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Common Stage Amplifiers Formulas

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List of 26 Common Stage Amplifiers Formulas

Common Stage Amplifiers

1) Amplifier Bandwidth in Discrete-Circuit Amplifier

Open Calculator

$$\mathrm{BW} = \mathrm{f_h} - \mathrm{f_L}$$

ex $0.25\text{Hz} = 100.50\text{Hz} - 100.25\text{Hz}$

2) Bypass Capacitance of CS Amplifier

Open Calculator

$$\mathrm{C_s} = \frac{1}{\mathrm{f_{tm}} \cdot \mathrm{R_{sig}}}$$

ex $$25.99935\mu\text{F} = \frac{1}{30.77\text{Hz} \cdot 1.25\text{k}\Omega}$$

3) Collector Base Junction Resistance of CE Amplifier

Open Calculator

$$\mathrm{R_c} = \mathrm{R_{sig}} \cdot (1 + \mathrm{g_m} \cdot \mathrm{R_L}) + \mathrm{R_L}$$

ex $11.68\text{k}\Omega = 1.25\text{k}\Omega \cdot (1 + 4.8\text{mS} \cdot 1.49\text{k}\Omega) + 1.49\text{k}\Omega$

4) Current Gain of CS Amplifier

Open Calculator

$$\mathrm{A_i} = \frac{\mathrm{A_p}}{\mathrm{A_v}}$$

ex $$3.698397 = \frac{3.691}{0.998}$$

5) Drain Voltage through Method of Open-Circuit Time Constants to CS Amplifier

Open Calculator

$$\mathrm{V_d} = \mathrm{v_x} + \mathrm{V_{gs}}$$

ex $15.32\text{V} = 11.32\text{V} + 4\text{V}$

6) Effective High Frequency Time Constant of CE Amplifier

Open Calculator

$$\tau_\mathrm{H} = \mathrm{C_{be}} \cdot \mathrm{R_{sig}} + (\mathrm{C_{cb}} \cdot (\mathrm{R_{sig}} \cdot (1 + \mathrm{g_m} \cdot \mathrm{R_L}) + \mathrm{R_L})) + (\mathrm{C_t} \cdot \mathrm{R_L})$$

ex $3.542055\text{s} = 27\mu\text{F} \cdot 1.25\text{k}\Omega + (300\mu\text{F} \cdot (1.25\text{k}\Omega \cdot (1 + 4.8\text{mS} \cdot 1.49\text{k}\Omega) + 1.49\text{k}\Omega)) + (2.889\mu\text{F} \cdot 1.49\text{k}\Omega)$

7) Equivalent Signal Resistance of CS Amplifier

Open Calculator

$$\text{fx}\quad R'_{sig} = \frac{1}{\left(\frac{1}{R_{sig}} + \frac{1}{R_{out}}\right)}$$

$$\text{ex}\quad 0.683466\text{k}\Omega = \frac{1}{\left(\frac{1}{1.25\text{k}\Omega} + \frac{1}{1.508\text{k}\Omega}\right)}$$

8) Frequency of Zero Transmission of CS Amplifier

Open Calculator

$$\text{fx}\quad f_{tm} = \frac{1}{C_s \cdot R_{sig}}$$

$$\text{ex}\quad 30.76923\text{Hz} = \frac{1}{26\mu\text{F} \cdot 1.25\text{k}\Omega}$$

9) High-Frequency Band given Complex Frequency Variable

Open Calculator

$$\text{fx}\quad A_m = \sqrt{\frac{\left(1 + \left(\frac{f_{3dB}}{f_t}\right)\right) \cdot \left(1 + \left(\frac{f_{3dB}}{f_o}\right)\right)}{\left(1 + \left(\frac{f_{3dB}}{f_p}\right)\right) \cdot \left(1 + \left(\frac{f_{3dB}}{f_{p2}}\right)\right)}}$$

$$\text{ex}\quad 12.19146\text{dB} = \sqrt{\frac{\left(1 + \left(\frac{50\text{Hz}}{36.75\text{Hz}}\right)\right) \cdot \left(1 + \left(\frac{50\text{Hz}}{0.112\text{Hz}}\right)\right)}{\left(1 + \left(\frac{50\text{Hz}}{36.532\text{Hz}}\right)\right) \cdot \left(1 + \left(\frac{50\text{Hz}}{25\text{Hz}}\right)\right)}}$$

10) High-Frequency Gain of CE Amplifier

Open Calculator

$$\text{fx}\quad A_{hf} = \frac{f_{u3dB}}{2 \cdot \pi}$$

$$\text{ex}\quad 0.200058 = \frac{1.257\text{Hz}}{2 \cdot \pi}$$

11) High-Frequency Response given Input Capacitance

Open Calculator

$$\text{fx}\quad A_{hf} = \frac{1}{2 \cdot \pi \cdot R_{sig} \cdot C_i}$$

$$\text{ex}\quad 0.244257 = \frac{1}{2 \cdot \pi \cdot 1.25\text{k}\Omega \cdot 521.27\mu\text{F}}$$

12) Input Capacitance in High-Frequency Gain of CE Amplifier

Open Calculator

$$C_i = C_{cb} + C_{be} \cdot (1 + (g_m \cdot R_L))$$

$$520.104\mu F = 300\mu F + 27\mu F \cdot (1 + (4.8mS \cdot 1.49k\Omega))$$

13) Input Resistance of CG Amplifier

Open Calculator

$$R_t = \frac{R_{in} + R_L}{1 + (g_m \cdot R_{in})}$$

$$0.478499k\Omega = \frac{0.78k\Omega + 1.49k\Omega}{1 + (4.8mS \cdot 0.78k\Omega)}$$

14) Load Resistance of CG Amplifier

Open Calculator

$$R_L = R_t \cdot (1 + (g_m \cdot R_{in})) - R_{in}$$

$$1.49712k\Omega = 0.480k\Omega \cdot (1 + (4.8mS \cdot 0.78k\Omega)) - 0.78k\Omega$$

15) Load Resistance of CS Amplifier

Open Calculator

$$R_L = \left(\frac{V_{out}}{g_m \cdot V_{gs}}\right)$$

$$1.498958k\Omega = \left(\frac{28.78V}{4.8mS \cdot 4V}\right)$$

16) Mid Band Gain of CE Amplifier

Open Calculator

$$A_{mid} = \frac{V_{out}}{V_{th}}$$

$$32.01335 = \frac{28.78V}{0.899V}$$

17) Midband Gain of CS Amplifier

Open Calculator

$$A_{mid} = \frac{V_{out}}{V'_{sig}}$$

$$32.01335 = \frac{28.78V}{0.899V}$$

18) Open Circuit Time Constant between Gate and Drain of Common Gate Amplifier

Open Calculator

$$T_{oc} = (C_t + C_{gd}) \cdot R_L$$

$$0.006309\text{s} = (2.889\mu\text{F} + 1.345\mu\text{F}) \cdot 1.49\text{k}\Omega$$

19) Open Circuit Time Constant in High Frequency Response of CG Amplifier

Open Calculator

$$T_{oc} = C_{gs} \cdot \left(\frac{1}{R_{sig}} + g_m\right) + (C_t + C_{gd}) \cdot R_L$$

$$0.006309\text{s} = 2.6\mu\text{F} \cdot \left(\frac{1}{1.25\text{k}\Omega} + 4.8\text{mS}\right) + (2.889\mu\text{F} + 1.345\mu\text{F}) \cdot 1.49\text{k}\Omega$$

20) Output Voltage of CS Amplifier

Open Calculator

$$V_{out} = g_m \cdot V_{gs} \cdot R_L$$

$$28.608\text{V} = 4.8\text{mS} \cdot 4\text{V} \cdot 1.49\text{k}\Omega$$

21) Resistance between Gate and Drain in Open Circuit Time Constants Method of CS Amplifier

Open Calculator

$$R_t = \frac{v_x}{i_x}$$

$$0.386085\text{k}\Omega = \frac{11.32\text{V}}{29.32\text{mA}}$$

22) Resistance between Gate and Source of CG Amplifier

Open Calculator

$$R_t = \frac{1}{\frac{1}{R_{in}} + \frac{1}{R_{sig}}}$$

$$0.480296\text{k}\Omega = \frac{1}{\frac{1}{0.78\text{k}\Omega} + \frac{1}{1.25\text{k}\Omega}}$$

23) Second Pole-Frequency of CG Amplifier

Open Calculator

$$f_{p2} = \frac{1}{2 \cdot \pi \cdot R_L \cdot (C_{gd} + C_t)}$$

$$25.22801\text{Hz} = \frac{1}{2 \cdot \pi \cdot 1.49\text{k}\Omega \cdot (1.345\mu\text{F} + 2.889\mu\text{F})}$$

24) Source Voltage of CS Amplifier

Open Calculator

fx $V_{gs} = V_d - v_x$

ex $4V = 15.32V - 11.32V$

25) Test Current in Open Circuit Time Constants Method of CS Amplifier

Open Calculator

fx $i_x = g_m \cdot V_{gs} + \frac{v_x + V_{gs}}{R_L}$

ex $29.48188mA = 4.8mS \cdot 4V + \frac{11.32V + 4V}{1.49k\Omega}$

26) Upper 3dB Frequency of CE Amplifier

Open Calculator

fx $f_{u3dB} = 2 \cdot \pi \cdot A_{hf}$

ex $1.256637Hz = 2 \cdot \pi \cdot 0.20$

Variables Used

- A_{hf} High Frequency Response
- A_i Current Gain
- A_m Amplifier Gain in Mid Band *(Decibel)*
- A_{mid} Mid Band Gain
- A_p Power Gain
- A_v Voltage Gain
- **BW** Amplifier Bandwidth *(Hertz)*
- C_{be} Base Emitter Capacitance *(Microfarad)*
- C_{cb} Collector Base Junction Capacitance *(Microfarad)*
- C_{gd} Gate to Drain Capacitance *(Microfarad)*
- C_{gs} Gate to Source Capacitance *(Microfarad)*
- C_i Input Capacitance *(Microfarad)*
- C_s Bypass Capacitor *(Microfarad)*
- C_t Capacitance *(Microfarad)*
- f_{3dB} 3 dB Frequency *(Hertz)*
- f_h High Frequency *(Hertz)*
- f_L Low Frequency *(Hertz)*
- f_o Frequency Observed *(Hertz)*
- f_p Pole Frequency *(Hertz)*
- f_{p2} Second Pole Frequency *(Hertz)*
- f_t Frequency *(Hertz)*
- f_{tm} Transmission Frequency *(Hertz)*
- f_{u3dB} Upper 3-dB Frequency *(Hertz)*
- g_m Transconductance *(Millisiemens)*
- i_x Test Current *(Milliampere)*
- R_c Collector Resistance *(Kilohm)*
- R_{in} Finite Input Resistance *(Kilohm)*
- R_L Load Resistance *(Kilohm)*
- R_{out} Output Resistance *(Kilohm)*
- R_{sig} Signal Resistance *(Kilohm)*

- R'_{sig} Internal Small Signal Resistance *(Kilohm)*
- R_t Resistance *(Kilohm)*
- T_{oc} Open Circuit Time Constant *(Second)*
- V_d Drain Voltage *(Volt)*
- V_{gs} Gate to Source Voltage *(Volt)*
- V_{out} Output Voltage *(Volt)*
- V'_{sig} Small Signal Voltage *(Volt)*
- V_{th} Threshold Voltage *(Volt)*
- v_x Test Voltage *(Volt)*
- τ_H Effective High Frequency Time Constant *(Second)*

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Time** in Second (s)
  Time Unit Conversion
- Measurement: **Electric Current** in Milliampere (mA)
  Electric Current Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion
- Measurement: **Capacitance** in Microfarad (µF)
  Capacitance Unit Conversion
- Measurement: **Electric Resistance** in Kilohm (kΩ)
  Electric Resistance Unit Conversion
- Measurement: **Electric Conductance** in Millisiemens (mS)
  Electric Conductance Unit Conversion
- Measurement: **Electric Potential** in Volt (V)
  Electric Potential Unit Conversion
- Measurement: **Sound** in Decibel (dB)
  Sound Unit Conversion

Check other formula lists

- **Common Stage Amplifiers Formulas**
- **Multi Stage Amplifiers Formulas**

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