

# Subject Name Solutions

4341105 – Summer 2025

Semester 1 Study Material

*Detailed Solutions and Explanations*

## Question 1(a) [3 marks]

Explain effect of negative feedback on gain and stability.

### Solution

Negative feedback significantly improves amplifier performance by reducing gain but enhancing stability and other parameters.

Parameter	Effect of Negative Feedback
<b>Gain</b>	Reduces overall gain
<b>Stability</b>	Increases stability
<b>Bandwidth</b>	Increases bandwidth

- **Gain reduction:** Makes amplifier more predictable
- **Stability improvement:** Reduces oscillations and distortions
- **Better control:** Provides consistent performance

### Mnemonic

“Gain Goes Down, Stability Stays Strong”

## Question 1(b) [4 marks]

State different types of feedback amplifier and advantages of negative feedback amplifier.

### Solution

Four basic feedback topologies exist based on input and output connections.

Type	Input Connection	Output Connection
<b>Voltage Series</b>	Series	Voltage
<b>Voltage Shunt</b>	Shunt	Voltage
<b>Current Series</b>	Series	Current
<b>Current Shunt</b>	Shunt	Current

### Advantages:

- **Reduced distortion:** Minimizes harmonic content
- **Increased bandwidth:** Better frequency response
- **Improved stability:** Consistent operation

### Mnemonic

“Very Smart Current Control”

## Question 1(c) [7 marks]

Derive an equation for overall gain of negative feedback voltage amplifier.

## Solution

For negative feedback amplifier, output is fed back to input in opposite phase.

**Circuit Analysis:** Let  $A$  = Open loop gain,  $f$  = Feedback factor

**Diagram:**

### Mermaid Diagram (Code)

```
{Shaded}  
{Highlighting} []  
graph LR  
    A[Input Vi] --{-{-}{}}--> B[Amplifier A]  
    B --{-{-}{}}--> C[Output Vo]  
    C --{-{-}{}}--> D[Feedback ]  
    D --{-{-}{}}--> E[Summing Junction]  
    A --{-{-}{}}--> E  
{Highlighting}  
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```

### Derivation:

- Input to amplifier:  $Vi - Vo$
- Output:  $Vo = A(Vi - Vo)$
- $Vo = AVi - A Vo$
- $Vo + A Vo = AVi$
- $Vo(1 + A) = AVi$
- Overall Gain:  $Af = A/(1 + A)$

### Key Points:

- Denominator  $(1 + A)$ : Called loop gain
- Stability factor: Determines system response
- Gain reduction: Traded for better performance

## Mnemonic

“Always Divide by  $(1 + \text{Loop})$ ”

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

Draw and explain current shunt type negative feedback amplifier and Derive the formula of input impedance and output impedance of it.

## Solution

Current shunt feedback samples output current and feeds back voltage in shunt with input.

**Circuit Diagram:**

### Mermaid Diagram (Code)

```
{Shaded}  
{Highlighting} []  
graph LR  
    A[Vi] --{-{-}{}}--> B["{}+"]  
    B --{-{-}{}}--> C[Amplifier A]  
    C --{-{-}{}}--> D[Ro]  
    D --{-{-}{}}--> E[RL]  
    D --{-{-}{}}--> F[Feedback Network ]  
    F --{-{-}{}}--> G["{}{-}"]  
    B --{-{-}{}}--> G  
{Highlighting}  
{Shaded}
```

### Analysis:

- Feedback type: Current sampling, voltage mixing
- Input impedance: Decreases due to shunt feedback
- Output impedance: Decreases due to current sampling

**Formulas:**

- Input Impedance:  $Z_{if} = Z_i / (1 + A)$
- Output Impedance:  $Z_{of} = Z_o / (1 + A)$

**Characteristics:**

- Low input impedance: Good for current sources
- Low output impedance: Good for voltage output
- Current-to-voltage converter: Useful in applications

**Mnemonic**

“Current Shunt Lowers Both Impedances”

**Question 2(a) [3 marks]**

Explain Barkhausen criteria for oscillations.

**Solution**

For sustained oscillations in feedback circuits, two conditions must be satisfied simultaneously.

Criteria	Condition	Description
<b>Magnitude</b>	$ A  = 1$	Loop gain unity
<b>Phase</b>	$A = 0^\circ \text{ or } 360^\circ$	Zero phase shift

- **Unity loop gain:** Ensures signal maintains amplitude
- **Zero phase shift:** Ensures positive feedback
- **Sustained oscillation:** Both conditions create self-sustaining signals

**Mnemonic**

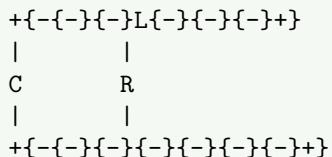
“One Magnitude, Zero Phase”

**Question 2(b) [4 marks]**

Explain use of tank circuit with neat diagram.

**Solution**

Tank circuit provides frequency selective positive feedback for oscillator circuits.

**Circuit Diagram:**

**Operation:** At resonant frequency, LC tank circuit exhibits:

Parameter	Value	Effect
<b>Reactance</b>	$XL = XC$	Resonance
<b>Impedance</b>	Maximum	High selectivity
<b>Phase</b>	$0^\circ$	Unity feedback

- **Energy storage:** L and C exchange energy
- **Frequency selection:** Sharp resonance characteristic
- **Oscillation sustenance:** Provides positive feedback

## Mnemonic

“Tank Stores Energy, Selects Frequency”

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

Draw and explain the Hartley Oscillator. Also state equation of oscillation frequency of it.

#### Solution

Hartley oscillator uses tapped inductor in tank circuit for frequency generation.

**Circuit Diagram:**

#### Mermaid Diagram (Code)

```
{Shaded}  
{Highlighting} []  
graph LR  
    A[Vcc] --> B[RFC]  
    B --> C[Collector]  
    C --> D[L1]  
    D --> E[L2]  
    E --> F[Emitter]  
    F --> G[C]  
    G --> E  
    C --> H[Output]  
{Highlighting}  
{Shaded}
```

#### Operation:

- Tapped inductor: L1 and L2 provide feedback
- Tank circuit: L1+L2 with C determines frequency
- Positive feedback: Phase shift through L1-L2 coupling

Frequency Formula:  $f = 1/[2 \sqrt{(L_1 + L_2)C}]$

#### Key Features:

- Good frequency stability: Inductor-based tuning
- Easy tuning: Variable inductor or capacitor
- RF applications: Suitable for high frequencies

## Mnemonic

“Hartley Has Tapped inductor”

### Question 2(a OR) [3 marks]

Explain term oscillator as positive feedback amplifier.

#### Solution

Oscillator generates AC signals using positive feedback without external input signal.

Parameter	Amplifier	Oscillator
Input	External signal	No external input
Feedback	May use negative	Uses positive
Output	Amplified input	Self-generated AC

- Self-sustaining: Positive feedback maintains oscillation
- Barkhausen criteria: Loop gain = 1, phase =  $0^\circ$
- Signal generation: Creates AC from DC supply

## Mnemonic

“Positive feedback Powers Perpetual signals”

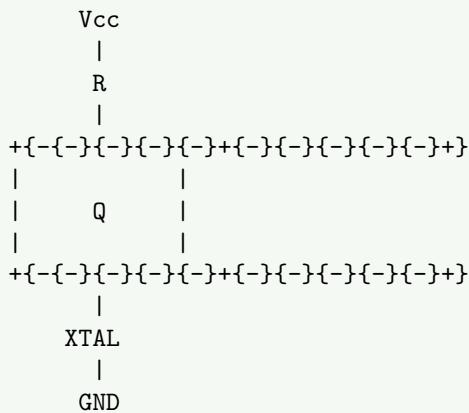
### Question 2(b OR) [4 marks]

Draw and explain the Crystal Oscillator.

#### Solution

Crystal oscillator uses piezoelectric effect of quartz crystal for high stability.

**Circuit Diagram:**



**Characteristics:**

Property	Value	Advantage
<b>Stability</b>	$\pm 0.01\%$	Very high
<b>Q factor</b>	>10,000	Sharp resonance
<b>Temperature</b>	Low drift	Stable frequency

- **Piezoelectric effect:** Mechanical vibration creates electrical signal
- **High Q:** Very stable frequency generation
- **Clock applications:** Used in digital systems

## Mnemonic

“Crystal Creates Constant frequency”

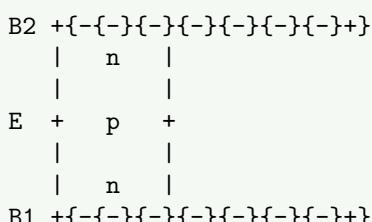
### Question 2(c OR) [7 marks]

Draw the Structure, symbol, equivalent circuit of UJT and explain it in brief.

#### Solution

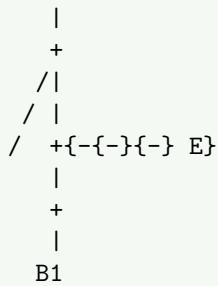
UJT (Unijunction Transistor) is three-terminal device with unique switching characteristics.

**Structure:**

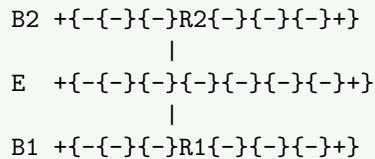


**Symbol:**

B2



**Equivalent Circuit:**



**Operation:**

- Intrinsic standoff ratio:  $= R_1/(R_1+R_2)$
- Peak point voltage:  $V_P = V_{BB} + V_D$
- Negative resistance: After peak point

**Applications:**

- Relaxation oscillator: Sawtooth wave generation
- Trigger circuits: SCR firing circuits
- Timing applications: RC charging circuits

### Mnemonic

“UJT Uses Unique Junction Technology”

## Question 3(a) [3 marks]

Classify power amplifier based on operating point.

### Solution

Power amplifiers are classified based on transistor conduction angle and bias point.

Class	Conduction Angle	Efficiency	Application
Class A	360°	25-50%	Audio, low power
Class B	180°	78.5%	Push-pull
Class AB	180° – 360°	60-70%	Audio power
Class C	<180°	>90%	RF, tuned

- **Bias point:** Determines operating class
- **Efficiency trade-off:** Higher efficiency, more distortion
- **Application specific:** Choose based on requirements

### Mnemonic

“All Big Amplifiers Can deliver power”

## Question 3(b) [4 marks]

Draw and Explain Complementary symmetry push-pull power amplifier.

## Solution

Uses NPN and PNP transistors for efficient power amplification without center-tapped transformer.

**Circuit Diagram:**

### Mermaid Diagram (Code)

```
{Shaded}  
{Highlighting} []  
graph LR  
    A[+Vcc] --> B[NPN Q1]  
    B --> C[Output]  
    C --> D[RL]  
    D --> E[PNP Q2]  
    E --> F[-]Vcc  
    G[Input] --> B  
    G --> E  
{Highlighting}  
{Shaded}
```

#### Operation:

- **Positive half-cycle:** NPN conducts, PNP off
- **Negative half-cycle:** PNP conducts, NPN off
- **Complementary action:** Both transistors handle alternate half-cycles

#### Advantages:

- **No transformer:** Direct coupling to load
- **High efficiency:** Class B operation
- **Compact design:** Fewer components
- **Good power transfer:** Direct coupling

## Mnemonic

“Complementary transistors Complete the cycle”

## Question 3(c) [7 marks]

Derive an equation for Efficiency of class B push pull amplifier.

## Solution

Class B push-pull amplifier has each transistor conducting for  $180^\circ$  of input cycle.

**Analysis:** For sinusoidal input:  $V_i = V_m \sin \omega t$

#### Output Power:

- Peak output voltage:  $V_{om} = V_{cc}$
- RMS output voltage:  $V_o(\text{rms}) = V_{cc}/\sqrt{2}$
- $P_o = V_o^2(\text{rms})/RL = V_{cc}^2/2RL$

#### Input Power:

- DC current (average):  $I_{dc} = 2I_m/$
- Where  $I_m = V_{cc}/RL$
- $P_{in} = V_{cc} \times I_{dc} = 2V_{cc}I_m/ = 2V_{cc}^2/RL$

**Efficiency Calculation:**  $\eta = P_o/P_{in} = (V_{cc}^2/2RL)/(2V_{cc}^2/RL) = /4 = 0.785 = 78.5\%$

#### Key Points:

- Maximum theoretical efficiency: 78.5%
- Class B advantage: Much higher than Class A (25%)
- Practical efficiency: Slightly lower due to losses

## Mnemonic

“Push-Pull Provides Pi/4 efficiency”

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

Differentiate between voltage and power amplifier.

#### Solution

Voltage and power amplifiers serve different purposes in electronic systems.

Parameter	Voltage Amplifier	Power Amplifier
<b>Purpose</b>	Increase voltage	Increase power
<b>Load</b>	High impedance	Low impedance
<b>Efficiency</b>	Not critical	Very important
<b>Distortion</b>	Must be low	Moderately acceptable
<b>Coupling</b>	RC/Direct	Transformer

- **Design priority:** Voltage gain vs power delivery
- **Application:** Signal processing vs driving loads
- **Circuit complexity:** Simple vs complex power stages

#### Mnemonic

“Voltage amplifies signal, Power drives load”

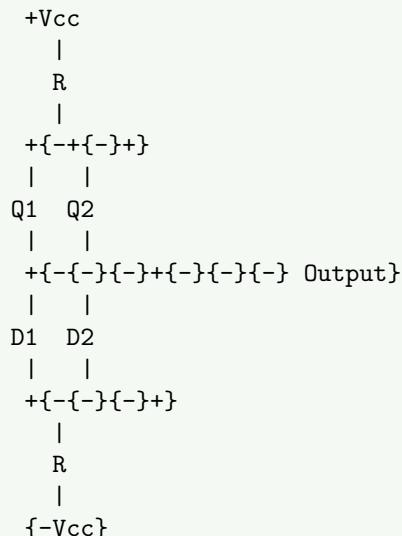
### Question 3(b OR) [4 marks]

Explain Class AB power amplifier with diagram.

#### Solution

Class AB operates between Class A and Class B, reducing crossover distortion.

**Circuit Diagram:**



**Operation:**

- **Slight forward bias:** Both transistors slightly on
- **Conduction angle:**  $>180^\circ$  but  $< 360^\circ$
- **Overlap conduction:** Eliminates crossover distortion

**Characteristics:**

Parameter	Value	Benefit
<b>Efficiency</b>	60-70%	Better than Class A
<b>Distortion</b>	Low	Better than Class B
<b>Bias</b>	Slight forward	Compromise solution

## Mnemonic

“AB Avoids Bad crossover distortion”

### Question 3(c OR) [7 marks]

Derive an equation for Efficiency of series fed class A power amplifier.

#### Solution

Series fed Class A amplifier has DC supply connected in series with load.

##### Circuit Analysis:

- DC supply voltage:  $V_{cc}$
- Quiescent current:  $I_{cq} = V_{cc}/2RL$  (for maximum power)
- Quiescent voltage:  $V_{ceq} = V_{cc}/2$

##### AC Analysis:

- Maximum output voltage swing:  $V_{om} = V_{cc}/2$
- Output power:  $P_o = V_{om}^2/2RL = V_{cc}^2/8RL$

##### DC Power:

- DC current:  $I_{dc} = I_{cq} = V_{cc}/2RL$
- Input power:  $P_{in} = V_{cc} \times I_{dc} = V_{cc}^2/2RL$

$$\text{Efficiency: } = P_o/P_{in} = (V_{cc}^2/8RL)/(V_{cc}^2/2RL) = 1/4 = 0.25 = 25\%$$

##### Key Points:

- Maximum theoretical efficiency: 25%
- Power wastage: 75% lost as heat
- Design limitation: Poor efficiency but good linearity

## Mnemonic

“Class A Achieves quarter efficiency”

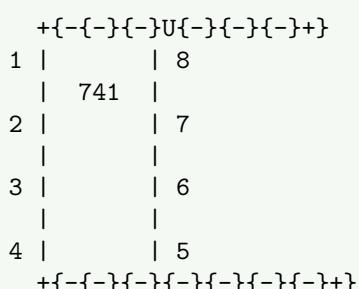
### Question 4(a) [3 marks]

Draw pin diagram of IC 741 OP-AMP and explain it.

#### Solution

IC 741 is 8-pin dual-in-line package operational amplifier with industry standard pinout.

##### Pin Diagram:



##### Pin Configuration:

Pin	Function	Description
1	Offset Null	Offset adjustment
2	Inverting Input	Negative input
3	Non-inverting Input	Positive input
4	-Vcc	Negative supply
5	Offset Null	Offset adjustment
6	Output	Amplifier output
7	+Vcc	Positive supply
8	NC	No connection

## Mnemonic

“Null, Negative, Positive, Negative supply, Null, Output, Positive supply, Nothing”

## Question 4(b) [4 marks]

Define the following OP-AMP parameters. 1. Input offset voltage 2. CMRR

### Solution

These parameters define the non-ideal characteristics of practical operational amplifiers.

#### 1. Input Offset Voltage (V<sub>io</sub>):

- **Definition:** DC voltage applied between inputs to make output zero
- **Typical value:** 1-5 mV for 741
- **Cause:** Mismatch in input transistors
- **Effect:** Output error in DC applications

#### 2. Common Mode Rejection Ratio (CMRR):

- **Definition:** Ability to reject common signals at both inputs
- **Formula:** CMRR = Ad/Acm
- **Typical value:** 90 dB for 741
- **Importance:** Noise immunity

Parameter	Symbol	Unit	Ideal	741	Typical
Input Offset Voltage	V <sub>io</sub>	mV	0	2	
CMRR	-	dB	$\infty$	90	

## Mnemonic

“Offset creates Output error, CMRR Rejects common signals”

## Question 4(c) [7 marks]

Explain inverting amplifier using IC 741 in detail.

### Solution

Inverting amplifier uses negative feedback with input applied to inverting terminal.

#### Circuit Diagram:

#### Mermaid Diagram (Code)

```
{Shaded}  
{Highlighting} []  
graph LR  
    A[Vin] --> B[R1]  
    B --> C["{}-{}"]  
    D["+"] --> E[Ground]  
    C --> F[IC 741]  
    F --> G[Vout]  
    G --> H[Rf]  
    H --> C  
{Highlighting}  
{Shaded}
```

**Analysis:** Using virtual short concept:

- **V<sub>+</sub> = V<sub>-</sub> = 0V** (virtual ground)
- **Input current:** I<sub>1</sub> = V<sub>in</sub>/R<sub>1</sub>
- **Feedback current:** I<sub>f</sub> = V<sub>out</sub>/R<sub>f</sub>
- **Current balance:** I<sub>1</sub> = I<sub>f</sub> (no current into op-amp)

#### Derivation:

- $V_{in}/R_1 = -V_{out}/R_f$
- **Voltage Gain:**  $A_v = -R_f/R_1$

### Characteristics:

Parameter	Expression	Notes
Voltage Gain	$-R_f/R_1$	Negative sign
Input Impedance	$R_1$	Low impedance
Output Impedance	$\sim 0\Omega$	Very low
Bandwidth	$f = GBW/ Av $	Gain-bandwidth product

### Applications:

- **Signal inversion:** Phase reversal
- **Scale factor:** Programmable gain
- **AC amplification:** With coupling capacitors

### Mnemonic

“Inverting Input gives Inverted output”

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

List characteristics of ideal OP-AMP.

### Solution

Ideal op-amp represents perfect amplifier with theoretical limits for all parameters.

Parameter	Ideal Value	Practical Impact
Open Loop Gain	$\infty$	Perfect amplification
Input Impedance	$\infty$	No input current
Output Impedance	$0\Omega$	Perfect voltage source
Bandwidth	$\infty$	No frequency limitation
CMRR	$\infty$	Perfect noise rejection
Slew Rate	$\infty$	No slew rate limiting
Input Offset	0V	No DC errors

- **Perfect performance:** All parameters optimized
- **Design simplification:** Analysis becomes easier
- **Practical approximation:** Close to ideal in many applications

### Mnemonic

“Infinite Input, Zero Output, Perfect Performance”

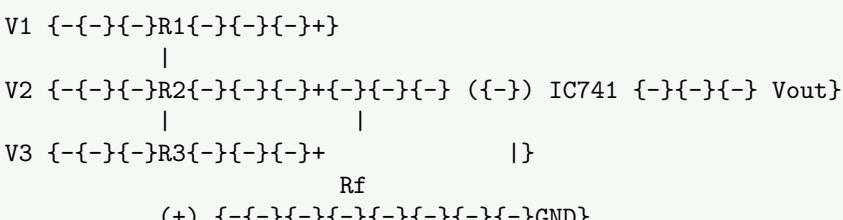
## Question 4(b OR) [4 marks]

Draw and explain summing amplifier using Op-amp.

### Solution

Summing amplifier adds multiple input voltages with programmable gain for each input.

#### Circuit Diagram:



**Analysis:** Using virtual ground concept ( $V_- = 0V$ ):

- Current through R1:  $I_1 = V_1/R_1$
- Current through R2:  $I_2 = V_2/R_2$

- Current through R3:  $I_3 = V_3/R_3$
- Total input current:  $I_{in} = I_1 + I_2 + I_3$

**Output Equation:**  $V_{out} = -R_f(V_1/R_1 + V_2/R_2 + V_3/R_3)$

**Special Cases:**

- Equal resistors:  $V_{out} = -(R_f/R)(V_1 + V_2 + V_3)$
- Unity gain:  $R_f = R$ ,  $V_{out} = -(V_1 + V_2 + V_3)$

**Applications:**

- **Audio mixing:** Multiple signal combination
- **Digital-to-analog:** Weighted resistor DAC
- **Signal processing:** Mathematical operations

### Mnemonic

“Sum inputs, Scale by resistor ratios”

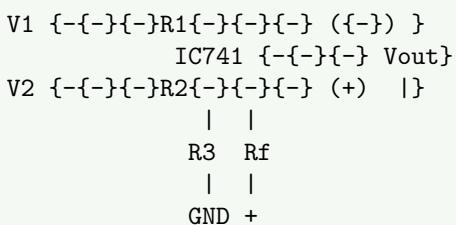
## Question 4(c) OR [7 marks]

Explain differential amplifier using IC 741 in detail.

### Solution

Differential amplifier amplifies the difference between two input signals while rejecting common signals.

**Circuit Diagram:**



**Analysis:** For the non-inverting input:

- $V_+ = V_2 \times R_3 / (R_2 + R_3)$

For the inverting input using virtual short:

- $V_- = V_+ = V_2 \times R_3 / (R_2 + R_3)$

Using current balance:

- $(V_1 - V_-) / R_1 = (V_- - V_{out}) / R_f$

**Output Equation:** When  $R_1 = R_2$  and  $R_3 = R_f$ :  $V_{out} = (R_f / R_1)(V_2 - V_1)$

**Key Features:**

Parameter	Value	Advantage
<b>Differential Gain</b>	$R_f / R_1$	Amplifies difference
<b>Common Mode Gain</b>	~0	Rejects common signals
<b>CMRR</b>	Very high	Excellent noise immunity

**Applications:**

- **Instrumentation:** Sensor signal processing
- **Noise rejection:** Differential signal transmission
- **Bridge circuits:** Strain gauge measurements

### Mnemonic

“Difference amplified, Common rejected”

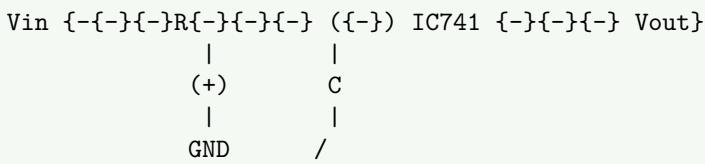
### Question 5(a) [3 marks]

Draw the circuit of integrator using Op-amp and its input and output waveforms.

#### Solution

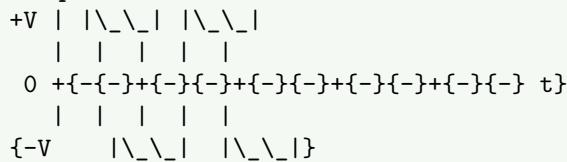
Op-amp integrator performs mathematical integration of input signal using RC feedback.

**Circuit Diagram:**

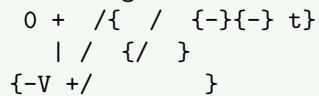


**Waveforms:**

**Input (Square Wave):**



**Output (Triangular):**



**Operation:**

- **Integration function:**  $V_{out} = -(1/RC)dt$
- **Square wave input:** Produces triangular output
- **Ramp generation:** Constant input gives linear ramp

#### Mnemonic

"Integration creates Triangular from square"

### Question 5(b) [4 marks]

State advantage and disadvantage of push-pull arrangement of power amplifier

#### Solution

Push-pull configuration uses two transistors operating in complementary fashion for power amplification.

**Advantages:**

Advantage	Benefit	Application
<b>High Efficiency</b>	Up to 78.5%	Battery operated
<b>No Transformer</b>	Compact design	Portable devices
<b>Low Distortion</b>	Better linearity	Audio systems
<b>Heat Distribution</b>	Shared between transistors	Thermal management

### Disadvantages:

Disadvantage	Problem	Solution
<b>Crossover Distortion</b>	Dead zone at zero crossing	Class AB bias
<b>Component Matching</b>	Requires matched transistors	Careful selection
<b>Thermal Runaway</b>	Temperature coefficient mismatch	Thermal coupling

### Applications:

- **Audio amplifiers:** High fidelity systems
- **Motor drivers:** DC motor control
- **RF amplifiers:** Communication systems

### Mnemonic

“Push-Pull Provides Power but Problems exist”

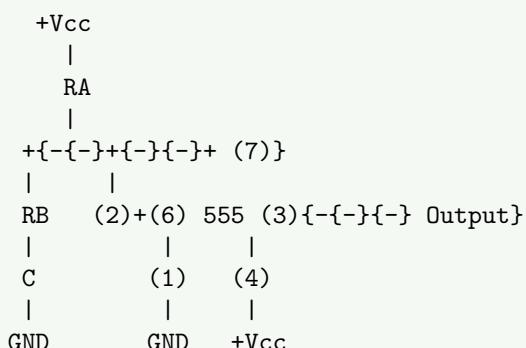
## Question 5(c) [7 marks]

Draw and explain astable multivibrator using 555 timer IC.

### Solution

Astable multivibrator generates continuous square wave output without external trigger using 555 timer.

#### Circuit Diagram:



#### Pin Connections:

- **Pin 1:** Ground
- **Pin 2:** Trigger (connected to pin 6)
- **Pin 3:** Output
- **Pin 4:** Reset (+Vcc)
- **Pin 6:** Threshold
- **Pin 7:** Discharge
- **Pin 8:** +Vcc

#### Operation:

1. **Charging phase:** C charges through RA + RB
2. **Threshold reached:** At 2/3 Vcc, output goes LOW
3. **Discharging phase:** C discharges through RB
4. **Trigger reached:** At 1/3 Vcc, output goes HIGH
5. **Cycle repeats:** Continuous oscillation

#### Timing Equations:

- **HIGH time:**  $t_1 = 0.693(RA + RB)C$
- **LOW time:**  $t_2 = 0.693(RB)C$
- **Total period:**  $T = t_1 + t_2 = 0.693(RA + 2RB)C$
- **Frequency:**  $f = 1.44/[(RA + 2RB)C]$
- **Duty cycle:**  $D = (RA + RB)/(RA + 2RB) \times 100\%$

#### Applications:

- **Clock generation:** Digital systems

- **LED flasher:** Blinking circuits
- **Tone generation:** Audio oscillators
- **PWM generation:** Motor speed control

### Mnemonic

“Astable Always oscillates Automatically”

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

Draw the block diagram of Op-amp and explain it.

### Solution

Op-amp internal structure consists of multiple stages for high gain and performance.

#### Block Diagram:

**Mermaid Diagram (Code)**

```
{Shaded}
{Highlighting} []
graph LR
    A[V+] --> B[Differential Amplifier]
    C[V{-}] --> B
    B --> D[Intermediate Amplifier]
    D --> E[Output Stage]
    E --> F[Output]
    G[Level Shifter] --> E
    D --> G
{Highlighting}
{Shaded}
```

#### Stage Functions:

Stage	Function	Characteristics
<b>Differential Input</b>	High input impedance	Low offset, high CMRR
<b>Intermediate Amplifier</b>	High voltage gain	Most of the gain
<b>Level Shifter</b>	DC level adjustment	Couples AC stages
<b>Output Stage</b>	Low output impedance	Current buffer

- **High gain:** Typically 100,000 or more
- **Wide bandwidth:** MHz range capability
- **Low output impedance:** Drives various loads

### Mnemonic

“Differential Input, Intermediate gain, Level shift, Output buffer”

## Question 5(b OR) [4 marks]

Explain about the terms related to power amplifier. i) Efficiency ii) Distortion.

### Solution

These parameters determine power amplifier performance and suitability for applications.

#### i) Efficiency ( ):

- **Definition:** Ratio of AC output power to DC input power
- **Formula:**  $= P_{o(AC)} / P_{in(DC)} \times 100\%$

- **Importance:** Determines heat dissipation and battery life
- Efficiency Comparison:**

Class	Efficiency	Application
<b>A</b>	25%	Low power, high fidelity
<b>B</b>	78.5%	Push-pull amplifiers
<b>AB</b>	60-70%	Audio amplifiers
<b>C</b>	>90%	RF applications

### ii) Distortion:

- **Definition:** Unwanted changes in output signal shape
- **Types:** Harmonic, intermodulation, crossover
- **Measurement:** Total Harmonic Distortion (THD)

### Distortion Sources:

- **Nonlinearity:** Transistor characteristics
- **Crossover:** Dead zone in push-pull
- **Thermal effects:** Temperature variations

### Mnemonic

“Efficiency measures Energy use, Distortion shows signal Degradation”

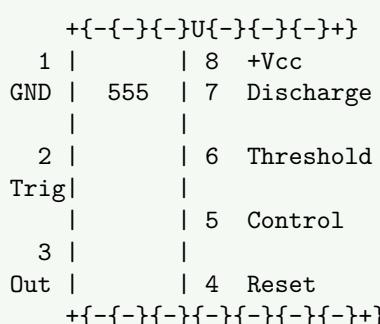
## Question 5(c OR) [7 marks]

Draw pin diagram of 555 timer IC. Also draw circuit diagram of two stage sequential timer using 555 timer IC.

### Solution

555 timer is versatile IC used for timing applications with standard 8-pin package.

#### Pin Diagram:

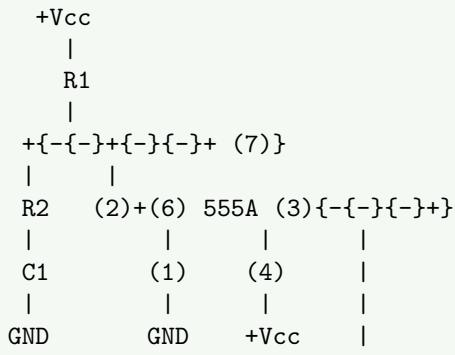


#### Pin Functions:

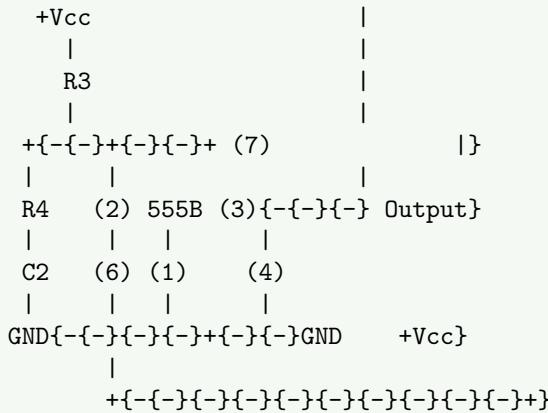
Pin	Name	Function
<b>1</b>	Ground	Common ground
<b>2</b>	Trigger	Starts timing cycle
<b>3</b>	Output	Timer output
<b>4</b>	Reset	Resets timer
<b>5</b>	Control	Voltage reference
<b>6</b>	Threshold	Stops timing cycle
<b>7</b>	Discharge	Discharges timing capacitor
<b>8</b>	Vcc	Supply voltage

## Two Stage Sequential Timer Circuit:

First Stage (555A):



Second Stage (555B):



### Operation:

1. **First timer:** Operates in monostable mode
2. **Trigger applied:** First timer gives output pulse
3. **Output duration:**  $T_1 = 1.1 \times R2 \times C1$
4. **Second timer:** Triggered by first timer's output
5. **Sequential operation:** Second timer starts after first completes
6. **Total delay:**  $T_1 + T_2$  where  $T_2 = 1.1 \times R4 \times C2$

### Applications:

- **Delay circuits:** Sequential switching
- **Traffic lights:** Timed sequence control
- **Industrial automation:** Process timing
- **Motor control:** Start-stop sequences

### Timing Equations:

- **Stage 1 delay:**  $T_1 = 1.1 R2 C1$
- **Stage 2 delay:**  $T_2 = 1.1 R4 C2$
- **Total sequence time:**  $T_{total} = T_1 + T_2$

### Key Features:

- **Independent timing:** Each stage separately adjustable
- **Sequential operation:** No overlap between stages
- **Reliable switching:** Clean digital transitions
- **Easy design:** Simple component calculation

### Mnemonic

“Sequential Stages Start Separately”