Research Migration Project

https://esim.fossee.in/research-migration-project

The Research Migration Project is an initiative of FOSSEE, IIT Bombay that promotes the use of eSim for reproducing published research circuits originally implemented using proprietary simulation tools. The objective is to migrate these validated designs to eSim to build an open-source resource database.

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Title of the circuit: Design and Simulation of Transistor-Level MC1741 Operational Amplifier

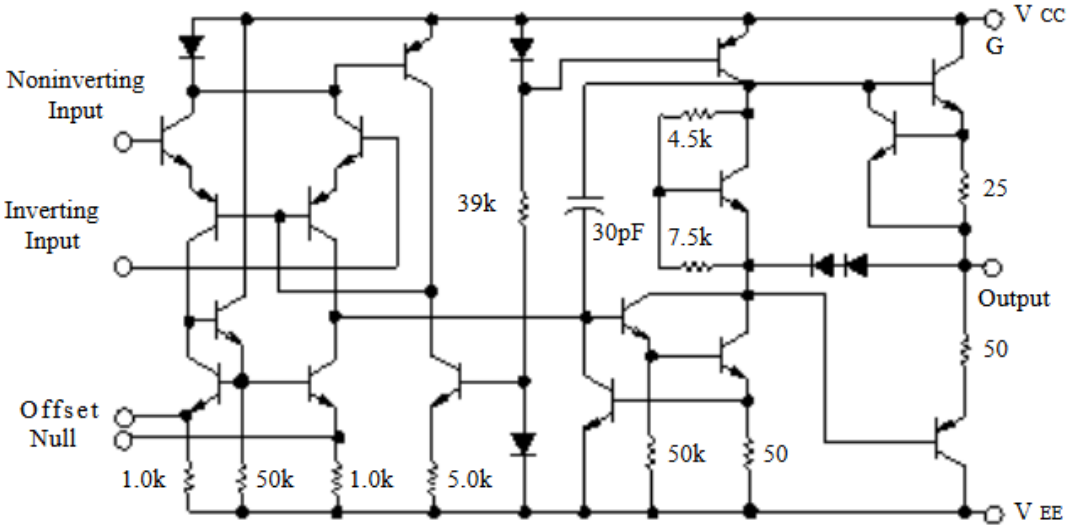
Theory/Description: To design and simulate a general-purpose bipolar operational amplifier (MC1741) for analog signal processing applications using transistor-level circuitry. The objective is to achieve high open-loop gain, adequate bandwidth, high input impedance, and stable frequency response through proper biasing and internal frequency compensation. The designed operational amplifier consists of a differential input stage, intermediate gain stage, and class-AB output stage, with current mirrors and diode networks used for bias stabilization. The performance of the MC1741 operational amplifier is analyzed using DC operating point analysis to verify correct biasing, AC analysis to obtain gain and frequency characteristics, and transient analysis to evaluate dynamic behaviour under time-varying input conditions.

Reason to reproduce with eSim : The MC1741 operational amplifier is a classical analog integrated circuit whose internal architecture provides valuable insight into fundamental op-amp design principles. Reproducing the MC1741 using eSim allows the complete transistor-level implementation of the device to be analyzed and verified in an open-source simulation environment. eSim enables accurate modelling of bipolar junction transistors, biasing networks, and frequency compensation components, making it suitable for studying the internal operation of integrated analog circuits. By reproducing this circuit in eSim, designers and students can evaluate key performance parameters such as biasing conditions, open-loop gain, frequency response, and output stage behavior, and correlate them with theoretical expectations. This approach also promotes the use of open-source EDA tools for analog circuit design and education.

Expected Outcome/outputs: The simulated MC1741 operational amplifier is expected to exhibit high open-loop voltage gain, proper DC biasing of all internal transistor stages, and a stable frequency response due to internal compensation. AC analysis should demonstrate a dominant pole behavior with a gradual roll-off in gain at higher frequencies, consistent with

classical MC1741 characteristics. The output stage is expected to operate in Class-AB mode, providing low output impedance and symmetrical output swing for both positive and negative input signals. Transient analysis should confirm stable time-domain response with minimal crossover distortion at the output. Overall, the simulation results are expected to validate the correct functional operation of the MC1741 operational amplifier.

Circuit Diagram(s):



Source/Reference(s):

[1] Gray, P. R., Hurst, P. J., Lewis, S. H., and Meyer, R. G., *Analysis and Design of Analog Integrated Circuits*, Wiley.

[2] Texas Instruments, *µA741 / MC1741 Operational Amplifier Datasheet*.

[3] Gray**, P. R., Hurst, P. J., Lewis, S. H., and Meyer, R. G.**, *Analysis and Design of Analog Integrated Circuits*, Wiley.