# VIVEKANANDA COLLEGE

***THAKURPUKUR KOLKATA-700063***

***NAAC ACCREDITED 'A' GRADE***

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|---|---|
| Topic | :Frequency Response of an Amplifier |
| Course Title | :Analog Systems and Applications |
| Paper | : PHS-A-CC-4-10-TH |
| Unit | : |
| Semester | : 4th |
| Name of the Teacher | : Somnath Paul |
| Name of the Department | : Physics |

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# Frequency response

- We know that gain factor are function of frequency.
- Amplifier gain versus frequency plot called frequency response curve.
- It is usefull to determine band width of the circuit.

# Logarithmic Scale

- Analysis of amplifiers normally extends over a wide frequency range
- Logarithmic scale makes it comfortable to plot the response between wide limits

Common logarithm: $x = \log_{10} a$

Natural logarithm: $y = \log_e a$

$\log_e a = 2.3 \log_{10} a$

# Decibels

❖The term *decibel has its origin in the* fact that power and audio levels are related on a logarithmic basis.

❖The bel (B) is defined by the following equation relating two power levels, P1 and P2 :

$$G = \log_{10} \frac{P_2}{P_1} \quad \text{bel}$$

The decibel (dB) is defined such that 10decibels = 1 bel

$$G_{dB} = 10 \log_{10} \frac{P_2}{P_1} \quad \text{dB}$$

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# Cascaded Stages

**One of the advantages of the logarithmic relationship is the manner in which it can be applied to cascaded stages.**

**The magnitude of the overall voltage gain of a cascaded system is given by**

$$|A_{v_T}| = |A_{v_1}| \cdot |A_{v_2}| \cdot |A_{v_3}| \cdots |A_{v_n}|$$

The equation below states that the decibel gain of a cascaded system is simply the sum of the decibel gains of each stage

$$G_{dB_T} = G_{dB_1} + G_{dB_2} + G_{dB_3} + \cdots + G_{dB_n} \quad \text{dB}$$

# Frequency response of Amplifier

Any frequency response curve can be split into three region

- ❖ Low frequency region
- ❖Mid Frequency region
- ❖High frequency region

# Low Frequency region

**To demonstrate how the larger coupling and bypass capacitors of a network will affect the frequency response of a system, the reactance of a 1-µF (typical value for such applications) capacitor is tabulated in Table below for a wide range of frequencies.**

*Variation in* $X_C = \dfrac{1}{2\pi f C}$ *with frequency for a 1-µF capacitor*

| $f$ | $X_C$ | |
|---|---|---|
| 10 Hz | 15.91 kΩ | Range of possible effect |
| 100 Hz | 1.59 kΩ | |
| 1 kHz | 159 Ω | |
| 10 kHz | 15.9 Ω | |
| 100 kHz | 1.59 Ω | Range of lesser concern (≅ short-circuit equivalence) |
| 1 MHz | 0.159 Ω | |
| 10 MHz | 15.9 mΩ | |
| 100 MHz | 1.59 mΩ | |

***The larger capacitors of a system will have an important impact on the response of a system in the low-frequency range and can be ignored for the high-frequency region.***

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# Mid Frequency region

❖In the mid-frequency range the effect of the capacitive elements is largely ignored

❖The amplifier considered ideal and composed simply of resistive elements and controlled sources

***The effect of the capacitive elements in an amplifier are ignored for the mid-frequency range when important quantities such as the gain and impedance levels are determined.***

# High Frequency region

❖The smaller capacitors that come into play in the higher frequencies region

❖The frequency-dependent parameters of the small-signal equivalent circuits will limit the high-frequency response of the system

*Variation in $X_C = \frac{1}{2\pi f C}$ with frequency for a 5 pF capacitor*

| $f$ | $X_C$ | |
|---|---|---|
| 10 Hz | 3,183 MΩ | Range of lesser concern (≡ open-circuit equivalent) |
| 100 Hz | 318.3 MΩ | |
| 1 kHz | 31.83 MΩ | |
| 10 kHz | 3.183 MΩ | |
| 100 kHz | 318.3 kΩ | Range of possible effect |
| 1 MHz | 31.83 kΩ | |
| 10 MHz | 3.183 kΩ | |
| 100 MHz | 318.3 Ω | |

***The smaller capacitors of a system will have an important impact on the response of a system in the high-frequency range and can be ignored for the low-frequency region.***

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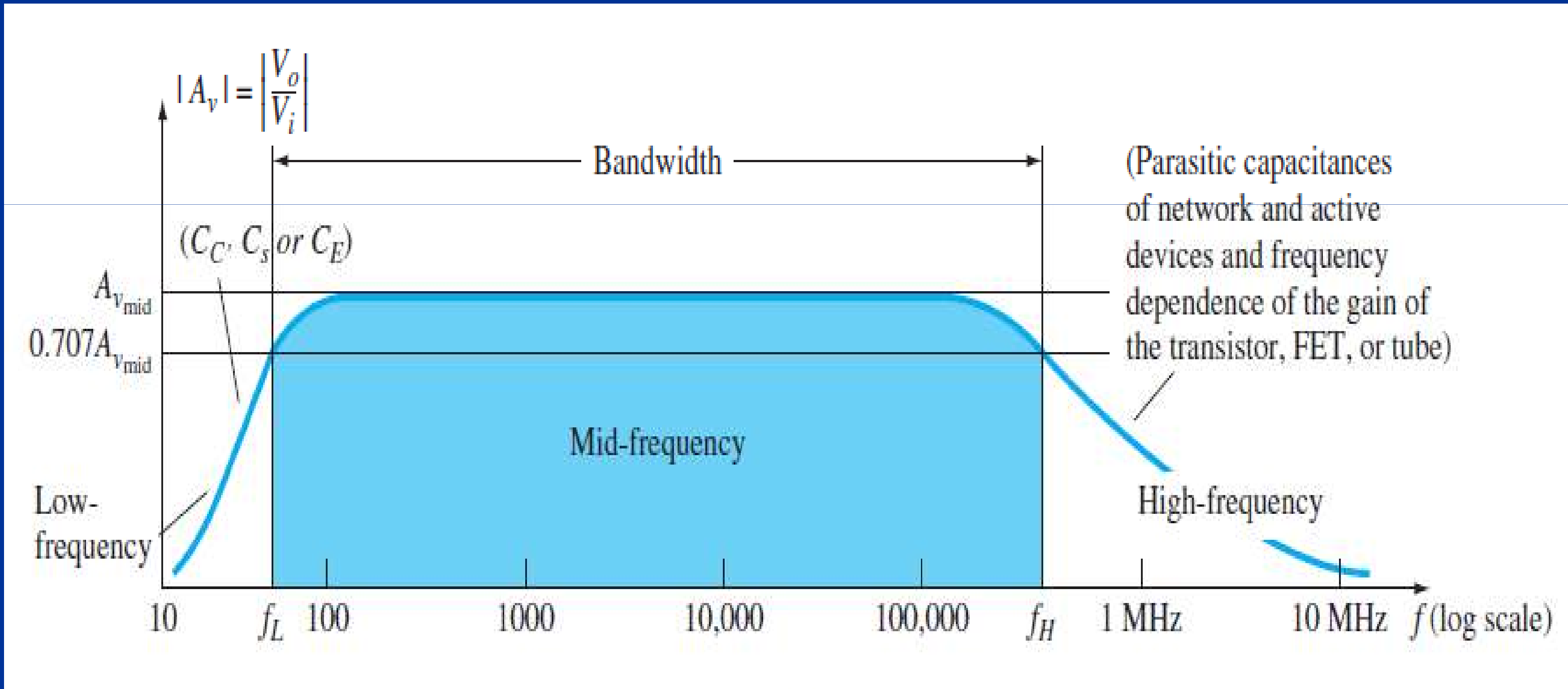
# Typical Frequency response curve

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# Phase plot for an RC-coupled amplifier