THE UNIVERSITY OF TEXAS AT ARLINGTON

COMPUTER SCIENCE AND ENGINEERIG

LABORATORY 5 REPORT

**ELECTRONICS LABORATORY**

Submitted toward the partial completion of the requirements for CSE 3323-002

**Submitted by,**

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**Lab 5: BJT Amplifier, NPN & PNP**

**Part 1: Amplifiers Designs**

NPN Design:

A math equations and formulas on a white paper

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PNP Design:

A paper with math equations and numbers

Description automatically generated with medium confidence

**Part 2: LT Spice Simulations**

NPN and PNP Circuit Diagram:

**A diagram of a circuit

Description automatically generated A diagram of a circuit

Description automatically generated**

.OP Simulations:

A screenshot of a computer

Description automatically generated

A screenshot of a computer

Description automatically generated

Findings:

|  |  |
| --- | --- |
| NPN | PNP |
| Vc = 5.17 V  Ic = 0.0094 A  Ve = 0.94 V  Vb = 1.65  Vb % error = 2.95% | Vc = 2.7 V  Ic = 0.0092 A  Ve = 7.01 V  Vb = 6.36 V  Vb % error = 0.95% |

8) What observation can you make about the values for R1, R2, RC, and RE for the PNP design relative to the values determined for the NPN design?

Re and Rc swap values and so do R1 and R2, for PNP relative to the NPN design.

9) If a -8V supply was available, could the NPN design be converted to the PNP design be changing ONLY the device and by replacing the 8V supply with a -8V supply?

No, this wouldn’t work since PNP and NPN behave differently regardless of a 8V or -8V supply

A computer screen shot of a diagram

Description automatically generated

NPN -8V supply does not look similar in any way to value from PNP.

**Part 3: AC LT Spice Analysis Simulations**

NPN and PNP Circuit Diagram:

**A diagram of a circuit

Description automatically generated** **A diagram of a circuit

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AC Simulations:

A computer screen shot of a computer

Description automatically generated

A computer screen shot of a computer screen

Description automatically generated

Findings:

1) Do a .AC simulation (decade, 10 pts per decade) from 1 Hz to 100 MHz. What is the midband gain in dB (at 10KHz)?

|  |  |
| --- | --- |
| NPN  @10KHz -> gain = 9dB | PNP  @10Hz -> gain = 9dB |

`

From this value, calculate numerical voltage gain and state the phase that goes with the gain.

|  |  |
| --- | --- |
| NPN  G = 20 log (Vout/Vin)  G/20 = log(Vout/Vin)  10^(G/20) = Vout/Vin  Vout/Vin = 10^(5/20)  Vout/Vin = 1.78 V/V  Phase Shift = -120 | PNP  G = 20 log (Vout/Vin)  G/20 = log(Vout/Vin)  10^(G/20) = Vout/Vin  Vout/Vin = 10^(5/20)  Vout/Vin = 1.78 V/V  Phase Shift = -120 |

What are the approximate –3 dB frequencies low and high. Include a screen shot in your report.

|  |  |
| --- | --- |
| NPN  High -> 12.6 Hz  Low -> 187.3 MHz | PNP  High -> 12.8 Hz  Low -> 169.2 MHz |

A computer screen shot of a computer

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TRAN Simulation:

Do a .TRAN simulation with frequency = 1 KHz and amplitude = 1V.

A screenshot of a computer

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A screenshot of a computer

Description automatically generated

**Part 4: Building the Amplifiers**

NPN Circuit Diagram:

A diagram of a circuit

Description automatically generated

Findings:

Measure Vc, Vb, Ve. Calculate Ic. Compare Ic and Vc to your goals.

Vc = 4.98 V

Vb = 1.66 V

Ve = 0.98 V

Ic = (8-4.98)/330 = 9.13 mA

Desired Vc = 5 V

Desired Ic = 10 mA

Measured values are close to desired values with some degree of error.

With function generator and scope, measure small signal midband gain / phase with output at collector, then f3dB low, and if possible f3dB high.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequencyy (Hz) | Vin | Vout | Gain | Phase |
| 1 | 1 | 0.3 | -10.4576 | 92 |
| 5 | 1 | 1.44 | 3.16725 | 96 |
| 10 | 1 | 1.9 | 5.575072 | 127 |
| 100 | 1 | 3.18 | 10.04854 | 176 |
| 500 | 1 | 3.22 | 10.15712 | 178 |
| 1k | 1 | 3.22 | 10.15712 | 179 |
| 5k | 1 | 3.22 | 10.15712 | 180 |
| 10k | 1 | 3.22 | 10.15712 | 180 |
| 50k | 1 | 3.38 | 10.57833 | 180 |
| 100k | 1 | 3.44 | 10.73117 | 180 |
| 1M | 1 | 3.38 | 10.57833 | 195 |
| 5M | 1 | 2.28 | 7.158697 | 238 |
| 10M | 1 | 1.42 | 3.045767 | 259 |

Mind-band Gain = 10 dB

F3dB low = 5 Hz

F3dB high = 10 MHz

What is the gain with output taken at the emitter?

Mind-band Gain (@10 kHz) = -0.291 dB

What is the max ppk output level at 1 KHz without significant distortion (on collector).

Max ppk @ 1 KHz 🡺 2.3 Vpp

PNP Circuit Diagram:

A diagram of a circuit

Description automatically generated

Findings:

Measure Vc, Vb, Ve. Calculate Ic. Compare Ic and Vc to your goals.

Vc = 3.05 V

Vb = 6.4 V

Ve = 7.12 V

Ic = (8-4.98)/330 = 9.13 mA

Desired Vc = 3 V

Desired Ic = 10 mA

Measured values are close to desired values with some degree of error.

With function generator and scope, measure small signal midband gain / phase with output at collector, then f3dB low, and if possible f3dB high.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Frequency (Hz) | Vin | Vout | Gain | Phase |
| 1 | 1 | 0.344 | -9.26883 | 107 |
| 5 | 1 | 1.08 | 0.668475 | 128 |
| 6 | 1 | 1.38 | 2.797582 | 120 |
| 10 | 1 | 1.72 | 4.710569 | 131 |
| 100 | 1 | 2.98 | 9.484325 | 172 |
| 500 | 1 | 3.02 | 9.600139 | 178 |
| 1k | 1 | 3.02 | 9.600139 | 179 |
| 5k | 1 | 3.04 | 9.657472 | 180 |
| 10k | 1 | 3.06 | 9.714429 | 180 |
| 50k | 1 | 3.22 | 10.15712 | 180 |
| 100k | 1 | 3 | 9.542425 | 171 |
| 1M | 1 | 3.12 | 9.883092 | 195 |
| 5M | 1 | 2.04 | 6.192603 | 243 |
| 10M | 1 | 1.27 | 2.076074 | 266 |

Mind-band gain = 10 dB

F3dB low = 6 Hz

F3dB high = 10 MHz

What is the gain with output taken at the emitter?

Mind-band Gain (@10 kHz) = -0.283 dB

What is the max ppk output level at 1 KHz without significant distortion (on collector).

Max ppk @ 1 KHz 🡺 1.9 Vpp

Why do we *need* C1/C3 between the function generator and the base bias resistors?

Their function might be to couple the signal to and from the transistor but block the DC current from flowing into it.