

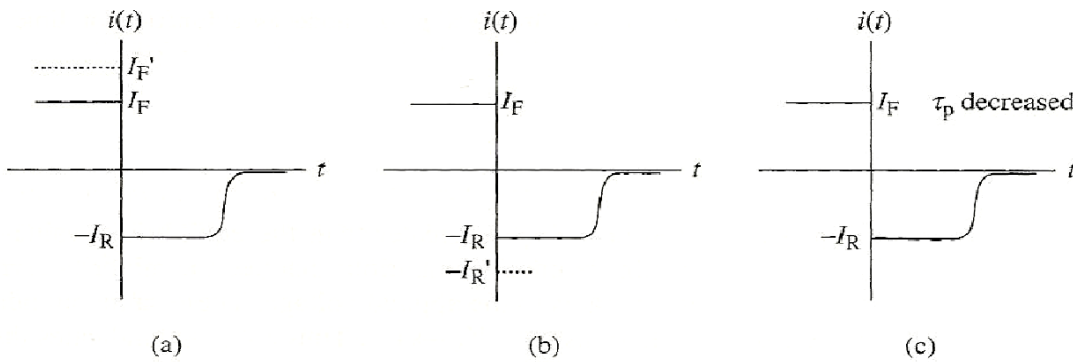
1:

**P:** Use the qualitative insight gained into the diode response to predict how key factors are expected to affect the observed  $i-t$  transient. The accuracy of the predictions will be checked after working out the quantitative theory.

The figures after the problem statement contain a base-line sketch of an  $i-t$  transient. Using a dashed line, sketch the expected modification to the base-line transient if as indicated on the figures:

- (a)  $I_F$  is increased to  $I'_F$ .
- (b)  $I_R$  is increased to  $I'_R$ .
- (c)  $\tau_p$  is decreased (made shorter).

Explain how you arrived at the modified  $i-t$  sketches.

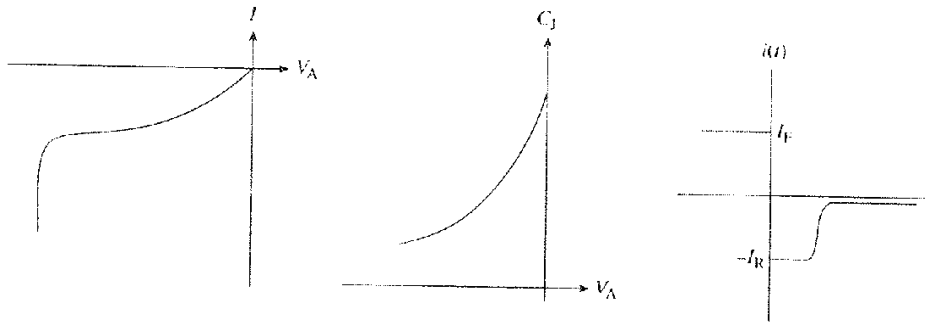


2:

The reverse-bias current-voltage ( $I-V_A$ ), junction capacitance ( $C_J-V_A$ ), and turn-off transient ( $i-t$ ) characteristics derived from a  $p^+n$  Si step junction diode maintained at room temperature are sketched to the right. After reproducing the figures, answer the following questions by adding a *dashed line* to the appropriate characteristic. Note that an answer of *no effect* (a dashed line the same as the given characteristic) is possible. In such cases write *no effect*.

(a-c) Roughly indicate how the  $I-V_A$ ,  $C_J-V_A$ , and  $i-t$  characteristics are modified if the  $n$ -side doping ( $N_D$ ) is *increased* by a factor of 2. All other parameters remain the same.

(d-f) Roughly indicate how the  $I-V_A$ ,  $C_J-V_A$ , and  $i-t$  characteristics are modified if the minority carrier lifetime on the  $n$ -side ( $\tau_p$ ) and the effective depletion-region generation lifetime ( $\tau_0$ ) are *increased* by a factor of 2. All other parameters remain the same.



3:

- The hole lifetime of a  $p^+n$  diode is measured by the diode-recovery method.
- For  $I_f = 1$  mA and  $I_r = 2$  mA,  $t_s$  is found to be 3 ns in an oscilloscope with a 0.1-ns rise time. Find  $\tau_p$ .
  - If the fast scope in (a) is not available and you have to use a slower scope with a 10-ns rise time, how can you make an accurate measurement? Describe your result.