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Title of the circuit: Design and Simulation of Anti-logarithmic Amplifier using Operational Amplifier

Theory: An anti-logarithmic (or exponential) amplifier is a non-linear analog circuit that produces an output voltage proportional to the anti-logarithm (exponential) of the applied input voltage. The circuit is typically implemented using an operational amplifier with a non-linear semiconductor device, such as a diode or the base-emitter junction of a Bipolar Junction Transistor (BJT) connected to its inverting input, and a linear resistor in the negative feedback loop.

When a diode is used at the input, the non-inverting terminal is grounded, making the inverting terminal a virtual ground. The current flowing through the forward-biased diode is governed by the Shockley diode equation:

$$I_f = I_s e^{\frac{V_{in}}{\eta V_T}}$$

where 'Is' is the reverse saturation current, 'Vin' is the input voltage across the diode, 'eta' is the ideality factor, and 'VT' is the thermal equivalent voltage. Because this exact current 'If' flows through the feedback resistor 'Rf', the output voltage 'Vo' is given by:

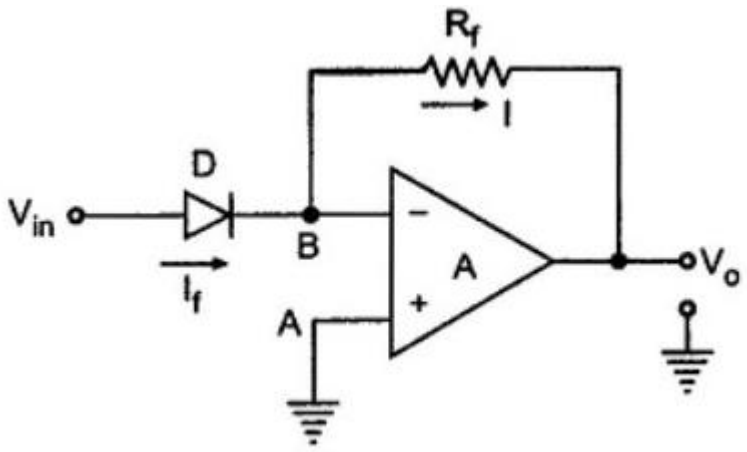
$$V_o = -R_f I_s e^{\frac{V_{in}}{\eta V_T}}$$

This demonstrates that the output voltage is exponentially proportional to the input voltage, accompanied by a 180-degree phase inversion.

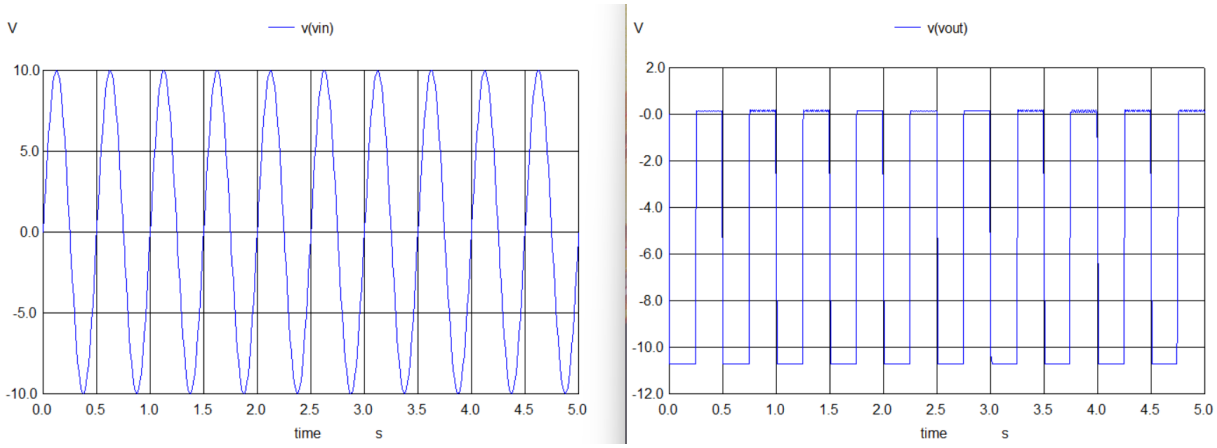
Reason to reproduce with eSim: Reproducing the anti-logarithmic amplifier in eSim provides a practical way to analyze non-linear operational amplifier applications. eSim's underlying engine is highly effective for simulating the exponential transfer characteristics of semiconductor junctions. This migration will help verify the mathematical relationship between input and output, observe the circuit's sensitivity to temperature variations 'VT', and evaluate the dynamic range before the op-amp hits saturation, serving as an excellent open-source educational resource for analog computation circuits.

Expected Outcome/Outputs: The expected outcome is a fully functional schematic of the anti-logarithmic amplifier designed in eSim. The simulation should successfully output an exponential voltage waveform in response to a linear input. The measurable outputs will be the transient and DC sweep analyses confirming that the natural logarithm of the output voltage scales linearly with the input voltage, successfully validating the anti-logarithmic mathematical operation.

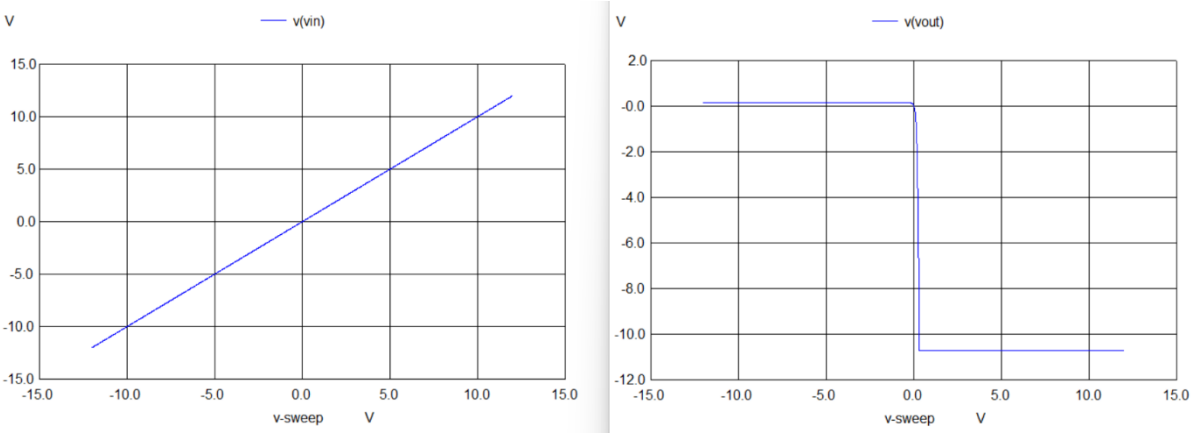
Circuit Diagram(s):



Expected Results:



Transient Output



DC Output

Journal:

- **Title:** Probabilistic Operational Amplifier
- **Authors:** Mylari Yaswanth
- **Link:** https://www.ijrar.org/papers/IJRAR19J2993.pdf

References:

- Virtual Labs, "Log and Antilog amplifiers," IIT Roorkee.