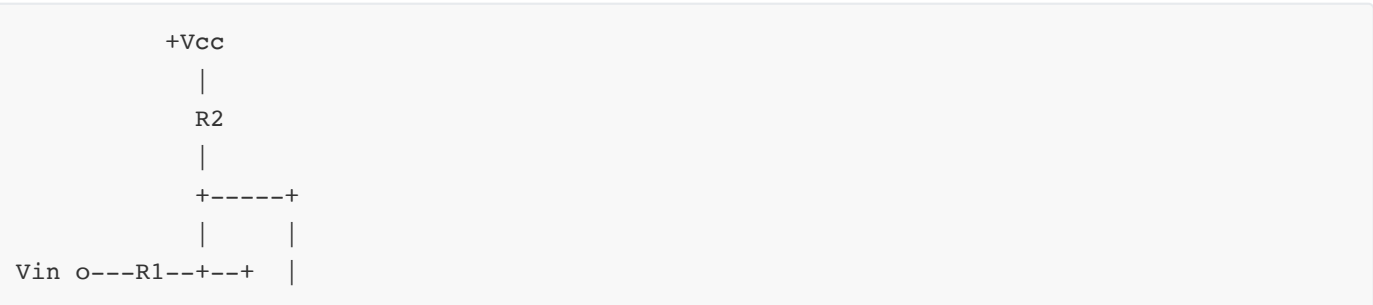
Answer:

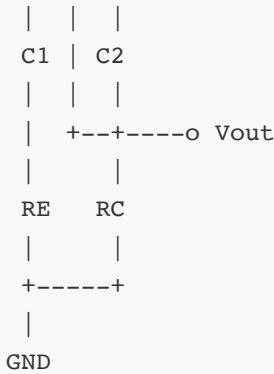
Parameter	Effect in Voltage Series Feedback
Input signal	Voltage
Feedback signal	Voltage
Input impedance	Increases
Output impedance	Decreases
Gain stability	Improves
Bandwidth	Increases

Diagram:



Practical Circuit:





- **Sampling method:** Output voltage is sampled and fed back to input
- **Mixing method:** Feedback signal is mixed in series with input signal
- **Working principle:** Reduces gain for improved stability and linearity
- **Applications:** Audio amplifiers, instrumentation amplifiers

**Mnemonic:** "Voltage Series - Impedance In Up, Out Down"

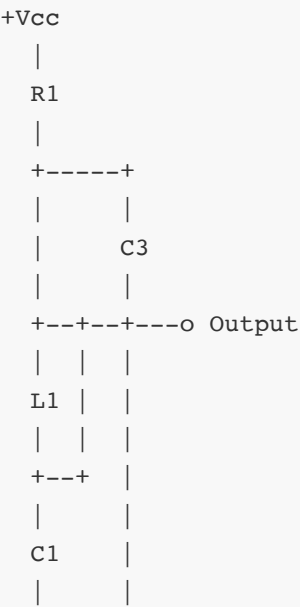
## Question 2(a) [3 marks]

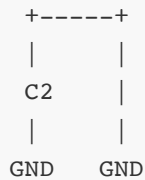
Write short note on Colpitts oscillator circuit.

Answer:

Component	Function
LC Tank	Determines oscillation frequency
Capacitive Voltage Divider	Provides feedback
Active Device	Provides gain to sustain oscillations

Diagram:





- **Frequency formula:**  $f = 1/(2\pi\sqrt{L \times (C1 \times C2)/(C1 + C2)})$
- **Feedback:** Provided by capacitive voltage divider (C1 and C2)
- **Applications:** RF oscillators, communication circuits

**Mnemonic:** "Colpitts Contains Capacitive divider"

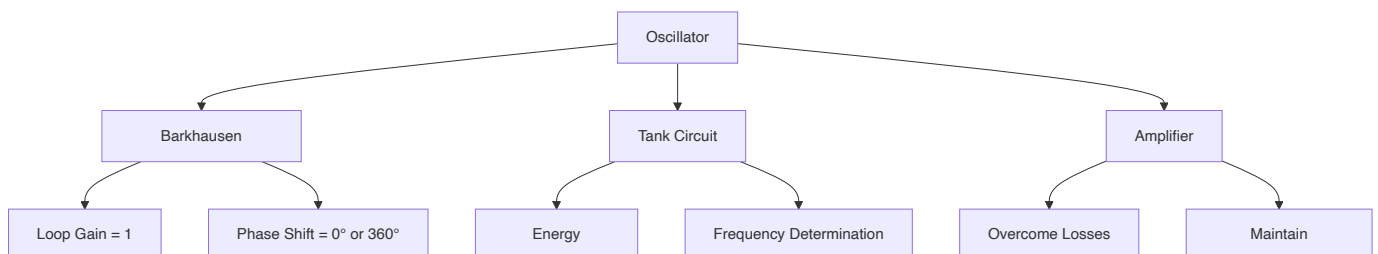
## Question 2(b) [4 marks]

Explain requirement of oscillator. i) Barkhausen Criterion. ii) Tank circuit. iii) Amplifier.

**Answer:**

Requirement	Function	Explanation
Barkhausen Criterion	Ensures sustained oscillation	Loop gain = 1, Phase shift = 0° or 360°
Tank Circuit	Determines frequency	Resonant LC circuit that stores energy
Amplifier	Provides gain	Compensates for circuit losses

**Diagram:**



- **Barkhausen Criterion:** Mathematical condition for sustained oscillations without damping
- **Tank Circuit:** LC circuit that determines frequency of oscillations
- **Amplifier:** Active device that provides energy to maintain oscillations

**Mnemonic:** "BAT - Barkhausen Amplifies Tank"

## Question 2(c) [7 marks]

Explain construction, working and V-I characteristics of UJT.

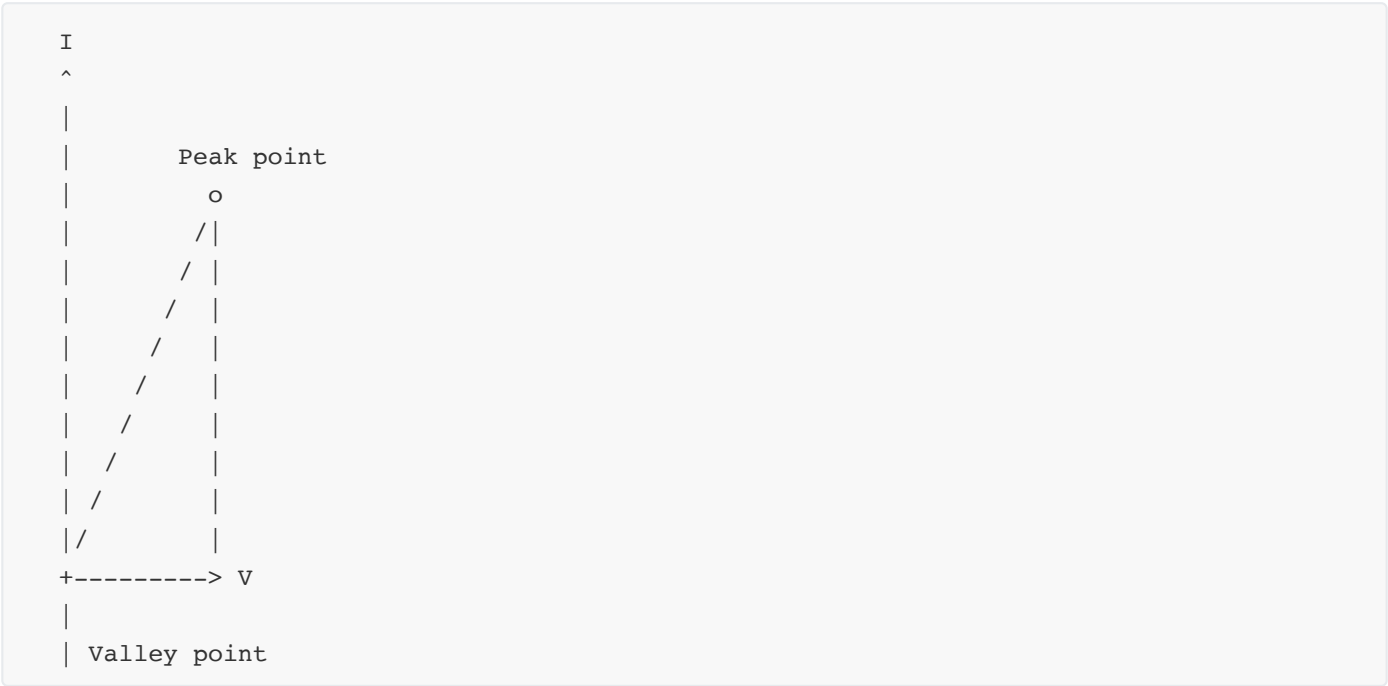
**Answer:**

Parameter	Description
Construction	Silicon bar with two base connections and one emitter
Symbol	Triangle with emitter on one side and two bases
Equivalent Circuit	Voltage divider with diode
Key Parameter	Intrinsic standoff ratio ( $\eta$ )

Diagram:



V-I Characteristic Curve:



- **Construction:** N-type silicon bar with P-type emitter junction
- **Working principle:** When emitter voltage  $> (\eta \times V_{BB})$ , device conducts
- **Regions of operation:** Cut-off, negative resistance, and saturation
- **Applications:** Relaxation oscillators, timing circuits, triggering devices

**Mnemonic:** "UJT Peaks Then Valleys - Negative Resistance Rules"

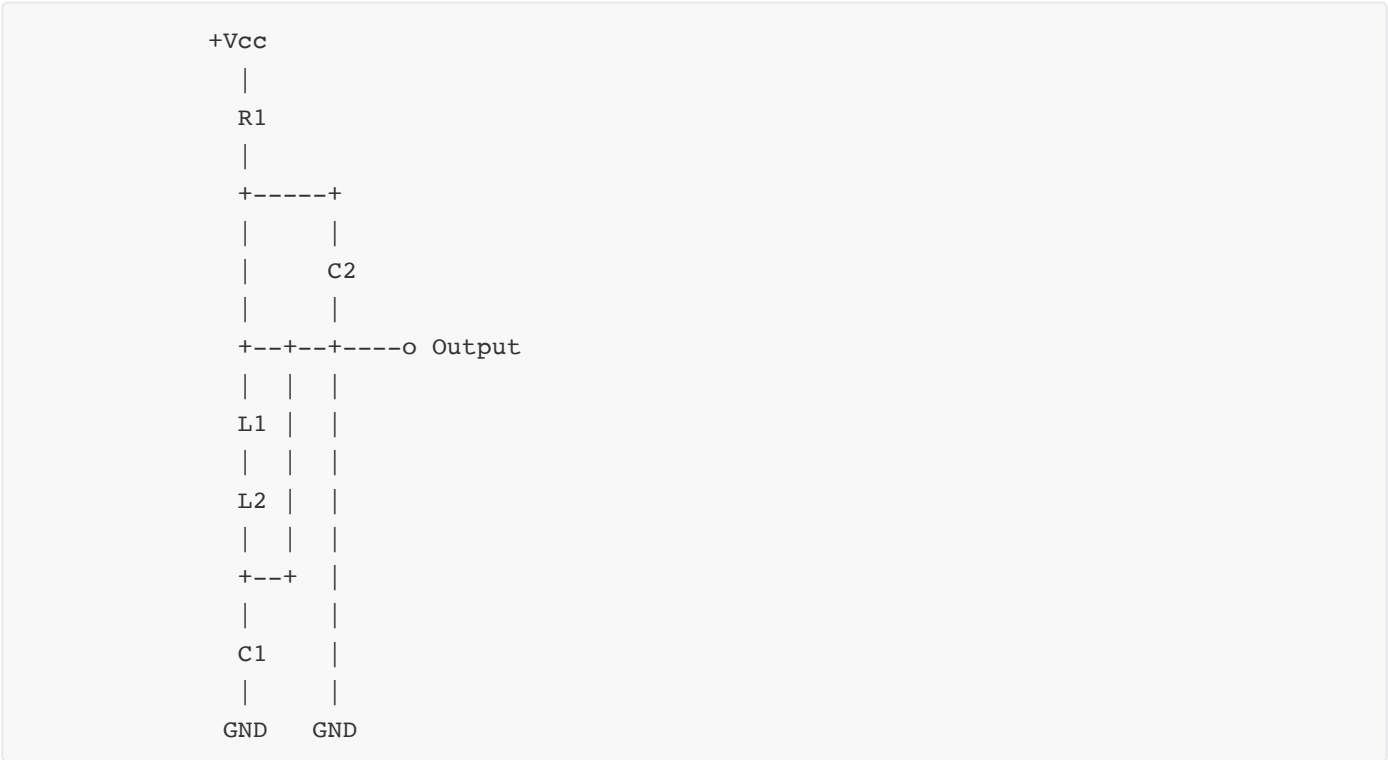
Question 2(a) OR [3 marks]

State the advantages, disadvantages and applications of Hartley oscillator.

Answer:

Advantages	Disadvantages	Applications
Easy tuning	Bulky inductors	RF generators
Wide frequency range	Mutual inductance issues	Radio receivers
Simple design	Difficult at high frequencies	Amateur radio
Good frequency stability	Requires center-tapped coil	Communication equipment

Diagram:



- **Key feature:** Uses tapped inductor for feedback
- **Frequency formula:**  $f = 1/(2\pi\sqrt{C \times (L1 + L2)})$
- **Distinguishing characteristic:** Inductive voltage divider for feedback

**Mnemonic:** "Hartley Has tapped Inductor"

Question 2(b) OR [4 marks]

Explain UJT as relaxation oscillator.

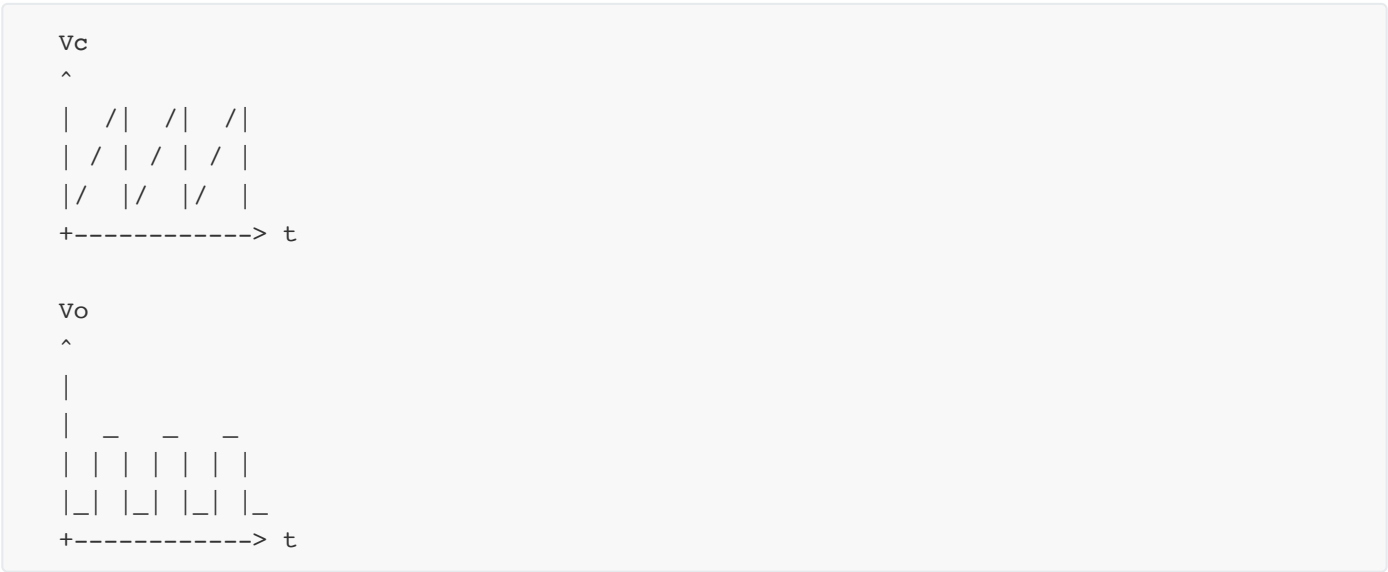
Answer:

Component	Function
UJT	Provides switching action
Capacitor	Timing element
Resistor	Controls charging rate
Output	Sawtooth waveform

Diagram:



Waveforms:



- **Operating principle:** Capacitor charges until UJT firing voltage, then rapidly discharges
- **Frequency formula:**  $f \approx 1/(RC \times \ln(1/(1-\eta)))$



- **Applications:** Timing circuits, pulse generators, control systems

**Mnemonic:** "Charge-Fire-Repeat - Sawtooth's Beat"

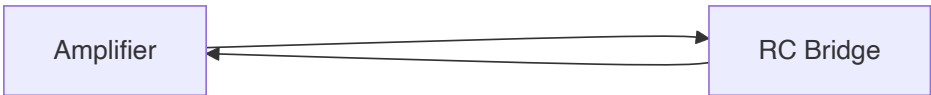
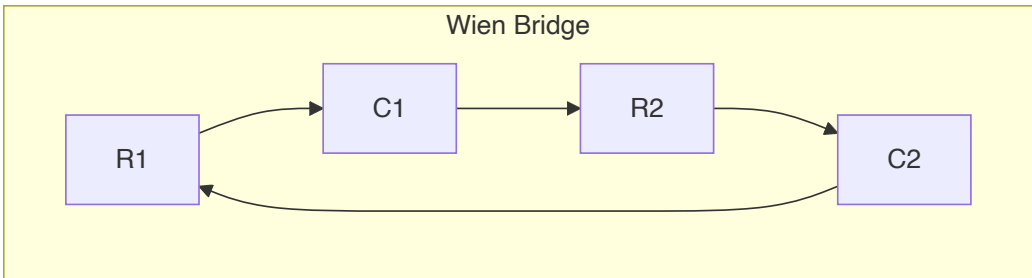
## Question 2(c) OR [7 marks]

Explain working of weinbridge oscillator with neat diagram also state the advantage, disadvantage and application for the same.

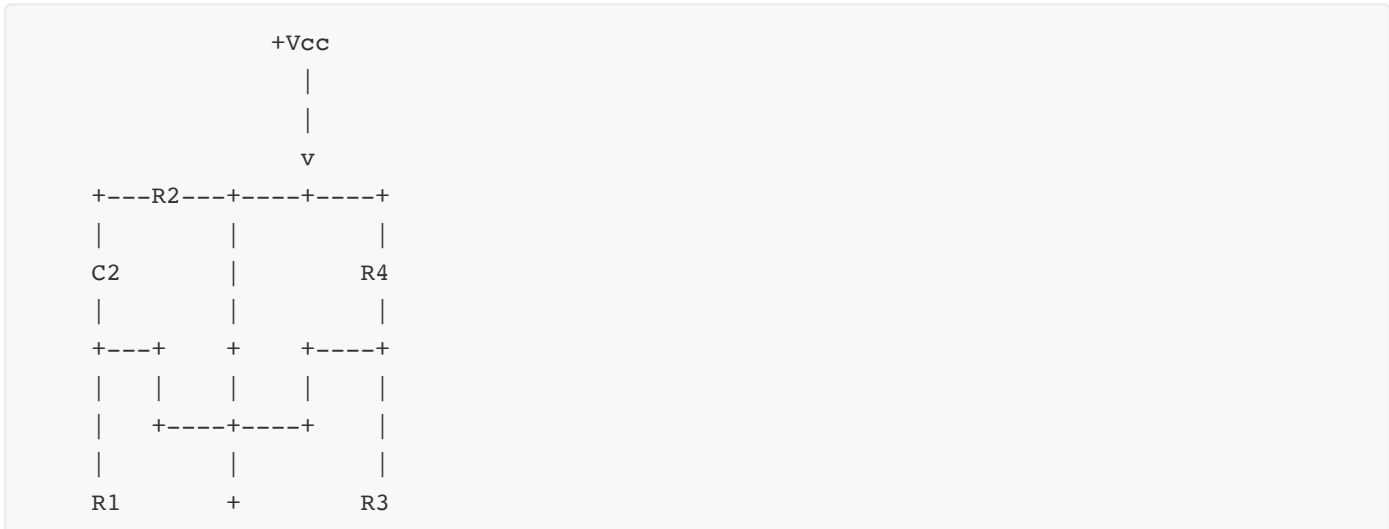
Answer:

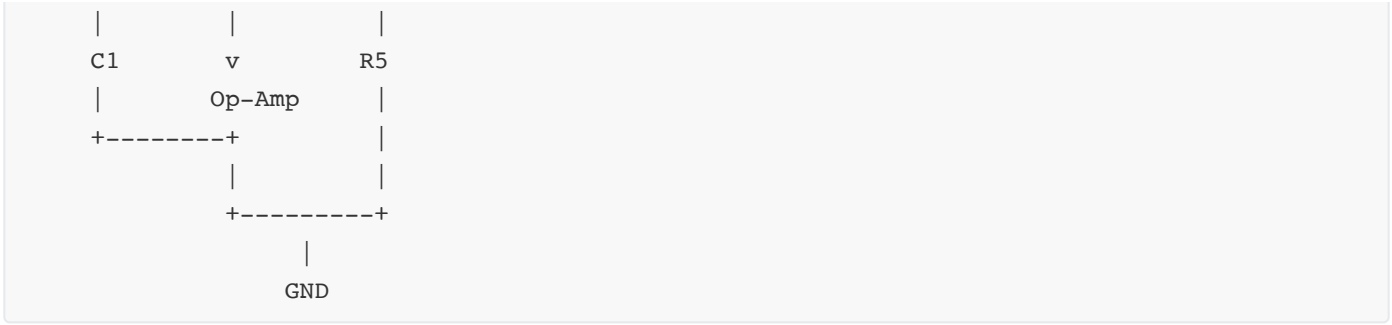
Parameter	Description
Configuration	RC feedback network in bridge formation
Frequency Formula	$f = 1/(2\pi RC)$ when $R1=R3$ and $C2=C4$
Feedback	Positive feedback through RC network
Phase Shift	$0^\circ$ at resonant frequency

Diagram:



Circuit:





**Advantages:**

- High frequency stability
- Low distortion output
- Simple RC components
- Easy to tune

**Disadvantages:**

- Limited frequency range
- Amplitude stabilization needed
- Sensitive to component variations
- Difficult to start oscillations

**Applications:**

- Audio test equipment
- Function generators
- Musical instruments
- Laboratory signal sources

**Mnemonic:** "Wien Works at  $R_1C_1=R_2C_2$  frequency"

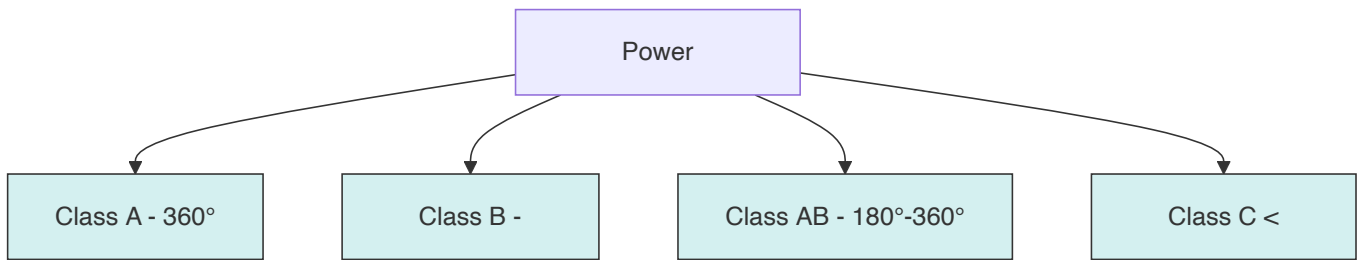
**Question 3(a) [3 marks]**

**Give classification of power Amplifier.**

**Answer:**

Classification Basis	Types
Based on Conduction Angle	Class A, B, AB, C
Based on Configuration	Single-ended, Push-pull, Complementary
Based on Coupling	RC coupled, Transformer coupled, Direct coupled
Based on Operation	Linear, Switching

**Diagram:**



- **Class A:** Conducts for full 360° cycle, highest linearity, lowest efficiency
- **Class B:** Conducts for 180° cycle, medium distortion, medium efficiency
- **Class AB:** Conducts for 180°-360° cycle, good linearity, good efficiency
- **Class C:** Conducts for <180° cycle, highest distortion, highest efficiency

**Mnemonic:** "A All-time, B Bisects, AB Almost-Bisects, C Cuts-more"

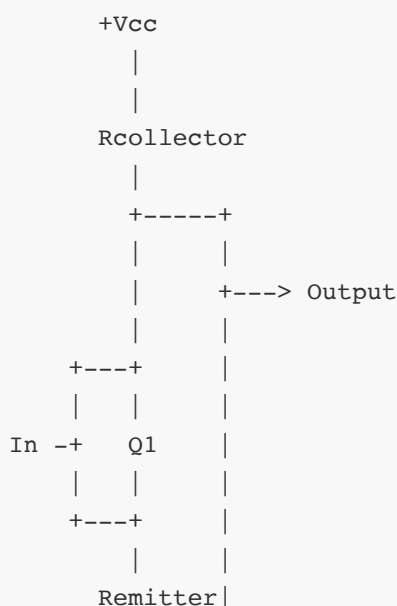
## Question 3(b) [4 marks]

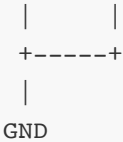
**Explain class A power amplifier.**

**Answer:**

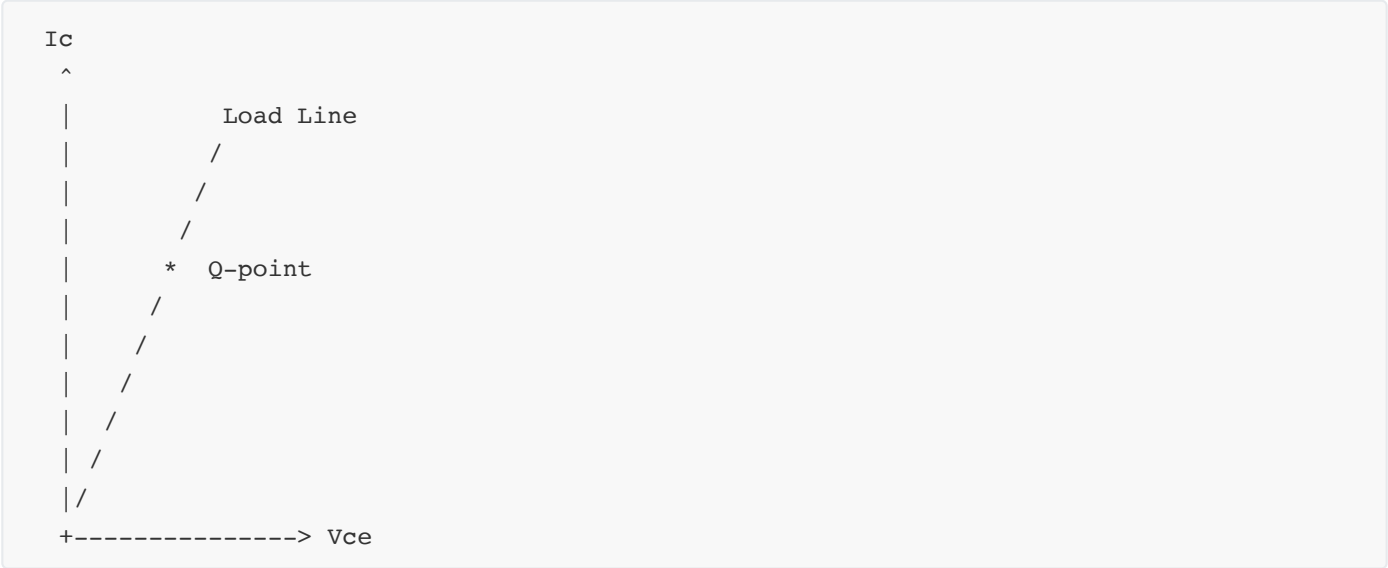
Parameter	Class A Amplifier
Conduction Angle	360° (full cycle)
Biasing	Q-point at center of load line
Efficiency	Low (25-30% max)
Distortion	Very low

**Diagram:**





Load Line:



- **Operating principle:** Transistor conducts for entire input cycle
- **Efficiency calculation:** Maximum theoretical efficiency = 50%
- **Practical efficiency:** Typically 25-30% due to losses
- **Applications:** Audio pre-amplifiers, low-power amplifiers where quality matters more than efficiency

Mnemonic: "Class A - Always conducting, All cycle"

Question 3(c) [7 marks]

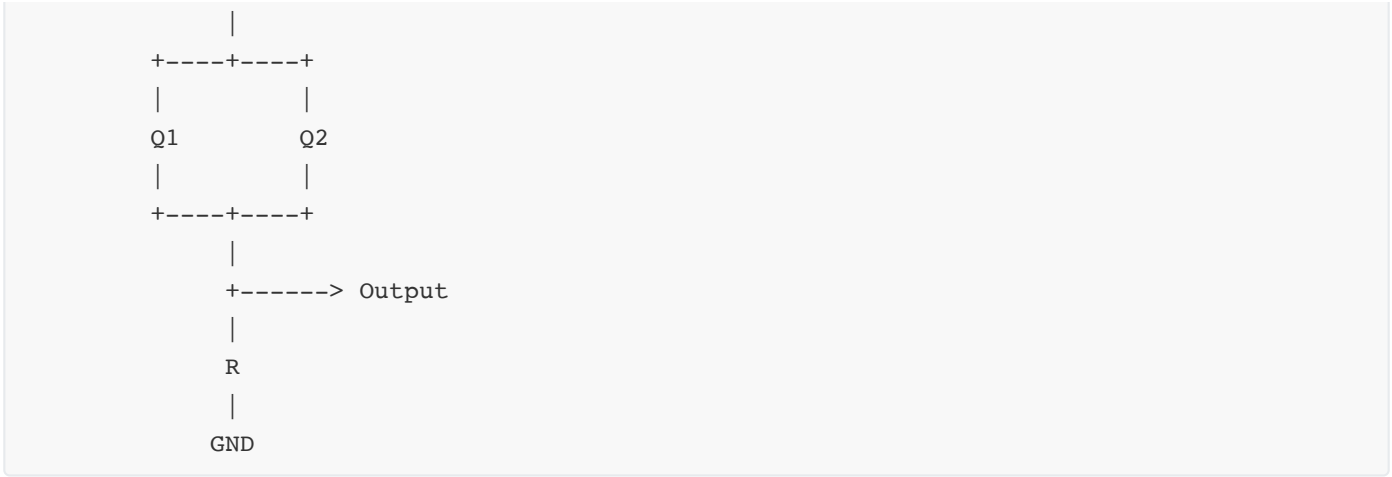
Explain the principle of push pull amplifiers and write short note on class B push pull amplifier.

Answer:

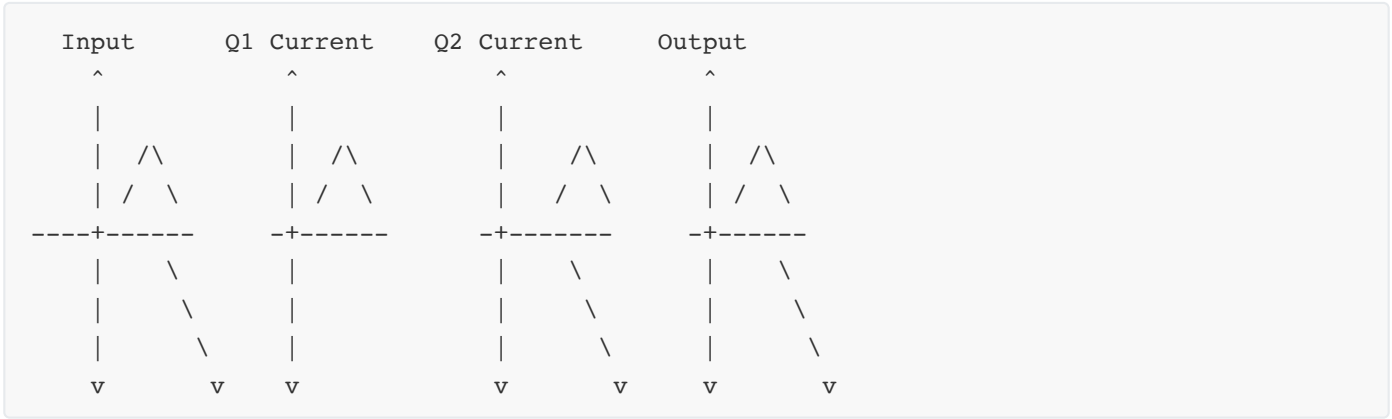
Push-Pull Principle	Class B Push-Pull
Uses two complementary devices	Each transistor conducts for half cycle
Reduces even harmonic distortion	Higher efficiency (78.5% theoretical)
Cancels DC magnetization in transformer	Suffers from crossover distortion
Provides higher output power	Requires proper biasing to minimize distortion

Diagram:





Waveforms:



- **Working principle:** Each transistor conducts for alternate half-cycles
- **Advantages:** Higher efficiency, reduced even harmonics, lower heat generation
- **Disadvantages:** Crossover distortion at transition points
- **Applications:** Audio power amplifiers, output stages of high-power systems

**Mnemonic:** "Push-Pull: Pair Processes alternate Pulses"

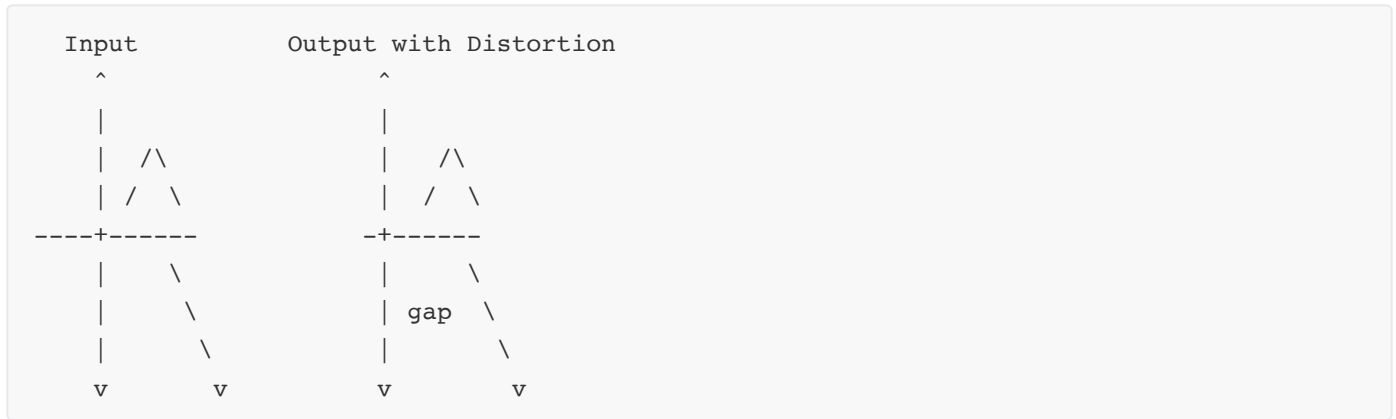
Question 3(a) OR [3 marks]

Discuss crossover distortion in push pull amplifier. How it can be removed.

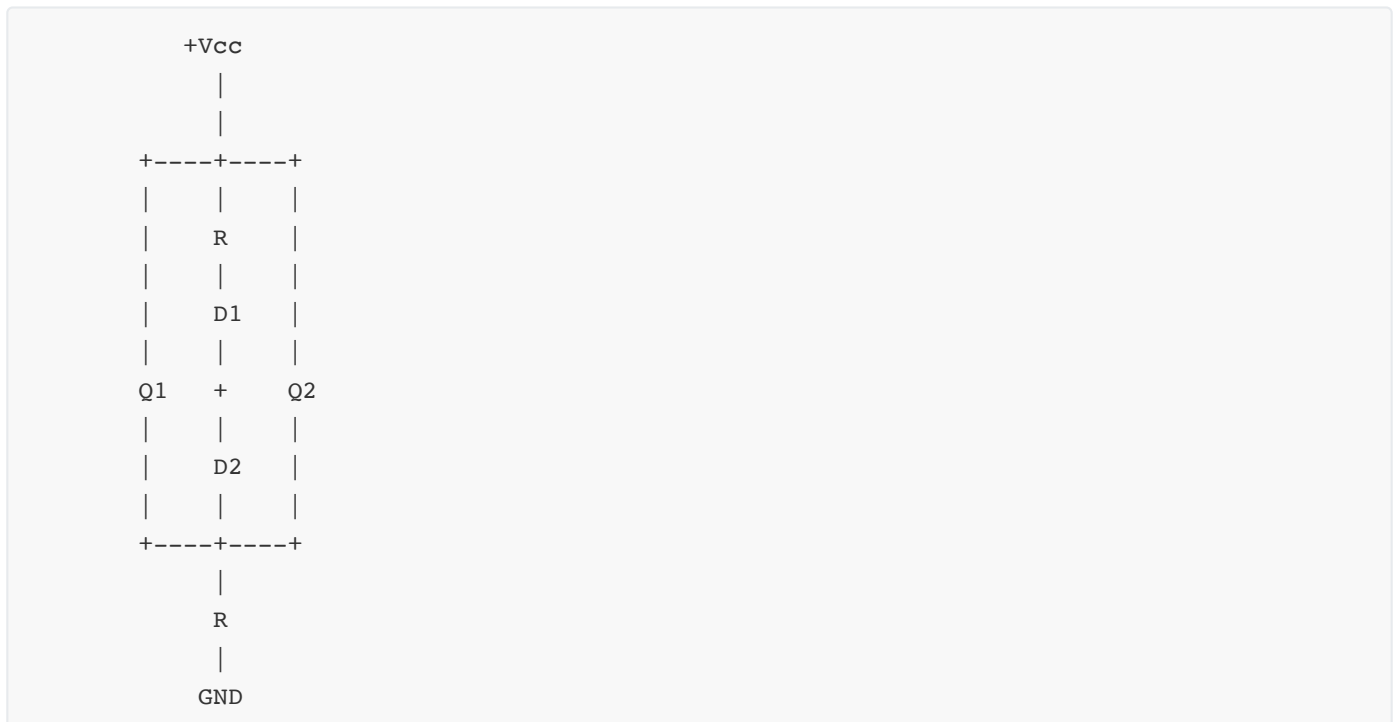
Answer:

Crossover Distortion	Solution Methods
Occurs at signal crossover points	Apply small bias voltage (Class AB)
Due to transistor's non-linear region	Use diode compensation networks
Creates "dead zone" around zero	Implement feedback correction
Affects small signals more	Use complementary emitter-follower stage

Diagram:



### Correction Circuit:



- **Cause:** Transistors require  $\sim 0.7V$  to turn on, creating dead zone
- **Effect:** Distortion particularly noticeable at low volumes
- **Solution:** Class AB biasing with diodes or VBE multiplier
- **Result:** Smoother transition between positive and negative half-cycles

**Mnemonic:** "Cross to Class AB Smooths the Gap"

## Question 3(b) OR [4 marks]

**Explain complimentary symmetry push-pull amplifier.**

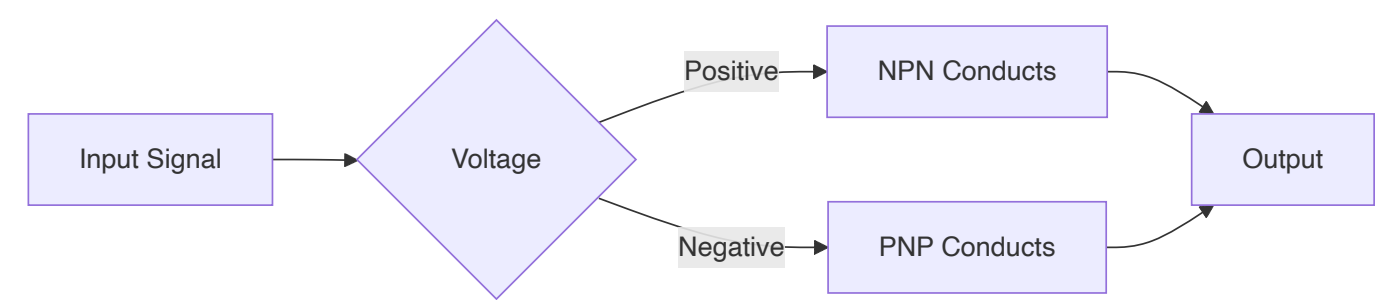
**Answer:**

Component	Purpose
NPN Transistor	Handles positive half-cycle
PNP Transistor	Handles negative half-cycle
Biasing Network	Reduces crossover distortion
Output Coupling	Direct coupling to load

Diagram:



Working Principle:



- **Key feature:** Uses complementary transistors (NPN and PNP) for push-pull operation
- **Advantage:** No output transformer required, direct coupling to load
- **Efficiency:** Typically 78.5% theoretical maximum
- **Applications:** Audio amplifiers, power output stages

**Mnemonic:** "NPN Pulls-up, PNP Pulls-down"

Question 3(c) OR [7 marks]

Derive the equation of efficiency for class B push pull Amplifier.

Answer:

Parameter	Formula	Description
DC Input Power	$P_{DC} = 2V_{CC} \times I_{DC}$	Power drawn from supply
AC Output Power	$P_{AC} = V_{rms}^2 / R_L$	Power delivered to load
Maximum Efficiency	$\eta = (\pi/4) \times 100\% = 78.5\%$	Theoretical maximum
Practical Efficiency	60-70%	Considering losses

Mathematical Derivation:

For a sinusoidal input:  $v(t) = V_m \sin(\omega t)$

Step 1: DC Input Power

- Input current per transistor:  $I_m / \pi$
- Total DC input power:  $P_{DC} = 2V_{CC} \times I_m / \pi$

Step 2: AC Output Power

- RMS output voltage:  $V_{rms} = V_m / \sqrt{2}$
- Maximum output voltage:  $V_m = V_{CC}$
- Output power:  $P_{AC} = V_{rms}^2 / R_L = V_m^2 / 2R_L$

Step 3: Efficiency Calculation

- $\eta = (P_{AC} / P_{DC}) \times 100\%$
- $\eta = ((V_m^2 / 2R_L) / (2V_{CC} \times I_m / \pi)) \times 100\%$
- Since  $V_m = V_{CC}$  and  $I_m = V_{CC} / R_L$
- $\eta = (\pi/4) \times 100\% = 78.5\%$

Diagram:





- **Power dissipation:** Most efficient when output voltage swing approaches VCC
- **Conduction angle:** Each transistor conducts for exactly 180°
- **Practical factors:** Biasing current, saturation voltage, and other losses reduce efficiency
- **Comparison:** Much higher than Class A (25-30%), less than Class C (>80%)

**Mnemonic:** "Pi-over-4 gives 78.5% - Class B's best"

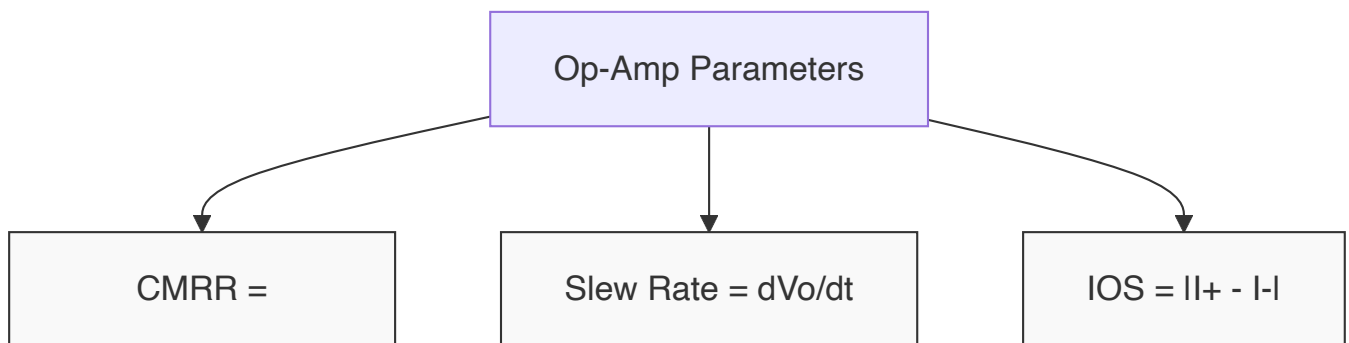
## Question 4(a) [3 marks]

Define.(i) CMRR (ii)slew rate.(iii)Input offset Current.

**Answer:**

Parameter	Definition	Typical Values
CMRR	Ratio of differential gain to common-mode gain	80-120 dB
Slew Rate	Maximum rate of change of output voltage	0.5-20 V/ $\mu$ s
Input Offset Current	Difference between currents into the two inputs	1-100 nA

**Diagram:**



- **CMRR:** Measures op-amp's ability to reject common-mode signals
- **Slew Rate:** Limits maximum frequency for undistorted output
- **Input Offset Current:** Causes output error even with identical inputs

**Mnemonic:** "Cancelling Mistakes Requires Ratios"

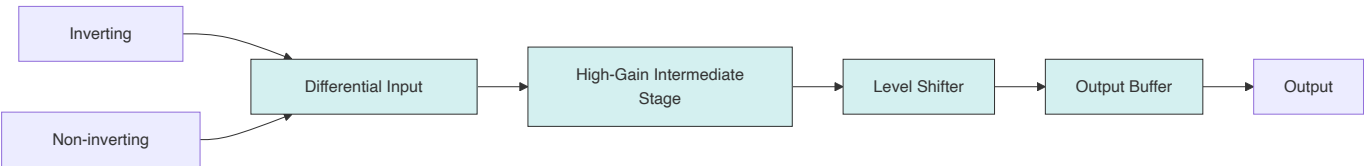
## Question 4(b) [4 marks]

Draw and explain the basic block diagram of an operational amplifier.

**Answer:**

Stage	Function
Differential Input	Accepts and amplifies difference between inputs
High-Gain Intermediate	Provides voltage amplification
Level Shifter	Shifts DC level for output stage
Output Buffer	Provides low output impedance

Diagram:



- **Differential input stage:** Converts differential input to single-ended output
- **High-gain stage:** Provides most of the open-loop gain
- **Level shifter:** Shifts signal level for proper output operation
- **Output stage:** Provides current gain and low output impedance

Mnemonic: "Diff-Amp Gain Shift Out"

## Question 4(c) [7 marks]

Explain in detail operational amplifier as integrator.

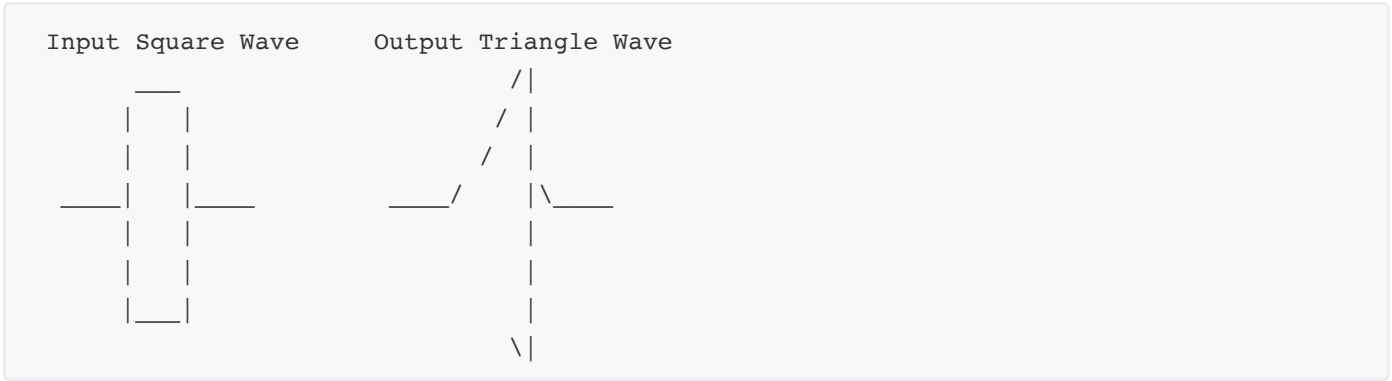
Answer:

Parameter	Description	Formula
Circuit	Op-amp with capacitor in feedback	-
Transfer Function	Output proportional to integral of input	$V_o = -(1/RC) \int V_i dt$
Frequency Response	Acts as low-pass filter	Gain = $1/(j\omega RC)$
Phase Shift	-90°	-

Diagram:



Input/Output Waveforms:



- **Working principle:** Capacitor integrates current over time
- **Mathematical basis:**  $V_o(t) = -(1/RC)\int V_i(t)dt + V_o(0)$
- **Limitations:** Capacitor leakage, op-amp input bias current cause drift
- **Applications:** Waveform generators, analog computers, active filters

**Mnemonic:** "Square-In Triangle-Out, RC sets the Slope"

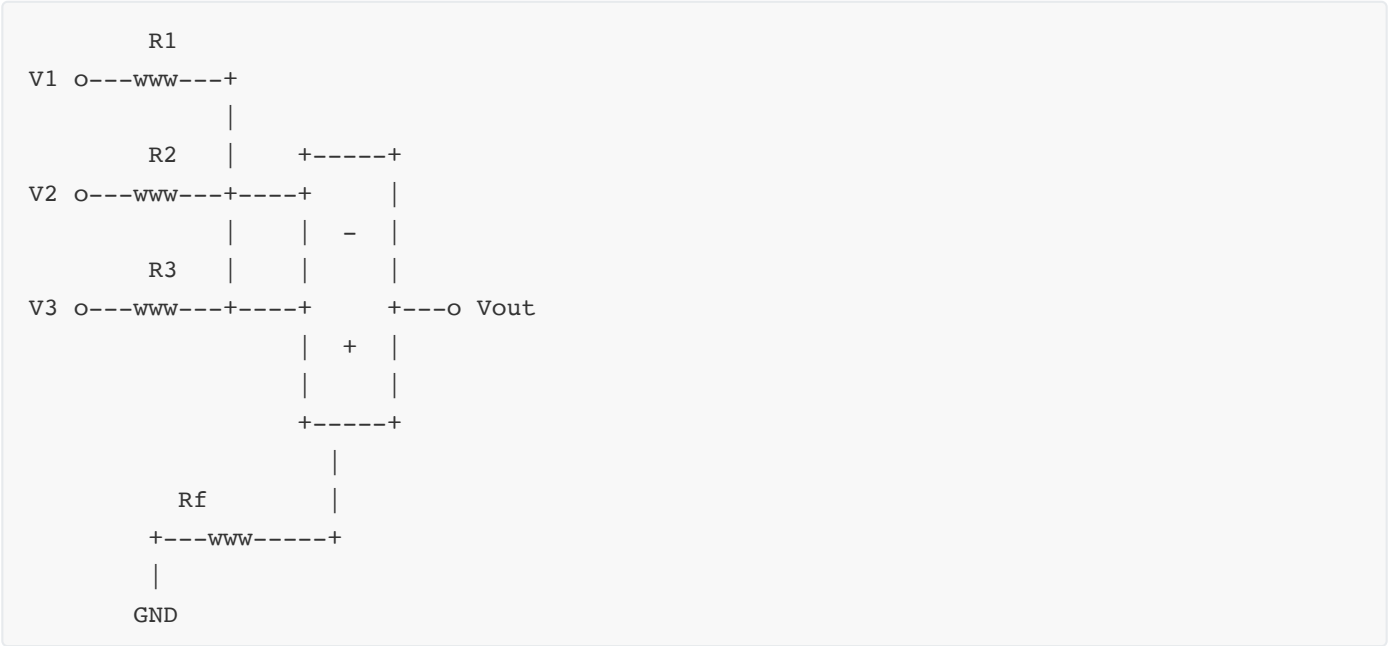
Question 4(a) OR [3 marks]

Explain operational amplifier as summing amplifier.

Answer:

Parameter	Description	Formula
Circuit	Multiple inputs with same feedback	$V_o = -(R_1/R_1 \times V_1 + R_1/R_2 \times V_2 + \dots)$
Equal Resistors	Simple addition/averaging	$V_o = -(V_1 + V_2 + \dots + V_n)$
Weighted Sum	Different input resistors	$V_o = -(K_1 V_1 + K_2 V_2 + \dots + K_n V_n)$
Inverting	Output inverted from inputs	-

Diagram:



- **Working principle:** Each input contributes current to summing junction
- **Applications:** Audio mixers, signal processing, analog computers
- **Virtual ground:** Summing point maintains near-zero voltage
- **Variations:** Inverting, non-inverting, and differential summer

**Mnemonic:** "Many Inputs, One Output - Sum It All"

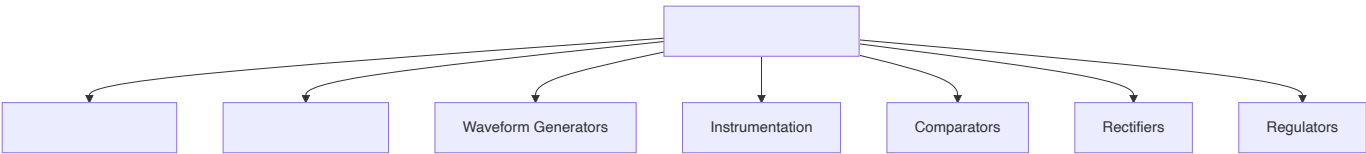
Question 4(b) OR [4 marks]

State the applications of operational amplifier.

Answer:

Application Category	Examples
Signal Processing	Amplifiers, Filters, Buffers
Mathematical Operations	Adders, Subtractors, Integrators, Differentiators
Waveform Generators	Sine, Square, Triangle, Pulse generators
Instrumentation	Instrumentation amplifiers, Current-to-voltage converters
Comparators	Zero crossing detectors, Window comparators
Precision Rectifiers	Full-wave, Half-wave rectifiers
Voltage Regulators	Series regulators, Shunt regulators

Diagram:



- **Linear applications:** Utilize op-amp in linear region for amplification, filtering
- **Non-linear applications:** Use saturation characteristics for comparison, limitation
- **Analog computation:** Perform mathematical operations on analog signals
- **Signal conditioning:** Adapt signals for analog-to-digital conversion

**Mnemonic:** "SMWIG-CR: Signal, Math, Wave, Instrument, Gate, Convert, Regulate"

## Question 4(c) OR [7 marks]

**Explain op-amp as inverting and non-inverting amplifier.**

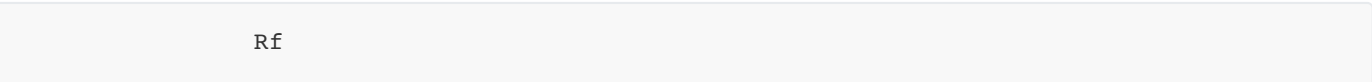
**Answer:**

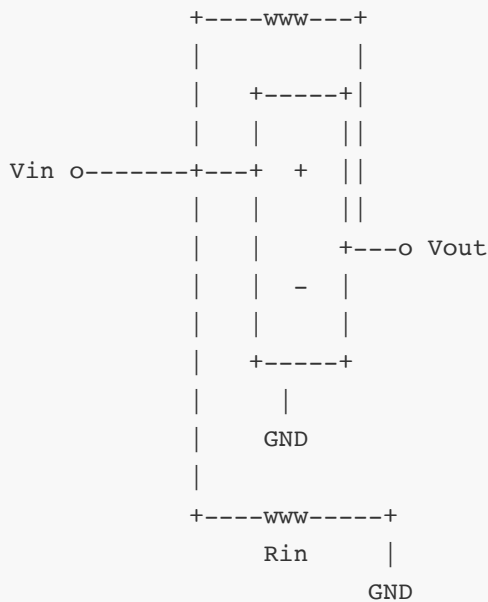
Parameter	Inverting Amplifier	Non-Inverting Amplifier
Circuit Configuration	Input to negative terminal	Input to positive terminal
Gain Formula	$A = -R_f/R_{in}$	$A = 1 + R_f/R_{in}$
Input Impedance	$= R_{in}$	Very high ( $\approx 10^9$ ohms)
Phase Shift	$180^\circ$	$0^\circ$
Virtual Ground	At negative input	Not applicable

**Inverting Amplifier:**



**Non-Inverting Amplifier:**



**Inverting Mode:**

- **Gain equation:**  $V_{out} = -(R_f/R_{in}) \times V_{in}$
- **Virtual ground:** Negative input maintained at  $\sim 0V$
- **Applications:** Signal inversion, controlled gain, summing

**Non-Inverting Mode:**

- **Gain equation:**  $V_{out} = (1 + R_f/R_{in}) \times V_{in}$
- **Minimum gain:** Always  $\geq 1$
- **Applications:** Buffering, voltage amplification with high input impedance

**Mnemonic:** "Invert: Negative is Input, Non-invert: Positive gets signal"

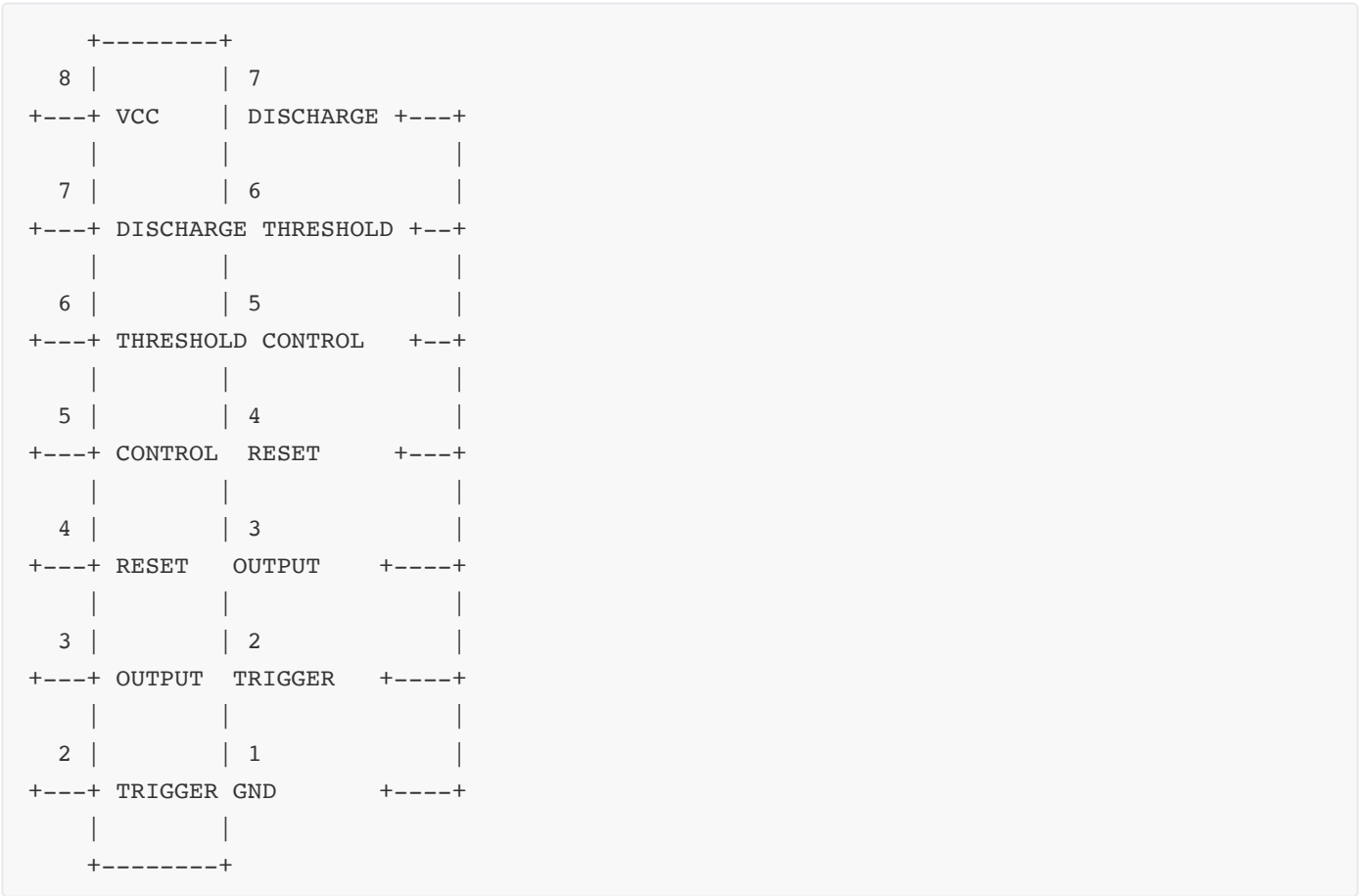
## Question 5(a) [3 marks]

Give pin description of IC555.

Answer:

Pin Number	Pin Name	Description
1	Ground	Connected to circuit ground
2	Trigger	Starts timing cycle when < 1/3 VCC
3	Output	Provides output signal
4	Reset	Terminates timing when LOW
5	Control Voltage	Adjusts threshold voltage
6	Threshold	Ends timing cycle when > 2/3 VCC
7	Discharge	Connected to timing capacitor
8	VCC	Positive supply voltage (5-15V)

Diagram:



- **Input pins:** Trigger, Reset, Threshold, Control Voltage
- **Output pins:** Output, Discharge
- **Power pins:** VCC, Ground
- **Internal structure:** Composed of comparators, flip-flop, discharge transistor

**Mnemonic:** "Ground Triggers Output Reset Control Threshold Discharges Voltage"

# Question 5(b) [4 marks]

Explain op-amp as differentiator.

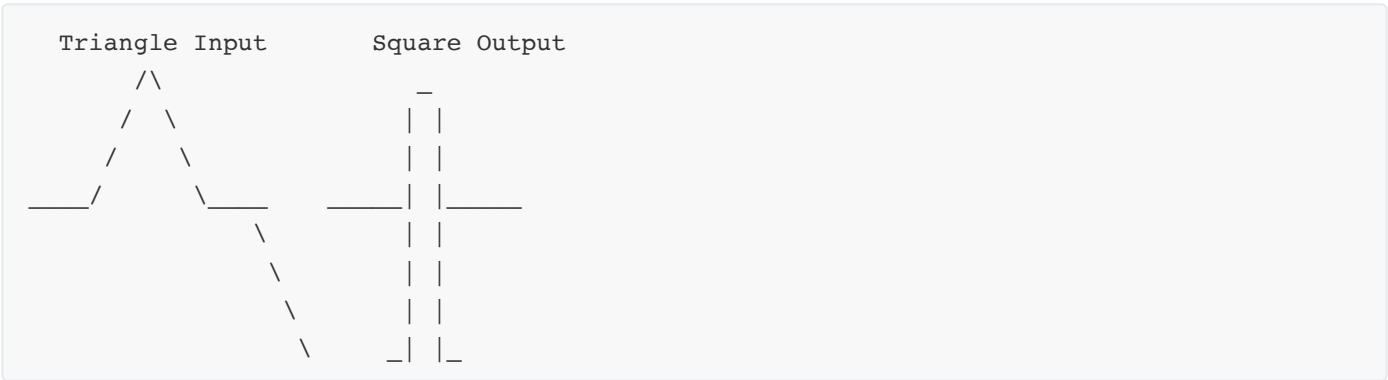
Answer:

Parameter	Description	Formula
Circuit	Op-amp with capacitor in input	$V_o = -RC(dV_i/dt)$
Transfer Function	Output proportional to rate of change	$H(s) = -sRC$
Frequency Response	Acts as high-pass filter	Gain increases with frequency
Phase Shift	+90°	-

Diagram:



Input/Output Waveforms:



- **Working principle:** Output voltage proportional to rate of change of input
- **Mathematical basis:**  $V_o = -RC(dV_{in}/dt)$
- **Practical limitations:** Sensitive to high-frequency noise
- **Applications:** Waveform generation, edge detection, rate-of-change indicator



**Mnemonic:** "Differentiator Delivers Derivatives - RC determines speed"

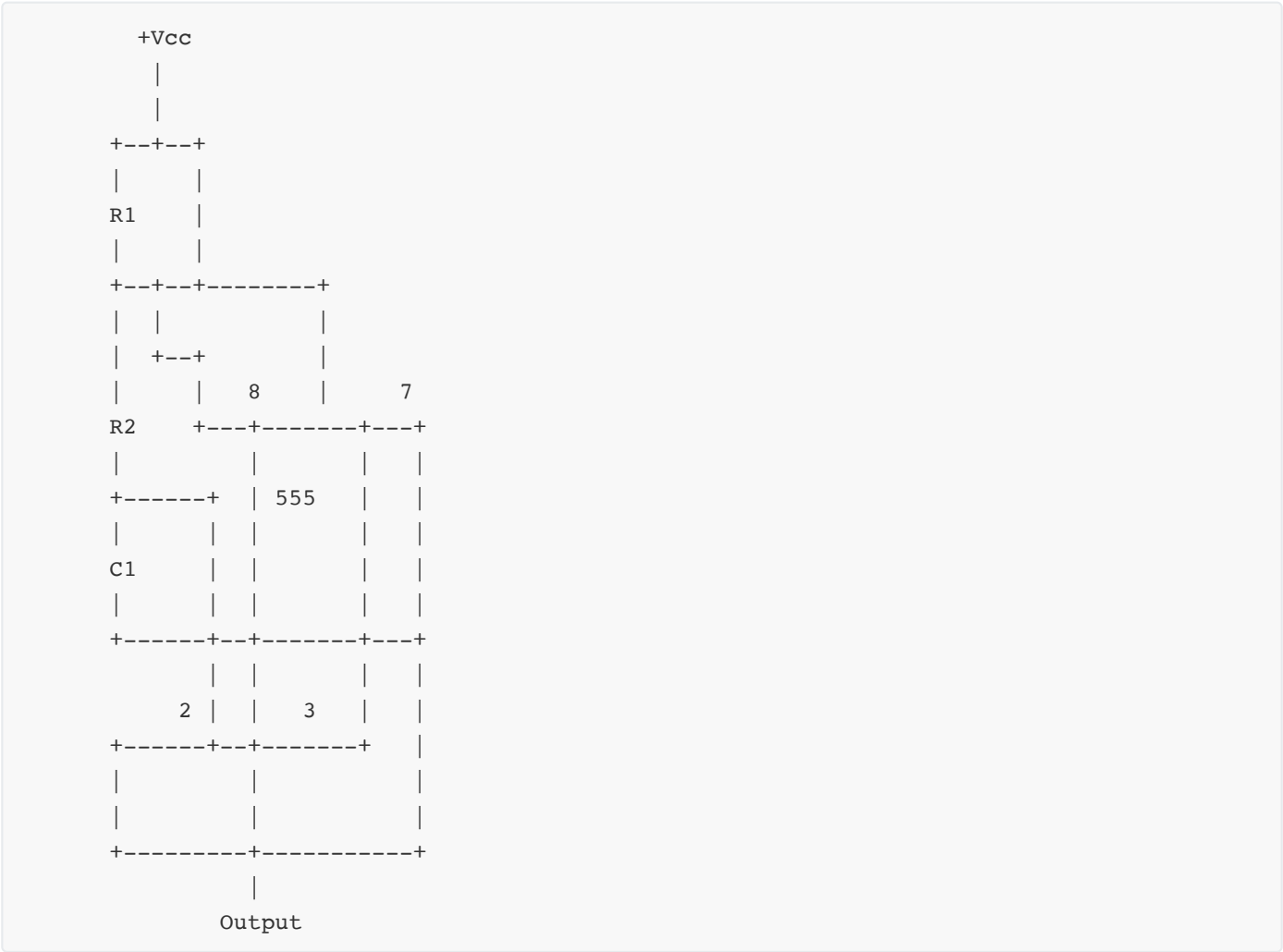
Question 5(c) [7 marks]

Explain IC 555 as astable and Monostable multivibrator.

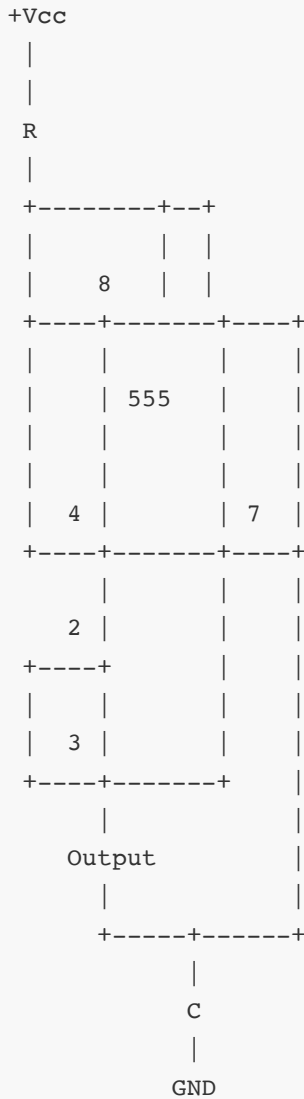
Answer:

Parameter	Astable Multivibrator	Monostable Multivibrator
Definition	Free-running oscillator	One-shot pulse generator
Stable States	None (continuously oscillates)	One stable state
Timing	$T = 0.693(RA+2RB)C$	$T = 1.1RC$
Trigger	Self-triggering	External trigger required
Output	Continuous square wave	Single pulse of fixed width

Astable Circuit:



Monostable Circuit:



### Astable Operation:

- **Working:** Capacitor charges through  $R_A + R_B$  and discharges through  $R_B$
- **Duty cycle:** Can be adjusted by proper selection of  $R_A$  and  $R_B$
- **Frequency:**  $f = 1.44 / ((R_A + 2R_B)C)$
- **Applications:** LED flashers, tone generators, clock pulse generators

### Monostable Operation:

- **Working:** Triggered by falling edge on pin 2, outputs HIGH for time  $T$
- **Time period:**  $T = 1.1RC$
- **Applications:** Time delays, pulse width modulation, debouncing

**Mnemonic:** "Astable Always Alternates, Monostable Makes One pulse"

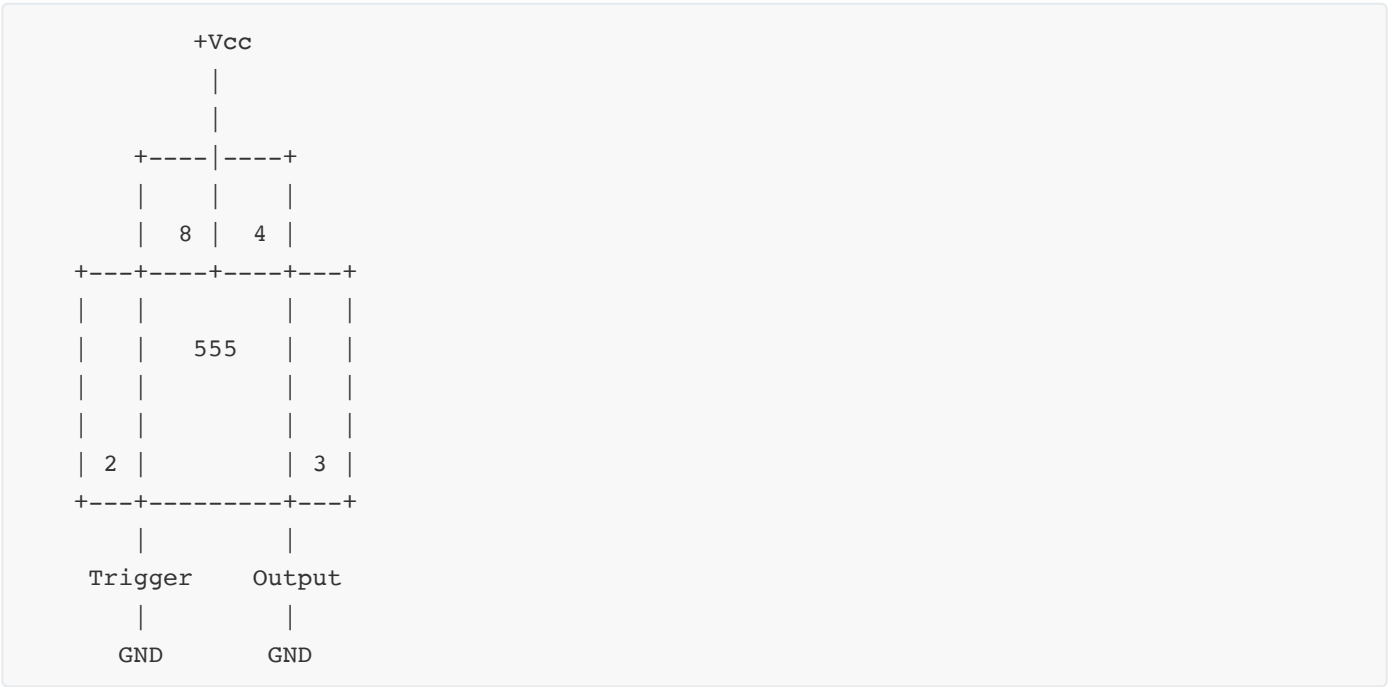
## Question 5(a) OR [3 marks]

Explain IC555 as Bistable multivibrator.

Answer:

Parameter	Description
Definition	Flip-flop circuit with two stable states
Triggering	SET by trigger pin (2), RESET by reset pin (4)
Stable States	Two (HIGH or LOW)
Time Period	No timing components needed

Diagram:



Truth Table:

Trigger (Pin 2)	Reset (Pin 4)	Output (Pin 3)
< 1/3 VCC	HIGH	HIGH
> 1/3 VCC	HIGH	No change
Any	LOW	LOW

- **SET operation:** Occurs when trigger pin falls below 1/3 VCC
- **RESET operation:** Occurs when reset pin is pulled LOW
- **Applications:** Latching switches, memory elements, flip-flops
- **Features:** No timing components (R, C) required

Mnemonic: "Bistable Bounces Between two states"

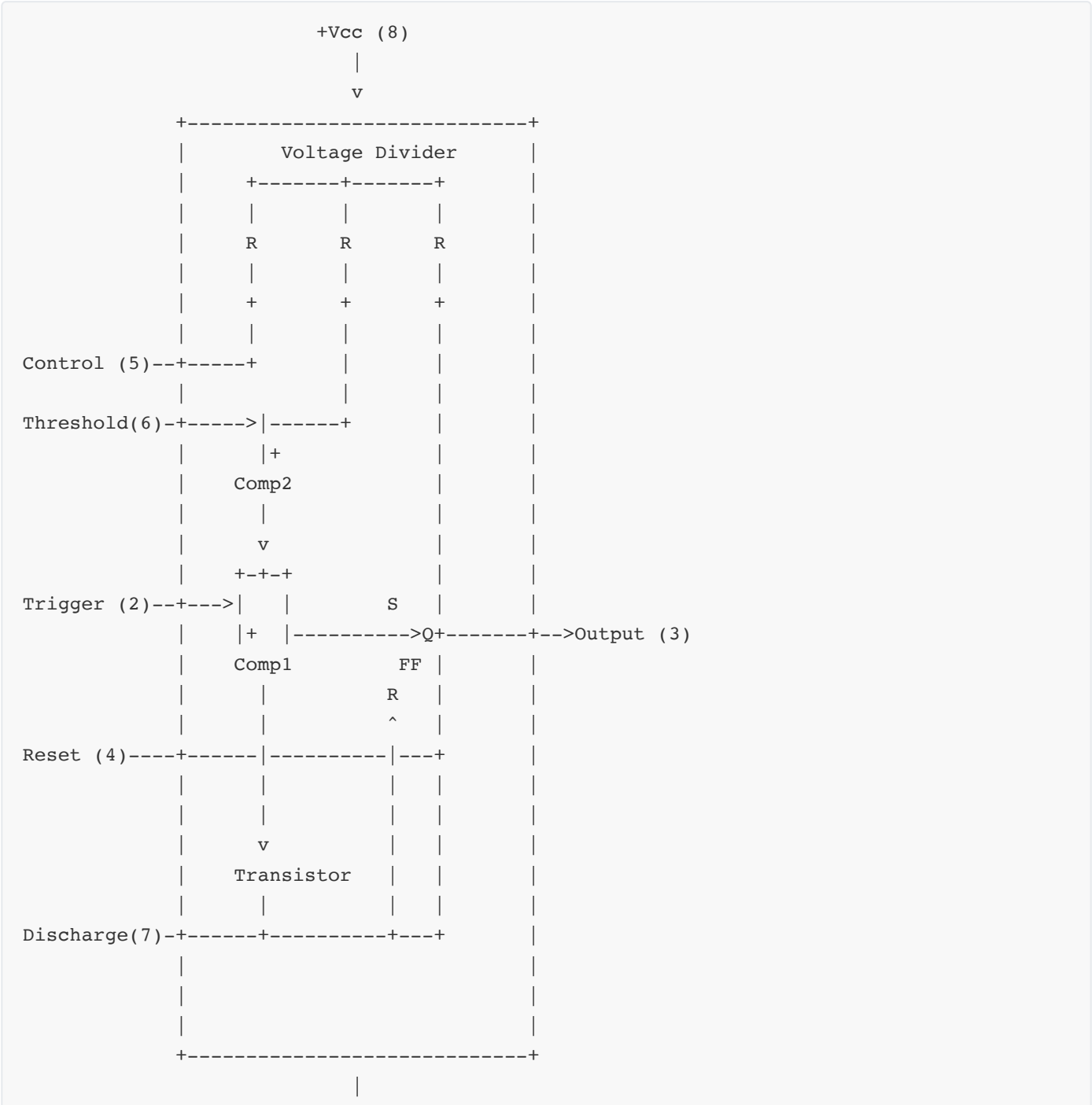
Question 5(b) OR [4 marks]

Explain the basic operation of IC555 with internal block diagram.

Answer:

Block	Function
Comparators	Monitor trigger and threshold voltages
Flip-Flop	Controls output state
Discharge Transistor	Discharges timing capacitor
Voltage Divider	Establishes reference voltages

Internal Block Diagram:



GND ( 1 )

Basic Operation:

- 1. **Voltage divider:** Creates 2/3 VCC and 1/3 VCC reference points
  - 2. **Comparator 1:** Triggers when pin 2 goes below 1/3 VCC
  - 3. **Comparator 2:** Resets when pin 6 goes above 2/3 VCC
  - 4. **Flip-flop:** Controls output state based on comparator inputs
  - 5. **Discharge transistor:** Connects pin 7 to ground when output is LOW
- **Versatility:** Can be configured in multiple modes (astable, monostable, bistable)
  - **Timing precision:** Determined by external RC components
  - **Wide supply range:** Functions from 4.5V to 16V

Mnemonic: "Comparators Control Flip-flop For Timing"

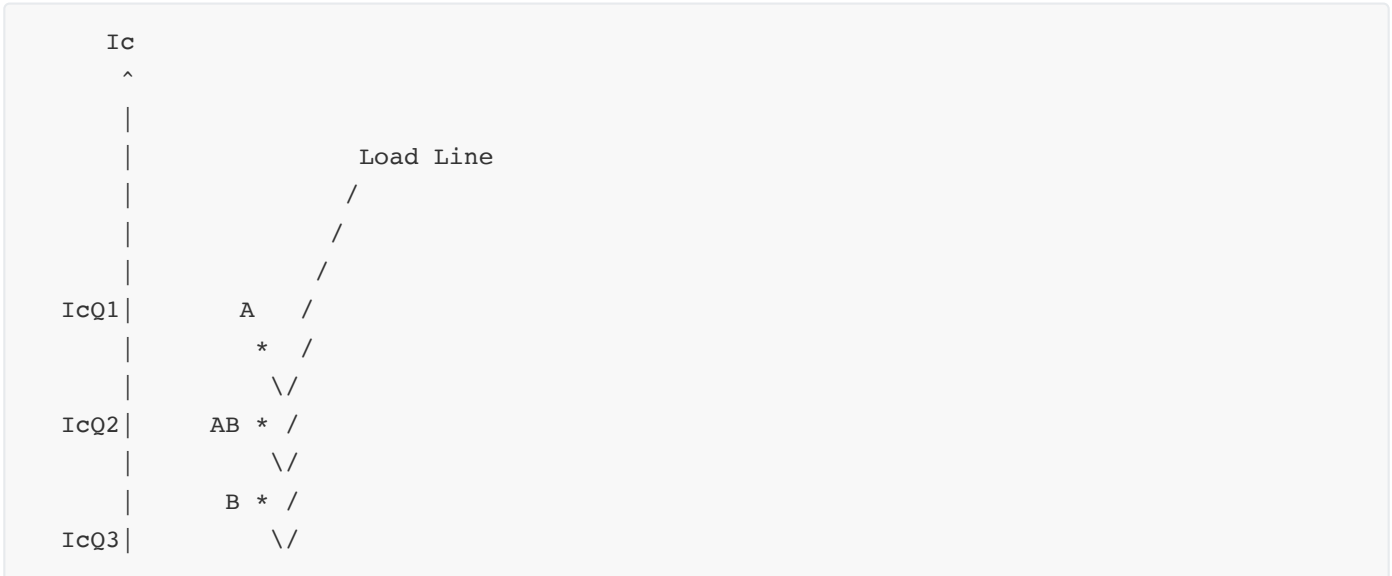
Question 5(c) OR [7 marks]

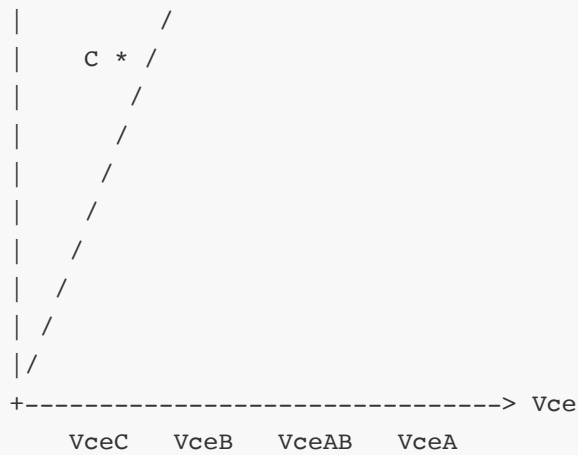
Explain how class A, Class B, Class C and Class AB Power amplifier are classified based on their Q Point location on load line, with diagram.

Answer:

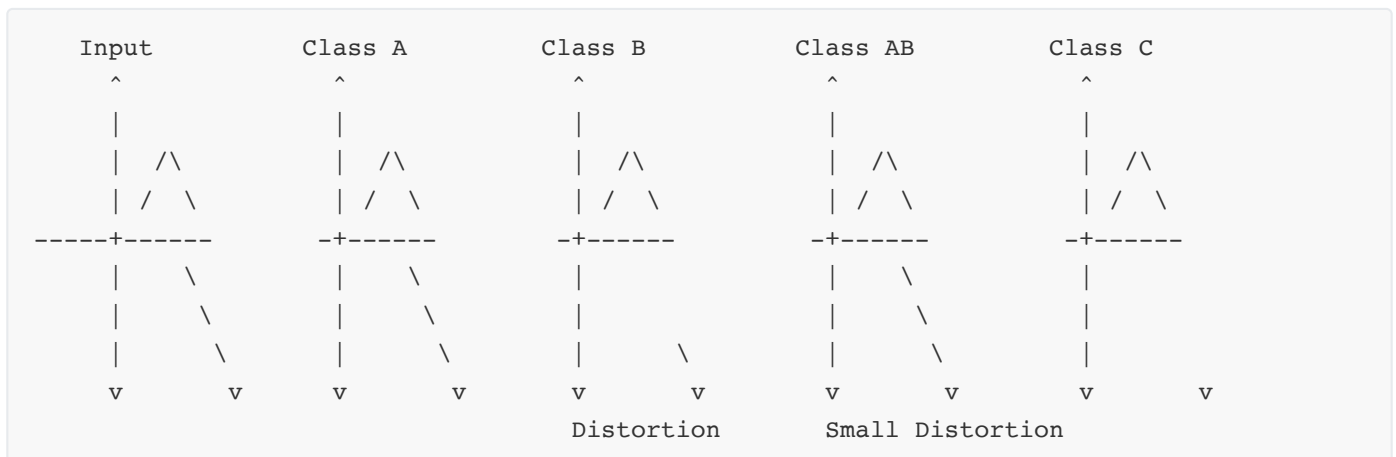
Amplifier Class	Q-Point Location	Conduction Angle	Efficiency
Class A	Center of load line	360°	25-30%
Class B	Cut-off point	180°	78.5%
Class AB	Slightly above cut-off	180°-360°	50-78.5%
Class C	Below cut-off	<180°	>80%

Diagram Load Line:





### Input/Output Waveforms:



### Class A Characteristics:

- **Q-point:** Center of load line
- **Bias:** Fixed bias maintains conduction for entire cycle
- **Linearity:** Excellent linearity, minimal distortion
- **Efficiency:** Poor (25-30%)

### Class B Characteristics:

- **Q-point:** At cutoff point
- **Bias:** Biased at cutoff, each device conducts for half-cycle
- **Distortion:** Crossover distortion at zero-crossing
- **Efficiency:** Good (78.5% theoretical)

### Class AB Characteristics:

- **Q-point:** Slightly above cutoff
- **Bias:** Small bias current eliminates crossover distortion
- **Linearity:** Good compromise between A and B
- **Efficiency:** Moderate (50-78.5%)

### **Class C Characteristics:**

- **Q-point:** Below cutoff
- **Bias:** Conducts for less than half-cycle
- **Distortion:** Severe distortion, requires tuned circuit
- **Efficiency:** Excellent (>80%)

**Mnemonic:** "Above center, Below center, Cut-off point, Down below - ABCD order for Q-point location"