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Test #1: EE 253 Electronics I FS13

September 13, 2013

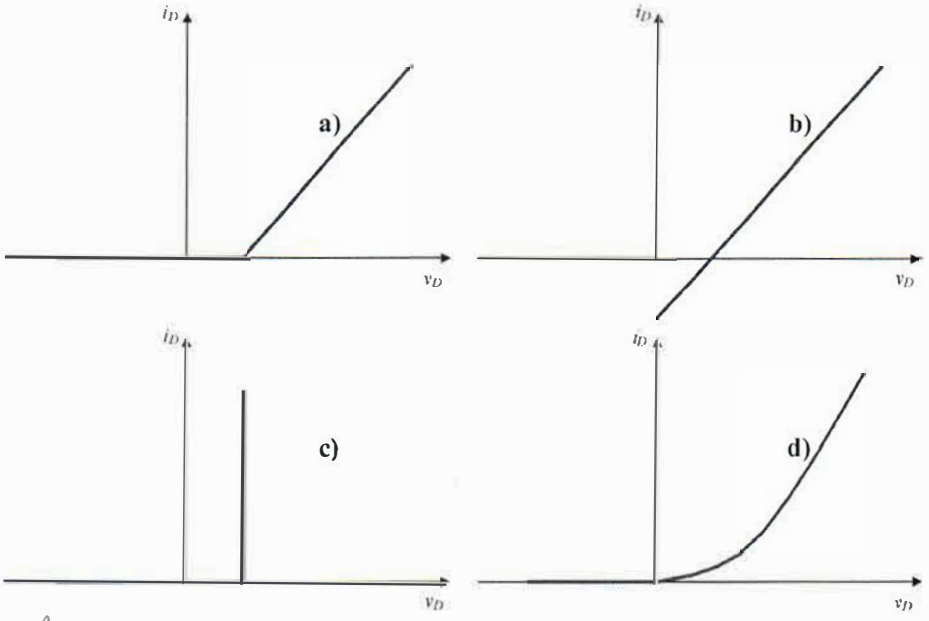
40 1) Multiple Choice Questions (40 points, no partial credits)

A 1.1) How many valence electrons do acceptor impurity atoms have, which are doped into Silicon?
a) 3; b) 4; c) 5; d) 6

C 1.2) What is a doping process?
a) A process to break covalent bonds;
b) A process to cause avalanche;
c) A process to improve carrier concentrations;
d) A process to create holes

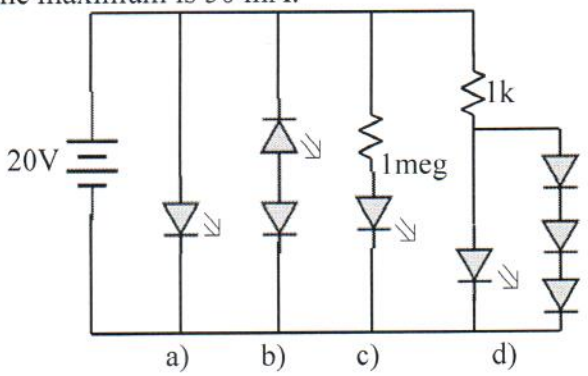
B 1.3) The built-in voltage in a stand-alone PN junction is initially caused by
a) Drift; b) Diffusion; c) Breakdown; d) Doping

C 1.4) Two diodes that have different turn-on voltage values are in parallel to form a current divider. Which of the following model could be used as a diode model, but is NOT suitable to analyze the current distribution between the two diodes in this case?

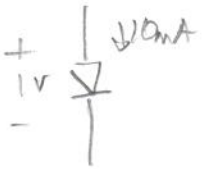


A 1.5) Thermal voltage V_T is approximately
a) 26 mV @ 300K; b) 26 mV @ any temperature;
c) 26 mV @ 300°F; d) 26 mV @ 300°C

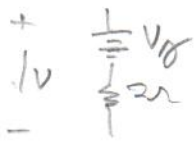
D 1.6) Which of the following LED is on? Assume $V_{\gamma LED} = 2V$, $r_{fLED} = 20\Omega$ for LEDs, and $V_\gamma = 0.7V$, $r_f = 0$ for all other diodes. Suppose the minimum LED current is 0.1 mA, and the maximum is 50 mA.



2.1 - 2 V / 20



D 1.7) A diode is biased in the "ON" region, V_γ is unknown, and $r_f = 2\Omega$. The voltage across the diode (V_D) is 1 V when the current flowing through it (I_D) is 10 mA. If I_D changes to 20mA, what is V_D now?
a) 1.04 V; b) 1.0 V; c) 0.98 V; d) 1.02 V



$V_\gamma = 1.02$

$V_\gamma = .98V$

B 1.8) For a reverse-biased PN junction (not biased in the breakdown region),
a) its depletion region is narrowed;
b) there's a leakage current which is often extremely small
c) current increases with voltage exponentially;
d) it can be modeled with a voltage source and a forward resistance

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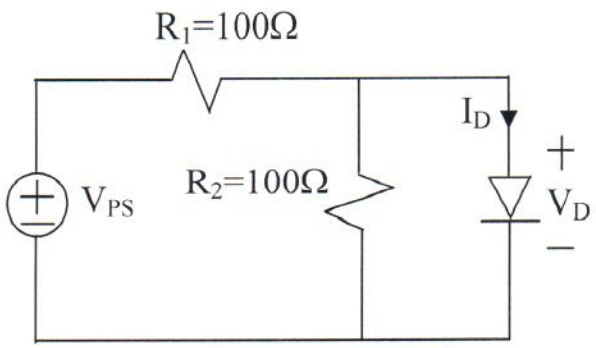
2) In the following diode circuit,



a) (20 points): if V_{PS} = 1.0 V, V_γ = 0.7 V and r_f = 0 Ω, what are the diode current I_D, the diode voltage V_D, and the dissipated power P_D in the diode?

$V_{PS} - R_1\left(I_D + \frac{V_D}{R_2}\right) - V_D = 0$ → If on

$1 = 100\left(I_D + \frac{.7}{100}\right) + .7$

$.3 = 100 I_D + .7$ ✗

$I_D < 0$ → Diode off → $V_D = V_{R_2} = V_{PS}\frac{100}{100+100} = .5V < .7V$

$V_D = .5V$

$I_D \approx 0A$

$P_D = ?$ −3

b) (20 points): if V_{PS} = 6.6 V, V_γ = 0.7 V and r_f = 2 Ω, what are the diode current I_D, the diode voltage V_D, and the dissipated power P_D in the diode?

$V_{PS} = R_1\left(I_D + \frac{V_D}{R_2}\right) + V_D$

$V_D = V_\gamma + I_D r_f = .7 + 2I_D$

$6.6 = 100\left(I_D + \frac{.7 + 2I_D}{100}\right) + .7 + 2I_D$

$6.6 = 100 I_D + .7 + 2I_D + .7 + 2I_D$

$5.2 = 104 I_D$

$I_D = 50mA$

$V_D = V_\gamma + 2I_D = .7 + 2(.05)$

$V_D = .8V$

$P_D = ?$ −3

3) (20 points) Design a circuit using diodes and resistors to produce the following I_I-V_I characteristics, where I_I and V_I are the input current and voltage to the overall circuit. Use the ideal diode model with $V_\gamma = 0.7\text{V}$ and $r_f = 0$. Please calculate resistor values.

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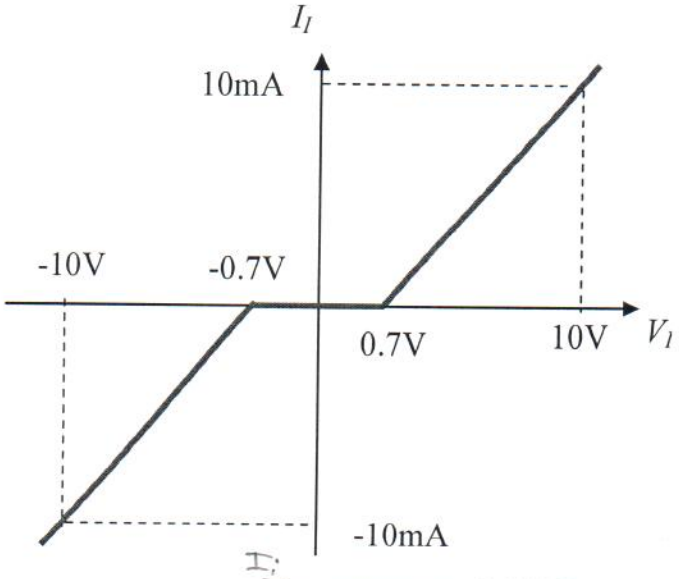
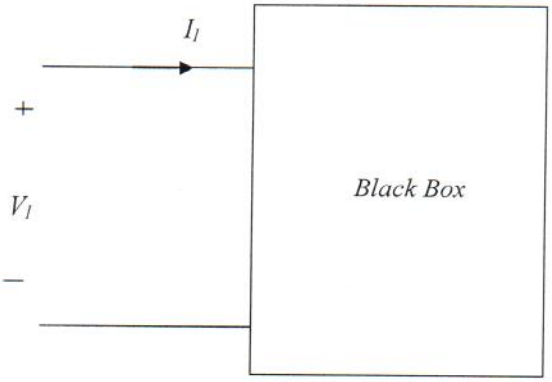
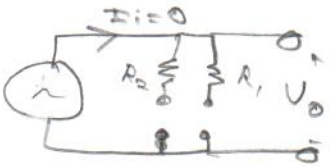
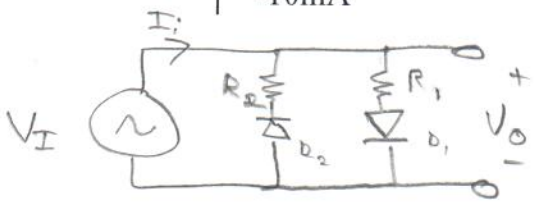




Diodes off

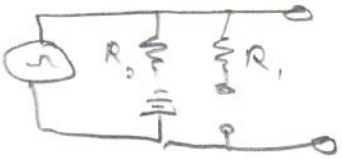
$-.7\text{V} \le V_I \le .7\text{V}$ $I_I = 0$





$V_I > .7\text{V}$

$V_I < .7\text{V}$ V_I



$V_I = R_1 I_I + V_\gamma$

$R_1 = \dfrac{V_I - V_\gamma}{I_I} = \dfrac{10 - .7}{10\text{mA}}$

$R_1 = 930\,\Omega$

$R_1 = R_2$

$R_2 = \dfrac{-10 + .7}{-10\text{mA}}$

$R_2 = 930\,\Omega$