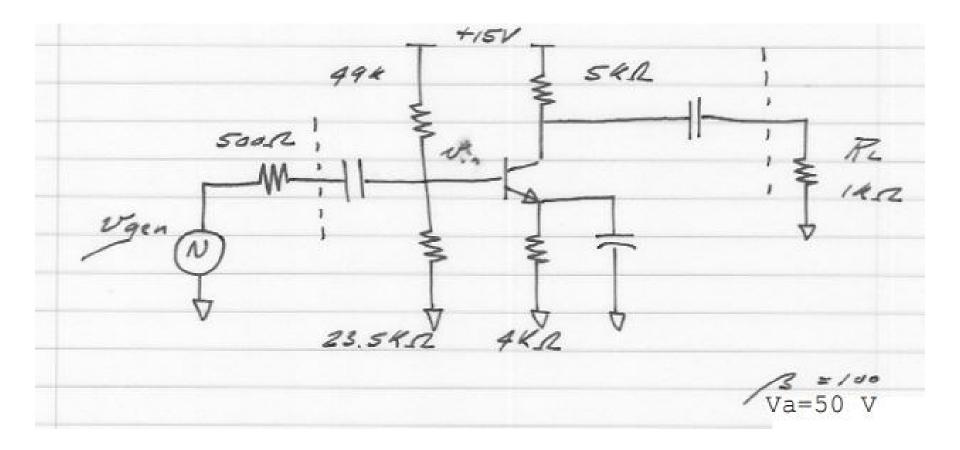
ECE137A Notes Set 3: Basic Common-Emitter Amplifier

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Common-Emitter Amplifier: 1950's-style



DC bias analysis: exact (slow) method

15.88K +151 494 4.86 Volts 23.54 15.94 I6(B+1) 4.866 2007 by KVL: 4.86 V = IL (15.942) + 0.7 V + (3+1) IS. 44R => IL = 10 µA and Ic = BIS = IMA

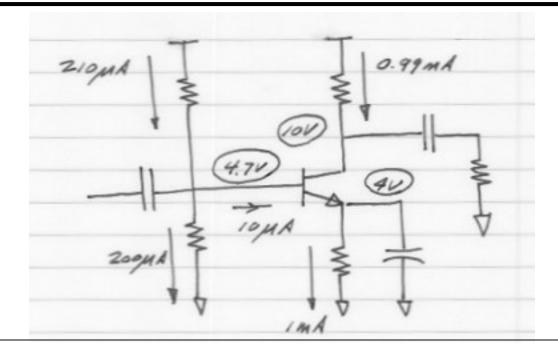
fast DC bias analysis: iteration

Relies on I_h having only small effect in well-designed circuit: treat I_h as a *perturbation*

First guess: assume 13=00 I6=0=> V2 = 4.86V 15.94 4.860 => V= = 4.16V => TE = 4.16/4/ = 1.04 mA Now, if BED => IE = 1.04 mA 134t 3 =00 => B=100 50 IS= 1.04 mA/100 ~ 10.4 MA Second guess - reanalyze with the base current we have found +159m1-4.86-0,16 = 4.700 4.70 -0.70 = 4.00 4.860 ~ JE = 4V14 KR = WIMA 10 MA IS = IMA/100 = 10 MA

Iteration can be repeated if necessary

DC bias solution



This circuit is AC coupled with RC bias network. Why teach such old-fashioned techniques ? (1) As we progress from single-transistor to multi-stage designs, it is easier to progress from AC to DC coupling than to start with DC-coupled designs. (2) AC coupled designs are easier for the first 1-2 lab projects. (3) Even modern RF gain stages *are* AC coupled.

Above all (4), we will quickly transition in the next 3 weeks to DC coupling.

AC small signal analysis.

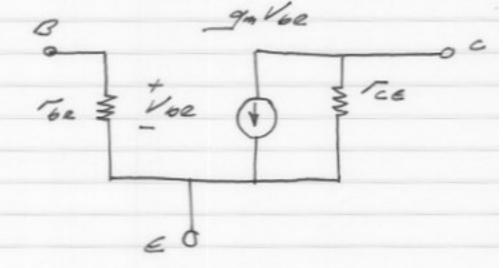
- replace the with small signal model - replace supplies with AC + - replace large + with short circuits - Z = 1/juc = is this very small? + if so, neglect - replace large -00- with open circuits Z=jul = is this large ! + it so, neglect.

 ω is the signal frequency.

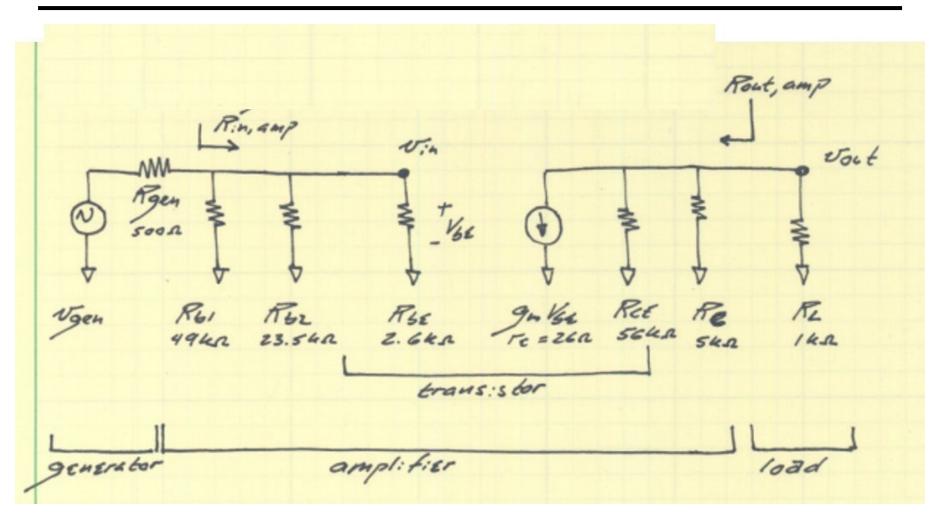
At some low ω , $1/j\omega C$ and $j\omega L$ become significant. We treat this in ece137B

Small-signal model

Te = VI/IE = 26mV/IMA = 2612 9M = a/12 = 1/2612 (x=0.99) To = Tes = (Ves + VA)/Ic = 56 U/IMA - 56 KA F= Fbe = (3+1) Fe = BFe = 100 (2.6) = 2.6 KA



Circuit diagram: small-signal



Small-signal analysis

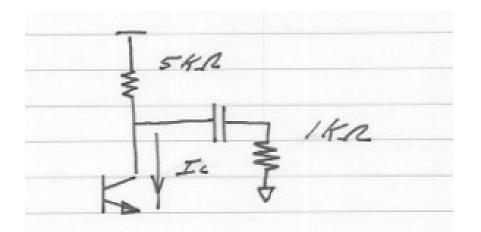
Rgeh 9mV:4 Ui Ngon M Rout, amp Rin, amp Reg = Roch, Amp // Re = 820 R

Rihamp = RS1 11 Rb2 11 Rb2 = 2.23 kr Rock, amp = REEll Re = 4.60 KA Vin /Vgen = Rin, amp / Rin, amp + Rgen) = 0.817 volv: = - 9 . Rieg = - 31.5

Limits on output swing

Output - small signal Output with larger input signal clipping due to catoff and saturation

Limits on output swing: cutoff



Clipping is large-signal, but AC, not DC. \rightarrow Capacitors remain AC short-circuits. $R_{Leq} = 5k\Omega || 1k\Omega = 800\Omega$

 $I_{CQ} = 1$ mA but $I_{C,min} = 0$ mA $\rightarrow \Delta I_C \downarrow_{max} = 1$ mA. We can decrease I_C by at most 1mA.

$$\Delta V_{out} \uparrow_{max} = 1 \text{mA} \cdot R_{Leq} = 0.8 \text{V}.$$

$$V_{out} \text{ can increase by at most } 0.8 \text{V}.$$

Limits on output swing: saturation

100 Under 6:45: VCEQ = 10-4 = 60 Minimum : VCEMin = VCESat 2 0.5V 2 VESTMENS = 6-0.5 = 5.5 Volts Since there is no as voltage on the emitter, this corresponds to A Vout & more man = 5.5 Volts.