|  |  |
| --- | --- |
| **Faculty Member: \_\_\_\_\_\_\_\_\_\_\_\_** | **Dated: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |
| **Semester:\_\_\_\_\_\_\_\_\_\_\_\_\_** | **Section: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |

**EE313: ELECTRONIC CIRCUIT DESIGN**

**Lab 7: Differential pair with resistive load**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Name** | **Reg. No** | **Viva** | **Analysis of data in Lab Report** | **Modern Tool Usage** | **Ethics and Safety** | **Individual and Teamwork** |
|  |  | **5 Marks** | **5 Marks** | **5 Marks** | **5 Marks** | **5 Marks** |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

**Objective**

Differential amplifiers are used mainly to suppress noise.  
Noise consists of typical differential noise and common-mode noise, of which the latter can easily be suppressed with an op-amp.  
There are two main causes of common-mode noise:

1. Noise is generated in the wires and cables, due to electromagnetic induction, etc., and it causes a difference in potential (i.e., noise) between the signal source ground and the circuit ground.
2. Current flowing into the ground of a circuit from another circuit causes a ground potential rise (noise).

Differential amplifiers are designed to amplify the difference between two signals; thus, such amplifiers are capable of reducing noise that is common to both inputs. We can quantify the differential-mode versus common-mode gain in a quantity called the common-mode rejection ratio (CMRR). Differential amplifiers also lend themselves to use in feedback, though we will not explore that usage in this lab. A typical differential amplifier with a single-ended output is the op-amp.

**Materials**

The items listed in table below will be needed for this lab, assume all NPN transistors are identical 2N2222 BJTs.

**CAUTION:** Please DO NOT leave the circuit on for long periods since there is a risk of heating up of transistors.

|  |  |
| --- | --- |
| **Components** | **Quantity** |
| Transistors: | 2N2222 NPN |
| Resistors: | 20k x 2 ,10k x 3 ,5.6k x 2 |
| Capacitors: | 0.1 µ F |

**PART 1- CALCULATION**

**Differential pair with resistive load:**

1. For the circuit shown in Figure 1, in PSPICE using 2N2222 transistors for the NPN BJTs

Use R3 = 10 k Ω, R1 = R2 = 5.6 k Ω, and VCC = 9 V.

b) Perform step by step, DC Analysis of the circuit and mention equations used for the same. Calculate the DC bias currents IC1, IC2, IC3, and Voltages VC1 and VC2. Also, attach picture(s) of handwritten calculations.

IC1:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, IC2:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ IC3:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

VC1:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ VC2:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**PART 2- SIMULATION:**

Simulate the circuit using Pspice /LTSpice .

1. Perform a Bias point Analysis and compare with your calculated values.

**IC1: 0.415 mA IC:0.415 mA IC3: 0.83 mA**

**VC1: 6.676 V VC2 6.676 V**

NOTE: We are using biasing resistors to supply DC voltage to the base of Q1 and Q2 (figure 1). This is because practically it is not possible to apply a DC offset to both waveforms from function generator.

1. Using Differential Markers, obtain the waveform for VOUT and sketch it in the area given below. Also, by

“Add plot to window” option in PSPICE, obtain output waveforms on Vo1 and V02 using voltage level marker.

Compare the waveforms obtained and comment on results.

1. Change the amplitude of V3 to 100m first and then change amplitude of V4 to 100m and observe and comment on results both cases.
2. Change the value of resistor R3 i.e , reference resistor for current mirror and discuss the impact on output and results.
3. Change the value of resistors R1 and R2 and observe your output.



Figure 1. Differential Amplifier with AC signal applied.

**PART 3- IMPLEMENTATION**

**Differential pair with resistive load:**

1. Construct the circuit, shown in Figure 1, on breadboard using 2N2222 transistors for the NPN BJTs. Check the Beta of all transistors.

Use R3 = 10 k Ω, R1 = R2 = 5.6 k Ω, and VCC = 9 V.

1. Make sure that you test your current source individually before loading it with an amplifier and do not keep the circuit powered up for prolonged periods in between measurements and discussions.

C) Measure the following parameters and compare with calculated and simulated results.

IC1:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, IC2:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ IC3:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

VC1:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ VC2:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Apply a 100mVpp signal of 1 kHz for both inputs.
2. Using Oscilloscope’s Math function, obtain the waveform for VOUT and sketch it in the area given below