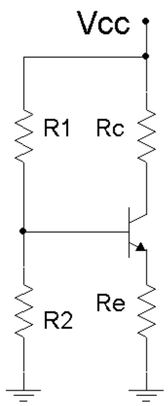
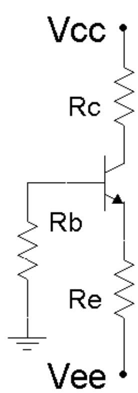
Linear Electronics DC Biasing Worksheet

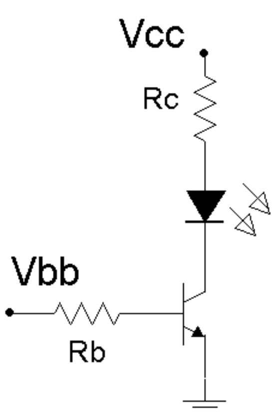
1. Plot the load line and determine V_B, V_E, I_C, V_C. Beta=200, R_1=40k, R_2=10k, R_C=8k, R_E=4.3k, V_{CC}=25V



2. Plot the load line and determine V_E, I_C, V_C. Beta=200, R_B=3k, R_C=1k, R_E=2k, V_{CC}=20V, V_{EE}=-10.7V



3. For the circuit below, determine the LED current. V_{LED}=2.0V, V_{CC}=5V, V_{BB}=3V, R_B=1k, R_C=100, Beta=100.



Linear Electronics DC Biasing Worksheet Answers

1. Using the unloaded (stiff) divider approximation:
$V_B=V_{CC}*R1/(R1+R2)=5V$
$V_E=V_B-V_{BE}$, $V_E=4.3V$
$I_C=V_E/R_E=4.3V/4.3k=1mA$
$V_{RC}=I_C*R_C=1mA*8K=8V$
$V_C=V_{CC}-V_{RC}=25V-8V=17V$
$V_{CE}=V_C-V_E=17V-4.3V=12.7V$

$I_{C(SAT)}=V_{CC}/(R_C+R_E)=25V/(8k+4.3k)=2.03mA$
$V_{CE(CUTOFF)}=V_{CC}=25V$

2. Using the approximation that the base is about 0VDC:
$V_E=0-V_{BE}=-.7V$
$V_{RE}=V_E-V_{EE}=-.7V-(-10.7V)= 10V$
$I_C=V_{RE}/R_E=10V/2k=5mA$
$V_{RC}=I_C*R_C=5mA*1K=5V$
$V_C=V_{CC}-V_{RC}=20V-5V=15V$
$V_{CE}=V_C-V_E=15V-(-.7V)=15.7V$

$I_{C(SAT)}=(V_{CC}+|V_{EE}|)/(R_C+R_E)=30.7V/(1k+2k)=10.23mA$
$V_{CE(CUTOFF)}= V_{CC}+|V_{EE}|=30.7V$

3. $I_{C(SAT)}=(V_{CC}-V_{LED})/R_C=(5V-2V)/100=30mA$
$I_B=(V_{BB}-V_{BE})/R_B=(3V-.7V)/1k=2.3mA$

Note that the saturation current is less than beta times larger than the base current. Therefore, the circuit must be in saturation and the LED current equals the saturation current of 30mA (**NOT** 2.3mA*100=230mA)! Remember, the quoted beta of 100 assumes that the circuit is operating in the linear region (but it’s not, it’s in saturation), therefore you can’t rely on the linear beta value of 100. When saturated, the effective beta drops (in this case to about 13).