ECE 3042 Lecture Exam No. 1 Spring 2013

FEBRUARY 22, 2013 FRIDAY 4-5 PM AD LOGIN____________

Name Tey

Totally Closed Book and Note. Calculator Permitted. Four Equally Weighted Problems. All Work Must Be Shown for Credit.

1. Shown below is a single stage common emitter amplifier with a unipolar power supply using a 2N3904 NPN BJT as the active device. It is specified that $V^+ = 15\,\text{V}$, $C_1 = C_2 = C_E = 300\,\mu\text{F}$, $R_C = 5.1\,\text{k}\Omega$, $R_{E1} = 2\,\text{k}\Omega$, and $R_L = 27\,\text{k}\Omega$. Design the circuit so that the dc collector current is 1.1 mA and the magnitude of the small-signal midband voltage gain is 7.3. For the design calculations assume that the base-to-emitter dc voltage drop is 0.65 V, the dc current in R_{B1} is $11 I_B$, $\beta = 322$, and the Early voltage is infinity. Assume that the thermal voltage is 25.9 mV. Determine the values of the resistors R_{B1}, R_{B2}, and R_{E2} to satisfy the design criteria.

$\alpha = \frac{\beta}{\beta+1} = 0.997$

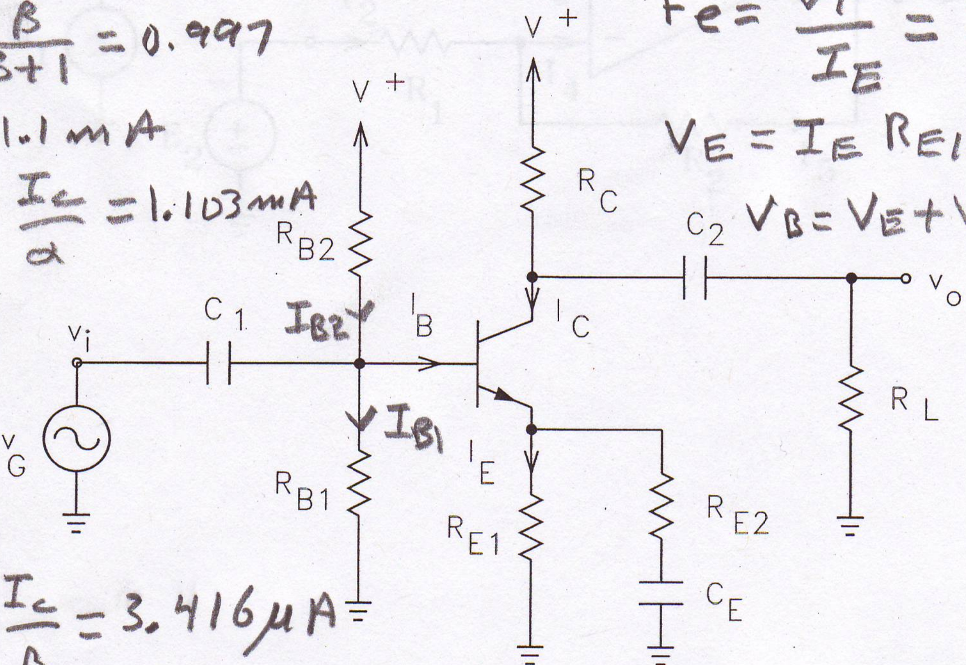
$r_e = \frac{V_T}{I_E} = 23.473\,\Omega$

$I_C = 1.1\,\text{mA}$

$V_E = I_E R_{E1} = 2.207\,\text{V}$

$I_E = \frac{I_C}{\alpha} = 1.103\,\text{mA}$

$V_B = V_E + V_{BE} = 2.857\,\text{V}$



$I_B = \frac{I_C}{\beta} = 3.416\,\mu\text{A}$

$I_{B1} = 11 I_B = 35.578\,\mu\text{A}$ $\quad I_{B2} = I_B + I_{B1} = 12 I_B = 40.994\,\mu\text{A}$

$R_{B1} = \frac{V_B}{I_{B1}} = 76.025\,\text{k}\Omega$ $\quad R_{B2} = \frac{V^+ - V_B}{I_{B2}} = 296.22\,\text{k}\Omega$

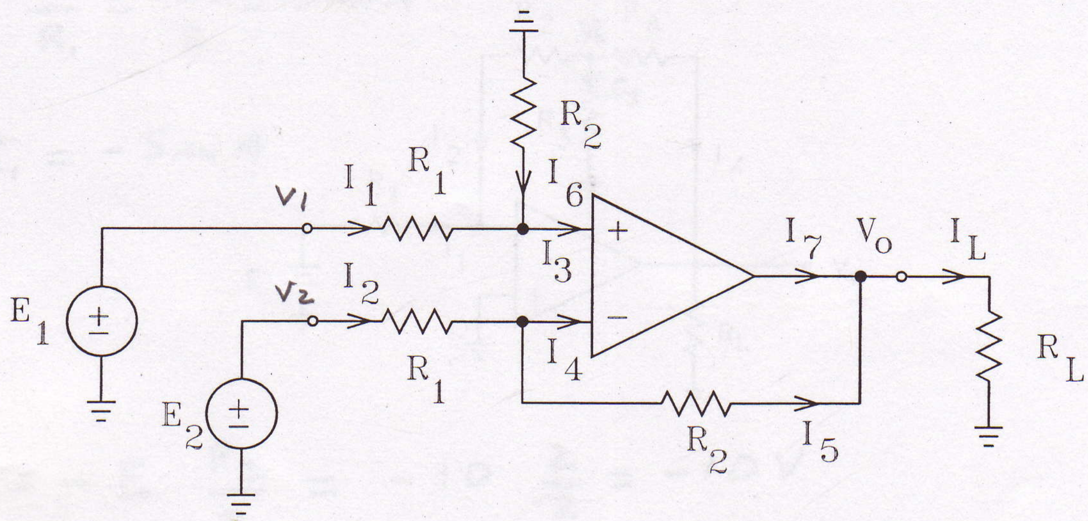
$A_v = -\alpha \frac{R_C \| R_L}{r_e + R_{E1} \| R_{E2}} = -7.3 \Rightarrow R_{E2} = 782.301$

R_{B1}	R_{B2}	R_{E2}
76 kΩ	296 kΩ	782 Ω

5 5 5

10 try

2. In the circuit shown below determine the currents I_1, I_2, I_7, I_L and the voltage V_o. The resistors are $R_1 = 4$ kΩ, $R_2 = 16$ kΩ, and $R_L = 2$ kΩ. The sources are dc voltage with $E_1 = 10$ V and $E_2 = 12$ V. Assume that the op amp is ideal. The voltages are referenced to ground.



$$I_1 = \frac{E_1}{R_1 + R_2} = \frac{10}{4+16} = 0.5 \text{ mA}$$

$$V_+ = \frac{R_2}{R_1+R_2} E_1 = \frac{16}{4+16} 10 = 8 \text{ V} = V_-$$

$$I_2 = \frac{E_2 - V_-}{R_1} = \frac{12-8}{4} = 1 \text{ mA} = I_5$$

$$V_o = \frac{R_2}{R_1}[V_1 - V_2] = \frac{16}{4}(10-12) = -8 \text{ V}$$

$$I_L = \frac{V_o}{R_L} = \frac{-8}{2} = -4 \text{ mA}$$

$$I_7 = I_L - I_5 = -4 - 1 = -5 \text{ mA}$$

4 4 4 4 4

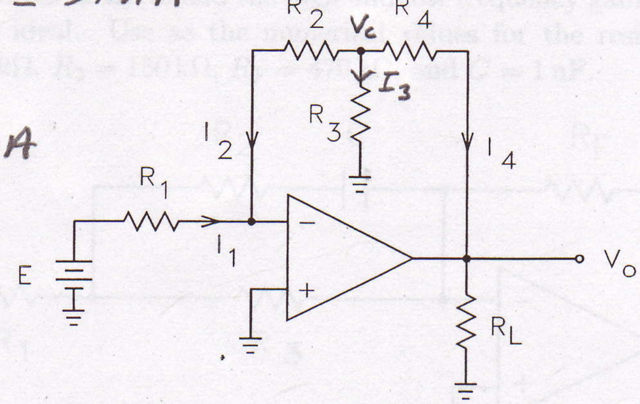
I_1	I_2	I_7	I_L	V_O
0.5 mA	1 mA	−5 mA	−4 mA	−8 V

5 try

3. The op amp in the circuit shown below is ideal. Determine $I_1, I_2, I_4,$ and V_o. The voltage source is $E = 10\,\text{V}$. The parameter values are: $R_1 = 2\,\text{k}\Omega$, $R_2 = 2\,\text{k}\Omega$, $R_3 = 5\,\text{k}\Omega$, $R_4 = 1\,\text{k}\Omega$, and $R_L = 10\,\text{k}\Omega$.

$I_1 = \frac{E}{R_1} = \frac{10}{2} = 5\,mA$

$I_2 = -I_1 = -5\,mA$



$V_c = -E \frac{R_2}{R_1} = -10 \frac{2}{2} = -10\,V$

$I_3 = \frac{V_c}{R_3} = -\frac{10}{5} = -2\,mA$

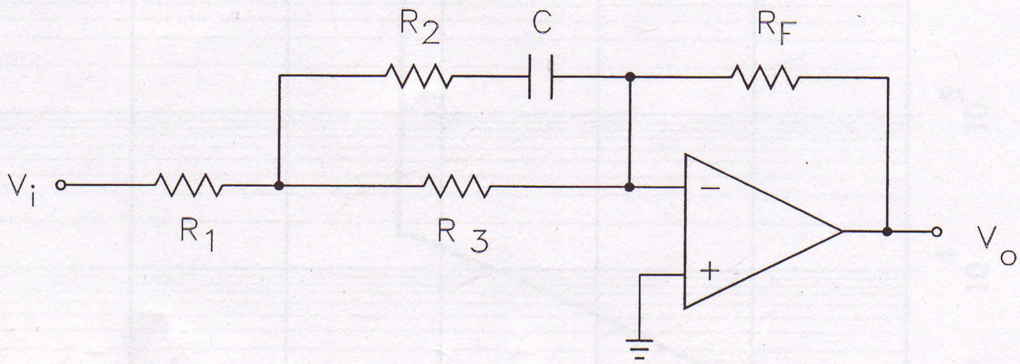
$I_4 = -(I_2 + I_3) = -(-5 - 2) = 7\,mA$

$V_o = V_c - R_4 I_4 = -10 - 1\times 7 = -17\,V$

4	4	4	4
I_1	I_2	I_4	V_o
5 mA	-5 mA	7 mA	-17 V

5 try

4. Determine the complex transfer function $\bar{T}(s) = \bar{V}_o/\bar{V}_i$ for the circuit shown below as a ratio of two polynomials in the complex frequency variable s. Specify it as a function of the complex frequency, s, and the symbols for the resistors and capacitor (not the numerical values). Plot the magnitude of the complex transfer function $\bar{T}(j\omega)$ in decibels as a function of the frequency f of the source as f varies from 1 Hz to 1 MHz. If applicable, determine the pole and zero frequencies in Hertz and the high and low frequency gains in decibels. Assume that the op amp is ideal. Use as the numerical values for the resistors and capacitors: $R_1 = 10\,\text{k}\Omega$, $R_2 = 1\,\text{k}\Omega$, $R_3 = 150\,\text{k}\Omega$, $R_F = 470\,\text{k}\Omega$, and $C = 1\,\text{nF}$.



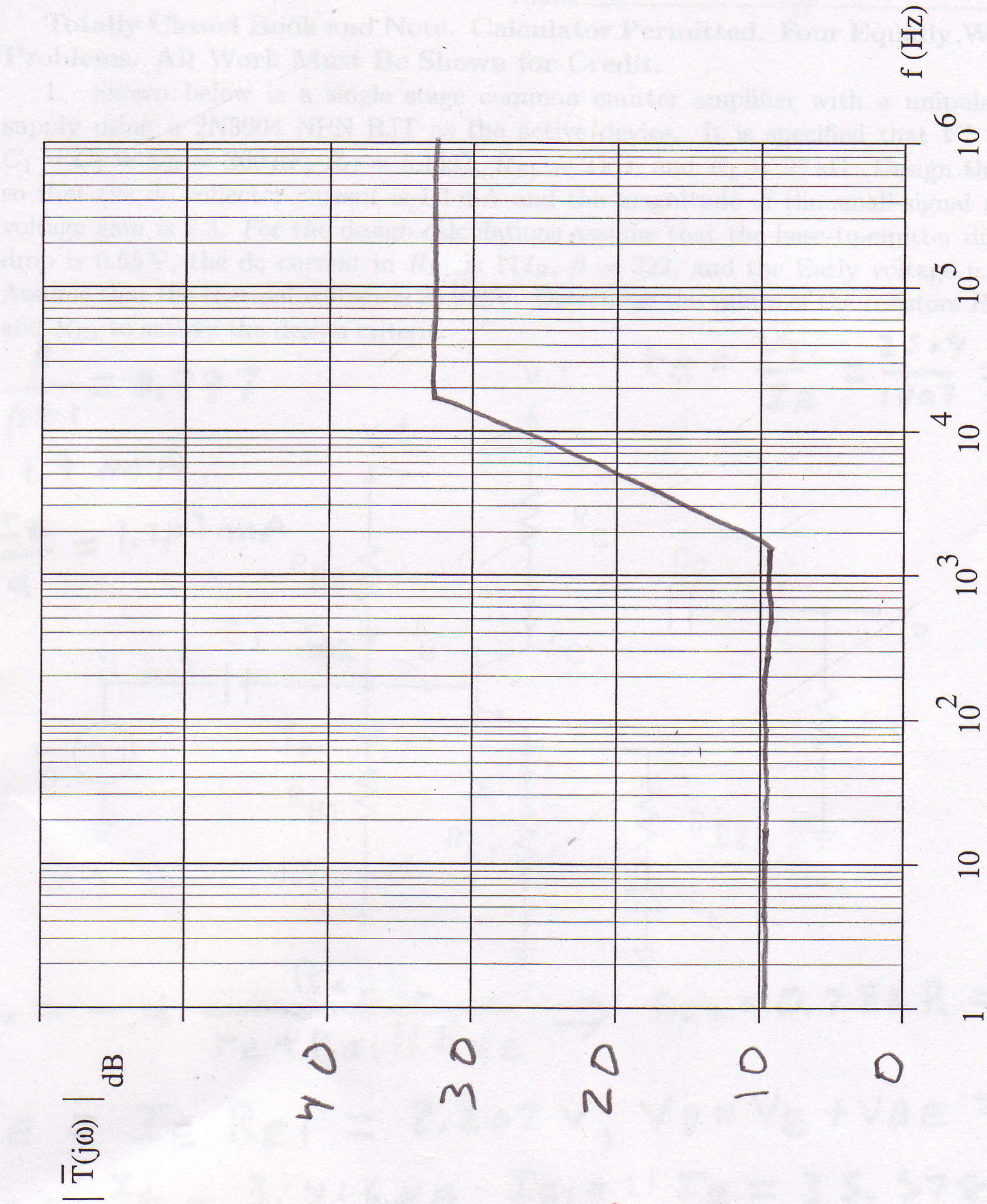
4 $\bar{T}(s) = K \dfrac{1+s\tau_z}{1+s\tau_p} = -\dfrac{R_F}{R_1+R_3}\dfrac{1+s(R_2+R_3)C}{1+s[R_2+R_1\|R_3]C}$

4 $f_p = \dfrac{1}{2\pi[R_2+R_1\|R_3]C} = 15.3\text{ kHz}$

4 $f_z = \dfrac{1}{2\pi(R_2+R_3)C} = 1.05\text{ kHz}$

4 $|\bar{T}(j0)|_{db} = 20\log_{10}\left|-\dfrac{R_F}{R_1+R_3}\right| = 9.36\text{ dB}$

4 $|\bar{T}(j\infty)|_{db} = 20\log_{10}\left|-\dfrac{R_F}{R_1+R_2\|R_3}\right| = 32.6\text{ dB}$



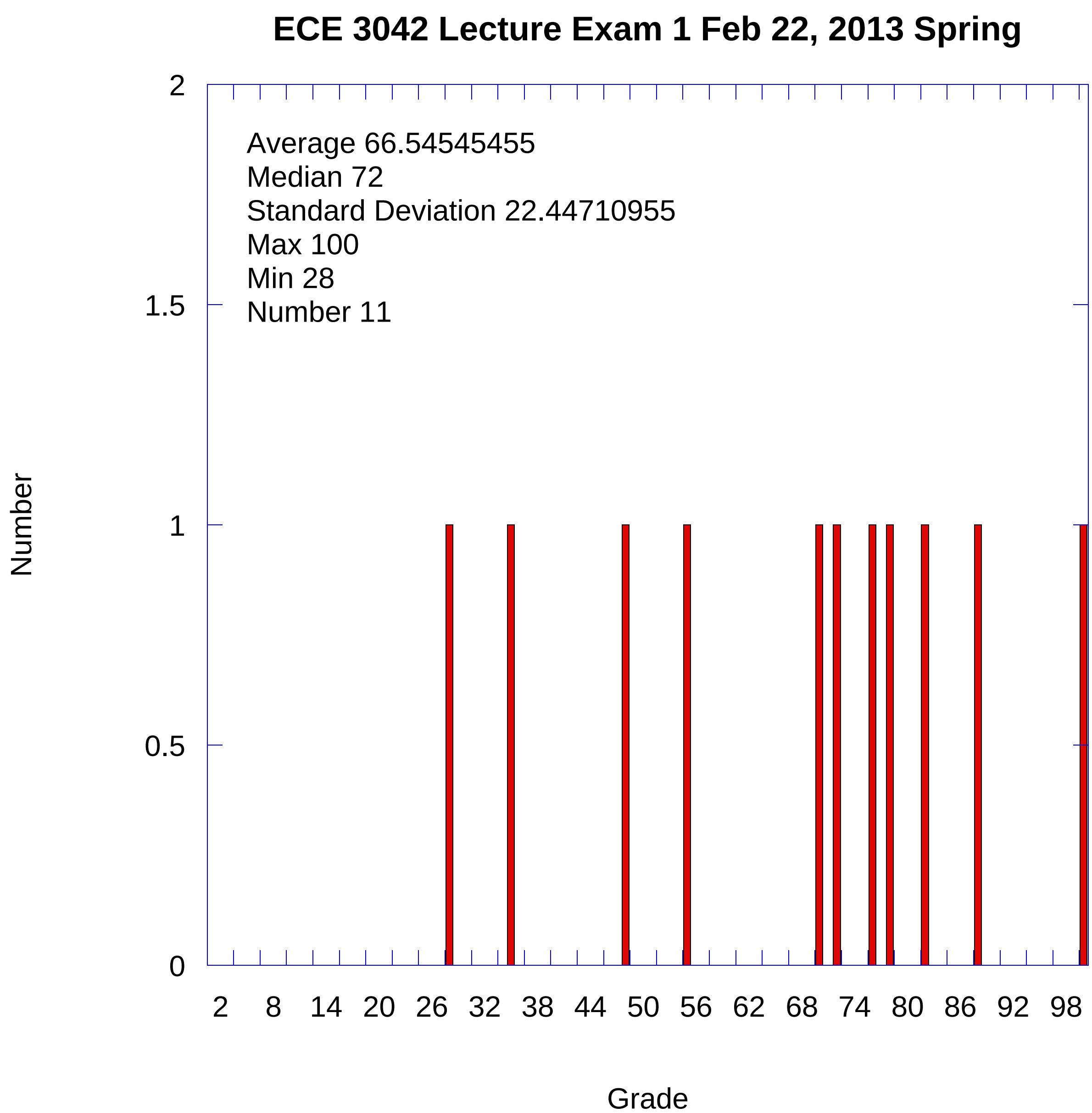
1 shape

1 fp

1 f3

1 |T(0)| dB

1 T(∞)| dB



ECE 3042 Lecture Exam 1 Feb 22, 2013 Spring
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Median 72
Standard Deviation 22.44710955
Max 100
Min 28
Number 11
Number
Grade
0
0.5
1
1.5
2
2
8
14
20
26
32
38
44
50
56
62
68
74
80
86
92
98