E151 Lecture 16

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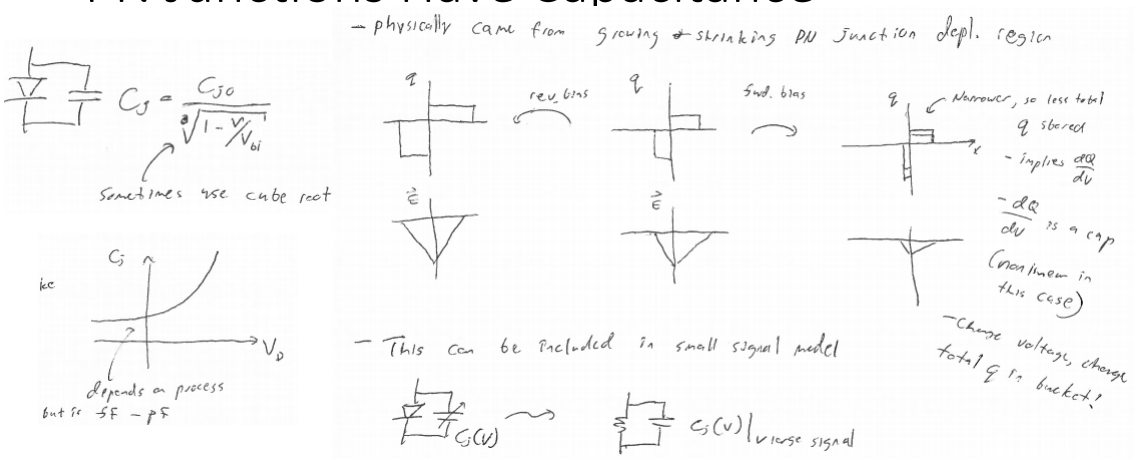
ENGR151

Disclaimer

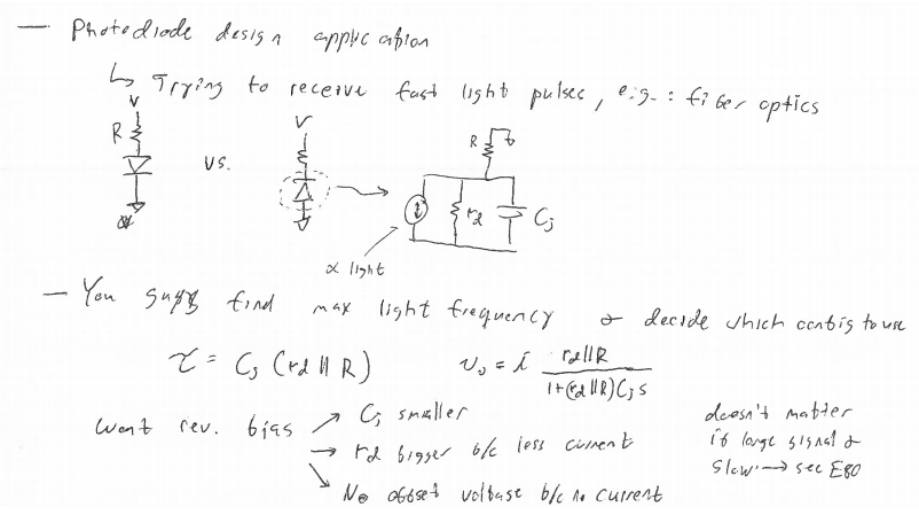
These are notes for Prof. Spencer to give the lecture, they were not intended as a reference for students. Students asked for them anyway, so I'm putting them up as a courtesy. Remember that they are not intended as a substitute for attending lecture.

PN Junctions Have Capacitance

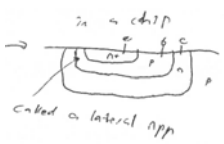


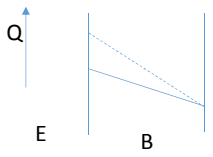
- Change in width results in more “space charge”

Optional: Should I fwd/rev Bias Photodiodes?



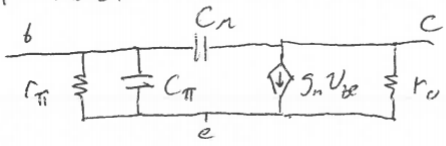
BJTs Have Two PN Junctions + Base Current





cap $C_b = \tau_F g_m$
- Forward transit time ~ 10 ps
- ratio of Q_b/I_C
- basically constant, device/tech

Small signal model



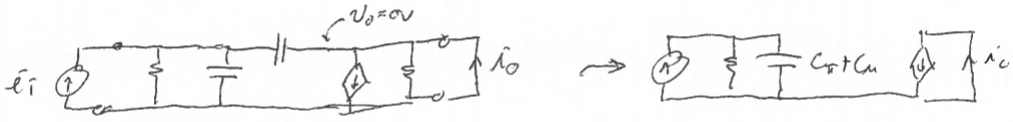
- Full Hybrid-π model
- $C_\pi = C_b + C_{je}$

- BE junction usually forward biased, BC usually reverse biased (small)
- Charge is in transit through the base all the time, need to supply more
  - Emitter charge goes to collector, so comes from base. Changing river level …

Describe BJT Small Signal Speed Limit with fT

How fast can we go?

– often measured w/ f_T, frequency where A_i drops to 1 (f_{max} where power gain = 1)



$i_o = g_m v_{be}$

$v_{be} = i_i \cdot \frac{R/(C_\pi + C_\mu)s}{R + 1/(C_\pi + C_\mu)s} = \frac{r_\pi}{1 + r_\pi(C_\pi + C_\mu)s}$

So $A_{iT} = \frac{\beta}{1 + \beta\left(\frac{C_\pi + C_\mu}{g_m}\right)s}$

$\rightarrow f_T \approx \frac{1}{2\pi} \frac{g_m}{C_\pi + C_\mu}$