Review Questions

1. What is a flatband diagram?
2. Discuss the motion of electrons and holes in a p-n junction in thermal equilibrium.
3. Define the built-in potential. Also provide an equation and state the implicit assumption(s).
4. How does the energy band diagram of a p-n junction change under forward and reverse bias?
5. What is the full depletion approximation? Why do we need the full depletion approximation?
6. Derive equation (4.3.17) from (4.3.13), (4.3.14) and (4.3.16).
7. Explain why the capacitance of a p-n junction (4.3.22) equals that of a parallel plate capacitor. How does the capacitance differ from a parallel plate capacitor?
8. How do you extract the doping profile shown in Fig. 4.3.4 from the capacitance shown in Fig. 4.3.3?
9. What mechanism(s) cause(s) current in a p-n junction?
10. How does one calculate the current in a p-n junction?
11. How does one solve the diffusion equation in the quasi-neutral regions?
12. What is the difference between the "long" and "short" diode analysis?
13. When can the recombination/generation current in the depletion region be ignored?
14. Which saturation current is voltage dependent, that for the "long" diode or the one for the "short" diode?
15. Why does one need to include edge effects when calculating the breakdown voltage of a diode?
16. Name two breakdown mechanisms and discuss the temperature dependence of the resulting breakdown voltage.
17. Describe the avalanche breakdown mechanism.
18. Describe tunneling.
19. Illustrate the generation of a photocurrent in a p-n diode by drawing an energy band diagram. Indicate the photo-generated carriers and their direction of motion.
20. Why is the photocurrent negative compared to the forward bias current through the same diode?
21. What limits the quantum efficiency of a photodiode?
22. What is the difference between a solar cell and a photodiode?
23. Why would solar cells be more efficient if the sun where a laser rather than a black body radiator?

24. What limits the power conversion efficiency of a solar cell?

25. Using equation 4.6.1 show that the open-circuit voltage increases as the photocurrent increases. Use this result to prove that the power conversion efficiency of a solar increases when using a concentrator which increases the incident power density.

26. Why is silicon not used to fabricated LEDs or laser diodes?

27. Why are planar LEDs so inefficient? How can the efficiency of an LED be improved beyond that of a planar LED?

28. How does the light emitted by an LED differ from that emitted by a laser diode?

29. What is stimulated emission?

30. Why does a laser diode need a waveguide?

31. Explain the lasing condition in words.

32. Describe the power versus current characteristic of a laser diode.