Basic Electronic Circuits
Fall 2007 Test 3

The following multiple choice questions are worth 2 points each.

1. How many bits per byte?

   (a) 2
   (b) 4
   (c) 8
   (d) 16

2. What is the largest unsigned decimal number that can be stored in 5 bits?

   (a) 15
   (b) 31
   (c) 16
   (d) 32

3. Which of the following is *not* an advantage of semiconductor devices over vacuum tubes?

   (a) smaller size
   (b) lower working voltage
   (c) lighter weight
   (d) ability to withstand high voltage spikes

4. The purpose of doping is to

   (a) make the charge carriers move faster
   (b) cause holes to flow
   (c) give a semiconductor material specific properties
   (d) protect devices from damage in case of transients

5. A semiconductor material is made N type by

   (a) adding an acceptor impurity
   (b) adding a donor impurity
   (c) injecting protons
   (d) taking neutrons away

6. A CMOS integrated circuit

   (a) can only work at low frequencies
   (b) requires very little power to function
   (c) requires considerable power to function
   (d) can only work at high frequencies

7. A disadvantage of MOS devices is the fact that

   (a) the charge carriers move slowly
   (b) the material does not react to ionizing radiation
   (c) they can be damaged by electrostatic discharges.
   (d) they must always be used at high frequencies

8. Which of the following does not result from adding an acceptor impurity?

   (a) The material becomes P type.
   (b) Current flows mainly in the form of holes.
   (c) Most of the carriers have positive charge.
   (d) The substance acquires an electron surplus.

9. In a P-type material, electrons are

   (a) the majority carriers
   (b) the minority carriers
   (c) entirely absent
   (d) bound to donor atoms

10. Holes move from

    (a) minus to plus potential
    (b) plus to minus potential
    (c) P-type to N-type material
    (d) N-type to P-type material

11. When a P-N junction does not conduct even though a voltage is applied, the junction is

    (a) reverse-biased at a voltage less than the avalanche voltage
    (b) overdriven
    (c) biased past the breaker voltage
    (d) in a state of avalanche effect

12. When a P-N junction is forwared-biased, conduction will not occur unless

    (a) the applied voltage exceeds the the forward turn-on voltage (about 0.7 V).
    (b) the applied voltage is less than the forward turn-on voltage.
    (c) the junction capacitance is high enough
    (d) the depletion region is wide enough

13. If the reverse bias exceeds the avalanche voltage in a P-N junction

    (a) the junction will be destroyed
    (b) the junction will insulate; no current will flow
    (c) the junction will conduct current
    (d) the junction will be destroyed AND no current will flow

14. A bipolar transistor has

    (a) three P-N junctions
    (b) three semiconductor layers
    (c) two N-type layers around a P-type layer
    (d) a low avalanche voltage

15. In the dual diode model of an NPN transistor, the emitter corresponds to

    (a) the point where the cathodes are connected together
    (b) the point where the cathode of one diode is connected to the anode of the other
    (c) the point where the anodes are connected together
    (d) either of the diode cathodes

16. A bipolar junction transistor acts like the following dependent source:

    (a) VCVS
    (b) CCCS
    (c) CCVS
    (d) VCCS

17. In a full-wave rectifier, the unfiltered output voltage

    (a) is the same frequency as the source
    (b) is twice the frequency of the source
    (c) is half the frequency of the source
    (d) is pure DC and does not depend on the frequency of the source.

18. In a MOSFET, MOS stands for

    (a) metal - output - source
    (b) metal - oxide - semiconductor
    (c) mesa - ozone - source
    (d) medium output semiconductor

19. A discrete isolated-gate field-effect transistor has

    (a) three terminals: source gate drain
    (b) three terminals: emitter base collector
    (c) three terminals: cathode gate anode
    (d) two terminals: cathode anode

20. Which of the following components is probably NOT found in a regulated power supply?

    (a) transformer
    (b) rectifier
    (c) amplifier
    (d) zener diode

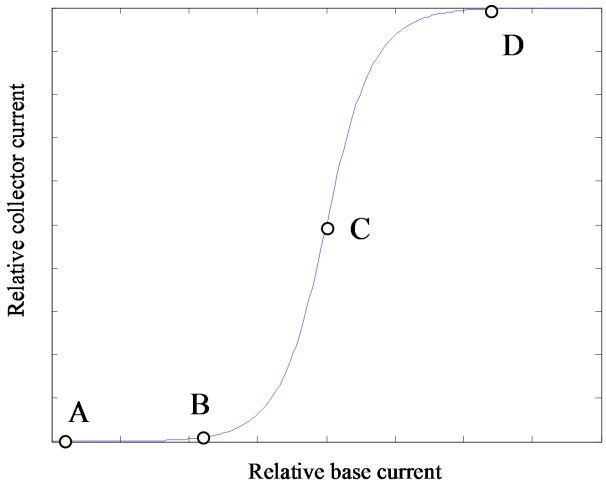
The following questions are worth 5 points each.

1. Find the following.
   (a) the range of unsigned decimal numbers that can be stored in 6 bits.
   (b) the range of signed decimal numbers that can be stored in 6 bits.
   (c) the largest unsigned hexidecimal number that can be stored in 6 bits.
   (d) the largest unsigned octal number that can be stored in 6 bits.
   (e) the largest unsigned binary number that can be stored in 6 bits.

2. Convert the following numbers as specified:
   (a) $(111011)_2$ to decimal
   (b) $(111011)_2$ to hexadecimal
   (c) $(21)_{10}$ to binary
   (d) $(21)_{10}$ to octal
   (e) $(34)_{12}$ to decimal

3. The input/output relationship for a transistor is $i_{out} = \beta i_{in}$. Write the input/output relationship for a VCCS.

4. Identify the points in the diagram below that correspond to the saturation region, the active region, and the cut-off region of an *NPN* bipolar junction transistor.



5. List the ideal values of input impedance R_{in}, output impedance R_{out} and gain A for an ideal operational amplifier.

6. List five of the six uses of a semiconductor or vacuum tube element.

7. Use the symbol diagram below to answer the following questions.

   (a) Are these BJT or FET symbols?

   (b) Label the PNP and NPN transistor symbols.

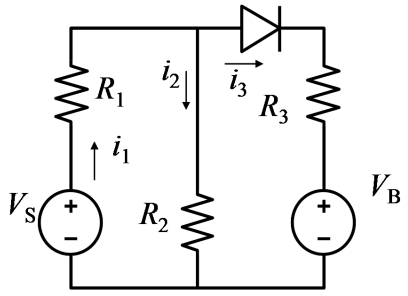
   (c) Label the base, emitter, and collector of the PNP transistor.

   (d) Label the base, emitter, and collector of the NPN transistor.

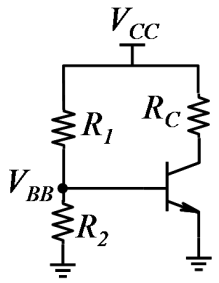
   (e) In the active mode of the PNP transistor is the current I_{BE} positive or negative.

8. What is photolithography and how is it used in semiconductor manufacturing?

9. Find the current i_2 in the diagram below, with $R_1 = R_2 = R_3 = 6\ \Omega$, $V_S = 12$ V, and $V_B = 5$ V. Does the diode conduct? If so, find the current i_3 flowing through the diode. Assume a 0.7 V diode turn-on voltage.



10. The following circuit diagram applies to this problem. Let $R_1 = 92$ kΩ, $R_2 = 46$ kΩ, $R_C = 4$ kΩ, $V_{CC} = 12$ V, and $\beta = 240$. Find V_{BB} and i_B.



11. Using the circuit diagram and circuit values from the previous problem, find V_{CE} and i_C. Is the transistor in the active region or the saturation region.

12. The following circuit diagram applies to this problem. Let $R_1 = 100$ kΩ, $R_2 = 50$ kΩ, $R_f = 200$ kΩ, and $R_C = 30$ kΩ. Find v_{out} as a function of v_1 and v_2 if the op-amp is ideal.