KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS
DEPARTMENT OF ELECTRICAL ENGINEERING
Electronic Circuits I - EE203

Experiment # 8

Differential Amplifier

OBJECTIVE

To study the performance of BJT differential amplifier. The differential gain, the common mode gain, the input resistance, and the output resistance will be calculated both theoretically and experimentally.

COMPONENTS REQUIRED

- Transistor - 2N2222
- Resistors 1KΩ, (5 No's), 4.7KΩ, 0.47KΩ, 2.7KΩ
- Capacitor 0.47μF

PRELAB WORK

Perform all of the experimental steps using PSPICE

EXPERIMENTAL WORK

1. **DC ANALYSIS:** Connect the differential amplifier circuit shown in Figure1. With both inputs grounded (why?), measure the DC voltage at all possible nodes and the DC currents in all branches. Specifically I, $V_{BE2,}$ $V_{CE2,}$ V_{CE3} and I_{C2}. Compare all DC results to your prelab calculations.
2. **AC ANALYSIS:** With input 2 grounded, connect a (30mV, 50kHz) sinusoidal signal to the input 1 and measure the small signal voltage gain using the oscilloscope. Notice the phase difference between the input and the output. Compare the value you obtain with the theoretical calculations of the differential gain. (The differential gain is the gain acquired by the difference voltage between the two inputs. This can be measured with both inputs receiving voltage or more easily with one of the inputs grounded and the other input receiving voltage. This is what we are doing).
3. With both inputs joined to each other repeat step (2). Now you are measuring the common mode gain. Compare the value you obtain with the corresponding theoretical value. (The common mode gain is the gain acquired by the sum of the two inputs. As you know from your lectures the output of the differential amplifier can be expressed as : $v_o = G_d(v_1-v_2) + G_c(v_1+v_2)$, thus when $v_1 = v_2$

the output voltage will be due only to the sum of the two inputs and gain will be the common mode gain).

4. Repeat step 2 after exchanging the inputs. Observe on the oscilloscope the phase difference between the input and the output in steps 2 and 4.
5. Disconnect R_L and repeat step 2. From the result you obtain in this and step 2 calculate the output resistance.
6. Disconnect the resistances R_S (from input 1) and repeat step 2. From the results of 2 and 6, calculate the input resistance.
7. **For demonstration only :** Apply a sinusoidal signal of (30mV, 50kHz) to one input and a triangular signal to the other input (15mV, 100kHz). Observe the output on your oscilloscope. Sketch the output and compare it with your expectations.

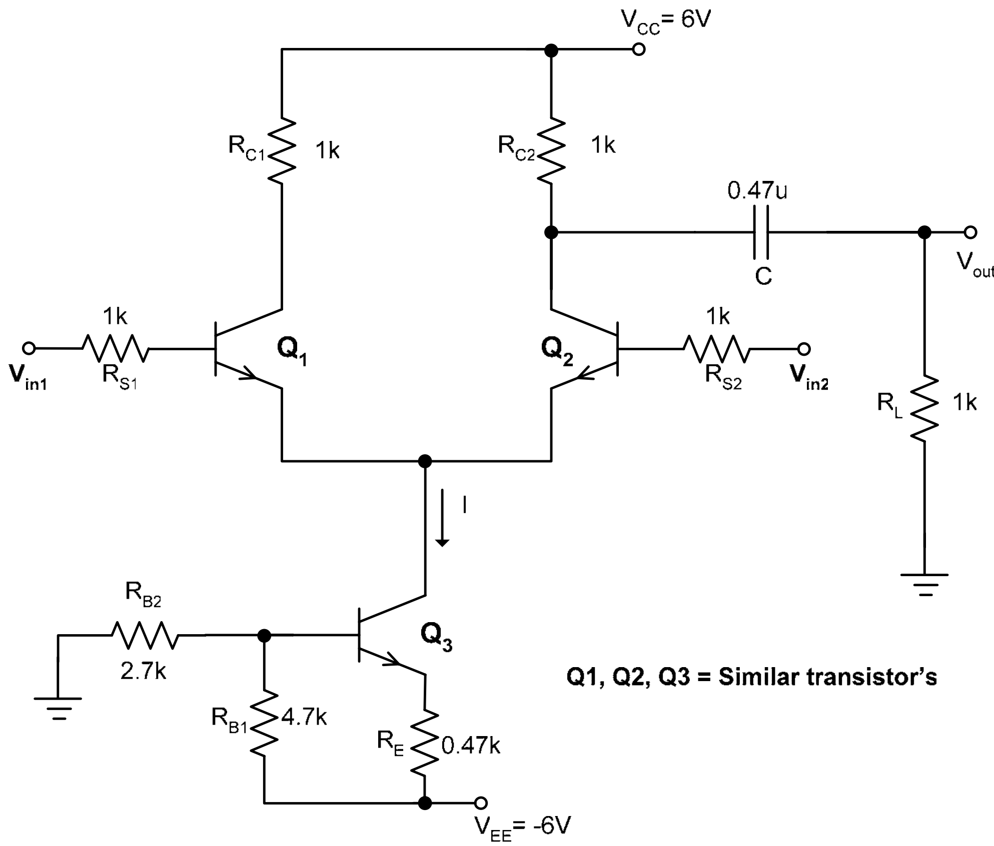

Figure 1 Differential Amplifier

DATA SHEET

The 2N2222 is BJT, the data sheet of this can be analyzed same as 2N3904 except few facts which will be clarified below.

2N3904 and 2N2222 are intended for rather different purposes. The 2N2222 has an I_C max of 800mA (metal case, the PN2222 has less current capabilities), while the 2N3904 has something like 300mA I_C max. The 2N3904 is a higher speed and generally lower noise device. The 2N2222 is a medium-low power switch with higher input and output capacitances. The 2N3904 is a low power switch with lower noise .h_{FE} is about the same for both.

NPN switching transistors — 2N2222; 2N2222A

FEATURES

- High current (max. 800 mA)
- Low voltage (max. 40 V).

APPLICATIONS

- Linear amplification and switching.

DESCRIPTION

NPN switching transistor in a TO-18 metal package.
PNP complement: 2N2907A.

PINNING

PIN	DESCRIPTION
1	emitter
2	base
3	collector, connected to case

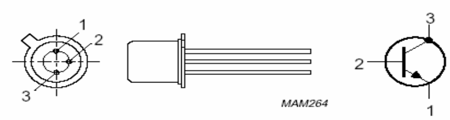

Fig.1 Simplified outline (TO-18) and symbol.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CBO}	collector-base voltage	open emitter			
	2N2222		–	60	V
	2N2222A		–	75	V
V_{CEO}	collector-emitter voltage	open base			
	2N2222		–	30	V
	2N2222A		–	40	V
I_C	collector current (DC)		–	800	mA
P_{tot}	total power dissipation	$T_{amb} \leq 25$ °C	–	500	mW
h_{FE}	DC current gain	$I_C = 10$ mA; $V_{CE} = 10$ V	75	–	
f_T	transition frequency	$I_C = 20$ mA; $V_{CE} = 20$ V; f = 100 MHz			
	2N2222		250	–	MHz
	2N2222A		300	–	MHz
t_{off}	turn-off time	$I_{Con} = 150$ mA; $I_{Bon} = 15$ mA; $I_{Boff} = -15$ mA	–	250	ns