Lab 6 – BJT Common-Emitter Circuit

* Standard Value Only !!! Substantial Error (Inconclusive)

Parameter	Formulas See Appendix	Calculated Value Ideal Resistors	Calculated Value Measured Resistors	Measured Value or Calc. from Meas.	Error Ideal Resistors	Error Measured Resistors
$v_{in} = 100\text{ mV (Pk-Pk)}$				104 mV	4.00%	
$f_{in} = 10\text{ kHz}$				10.03 kHz	0.30%	
$V_{CC} = 10\text{ V}$				10.00 V	0.00%	
$V_{EE} = -10\text{ V}$				-10.00 V	0.00%	
$R_F = 10\text{ k}\Omega$				9.83 kΩ	1.70%	
$R_L = 10\text{ k}\Omega$				9.86 kΩ	1.40%	
R_C	(1)	1 kΩ		0.98 kΩ	2.00%	
$R_{E1} = 50\ \Omega$			51 Ω	50.8 Ω	0.39%	
R_{E2}	(18)	918.91 Ω	910 Ω	940 Ω	3.30%	
C_C	(12)	1.9284 µF	*2.2 µF			
C_B	(10)	3.4600 µF	*3.3 µF			
C_E	(20)	31.998 µF	*33 µF			
$A_v\ (\text{V/V}) = -20\text{ V/V}$	(21)	-15.692 V/V	-15.401 V/V	NA	NA	NA
$A_v\ (\text{dB}) = 26.02\text{ dB}$	(22)	23.914 dB	23.751 dB	NA	NA	NA
g_m	(2)	385.31 mA/V				
$f_{min} = 100\text{ Hz}$				NA	NA	NA
$\alpha = \beta/(\beta+1)$	NA	256/257				
$\beta = 256$						
$V_A = 74.03\text{ V}$						
$V_T = 25.8519\text{ mV}$						
V_C	(15)	10 V		3.15 V	!!!	!!!
V_B	(16)	389.11 mV		-2.40 V	!!!	!!!
V_E	(17)	-310.89 mV		-3.05 V	!!!	!!!
$V_B - V_E \approx 0.7\text{ V}$						
I_C	(13)	9.9611 mA		NA	NA	NA
I_B	(14)	38.911 µA		NA	NA	NA
$I_E = 10\text{ mA}$				NA	NA	NA
r_o	(3)	7.4319 kΩ				
r_π	(4)	664.39 Ω				
$R_{\text{coll.}}$	(5)	150.66 kΩ	153.53 kΩ			
R_{base}	(6)	13.514 kΩ	13.771 kΩ			
$R_{\text{in,F}}$	(7)	476.19 Ω				
$R_{\text{out,F}}$	(8)	9.5238 kΩ				
$R_{C,\text{tot}}$	(11)	825.33 Ω	825.41 Ω			
$R_{B,\text{tot}}$	(9)	459.98 Ω	460.27 Ω			
$R_{E,\text{tot}}$	(19)	49.739 Ω	50.605 Ω			

Appendix

$(1)\ A_v \approx -\dfrac{R_C}{R_{E1}}$ $(2)\ g_m = \dfrac{\alpha I_E}{V_T} = \dfrac{I_C}{V_T}$ $(3)\ r_o = \dfrac{V_A}{\alpha I_E} = \dfrac{V_A}{I_C}$ $(4)\ r_\pi = \dfrac{\beta}{g_m}$

$(5)\ R_{\text{coll.}} = R_{E1} + r_o + g_m r_o R_{E1}$ $(6)\ R_{\text{base}} = r_\pi + (\beta+1)R_{E1}$ $(7)\ R_{\text{in,F}} = \dfrac{R_F}{1+|A_v|}$ $(8)\ R_{\text{out,F}} = \dfrac{R_F}{1+1/|A_v|}$

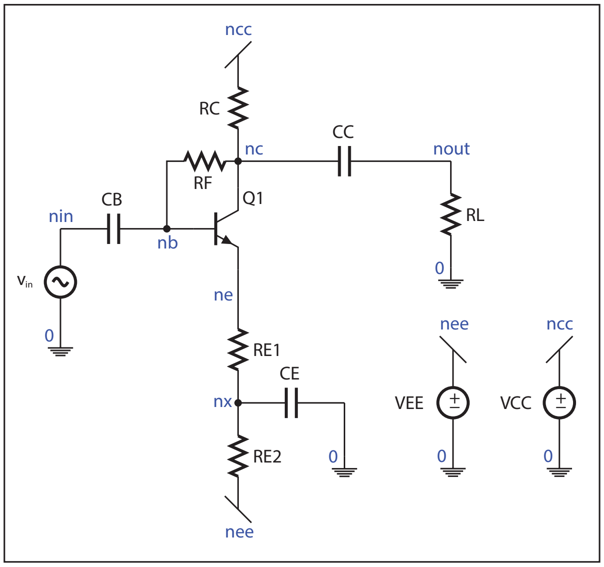
$(9)\ R_{B,\text{tot}} = R_{\text{base}} \,||\, R_{\text{in,F}}$ $(10)\ C_B = \dfrac{1}{2\pi f_{\min} R_{B,\text{tot}}}$ $(11)\ R_{C,\text{tot}} = R_C \,||\, R_L \,||\, R_{\text{coll.}} \,||\, R_{\text{out,F}}$ $(12)\ C_C = \dfrac{1}{2\pi f_{\min} R_{C,\text{tot}}}$

$(13)\ I_C = \alpha I_E$ $(14)\ I_B = I_C / \beta$ $(15)\ V_C = R_C (I_C + I_B)$ $(16)\ V_B = R_F I_B$

$(17)\ V_B - V_E \approx 0.7$ $(18)\ V_E - V_{EE} = (R_{E1} + R_{E2}) I_E$ $(19)\ R_{E,\text{tot}} = \left(R_{E1} + \dfrac{\alpha}{g_m}\right) || R_{E2}$ $(20)\ C_E = \dfrac{1}{2\pi f_{\min} R_{E,\text{tot}}}$

$(21)\ A_v(\text{V/V}) = \dfrac{-g_m R_{C,\text{tot}}}{1+g_m R_{E1}}$ $(22)\ A_v(\text{dB}) = 20\log|A_v(\text{V/V})|$

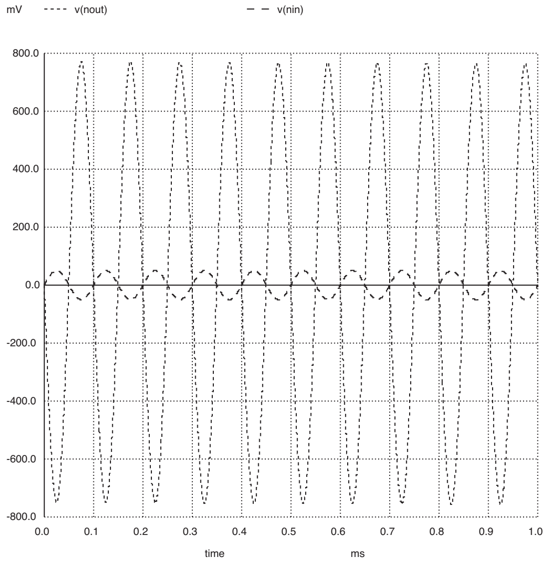
CD.1



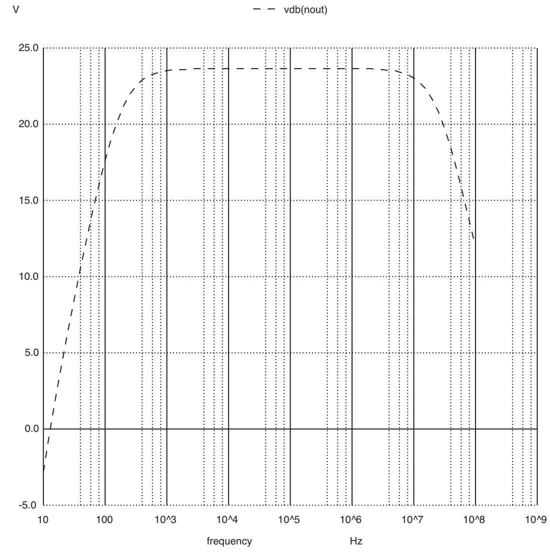
PL.1

v_{out} = 1.527 V (Pk-Pk)

A_v = -15.273 V/V
A_v = 23.679 dB



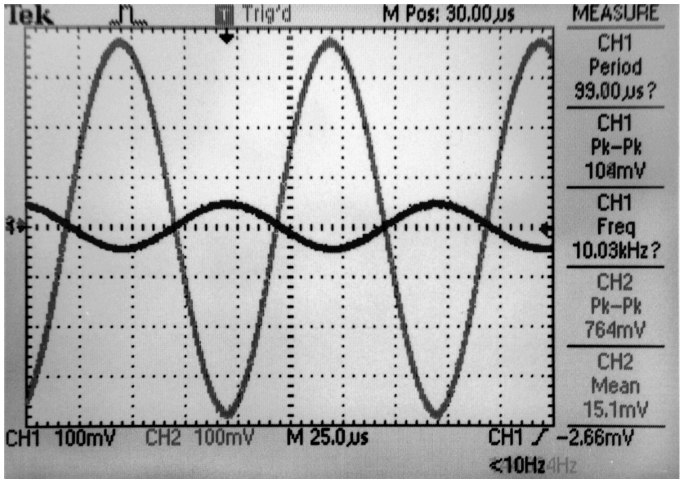
PL.2



OP.1

v_{out} = 764 mV (Pk-Pk)

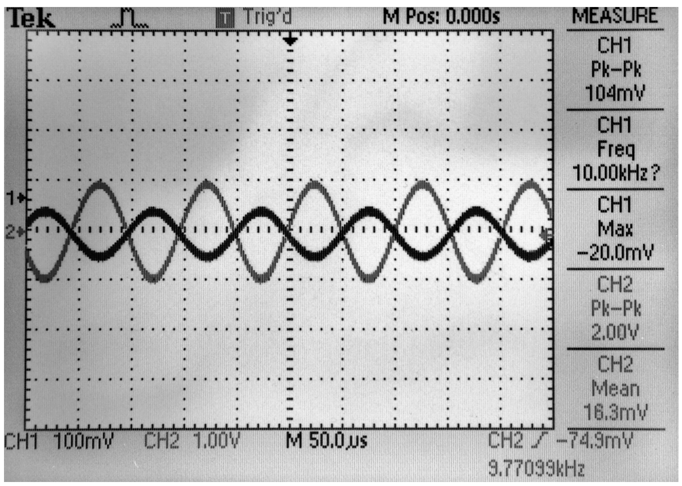
v_{in} (CH1)
v_{out} (CH2)



OP.2

v_{out} = 2.0 V (Pk-Pk)

v_{in} (CH1)
v_{out} (CH2)



Commentary

- The DC operating point analysis results yielded inconclusive results compared to the calculated results. However, we see from figure OP.1 that the output signal is yielding increased gain and the correct phase shift. Although the resulting measured values do not appear reasonably close at all, at least the output waveform positively correlates with that of the calculated waveforms. From figure OP.2 which was achieved from another lab colleague, however, the gain value is a much better match against the calculated values.