

<http://www.ece.umd.edu/~pabshire/enee312h.htm>

due Thursday, April 11, 2002

- 1) A particular bipolar IC process has the following tolerances in the dimensions and parameters of an *npn* transistor:
- $N_{DE} = 1.2 \times 10^{19} \pm 10^{18} \text{ cm}^{-3}$, $W_E = 500 \pm 40 \text{ nm}$
 $N_{AB} = 4 \times 10^{17} \pm 2 \times 10^{16} \text{ cm}^{-3}$, $W_B = 350 \pm 30 \text{ nm}$
 $N_{DC} = 4 \times 10^{16} \pm 10^{15} \text{ cm}^{-3}$, $W_C = 1 \pm 0.05 \text{ } \mu\text{m}$
- The emitter area is $A_E = 100 \text{ } \mu\text{m}^2$, and the collector area is $A_C = 750 \text{ } \mu\text{m}^2$.
- Assuming that the parameter and dimensional variations are independent, find the average and variation of the saturation current I_S .
 - For a fixed base-emitter bias $V_{BE} = 720 \text{ mV}$ and base-collector bias $V_{BC} = -2.3 \text{ V}$, find the average and variation of the collector current I_C .
 - Assuming that the parameter and dimensional variations are independent, find the average and variation of the forward current gain β_F .
 - Find the minimum and maximum values of the forward current gain β_F for this process, by using the extreme values of the device parameters and dimensions.
- 2) This exercise covers the qualitative effects of parameter and dimensional changes on the model parameters of an *npn* transistor. In the following table, fill in each entry with +, -, or 0 to represent an increase, a decrease, or no effect as a result of an increase in the parameter in the left-hand column. You may use the saturation current as defined in Sedra & Smith. The operating point (I_C , V_{CE}) remains fixed.

Parameter	Forward gain β_F	Reverse gain β_R	Saturation current I_S	Early Voltage V_A
N_{DE}				
W_E				
D_{hE}				
N_{AB}				
W_B				
D_{eB}				
N_{DC}				
W_C				
D_{hC}				

- 3) – 7) Complete Sedra & Smith problems 4.63, 4.85, 4.96, 4.133, 4.135

Research Question:

What is a translinear circuit? Who invented the name “translinear”? Why?

How are translinear circuits related to bipolar junction transistors?

Provide the citation information for the first, definitive publication on translinear circuits.

Hint: The publication appeared in the journal *Electronics Letters*.