Two major functions performed by electronic device
a - Switching  b - Amplifying

P R A C T I C A L A M P L I F I E R

Amplifier classification in terms of

a - Number of stages  b - Size of the signals  c - frequency range  d - bandwidth

• audio amplifier amplifies signal from 30 to 15000 Hz
• Direct-coupled amplifier amplifying signal from 0 to a few cycles per second used to measuring
  a - structural vibration  b - temperature vibration  c - current generated within the human body
• Video amplifier in TV receiver amplifies picture from 30 to 4,000,000 Hz
• Radio frequency amplifier FM
• Amply and tuned to select signal from one station and reject all other
**Amplification and Distortions**

The voltage gain \( A_v \) for ac signals is given by:

\[
A_v = \frac{V_{\text{out}}}{V_{\text{in}}} = A e^{j\theta} = A \angle \theta
\]

- \( A_v \) is the complex ratio of two voltage phasors.
- **Linear amplifier** \( A \angle \theta \) is independent of signal amplitude and frequency; the output is a replica of the input signal.
- **Nonlinear amplifier** introduces amplitude distortion; \( A \) is not a simple constant.

- Frequency component in the output which is not present in the input: second or third harmonic.
- Excessively large signals applied to a nonlinear element, e.g., transistor, introduces amplitude distortion.

![Amplitude distortion](image)
Noise
• Random signals unrelated to the input greatest importance in input stage snow TV when the signal is very weak
• Any noise introduced with the input signal amplified by all subsequent stage.

Sources of noise
• Random thermal motion of electrons in the amplifier circuit element
• The shot effect of individual electron crossing a junction.

Dynamic range amplifier
Frequency - response curve audio amplifier.
Frequency distortion all frequencies not amplified equally the gain is a function of frequency
Signal consisting of a fundamental 1 kHz tenth harmonic 10 kHz and a hundredth harmonic 100 kHz different wave form after amplification No amplifier is completely free from frequency distortion.
**phase distortion**

- \( \theta = \omega t \)  ➤ function of frequency
- amplitude ➤ unchanged
- phase positions are shifted
- phase distortion changes the shape of the output wave.
- The eye is sensitive to phase distortion
- The ear is sensitive to amplitude

- Capacitor and inductive reactance ➤ frequency dependent
- Some transistors parameter are frequency dependent

*In design of untuned or wide - band amplifiers ➤ special steps are taken to reduce the variation in gain with frequency.*
**Practical consideration**

- A simplified two-stage phonograph amplifier
- *The practical consideration*

**Biasing** ➤ T ➤ operated in linear portion of their output characteristics

- $V_{CC} ➤ V_{VE} ➤ T_1 ➤ T_2 ➤ I_B$ through $R_{B1} ➤ R_{B2} ➤ R_D$ ➤

**Coupling** ➤ $RC$ ➤ transformers

- The voltage ➤ coupled to $T_1$ by $R_{VC}$ and $Cc$
- $T_1$ ➤ coupled to $T_2$ by $R_C$ and $C_C$
- The loudspeaker ➤ coupled to $T_2$ by transformer (T) ➤ more expensive the $R_C$ coupling.
- Combination of $R_D$ and $C_D$ ➤ *decoupling filter* ➤ prevent amplified signal feedback ➤ overcome the internal resistance of the battery which supplying several stages.
Load Impedance

**Untuned amplifier** $R_L$ purely resistive minimize the variation in gain with frequency:

**Tuned amplifier** $R_L$ paralleled resonant circuit.

- Large $R_C \gg IR$ (large voltage)

Input and output Amplifier

- High input impedance minimize "loading" of the preceding stage.
- Signal output of $T_1$ determined by $R_C \gg R_{BS}$ input resistance of $T_2$.

Unintentional Elements

- Wring diagram component not circuit element the energy stored in straight conductor magnetic filed electric field represent by wiring capacitance.
- Energy storage a difference in potential between $G \gg S$ MOSFET depletion region of BJT.
BIASING CIRCUITS

Establish the proper operating point.

Biasing problems ➔ because

- Wide variation in device parameters ➔ mass-produced transistors.
- Complicated interrelation ➔ transistor variables.
- Sensitivity of semiconductor devices to temperature.

FET Biasing

FETs ➔ used ➔ "small - signal" amplifier

- Signals are large its parabolic transfer characteristic ➔ amplitude distortion
- Small signal ➔ required bias is not critical
**Chapter (4)**
Large – Signal Amplifiers

**DE MOSFET**

- Simple biasing ➤ DE MOSFET ➤ unique transfer characteristic ➤ operation point ➤ $V_{GS} = 0$
- Operation ➤ constant - current ➤ biasing ➤ $V_{DD}$

Amplifier circuit consist ➤ Fig. C
- Voltage supply ➤ $V_{DD}$
- Drain resistor ➤ $R_D$
- Gate resistor $R_G$ ➤ ties G to S

**Fig. a**
- A small- signal voltage applied to the input ➤ current output.  
  \[ V_o = V_{DD} - i_D R_D \]

- $v_o$ ➤ contains a signal component that is an amplified replica of the input voltage.

Practice Problem (12-2)