

## Reading for EET 131 Unit 4 BP Transistor Amplifier DC Biasing

Sec #	Topics	Pages to Read	# of Pg
6-8	The PA System Introduction	305 last 2 Par and 306 1 <sup>st</sup> Par and Fig 6-46	¼
4-4	Transistor Amp waveform <b>Superposition</b>	182 bottom ½	½
4-3	<b>Intro</b> to Bipolar Amp <b>DC Bias</b>	170 top ½	½
<p><b>Note:</b> <b>Load lines</b> are not used for design or analysis anymore because characteristic curves are not available in data books anymore. ∴ We will not use load lines for Biasing Calculations.</p> <p>You don't need load lines to do Biasing calculations. All calculations can be done using Transistor DC &amp; AC Ckts, Data Sheets, and Scope waveforms. We will use load lines for explanation purposes only</p>			
4-3	<b>The DC Load Line</b>	176 middle ½	½
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9-1	Introduction to Class A Small & Large signal Amplifiers	428 top ½	½
9-1	<b>(Centered Q Pt.)</b> Linear Operation	428 bottom ¼ , 429 top ½ &	1 ½
5-1	(skip 429 Fig 9-2)	221 bottom ¾	
5-1	<b>(Shifted Q Pt.)</b> Waveform Distortion	218	3
9-1	(Scope waveforms are on Bottom)	429 bottom ½ , 430 top ½	
5-1	(Left is Bottom & Rt. is Top of Scope)	222	

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Sec #	Topics	Pages to Read	# of Pg
4-3	<b>The <span style="border: 1px solid black; padding: 2px;">Voltage Divider Biasing</span> is stable with changes in Temp &amp; <math>h_{FE}</math></b>		
4-3	<b>B or <math>h_{FE}</math> varying with Temperature &amp; <math>I_C</math></b>	177 bottom ½	½
6-3	Page 276 Under “Stability of the Voltage Gain” 1 <sup>st</sup> Two Par and Eq. <b>Note: The DC biasing is the Same for all 3 basic configurations (CE, CC, &amp; CB).</b>		¼
5-2	Voltage Divider Biasing <b>Introduction</b>	224 bottom ½ , 225 top ½	1
5-2	Voltage Divider Biasing <b>Calculations</b> <b>Note: (These calculations are Very important)</b>	227 bottom ¾ starting at Eq 5-2 thru 229 top ¼ Note: (Skip $R_{IN (Base)}$ Calculations.)	2
9-1	<b>DC Quiescent Power Dissipation</b>	431 middle ¼	¼
4-3	Maximum Transistor Ratings	178, 179 last par 180 top ¼	1 ½
9-1	(Optional) Heat Dissipation	428 2 <sup>nd</sup> par up from bottom	¼
<b>Total Pages =</b>			<b>12 ¼</b>

### Voltage – Divider Bias

(From 121 Text)

The two dc bias sources can be replaced by a single dc source and a resistive voltage divider. Although there are other bias methods, this one is the most widely used.

The voltage-divider bias configuration uses a single dc source to provide forward-reverse bias to the transistor, as shown in Figure 17–6. Resistors  $R_1$  and  $R_2$  form a voltage divider that provides the base bias voltage. Resistor  $R_E$  allows the emitter to rise above ground potential.

The voltage divider bias provides a very small base current to the transistor compared to the bias current. For a properly designed circuit, the loading effect is negligible and can be ignored.

The input resistance at the transistor base depends on  $\beta_{DC}$  and is approximately

#### Base Voltage

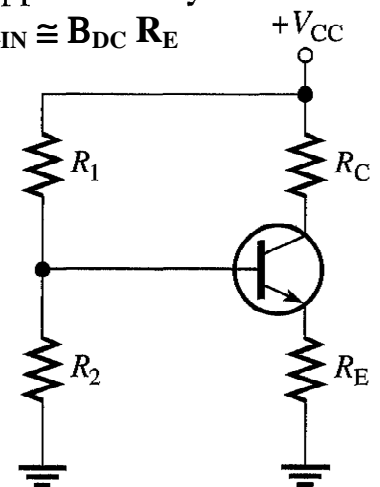
$$R_{IN} \cong \beta_{DC} R_E$$

Using the voltage –divider formula, you get the following equation for the approximate Base voltage for the circuit in figure shown:

$$V_B \cong \left( \frac{R_2}{R_1 + R_2} \right) V_{CC}$$

Once you have determined the Base voltage, you can determine the Emitter voltage  $V_E$  (for an NPN transistor).

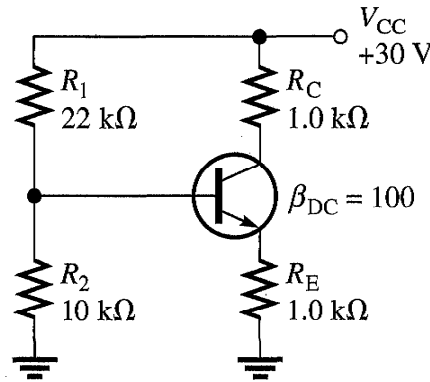
$$V_E = V_B - 0.7V$$



## Example Voltage Divider Calculations

Determine  $V_B$ ,  $V_E$ ,  $V_C$ ,  $V_{CE}$ ,  $I_B$ ,  $I_E$ , and  $I_C$  in Figure 17-7.

▶ **FIGURE 17-7**



**Solution** The base voltage is approximately

$$V_B \cong \left( \frac{R_2}{R_1 + R_2} \right) V_{CC} = \left( \frac{10 \text{ k}\Omega}{32 \text{ k}\Omega} \right) 30 \text{ V} = \mathbf{9.38 \text{ V}}$$

Therefore,

$$V_E = V_B - 0.7 \text{ V} = \mathbf{8.68 \text{ V}}$$

Now that you know  $V_E$ , you can find  $I_E$  by Ohm's law.

$$I_E = \frac{V_E}{R_E} = \frac{8.68 \text{ V}}{1.0 \text{ k}\Omega} = \mathbf{8.68 \text{ mA}}$$

Since  $\alpha_{DC}$  is so close to 1 for most transistors, it is a good approximation to assume that  $I_C \cong I_E$ . Thus,

$$I_C \cong \mathbf{8.68 \text{ mA}}$$

Use  $I_C = \beta_{DC} I_B$  and solve for  $I_B$ .

$$I_B = \frac{I_C}{\beta_{DC}} = \frac{8.68 \text{ mA}}{100} = \mathbf{86.8 \mu\text{A}}$$

Since you know  $I_C$ , you can find  $V_C$ .

$$V_C = V_{CC} - I_C R_C = 30 \text{ V} - (8.68 \text{ mA})(1.0 \text{ k}\Omega) = 30 \text{ V} - 8.68 \text{ V} = \mathbf{21.3 \text{ V}}$$

Since  $V_{CE}$  is the collector-to-emitter voltage, it is the difference of  $V_C$  and  $V_E$ .

$$V_{CE} = V_C - V_E = 21.3 \text{ V} - 8.68 \text{ V} = \mathbf{12.6 \text{ V}}$$