Subject Name Solutions

4321103 – Summer 2023

Semester 1 Study Material

Detailed Solutions and Explanations

Question 1(a) [3 marks]

Explain thermal runaway in details.

Solution

Thermal runaway is a destructive mechanism in BJT transistors where increased temperature creates a self-reinforcing cycle leading to device failure.

```
flowchart LR
    A[Increase in Temperature] {-{-} B[Increase in Ic]}
    B {-{-} C[Increase in Power Dissipation]}
    C {-{-} D[Further Increase in Temperature]}
    D {-{-} A}
```

- **Heat Generation**: Temperature rises from normal operation
- **Leakage Current**: Collector current Ic increases with temperature
- **Power Dissipation**: More power = Temperature rises further
- **Destructive Cycle**: Continuous cycle until transistor destroys itself

Mnemonic

"The Higher Temperature, The Higher Current"

Question 1(b) [4 marks]

Define amplifier with simple block diagram write down amplifier parameters.

Solution

An amplifier is an electronic device that increases the power, voltage or current of an input signal.

```
flowchart LR
    A[Input Signal] {-{-}|Vin| B[AMPLIFIER]}
    B {-{-}|Vout| C[Output Signal]}
    D[Power Supply] {-{-} B}
```

Amplifier Parameter	Description
Voltage Gain (Av)	Ratio of output voltage to input voltage
Current Gain (Ai)	Ratio of output current to input current
Power Gain (Ap)	Product of voltage gain and current gain
Bandwidth	Range of frequencies amplifier can handle
Input Impedance	Resistance seen by the input source
Output Impedance	Internal resistance of amplifier

Mnemonic

"VIPS-BIO" (Voltage, Input impedance, Power, Supply, Bandwidth, Impedance Output)

Question 1(c) [7 marks]

Define Biasing in transistor? Write down types of biasing methods. Explain the voltage divider biasing method in details.

Solution

Biasing is the process of establishing a stable operating point (Q-point) for a transistor by applying DC voltages.

Biasing Method	Key Features
Fixed Bias	Simple, poor stability
Collector Feedback	Self-adjusting, better stability
Voltage Divider	Best stability, widely used
Emitter Bias	Good stability, negative feedback

Voltage Divider Biasing:

```
flowchart LR
    VCC((+VCC)) {-{-}{-} R1}
    R1 {-{-}{-} R2 \& B((Base))}
    R2 {-{-}{-} GND}
    B {-{-}{-} C((Collector))}
    B {-{-}{-} E((Emitter))}
    C {-{-}{-} RC {-}{-}{-} VCC}
    E {-{-}{-} RE {-}{-}{-} GND}
```

- **R1 & R2**: Form voltage divider to provide stable base voltage
- **RE**: Provides stabilization through negative feedback
- **RC**: Determines collector current and voltage gain
- **Stability**: Best stability against temperature variations

Mnemonic

"Divide Voltage Before Transistor Conducts"

Question 1(c) OR [7 marks]

Explain Heat sink.

Solution

A heat sink is a passive heat exchanger that transfers heat from electronic devices to the surrounding air.

```
flowchart LR
    A[Heat Source/Transistor] {-{-} B[Interface Material]}
    B {-{-} C[Heat Sink Base]}
    C {-{-} D[Heat Sink Fins]}
    D {-{-} E[Ambient Air]}
```

Component	Function
Base	Conducts heat from device
Fins	Increases surface area for heat dissipation
Thermal Interface Material	Improves contact between device and sink
Types	Extruded, Bonded, Folded, Die-cast

- **Thermal Resistance**: Lower is better for heat dissipation
- **Material**: Usually aluminum or copper for good conductivity
- **Surface Area**: More fins means better cooling
- **Air Flow**: Critical for efficient heat removal