RESEARCH MIGRATION PROJECT

Name of the participant : Sneha gosain

Title of the circuit : Smart Biomedical Signal Processing System

Theory/Description : Synopsis for eSim Summer Fellowship 2025

1. Project Overview

The Smart Biomedical Signal Processing System is designed to efficiently acquire, process, and analyze biomedical signals, such as Electromyography (EMG), Electrocardiography (ECG), and Electroencephalography (EEG). The system integrates analog signal conditioning, analog-to-digital conversion (ADC), and digital signal processing to enhance signal quality and improve medical diagnostics. This project will be implemented and simulated using eSim v2.3 or v2.4, ensuring accuracy and reproducibility in circuit design.

2. Objective

- **To develop a low-power, high-precision biomedical signal processing system.**
- **To implement adaptive noise filtering for enhanced signal clarity.**
- **To simulate the integration of low-noise amplifiers (LNAs), ADCs, and real-time signal processing circuits in eSim.**
- **To ensure compatibility with real-world biomedical devices through an optimized design approach.**

3. Technical Components

1. **Analog Signal Conditioning:**
    - **Low-noise amplifiers (LNAs) to enhance weak bio-signals.**
    - **Active bandpass filtering to remove noise and unwanted frequencies.**
2. **Analog-to-Digital Conversion (ADC):**
    - **Low-power ADC with reconfigurable sampling rates.**
    - **Implementation of power-efficient data conversion techniques.**
3. **Digital Signal Processing (DSP):**

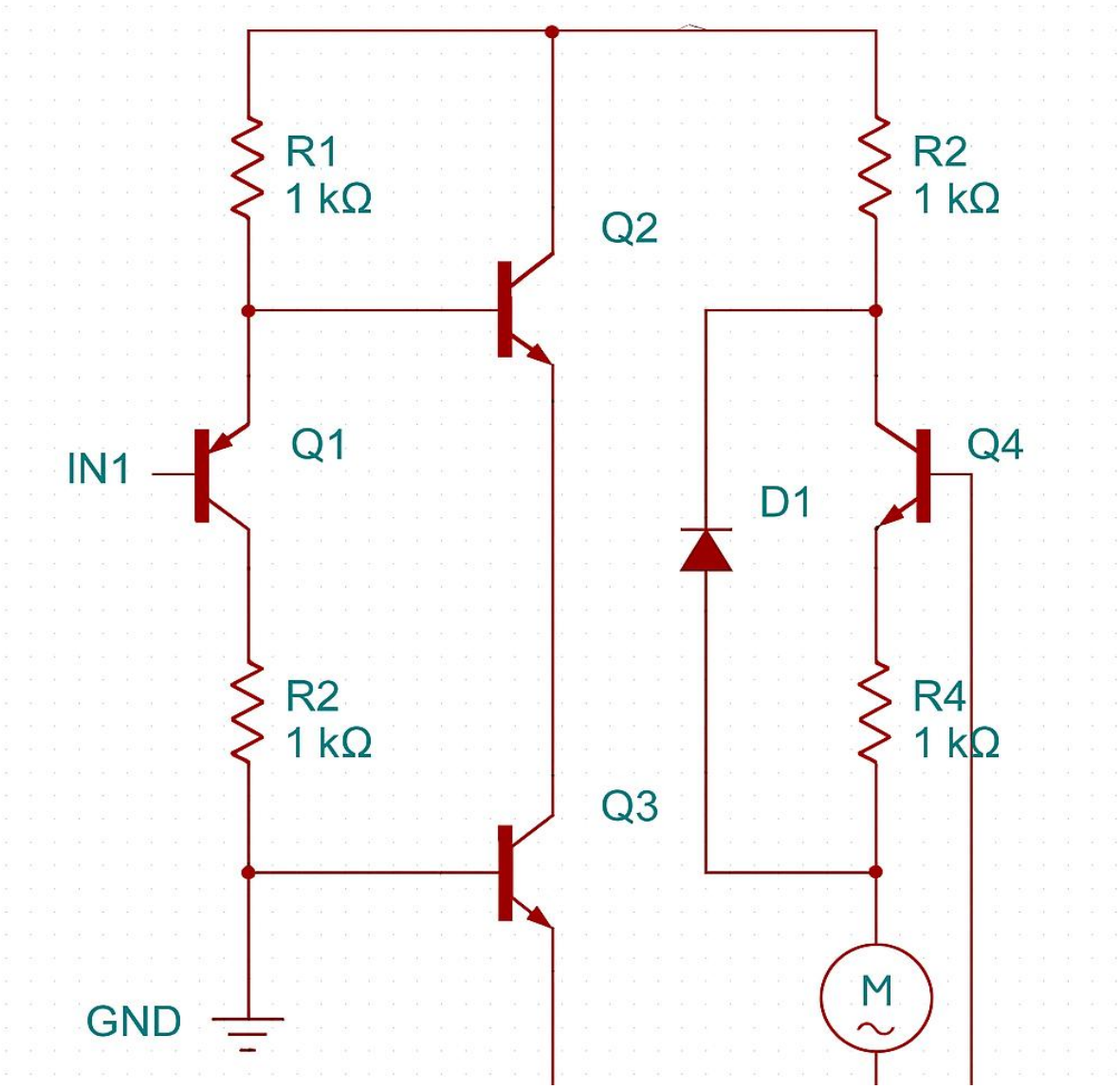
- **Adaptive filtering for real-time noise reduction.**
- **Signal feature extraction for intelligent data analysis.**

4. **Simulation in eSim:**
    - **Full circuit implementation in eSim v2.3 or v2.4.**
    - **Verification of signal quality through waveform analysis.**

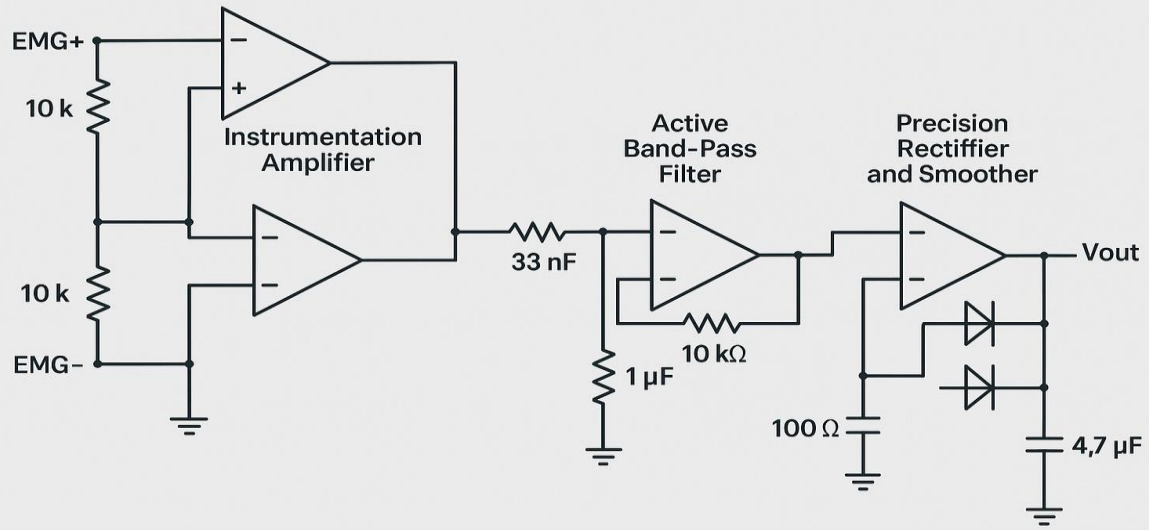
4. Expected Outcomes

- **A fully simulated biomedical signal processing system in eSim.**
- **Improved accuracy and efficiency of bio-signal acquisition.**
- **Practical applications in wearable healthcare devices, prosthetics, and medical monitoring systems.**

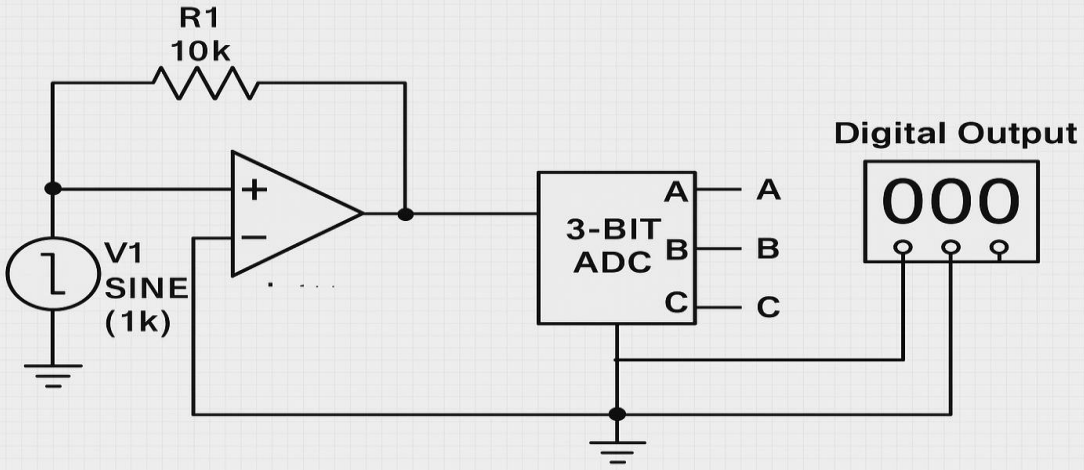
Circuit Diagram(s) :



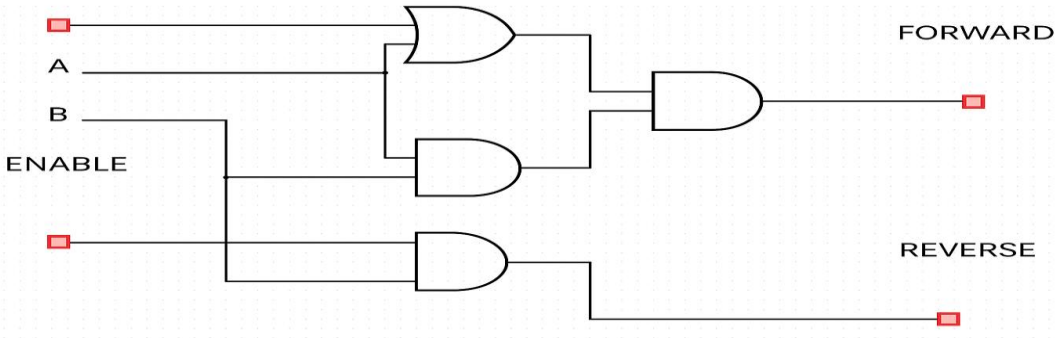
EMG Signal Conditioning Circuit



Analog-to-Digital Converter (ADC) Simulation



Motor Control Logic Circuit



Results (Input, Output waveforms and/or Multimeter readings) :

Expected Outcomes

- **A fully simulated biomedical signal processing system in eSim.**
- **Improved accuracy and efficiency of bio-signal acquisition.**
- **Practical applications in wearable healthcare devices, prosthetics, and medical monitoring systems.**

Source/Reference(s) :

1. **A 1V 5-bit Low Power Level Crossing ADC with OFF state in Idle Time for Biomedical Applications in 0.18µm CMOS**
    - **Authors: Lucas Moura Santana, Duarte Lopes de Oliveira, Lester de Abreu Faria**
    - **Source: arXiv preprint (Link)**
    - **Summary: Discusses power-efficient ADCs for biomedical applications.**
2. **A 97 fJ/Conversion Neuron-ADC with Reconfigurable Sampling and Static Power Reduction**
    - **Authors: Jinbo Chen, Hui Wu, Jie Yang, Mohamad Sawan**
    - **Source: arXiv preprint (Link)**
    - **Summary: Explores bio-inspired ADC design with adaptive sampling rates.**
3. **Low-Noise Wide-Band Amplifiers in Bipolar and CMOS Technologies**
    - **Authors: Zhong Yuan Chang, Willy M. C. Sansen**
    - **Source: Book**
    - **Summary: Covers the design of LNAs for biomedical applications.**