Lecture 1 Introduction to Electronic

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Electronic Engineering

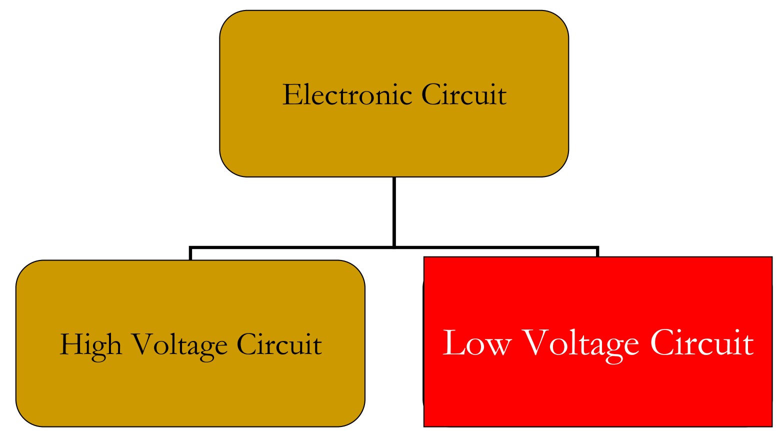
- Lecture 1 Introduction to Electronic
- Lecture 2 Diode and Diode Application
- Lecture 3 Bipolar Junction Transistors (BJT)
- Lecture 4 Enhancement MOSFET (MOSFET)
- Lecture 5 Differential and Multistage Amplifier
- Lecture 6 Frequency Response
- Lecture 7 OP-Amp Applications
- Lecture 8 Feedback
- Lecture 9 Filter
- Lecture 10 Oscillator
- Lecture 11 Power Amplifier
- Lecture 12 Power Electronic Device

Introduction to Electronic

- Microelectronic in Market
  - Computation
  - Communication
  - Other

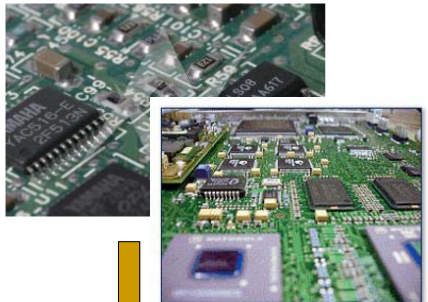
Serving the $1 Trillion Electronic Market

Classification of Level Voltage on Circuit



Introduction to Electronic

- Microelectronic Circuit

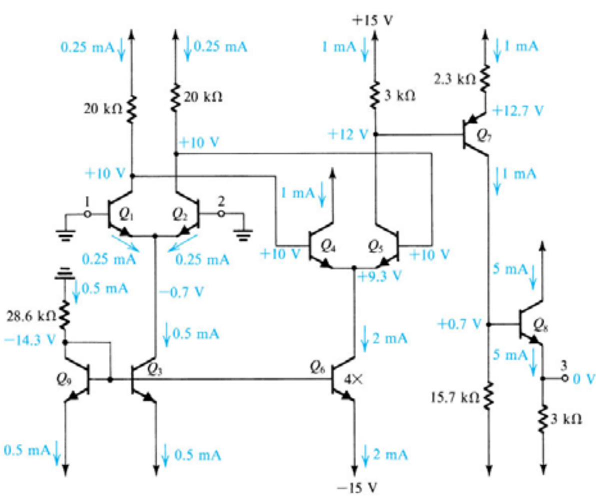


- Electronic Circuit
- Integrated Circuit

Applications of Semiconductors

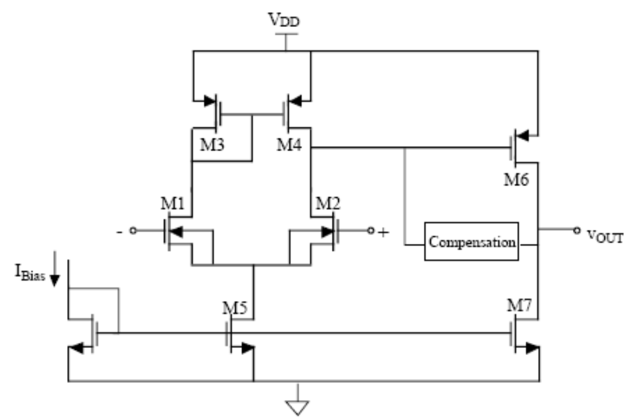
- Logic Circuit
  - Computer, Digital Signal Processing
- Amplifier
  - HI-Fi, Wireless and Microwave Communication, Telephone
- Memories
  - DRAM, SRAM, NVRAM
- Lasers
  - Optical Fiber Communication, CD Players
- Photodiodes
  - Receivers for Optical Communication, Digital Camera
- Charge Coupled Device (CCD)
  - Digital Camera
- Many Others
  - Sensors, Actuators, MEMS, Displays

Low Voltage Circuit



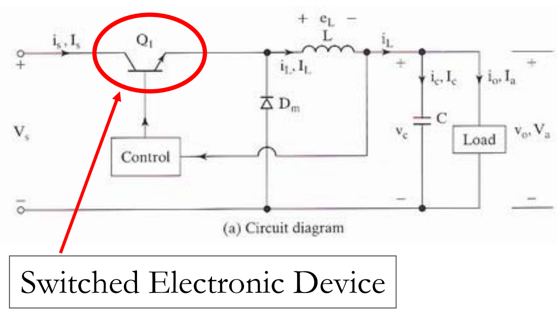
- Op-Amp Architecture
  - BJT

Low Voltage Circuit (con)

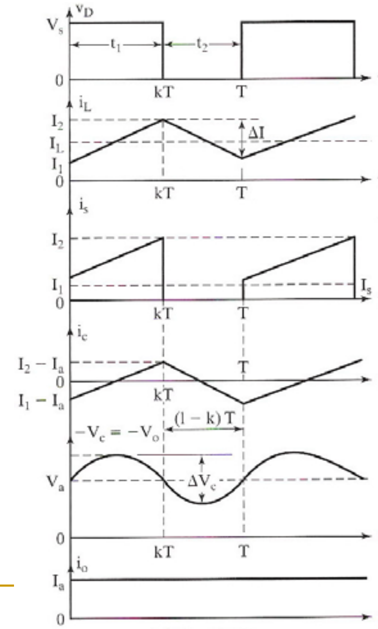


- Op-Amp Architecture
  - MOS Transistor

High Voltage Circuit



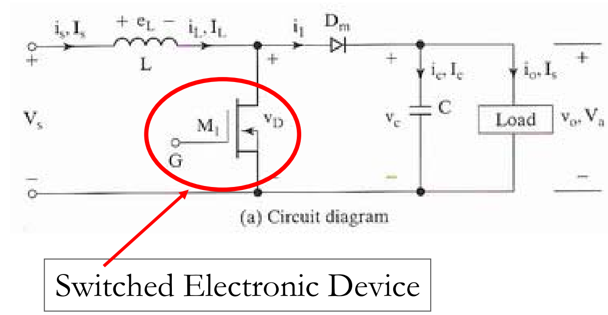
(a) Circuit diagram



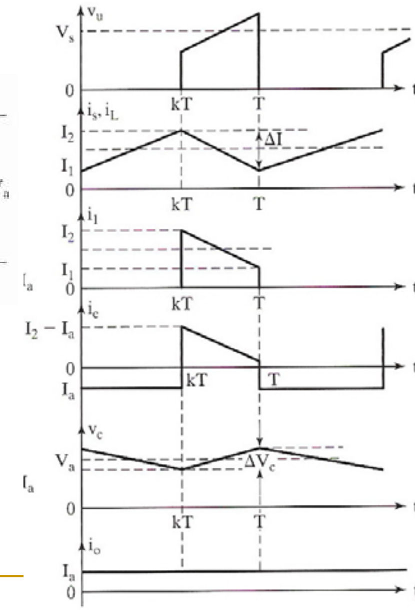
(c) Waveforms

Buck Converter circuit

High Voltage Circuit (con)



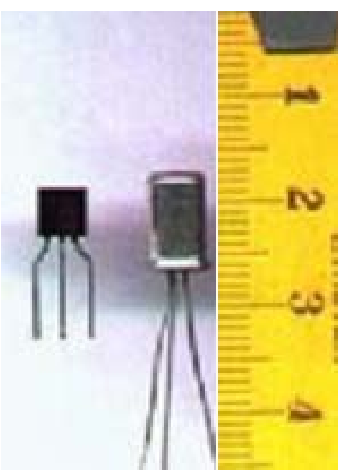
(a) Circuit diagram



(c) Waveforms

Boost Converter circuit

Transistor

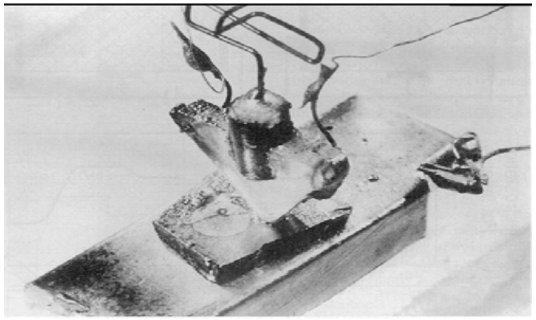


- Transistor is a semiconductor element
- Has three terminals
- A small current or voltage applied to one terminal controls the current through the other two
- It is the key component in all modern electronics

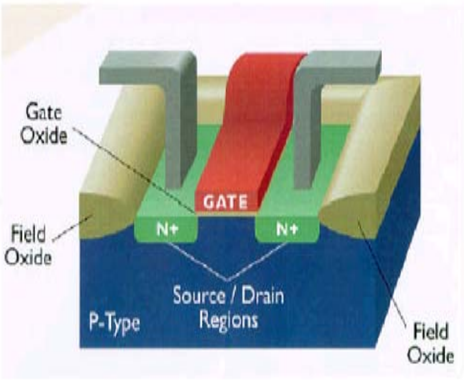
What can Transistor do?

- In digital circuits
  - Very fast electrical switch
  - Function as logic gate
  - RAM-type memory
- In analog circuits
  - Amplify current signals
  - Amplify voltage signals

The First Transistor 1948



VLSI- Transistor 2004

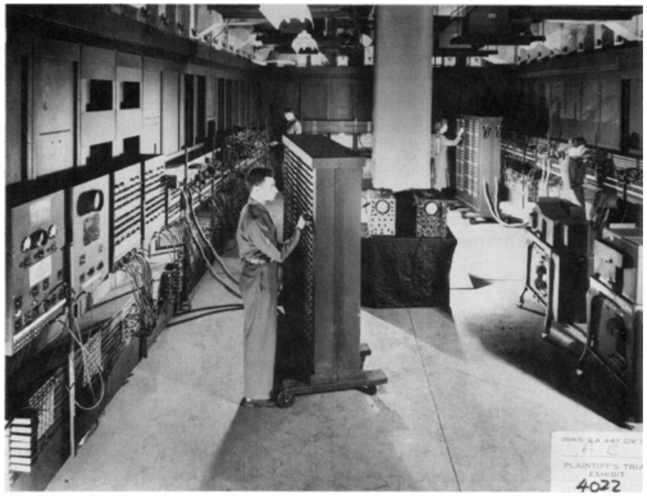


- Side-intersection for an integrated transistor
- Today's technology reached the nanometer scale
- 90nm transistors are used in Pentium 4

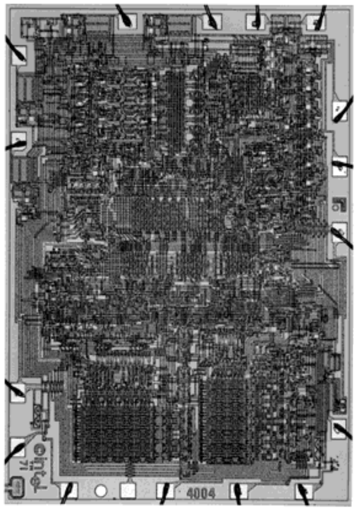
The Transistor vs. the Vacuum Tube

- Transistor
  - Made from semiconductor
  - Small
  - Fast
  - Reliable and effective
- Vacuum Tube
  - Similar to Light Bulb
  - Big and bulky
  - Slow
  - generates a lot of heat
  - Burns out

ENIAC - The first electronic computer (1946)

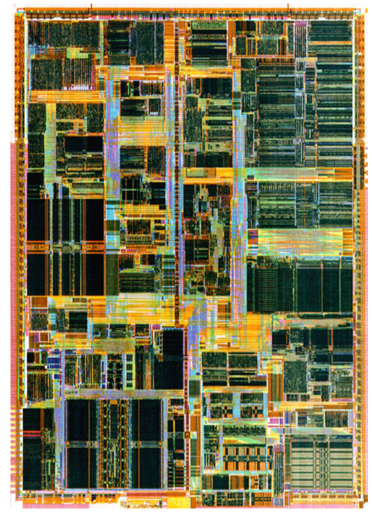


Intel 4004 Micro-Processor



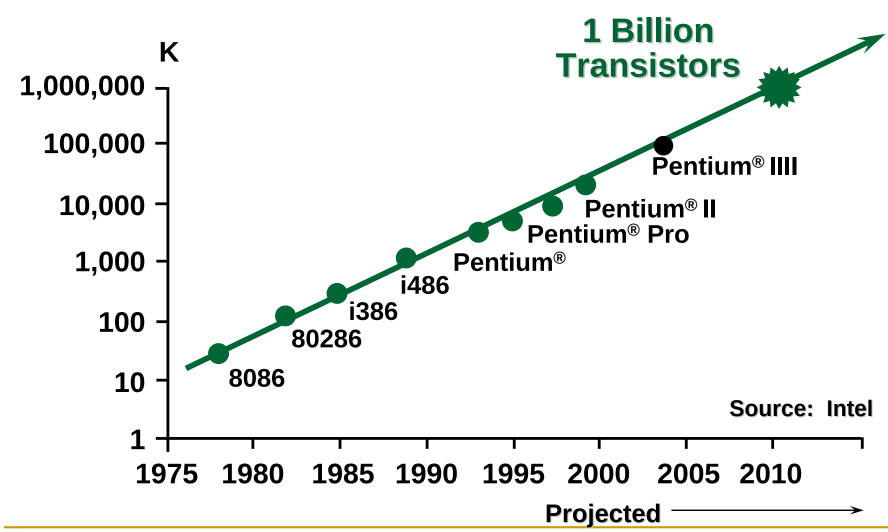
- 1971
- 1000 Transistors
- 1 MHz Operation

Pentium (IV) microprocessor Intel

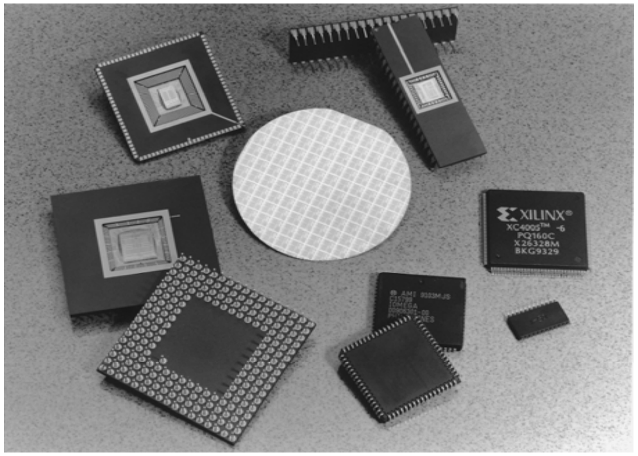


- 2002
- 60 Million Transistors
- 3.0 – 3.6 GHz Operations

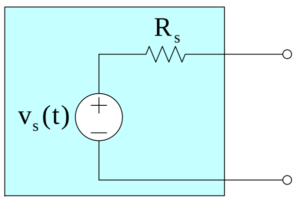
Moor's Law



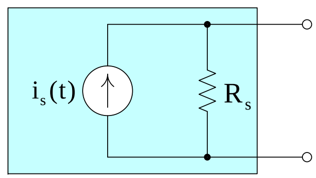
Package Types



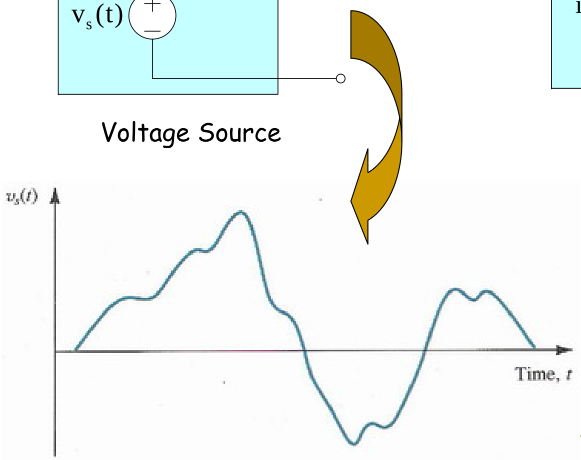
1.1 Signal



Voltage Source



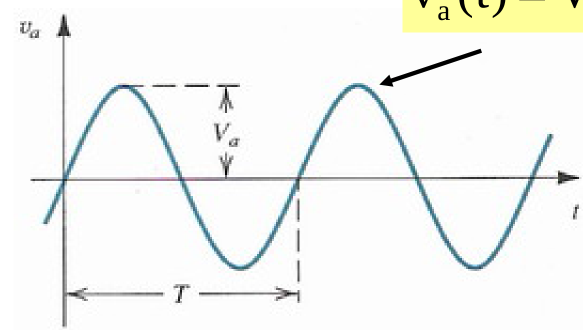
Current Source



- Output Signal of Voltage Source

1.2 Frequency Spectrum of Signals

$$v_a(t) = V_a \sin \varpi t$$

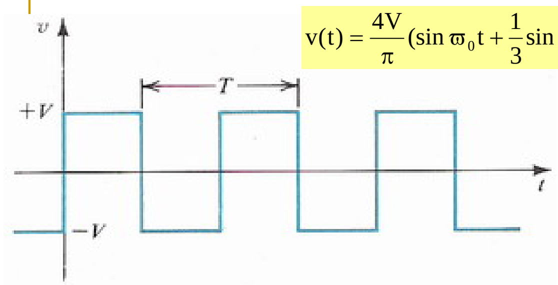


Sine Wave

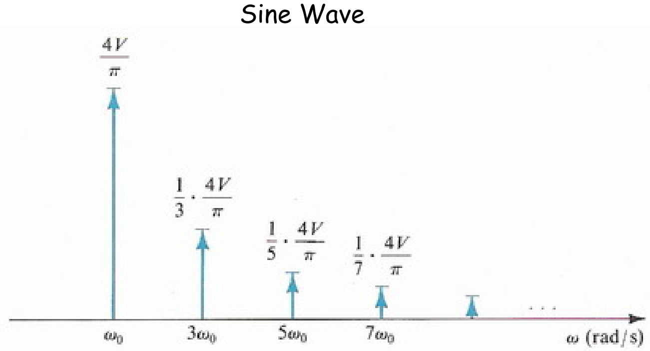
$$\varpi = 2\pi f$$

$$f = \frac{1}{T}$$

$$v(t) = \frac{4V}{\pi}(\sin \varpi_0 t + \frac{1}{3}\sin 3\varpi_0 t + \frac{1}{5}\sin 5\varpi_0 t + \cdots)$$

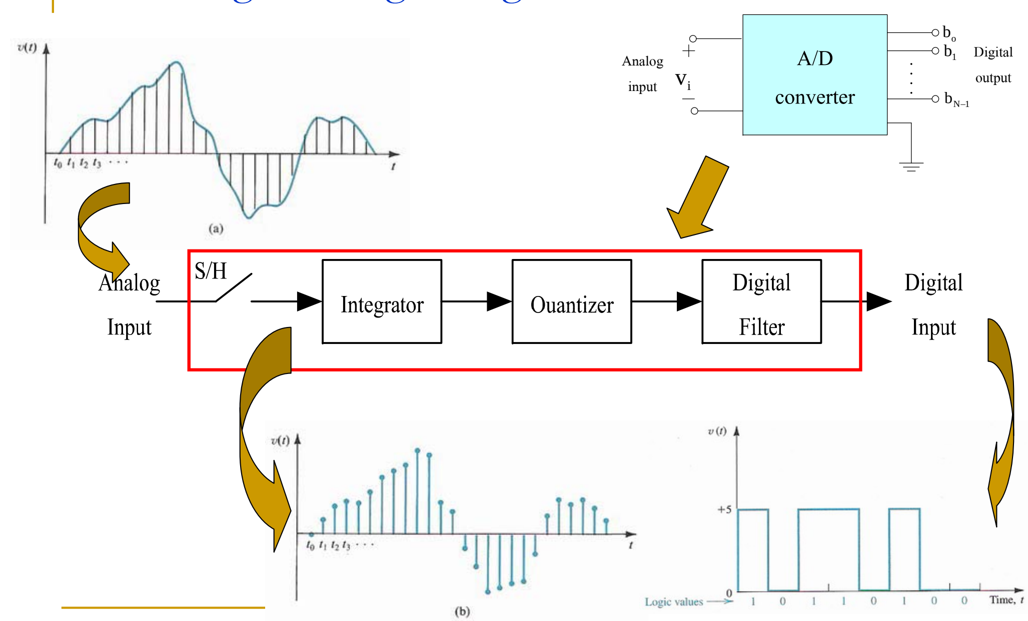


Sine Wave

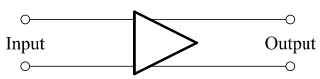


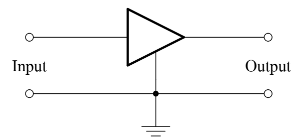
Frequency Spectrum

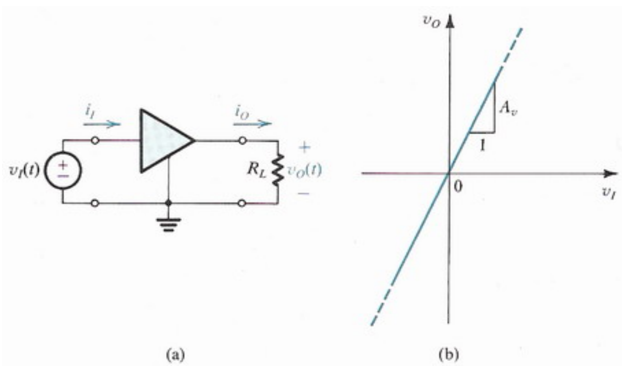
1.3 Analog and Digital Signals



1.4 Amplifiers







$$A_v = \frac{v_{out}}{v_{in}}$$

Amplifiers

- Linear Signal Amplification:
  $$v_0(t) = Av_i(t)$$
- A: Amplifier gain equals the slope
- Distortion changes waveform as in figure
- No real life amplifier is perfectly linear, distortion due to clipping

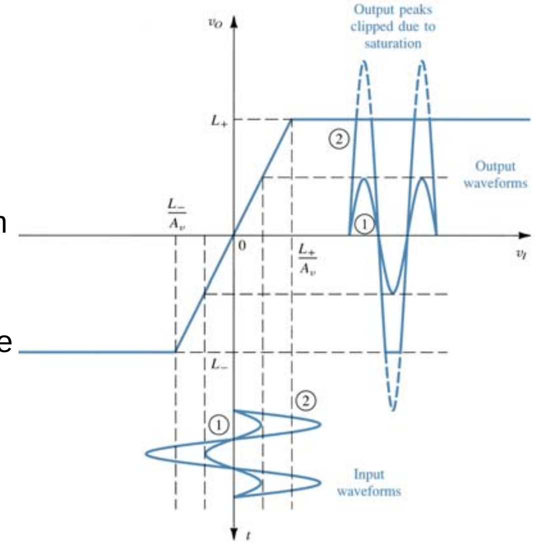
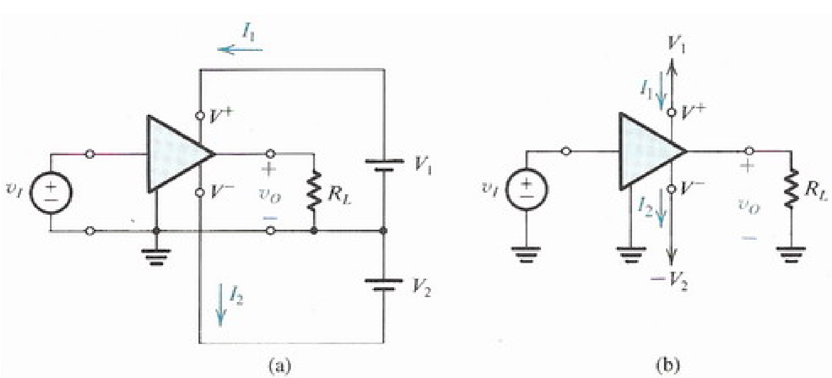
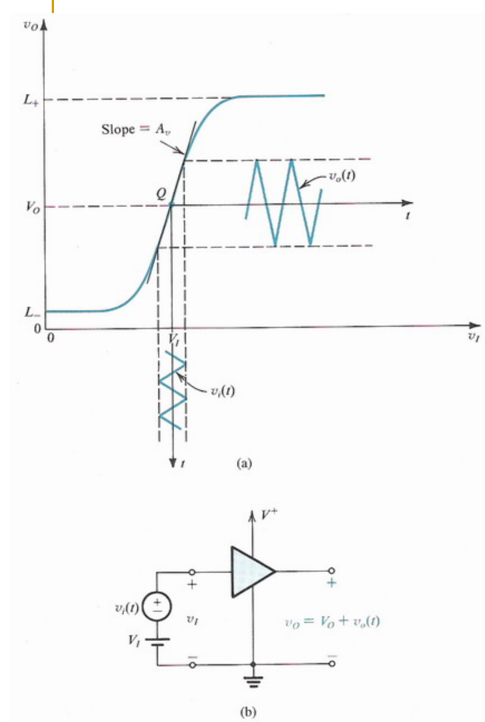


Fig. 1.13 An amplifier transfer characteristic that is linear except for output saturation.





1.5 Circuit Models for Amplifiers

Nonlinearity

- Most amplifiers are only linea in a narrow range of operatio
- To linearize, bias the circuit with a dc voltage, labeled Q, the quiescent point.

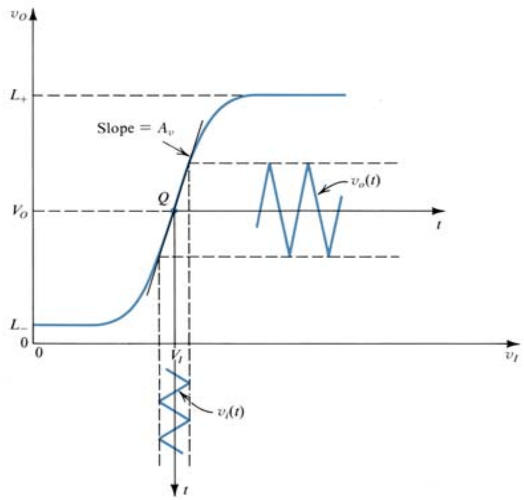


Fig. 1.14 (a) An amplifier transfer characteristic that shows considerable nonlinearity.

1.6 Frequency Response of Amplifiers

- Low Pass Filter (LPF) Frequency Response
- Magnitude Response

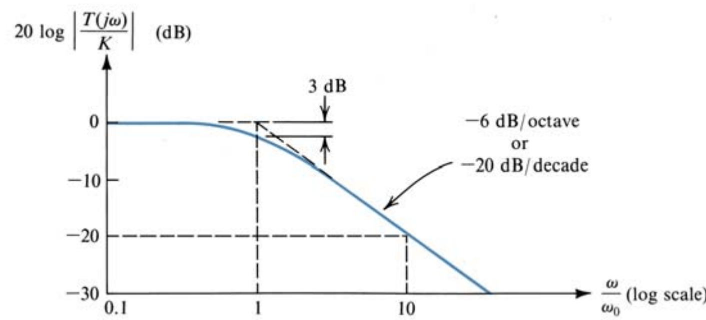


Fig. 1.23 (a) Magnitude of STC networks of the low-pass type.

LPF Frequency Response

- Phase Response

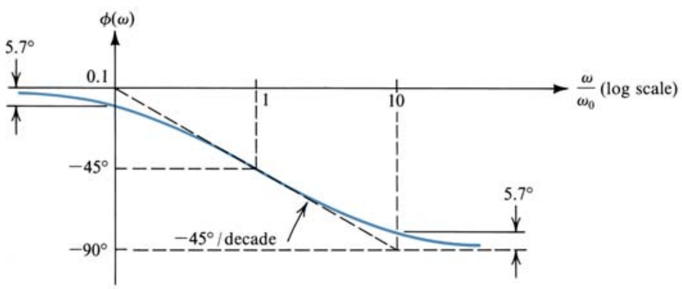


Fig. 1.23 (b) phase response of STC networks of the low-pass type.

High Pass Filter Frequency Response

- Magnitude Response

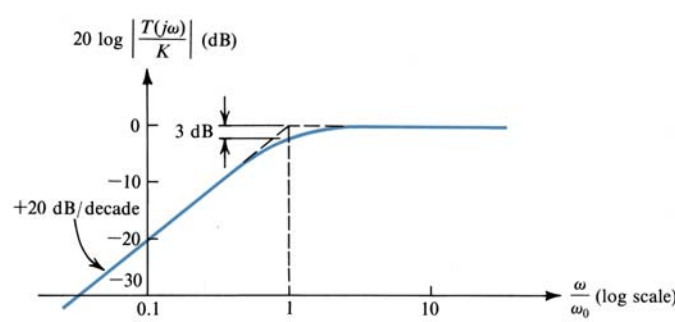


Fig. 1.24 (a) Magnitude of STC networks of the high-pass type.

High Pass Filter Frequency Response

- Phase response

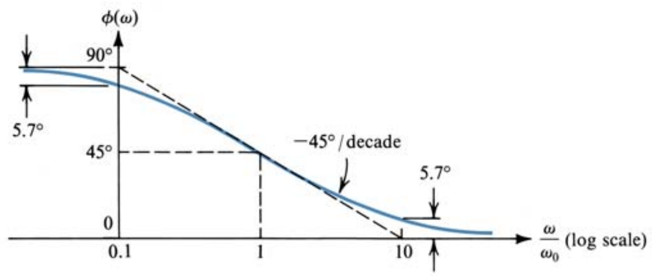


Fig. 1.24 (b) phase response of STC networks of the high-pass type.

Thank you