Question 1(a) [3 marks]

Explain amplifier parameters Ai, Ri and Ro for CE configuration.

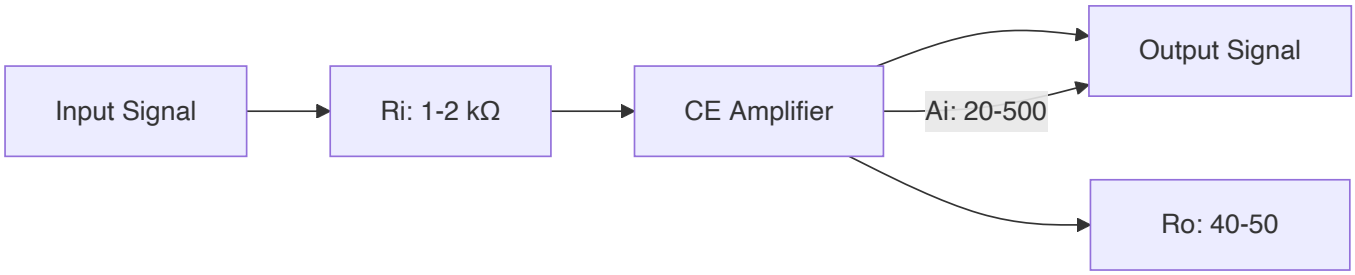
Answer:

Common Emitter (CE) amplifier parameters:

Table: CE Amplifier Parameters

Parameter	Definition	CE Configuration
Current Gain (Ai)	Ratio of output current to input current	High (20-500)
Input Resistance (Ri)	Opposition to current flow at input	Medium (1-2 kΩ)
Output Resistance (Ro)	Opposition to current flow at output	High (40-50 kΩ)

Diagram:



Mnemonic: "CAR" - CE has Current gain high, Average input resistance, and Robust output resistance.

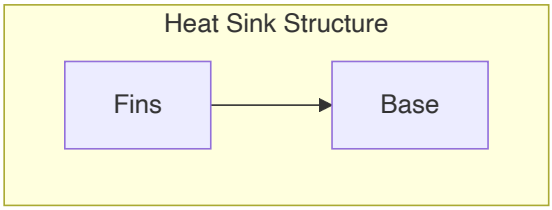
Question 1(b) [4 marks]

Write short-note on heat sink.

Answer:

Heat Sink: Device that absorbs and dissipates heat from electronic components

Diagram:



Types of Heat Sinks:

- **Passive Heat Sinks**: Rely on natural convection
- **Active Heat Sinks**: Use fans for forced air convection
- **Liquid-cooled Heat Sinks**: Use liquid for better heat transfer

Key Functions:

- **Thermal Conduction**: Draws heat away from components
- **Thermal Convection**: Transfers heat to surrounding air
- **Surface Area**: Fins increase surface area for better cooling

Mnemonic: "CRAFT" - Cooling through Radiation And Fins for Transistors.

Question 1(c) [7 marks]

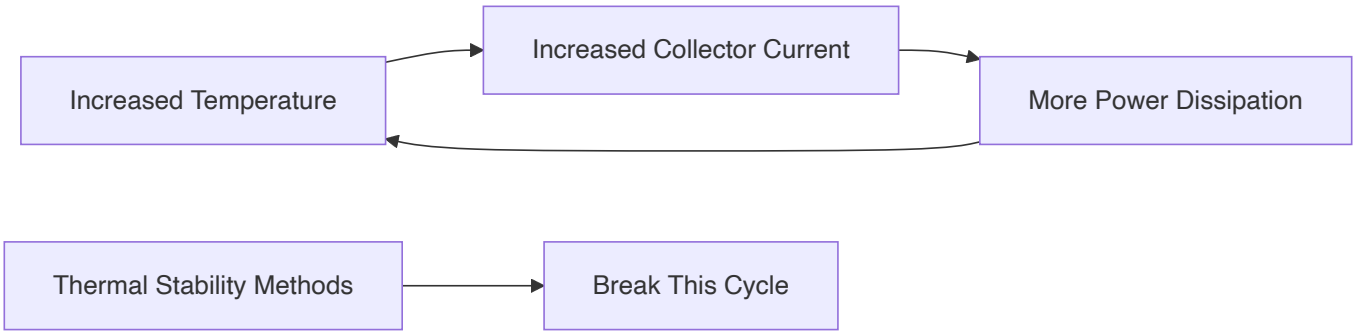
Describe Thermal Runaway and Thermal Stability. How can overcome thermal run away in transistor?

Answer:

Thermal Runaway: Self-reinforcing process where increased temperature causes more current flow, which further increases temperature

Thermal Stability: Ability of a transistor circuit to maintain stable operation despite temperature changes

Diagram:



Methods to Overcome Thermal Runaway:

- **Heat Sink**: Absorbs and dissipates excess heat
- **Negative Feedback**: Using emitter resistor for stabilization
- **Bias Stabilization**: Voltage divider biasing circuit
- **Temperature Compensation**: Using diodes or thermistors

Key Points:

- **IC = ICBO(1+β) + βIB**: Shows collector current dependence
- **ICBO doubles**: For every 10°C temperature rise
- **Stability Factor S**: Lower S means better stability

Mnemonic: "RENT" - Reduce heat with sinks, Emitter resistors stabilize, Negative feedback helps, Temperature compensation.

Question 1(c) OR [7 marks]

Write down types of biasing methods. Explain the voltage divider biasing method in details.

Answer:

Types of Biasing Methods:

- Fixed Bias
- Collector-to-Base Bias
- Voltage Divider Bias
- Emitter Bias
- Collector Feedback Bias

Voltage Divider Bias Circuit:

Operation:

- **R1 and R2**: Form voltage divider providing base voltage
- **RE**: Provides stability and negative feedback
- **Stable Bias Point**: Less affected by temperature and β variations

Advantages:

- **Excellent Stability**: Less affected by temperature variations
- **Independent of β**: Bias point not greatly affected by transistor gain

- **Widely Used**: Most common biasing method for amplifiers

Mnemonic: "DIVE" - Divider biasing Is Very Effective for stability.

Question 2(a) [3 marks]

Explain Stability Factor with features.

Answer:

Stability Factor (S): Measure of how well a biasing circuit maintains stable operation with temperature changes

Mathematical Definition:
S = ΔIC/ΔICBO (Change in collector current / Change in reverse saturation current)

Table: Stability Factors for Different Bias Circuits

Biasing Method	Stability Factor	Stability Level
Fixed Bias	S = 1+β	Poor
Collector-to-Base	S = β/(1+β)	Better
Voltage Divider	S ≈ 1	Excellent

Key Features:

- **Lower S Value**: Indicates better stability (ideal S=1)
- **Temperature Resistance**: Measures immunity to temperature changes
- **Circuit Design Tool**: Helps compare biasing methods

Mnemonic: "SOS" - Stability Of circuit Shows in its S-factor.

Question 2(b) [4 marks]

Describe direct coupling technique of cascading.

Answer:

Direct Coupling: Connecting stages without coupling capacitors, directly connecting collector of one stage to base of next

Diagram:

```
   |      |-------+            |      |-------+
   |      |       |            |      |
Input     |       |            |      |
  +-------|B      |            |      |
          |       |            |      |
          |       E            |      E
          |       |            |      |
        GND     GND          GND    GND

        First Stage           Second Stage
```

Key Characteristics:

- **No Coupling Components**: Direct electrical connection
- **Full Frequency Response**: Good low-frequency performance
- **DC Level Shifting**: Required between stages

Applications:

- **Operational Amplifiers**: Internal stages
- **DC Amplifiers**: Where low-frequency response is critical

Mnemonic: "DIRECT" - DC signals Immediately REach Connecting Transistors.

Question 2(c) [7 marks]

Explain frequency response of two stage RC coupled amplifier.

Answer:

RC Coupled Amplifier: Uses resistor-capacitor networks to couple between amplification stages

Frequency Response Diagram:

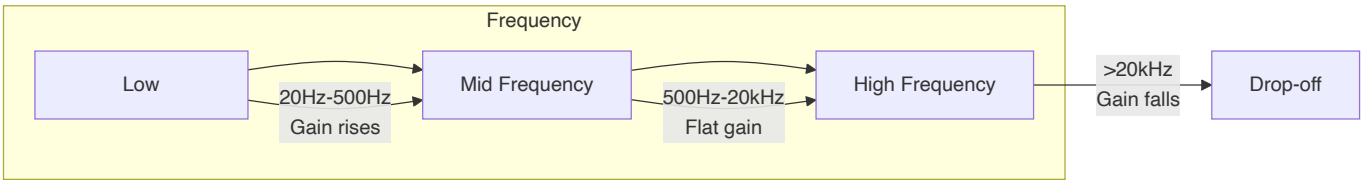


Table: Frequency Regions

Region	Frequency Range	Characteristics	Limiting Components
Low	20Hz-500Hz	Gain rises with frequency	Coupling capacitors
Mid	500Hz-20kHz	Constant gain (maximum)	None
High	>20kHz	Gain falls with frequency	Transistor capacitance

Two-Stage Effect:

- **Bandwidth**: Narrower than single stage
- **Gain**: Approximately square of single stage ($A_1 \times A_2$)
- **Phase Shift**: Doubled at low and high frequencies

Mnemonic: "LMH" - Low frequencies by coupling caps, Mid frequencies flat, High frequencies by transistor caps.

Question 2(a) OR [3 marks]

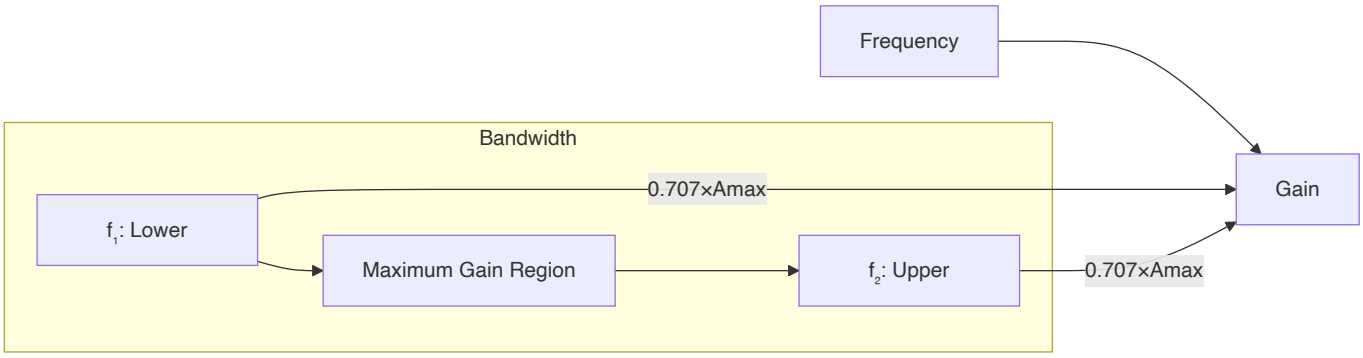
Briefly explain bandwidth and gain-bandwidth product of an amplifier.

Answer:

Bandwidth (BW): Range of frequencies where amplifier gain is at least 70.7% of maximum gain

Gain-Bandwidth Product (GBP): Product of voltage gain and bandwidth, constant for a given amplifier

Diagram:



Key Formulas:

- **Bandwidth**: BW = $f_2 - f_1$
- **Gain-Bandwidth Product**: GBP = $A_0 \times$ BW (constant)

Mnemonic: "BAND" - Bandwidth And gain Never Drop together (one increases when other decreases).

Question 2(b) OR [4 marks]

Explain effects of emitter bypass capacitor and coupling capacitor on frequency response of an amplifier.

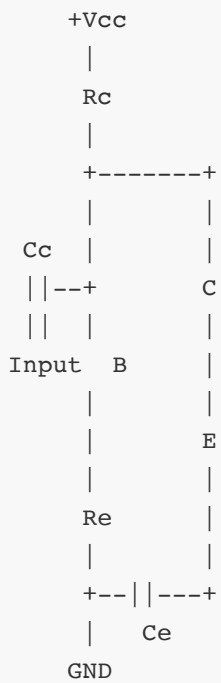
Answer:

Effects on Frequency Response:

Table: Capacitor Effects

Capacitor	Function	Effect on Frequency Response
Coupling Capacitor (Cc)	Blocks DC, passes AC	Limits low-frequency response
Bypass Capacitor (Ce)	Bypasses emitter resistor	Increases gain at mid and high frequencies

Diagram:



Key Effects:

- **Without Ce**: Lower gain, better stability, better low-frequency response
- **Without Cc**: DC coupling, excellent low-frequency response
- **Capacitor Values**: Determine cutoff frequencies (f_1, f_2)

Mnemonic: "CELL" - Coupling affects Extremely Low frequencies, bypass affects Low to high.

Question 2(c) OR [7 marks]

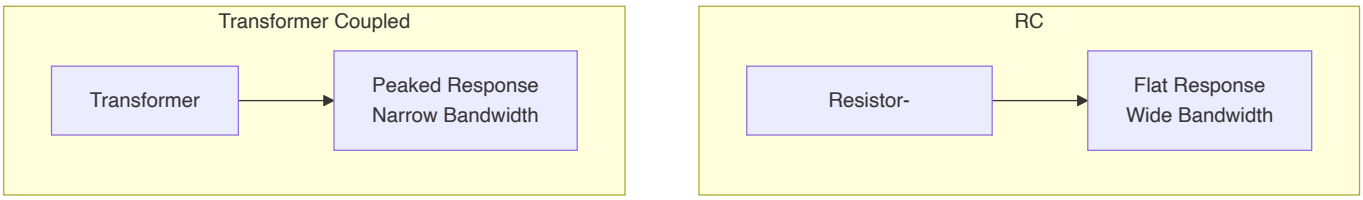
Compare transformer coupled amplifier and RC coupled amplifier

Answer:

Table: Comparison of Transformer Coupled vs RC Coupled Amplifier

Feature	Transformer Coupled	RC Coupled
Coupling Element	Transformer	Capacitor and Resistor
Efficiency	High (90%)	Moderate (20-30%)
Size and Weight	Bulky and Heavy	Compact and Light
Cost	Expensive	Inexpensive
Frequency Response	Poor (limited bandwidth)	Good (wide bandwidth)
Impedance Matching	Excellent	Poor
DC Isolation	Complete	Only AC signals
Distortion	Higher	Lower

Diagram:



Applications:

- **RC Coupled**: Audio amplifiers, general-purpose amplifiers
- **Transformer Coupled**: Power amplifiers, radio transmitters

Mnemonic: "TRIP" - Transformers are Robust for Impedance matching, Problematic for bandwidth.

Question 3(a) [3 marks]

Describe the transistor used as a tuned amplifier.

Answer:

Tuned Amplifier: Amplifier that selectively amplifies signals within a narrow frequency band

Diagram:

```
    +Vcc
     |
     |
     +---+
     |   |
     L   |
     |   |
Cin  |   |
 ||--+---+
```

```
  ||  |   |
Input   B |
      |   |
      |   C      Cout
      |   +------||----+ Output
      |   |             |
      |   E             |
      |   |             |
      |  Re             |
      |   |             |
     GND GND           GND
```

Key Components:

- **LC Tank Circuit**: Determines resonant frequency
- **Transistor**: Provides amplification
- **Resonant Frequency**: $f_0 = 1/(2\pi\sqrt{LC})$

Applications:

- **Radio Receivers**: Selects desired frequency
- **TV Tuners**: Channel selection
- **RF Amplifiers**: Communication systems

Mnemonic: "TUNE" - Transistors Using Narrowband Elements for frequency selection.

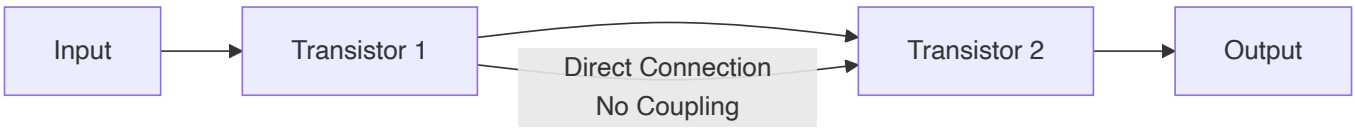
Question 3(b) [4 marks]

Explain in brief Direct coupled amplifier.

Answer:

Direct Coupled Amplifier: Multiple stage amplifier where stages are connected directly without coupling capacitors or transformers

Diagram:



Key Characteristics:

- **DC Amplification**: Can amplify from DC to high frequencies
- **No Coupling Elements**: Collector directly connected to next base
- **Level Shifting**: Required between stages
- **Thermal Drift**: Challenge due to direct DC coupling

Applications:

- **Operational Amplifiers**: Internal stages
- **DC Amplifiers**: Laboratory instruments
- **Sensing Circuits**: Temperature and pressure sensors

Mnemonic: "DCAP" - Direct Coupled Amplifier Passes all frequencies including DC.

Question 3(c) [7 marks]

Describe the importance of h parameters in two port networks. Draw h-parameters circuit for CE amplifier.

Answer:

h-parameters (hybrid parameters): Set of four parameters that define behavior of two-port network

Importance:

- **Complete Characterization**: Fully describes amplifier behavior
- **Easy Measurement**: Can be measured under simple conditions
- **Analysis Tool**: Simplifies circuit analysis
- **Standardized Approach**: Universal method for comparing transistors

h-parameter Equations:

- $V_1 = h_{11}I_1 + h_{12}V_2$
- $I_2 = h_{21}I_1 + h_{22}V_2$

h-parameter Circuit for CE Amplifier:

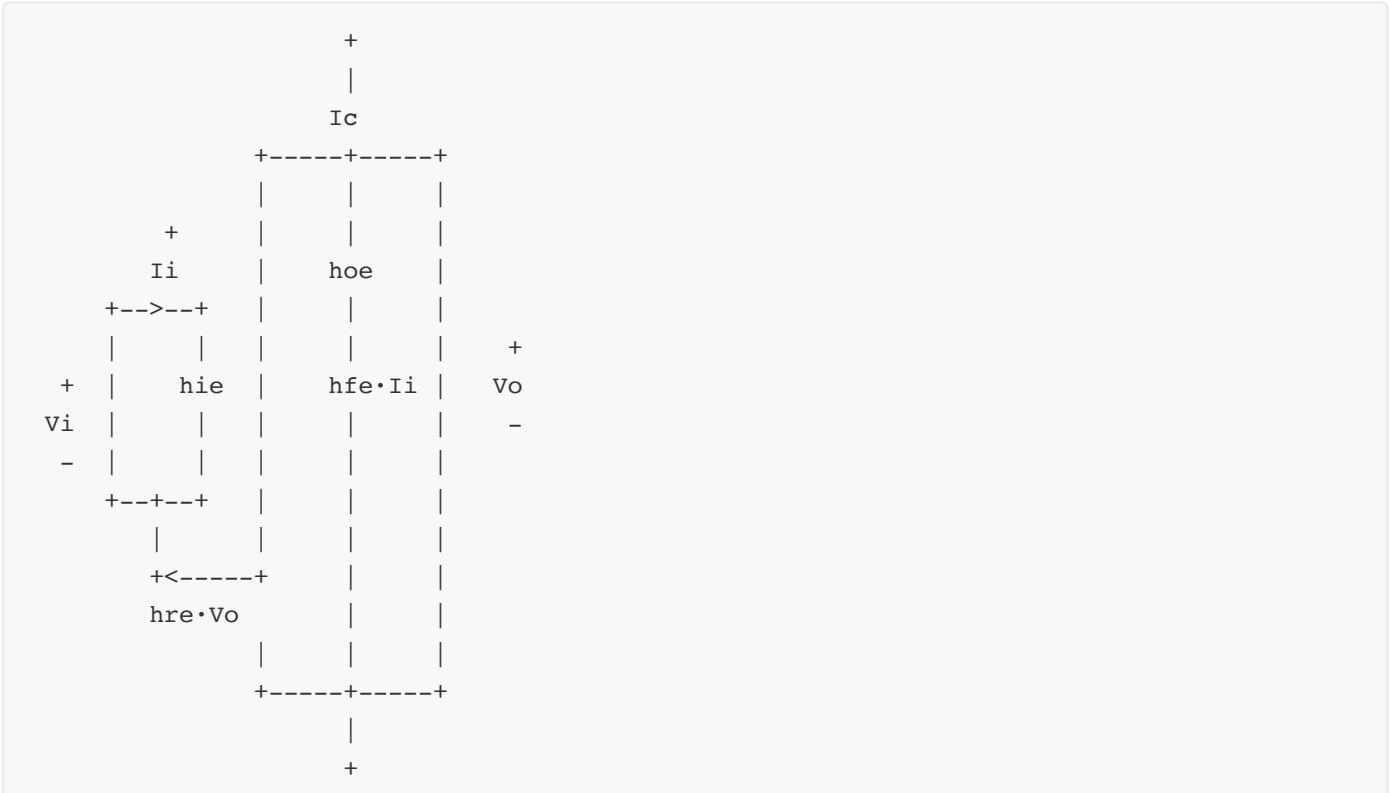


Table: h-parameters for CE Configuration

Parameter	Symbol	Typical Value	Physical Meaning
Input impedance	h_{11} (hie)	1-2 kΩ	Input resistance with output shorted
Reverse voltage transfer	h_{12} (hre)	$1\text{-}4 \times 10^{-4}$	Reverse feedback ratio
Forward current transfer	h_{21} (hfe)	20-500	Current gain (β)
Output admittance	h_{22} (hoe)	20-50 μS	Output conductance

Mnemonic: "HIRE" - h-parameters Include Resistance and current gain Effectively.

Question 3(a) OR [3 marks]

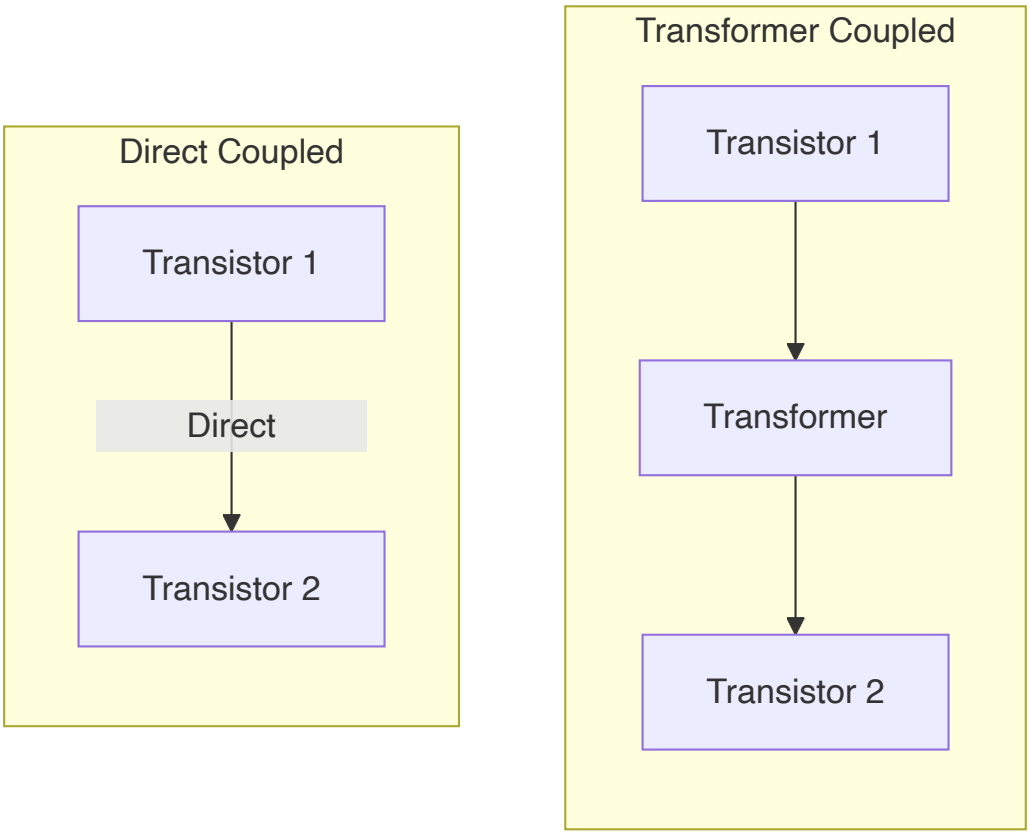
Compare transformer coupled amplifier and direct coupled amplifier.

Answer:

Table: Comparison between Transformer and Direct Coupled Amplifiers

Feature	Transformer Coupled	Direct Coupled
Coupling Element	Transformer	None (direct connection)
Frequency Response	Limited at low frequencies	Excellent (DC to high freq)
DC Isolation	Complete	None
Size	Bulky	Compact
Cost	Higher	Lower
DC Shift Problem	No	Yes

Diagram:



Mnemonic: "TDC" - Transformers provide DC isolation, Direct provides Complete frequency range.

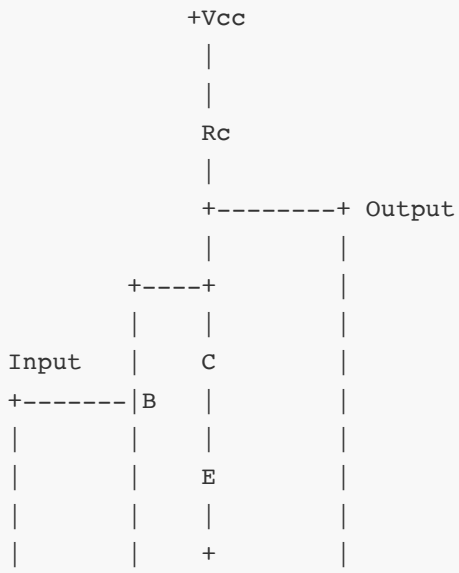
Question 3(b) OR [4 marks]

Draw and Explain circuit diagram of common emitter amplifier.

Answer:

Common Emitter Amplifier: Configuration where emitter is common to both input and output circuits

Circuit Diagram:



```
      |        |     |         |
      |        |    Re         |
      |        |     |         |
     GND      GND   GND       GND
```

Operation:

- **Input**: Applied between base and emitter
- **Output**: Taken from collector and emitter
- **Phase Shift**: 180° between input and output
- **Gain**: High voltage and current gain

Key Features:

- **High Gain**: Typical voltage gain 300-1000
- **Medium Input Impedance**: 1-2 kΩ
- **High Output Impedance**: 40-50 kΩ
- **Signal Inversion**: Output is inverted

Mnemonic: "CEA" - Common Emitter Amplifies with signal inversion.

Question 3(c) OR [7 marks]

Draw Transistor Two Port Network and describe h-parameters for it. Write down advantages of hybrid parameters.

Answer:

Transistor Two-Port Network:

```
         I1              I2
         -->             -->
     +--------+      +--------+
     |        |      |        |
     |        |      |        |
   + |        |      |        | +
 V1  |  Two   |      |  Port  | V2
   - |        |      |        | -
     |        |      |        |
     |        |      |        |
     +--------+      +--------+
```

h-parameter Equations:

- $V_1 = h_{11}I_1 + h_{12}V_2$
- $I_2 = h_{21}I_1 + h_{22}V_2$

Table: h-parameters Description

Parameter	Symbol	Description	Measurement Condition
Input impedance	h_{11}	Ratio of V_1/I_1	$V_2 = 0$ (Output shorted)
Reverse voltage transfer	h_{12}	Ratio of V_1/V_2	$I_1 = 0$ (Input open)
Forward current transfer	h_{21}	Ratio of I_2/I_1	$V_2 = 0$ (Output shorted)
Output admittance	h_{22}	Ratio of I_2/V_2	$I_1 = 0$ (Input open)

Advantages of Hybrid Parameters:

- **Easy Measurement**: Simple conditions for each parameter
- **Universality**: Works for all transistor configurations
- **Complete Characterization**: Fully describes behavior
- **Mathematical Simplicity**: Linear equations
- **Standardized**: Industry standard for specification

Mnemonic: "HAEM" - Hybrid parameters Are Easily Measured and mathematically simple.

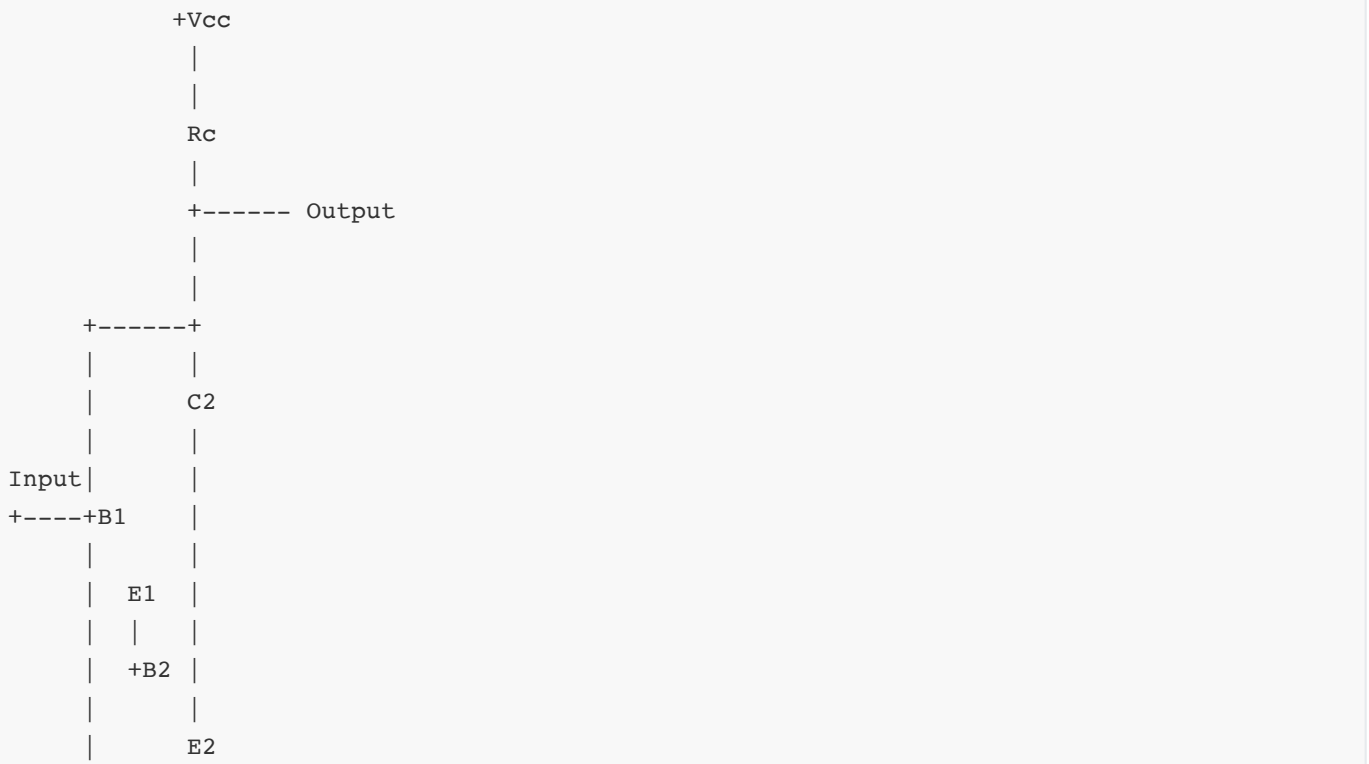
Question 4(a) [3 marks]

Explain Darlington pair and its applications.

Answer:

Darlington Pair: Configuration of two transistors where emitter of first is connected to base of second

Diagram:



```
     |       |
    GND     GND
```

Key Features:

- **Very High Current Gain**: $\beta_1 \times \beta_2$ (typical 1000-30000)
- **High Input Impedance**: $\beta_2 \times Rin_1$
- **Low Output Impedance**: Similar to single transistor

Applications:

- **Power Amplifiers**: Audio equipment
- **Buffer Circuits**: High impedance to low impedance
- **Motor Drivers**: Control high-current loads
- **Touch Sensors**: High sensitivity applications

Mnemonic: "DISH" - Darlington Integrates Stages for High current gain.

Question 4(b) [4 marks]

Describe the diode clamper circuit with necessary diagram.

Answer:

Clamper Circuit: Shifts the DC level of a waveform without changing its shape

Diagram:

```
            C1
Input +----||----+----+ Output
                 |    |
                 |    |
                 R    D
                 |    |
                 |    |
                GND  GND
```

Operation:

- **Positive Clamper**: Shifts waveform downward
- **Negative Clamper**: Shifts waveform upward
- **Capacitor**: Blocks DC, passes AC
- **Diode**: Conducts during one half-cycle
- **Resistor**: Discharge path for capacitor

Time Constants:

- **Charging**: Very small (diode forward resistance × C)
- **Discharging**: Large (R × C) compared to signal period

Applications:

- **TV Signal Processing**: Restores DC component
- **Pulse Circuits**: Level shifting
- **Signal Processing**: DC restoration

Mnemonic: "CLAMP" - Circuit Levels Are Modified Precisely.

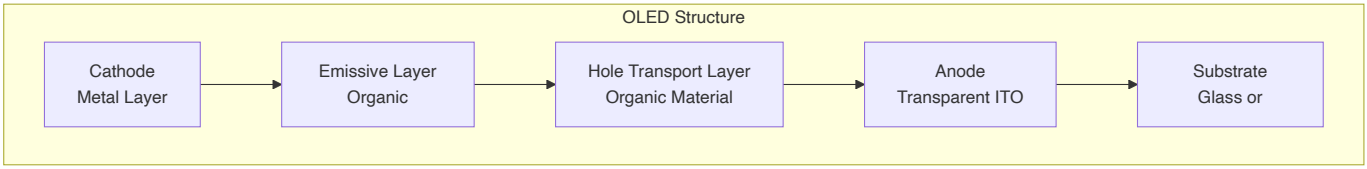
Question 4(c) [7 marks]

Explain the construction, working and applications of OLED.

Answer:

OLED (Organic Light Emitting Diode): Light-emitting device using organic compounds

Construction:



Working Principle:

- **Electron Injection**: Cathode injects electrons
- **Hole Injection**: Anode injects holes
- **Recombination**: Electrons and holes combine in emissive layer
- **Light Emission**: Energy released as photons
- **Color Control**: Different organic materials emit different colors

Table: OLED Types

Type	Structure	Key Feature
PMOLED	Passive Matrix	Simpler design, lower cost
AMOLED	Active Matrix	Better refresh rates, higher resolution
TOLED	Transparent	See-through when off or on
FOLED	Flexible	Can be bent or rolled

Applications:

- **Displays**: Smartphones, TVs, smartwatches
- **Lighting**: Thin, efficient lighting panels
- **Signage**: High-contrast digital signs

- **Wearable Technology**: Flexible displays

Mnemonic: "OLED" - Organic Layers Emit Directly when electrically stimulated.

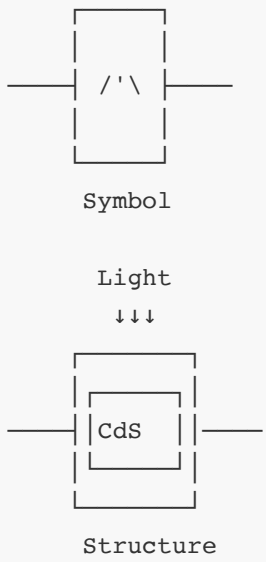
Question 4(a) OR [3 marks]

Explain Short note on LDR.

Answer:

LDR (Light Dependent Resistor): Photoresistor whose resistance decreases with increasing light intensity

Symbol and Structure:



Key Characteristics:

- **Material**: Usually Cadmium Sulfide (CdS)
- **Dark Resistance**: High (MΩ range)
- **Light Resistance**: Low (kΩ range)
- **Response Time**: Milliseconds to seconds

Applications:

- **Light Sensors**: Automatic lighting control
- **Camera Exposure Control**: Light metering
- **Street Light Control**: Dawn-to-dusk activation
- **Alarm Systems**: Light beam detection

Mnemonic: "LORD" - Light Oppositely Reduces the Device's resistance.

Question 4(b) OR [4 marks]

Describe the diode clipper circuit with necessary diagram.

Answer:

Clipper Circuit: Removes (clips) portion of input signal that exceeds certain voltage level

Diagram (Positive Clipper):

Types of Clippers:

- **Positive Clipper**: Removes positive peaks
- **Negative Clipper**: Removes negative peaks
- **Biased Clipper**: Clips at non-zero reference
- **Combination Clipper**: Clips both peaks

Operation:

- **Diode ON**: When signal exceeds reference voltage
- **Diode OFF**: When signal is below reference voltage
- **Clipping Level**: Determined by reference voltage

Applications:

- **Wave Shaping**: Creating square waves
- **Circuit Protection**: Voltage limiting
- **Noise Removal**: Limiting impulse noise

Mnemonic: "CLIP" - Circuit Limits Input Peaks using diodes.

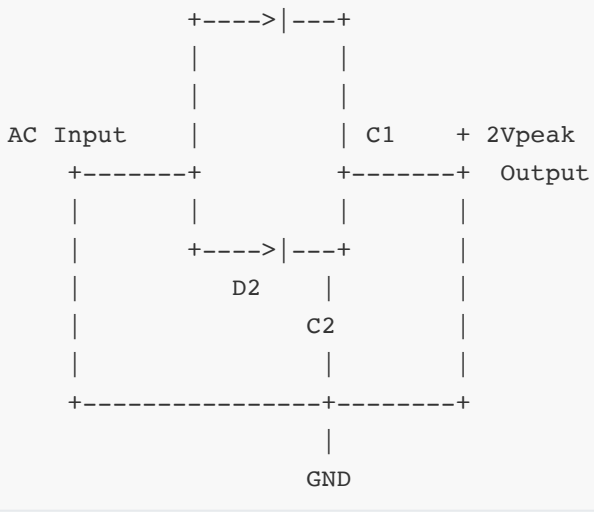
Question 4(c) OR [7 marks]

Explain Half Wave and Full wave Voltage Doubler.

Answer:

Voltage Doubler: Circuit that produces DC output voltage approximately twice the peak input voltage

Half-Wave Voltage Doubler:



Full-Wave Voltage Doubler:

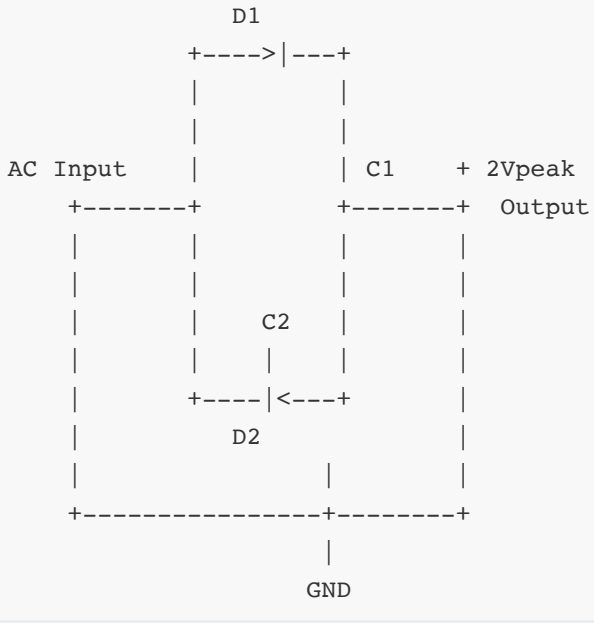


Table: Comparison

Feature	Half-Wave	Full-Wave
Ripple	Higher	Lower
Efficiency	Lower	Higher
Response Time	Slower	Faster
Components	2 diodes, 2 capacitors	2 diodes, 2 capacitors
Regulation	Poor	Better

Operation:

- **Half-Wave**: Charges each capacitor on alternate half-cycles
- **Full-Wave**: Charges both capacitors on every cycle

- **Output**: Sum of voltages across both capacitors

Applications:

- **Power Supplies**: Low-current high-voltage needs
- **Cascade Connection**: For voltage multiplication
- **Electronic Flash**: Camera equipment
- **CRT Displays**: High voltage generation

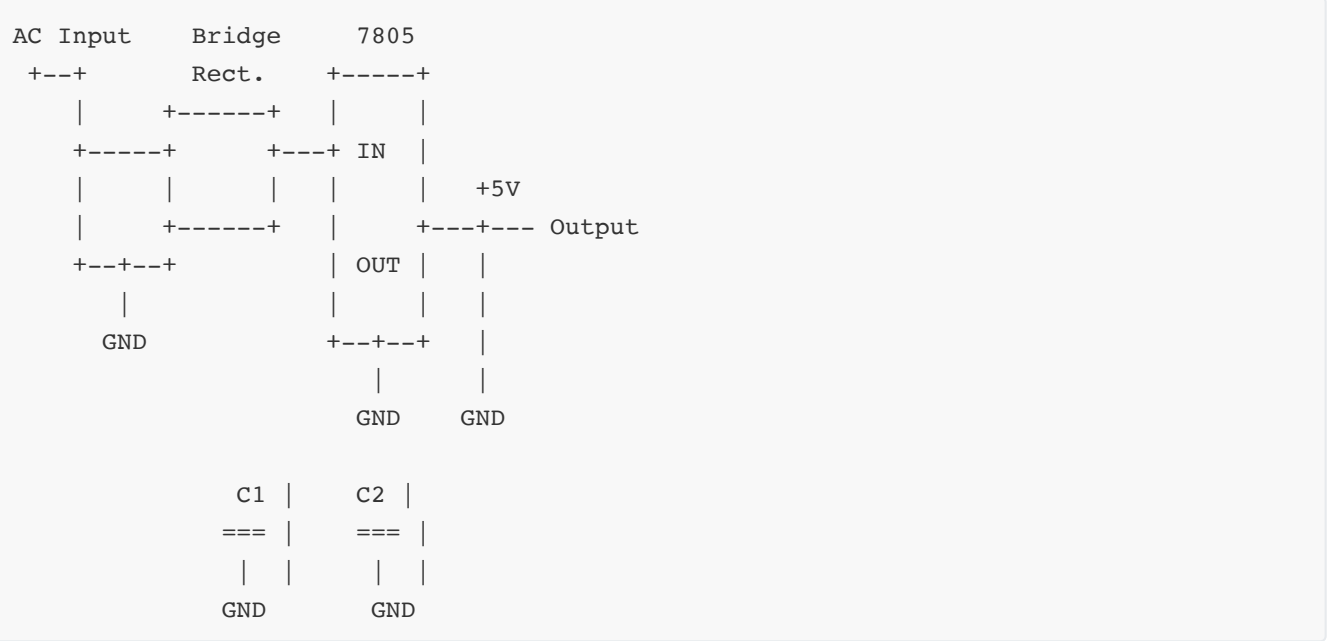
Mnemonic: "DOUBLE" - Diodes Organize Unidirectional Boost, Lifting Electricity to twice input.

Question 5(a) [3 marks]

Draw circuit diagram for +5 v Power Supply using its IC

Answer:

+5V Power Supply Using 7805 Voltage Regulator IC (continued):



Key Components:

- **7805 IC**: Three-terminal fixed voltage regulator
- **Input Capacitor (C1)**: Filters input ripple
- **Output Capacitor (C2)**: Improves transient response
- **Bridge Rectifier**: Converts AC to pulsating DC

Mnemonic: "FIVE" - Fixed IC Voltage Efficiently provided.

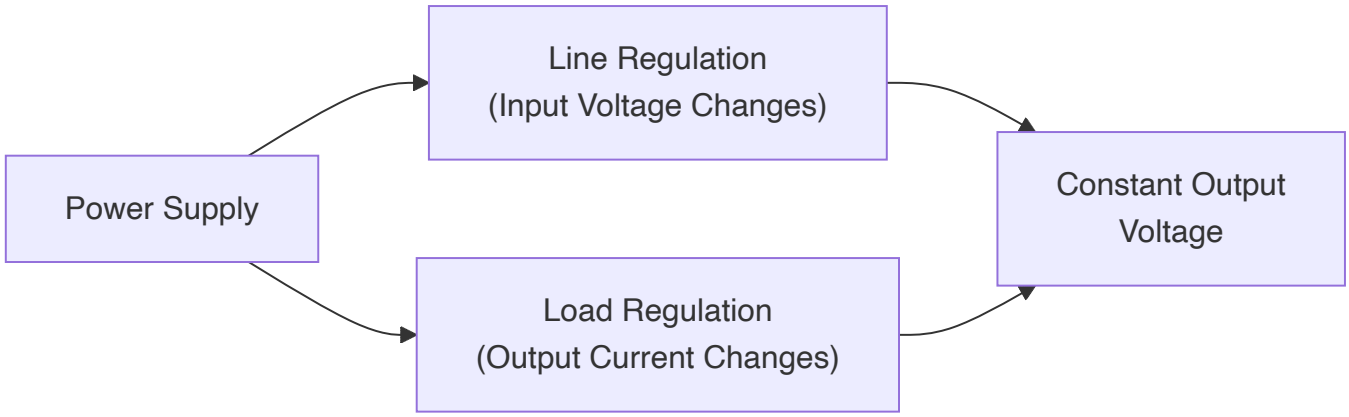
Question 5(b) [4 marks]

Discuss load regulation and line regulation in reference to power supply.

Answer:

Load Regulation: Ability of power supply to maintain constant output voltage despite load current changes

Diagram:



Formulas:

- **Load Regulation**: $(V_1 - V_2)/V_2 \times 100\%$
  - V_1 = No-load voltage
  - V_2 = Full-load voltage
- **Line Regulation**: $(V_1 - V_2)/V_2 \times 100\%$
  - V_1 = Output voltage at maximum input
  - V_2 = Output voltage at minimum input

Key Points:

- **Lower Percentage**: Better regulation
- **Feedback Circuit**: Improves regulation performance
- **IC Regulators**: Typically offer good regulation (0.01-0.1%)

Mnemonic: "LINE LOAD" - Line Is Normal-input Efficiency, LOAD is Output Adjustment Defense.

Question 5(c) [7 marks]

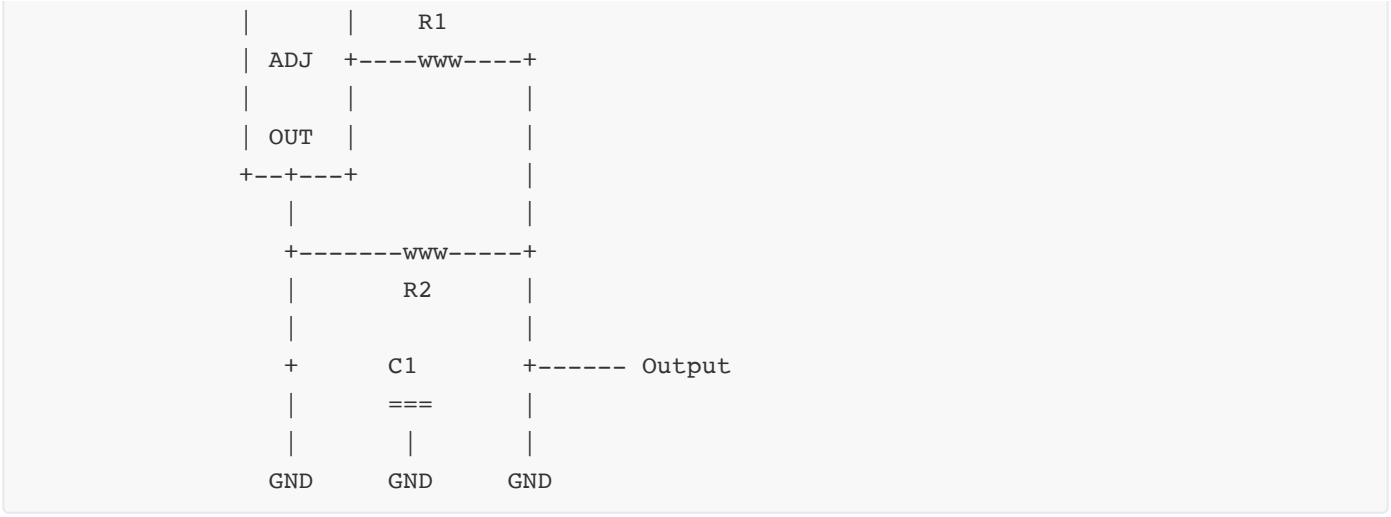
Explain adjustable voltage regulator using LM317 with circuit diagram.

Answer:

LM317 Adjustable Voltage Regulator: Three-terminal device that provides variable regulated output voltage

Circuit Diagram:

```
              LM317
            +------+
            |      |
Input -----+ IN    |
```



Operation:

- **Reference Voltage**: 1.25V between OUT and ADJ terminals
- **Output Voltage**: VOUT = 1.25V × (1 + R2/R1)
- **Adjustment Range**: 1.25V to 37V
- **Maximum Current**: 1.5A (with proper heat sink)

Component Selection:

- **R1**: Typically 240Ω
- **R2**: Variable resistor to adjust output
- **C1**: Output capacitor for stability (1-10μF)

Key Features:

- **Current Limiting**: Built-in protection
- **Thermal Shutdown**: Protection against overheating
- **Safe Area Protection**: For output transistors
- **Ripple Rejection**: 80dB typically

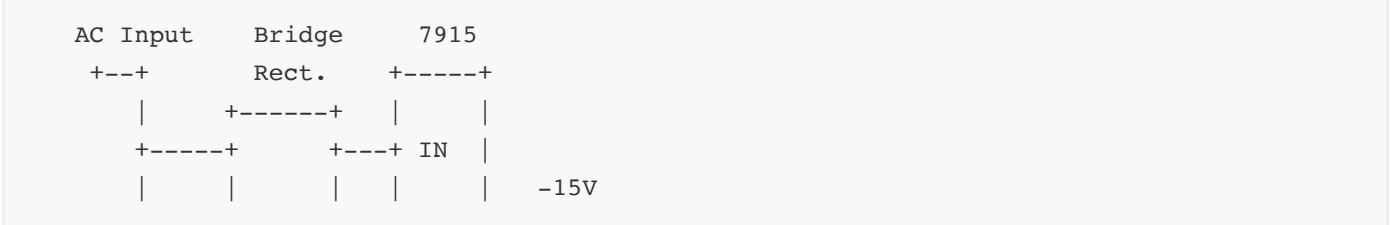
Mnemonic: "VARY" - Voltage Adjustable Regulator Yields custom outputs.

Question 5(a) OR [3 marks]

Draw circuit diagram for -15 v Power Supply using its IC

Answer:

-15V Power Supply Using 7915 Voltage Regulator IC:



```
        |     +------+    |     +---+--- Output
        +--+--+           | OUT |    |
           |              |     |    |
         GND              +--+--+    |
                             |       |
                           GND     GND

                  C1 |     C2 |
                  === |    === |
                   |  |     |  |
                  GND        GND
```

Key Components:

- **7915 IC**: Three-terminal negative voltage regulator
- **Input Capacitor (C1)**: Filters input ripple
- **Output Capacitor (C2)**: Improves transient response
- **Bridge Rectifier**: Converts AC to pulsating DC

Mnemonic: "NINE" - Negative IC Needs Efficient filtering.

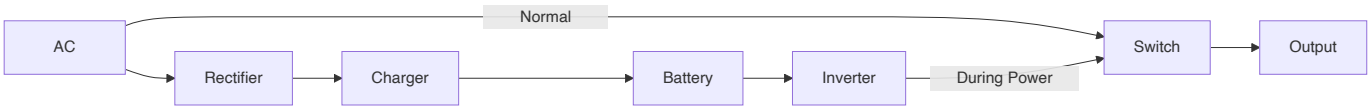
Question 5(b) OR [4 marks]

Explain working of UPS.

Answer:

UPS (Uninterruptible Power Supply): Device providing emergency power when main power fails

Block Diagram:



Types of UPS:

- **Offline/Standby UPS**: Switches to battery when power fails
- **Line-Interactive UPS**: Has voltage regulation
- **Online/Double-Conversion UPS**: Always uses battery power

Key Components:

- **Rectifier**: Converts AC to DC
- **Battery**: Stores energy
- **Inverter**: Converts DC back to AC
- **Control Circuit**: Monitors power and switches source

Applications:

- **Computers**: Prevents data loss
- **Medical Equipment**: Critical operations
- **Industrial Controls**: Prevents costly interruptions
- **Telecommunications**: Maintains connections

Mnemonic: "UPBEAT" - Uninterruptible Power Backup Ensures Available Technology.

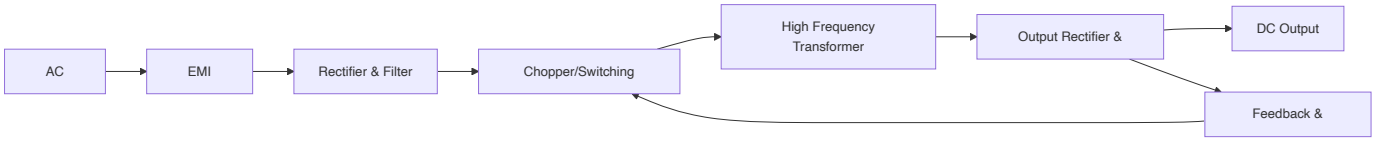
Question 5(c) OR [7 marks]

Draw and explain SMPS block diagram with its advantages and disadvantages.

Answer:

SMPS (Switch Mode Power Supply): Power supply that uses switching regulation for efficiency

Block Diagram:



Operation:

- **EMI Filter**: Reduces electromagnetic interference
- **Rectifier**: Converts AC to unregulated DC
- **Switching Circuit**: Chops DC at high frequency (20-100 kHz)
- **Transformer**: Provides isolation and voltage conversion
- **Output Stage**: Rectifies and filters to clean DC
- **Feedback Loop**: Controls switching for regulation

Advantages:

- **High Efficiency**: 70-90% (vs. 30-60% for linear)
- **Small Size**: Higher operating frequency means smaller components
- **Light Weight**: Smaller transformer and heat sinks
- **Wide Input Range**: Can operate on various input voltages
- **Low Heat Generation**: Less power wasted as heat

Disadvantages:

- **Complex Design**: More sophisticated circuitry
- **EMI Generation**: Switching creates interference
- **Higher Cost**: For low-power applications
- **Noise**: Higher output noise than linear supplies
- **Slower Response**: To sudden load changes

Applications:

- **Computers**: Desktop and laptop power supplies
- **TVs and Monitors**: Compact power source
- **Mobile Chargers**: Small, efficient adapters
- **Industrial Power**: High-efficiency needs

Mnemonic: "SWITCH" - Smaller Weight, Improved Thermal efficiency, Complex Hardware.