ECE-255
Exam I
February/09/2012

Name: ___________________________________
(Please print clearly)

Student ID: _________________

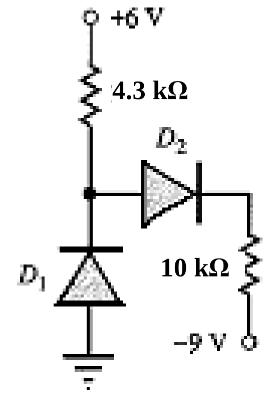
INSTRUCTIONS

- This is a closed book, closed notes exam.
- Carefully mark your multiple choice answers on the scantron form. Work on multiple choice problems and marked answers in the test booklet will not be graded. Nothing is to be on the seat beside you.
- When the exam ends, all writing is to stop. This is not negotiable. No writing while turning in the exam/scantron or risk an F in the exam.
- All students are expected to abide by the customary ethical standards of the university, i.e., your answers must reflect only your own knowledge and reasoning ability. As a reminder, at the very minimum, cheating will result in a zero on the exam and possibly an F in the course.
- Communicating with any of your classmates, in any language, by any means, for any reason, at any time between the official start of the exam and the official end of the exam is grounds for immediate ejection from the exam site and loss of all credit for this exercise.

1. A silicon sample at room temperature has an intrinsic carrier concentration of $n_i = 10^{10}$ cm^{-3}. It is doped with $N_A = 5\times10^{16}$ boron atoms/cm^3 and $N_D = 6\times10^{12}$ arsenic atoms/cm^3. The electron mobility is measured as $\mu_n = 1000$ $cm^2/V\cdot s$. What is the electron concentration in this material and electron current density when an external field of E=100 V/cm is applied? $q=1.6\times10^{-19}$ C

(1) $n = 5\times10^{16}$ /cm^3; $j_n = 800 A/cm^2$
(2) $n = 2\times10^{3}$ /cm^3; $j_n = 3.2\times10^{-11} A/cm^2$
(3) $n = 6\times10^{2}$ /cm^3; $j_n = 800 A/cm^2$
(4) $n = 5\times10^{6}$ /cm^3; $j_n = 8\times10^{-8} A/cm^2$
(5) $n = 6\times10^{2}$ /cm^3; $j_n = 9.6\times10^{-12} A/cm^2$
(6) $n = 2\times10^{3}$ /cm^3; $j_n = 8\times10^{-8}/cm^2$
(7) None of the above

2. Find the current in each diode in the circuit shown below using the constant voltage drop model with V_{on} = 0.70 V, R_D=0.



(1) I_{D1} =0A, I_{D2} =0A

(2) I_{D1} =1.4mA, I_{D2} =0A

(3) I_{D1} =0A, I_{D2} =1.05mA

(4) I_{D1} =0A, I_{D2} =1mA

(5) I_{D1} =0A, I_{D2} =0.97mA

(6) I_{D1} =1.4mA, I_{D2} =0.97mA

(7) None of the above

3. The Zener diode in the circuit has an equivalent resistance R_Z = 20 Ω. From the diode data sheet we find that if the voltage across the Zener diode is 6.4 V at I_Z = 20 mA. Determine the output voltage V_{out}.

(1) V_{out} =6.4V

(2) V_{out} =6.0V

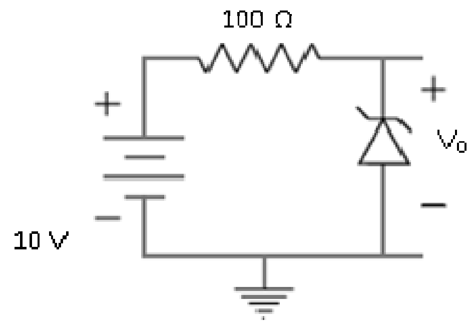
(3) V_{out} =6.67V

(4) V_{out} =6.365V

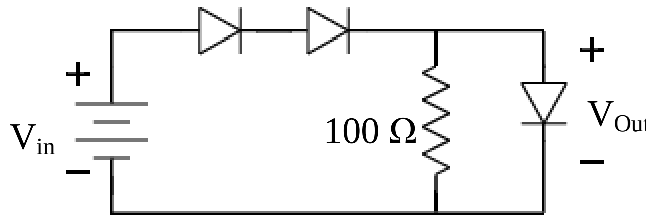
(5) V_{out} =0V

(6) V_{out} =10 V

(7) None of the above



4. Using a piecewise linear diode models having an ideal diode, V_{on} = 0.7 V, and R_D = 20 Ω for each diode in the circuit, determine the input voltage V_{in} required to produce an output voltage, V_{out}, of **exactly** 0.6V.



(1) V_{in} =2V

(2) V_{in} =2.24V

(3) V_{in} =1.4V

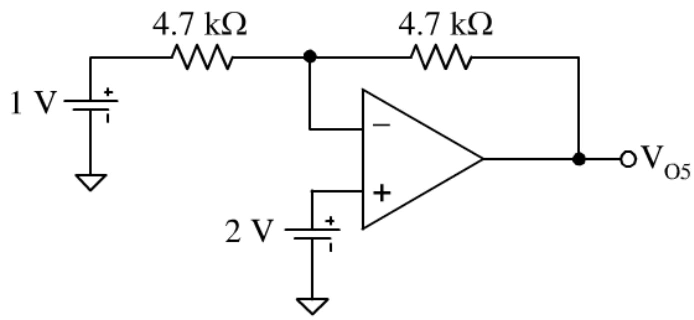
(4) V_{in} =5V

(5) V_{in} =1.64V

(6) V_{in} =2.1V

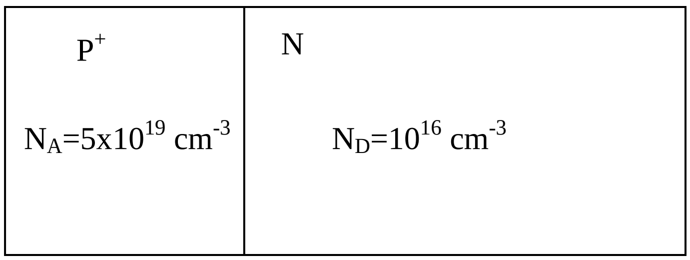
(7) None of the above

5. Solve for the DC output voltage in the following circuit, assuming that the op amp is an ideal device.



(1) V_O =+1V (2) V_O =+2V (3) V_O =+3V
(4) V_O =+4V (5) V_O =+5V (6) V_O =0V
(7) None of the above

(6) Figure below shows a p^+-n diode with the following doping levels, depletion layer width is ??? and is mostly in the ??? layer. V_T=25 mV, $n_i=10^{10}$ cm^{-3}, $\varepsilon_s=11.9\,\varepsilon_o$, $\varepsilon_o=8.85\text{x}10^{-14}$ F/cm, $q=1.6\text{x}10^{-19}$ C



(1) 0.7 µm, mostly in the n region

(2) 0.7 µm, mostly in the p region

(3) 0.34 µm, mostly in the n region

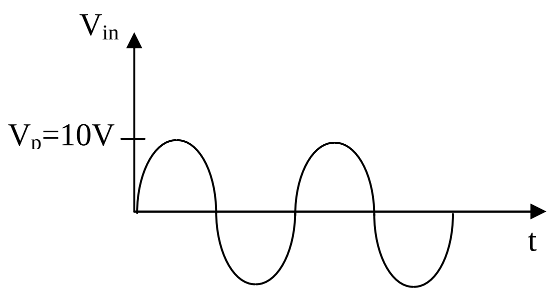
(4) 1 µm, mostly in the n region

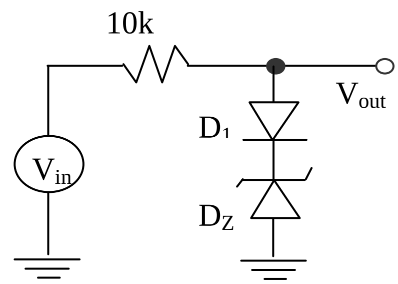
(5) 0.34 µm, mostly in the p region

(6) 0.17 µm, mostly in the p region

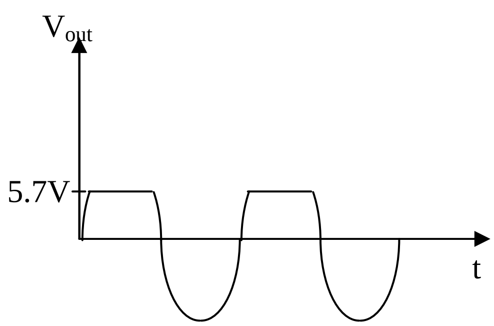
(7) None of these

(7) For the circuit shown below, if a sinusoidal wave is applied to the input, which one of the curves is the output voltage? (V_{on}=0.7V, R_D=R_Z=0, V_Z=5V for D_Z, and V_{on}=0.7V, R_D=0, V_{BR}=20V for D_1)

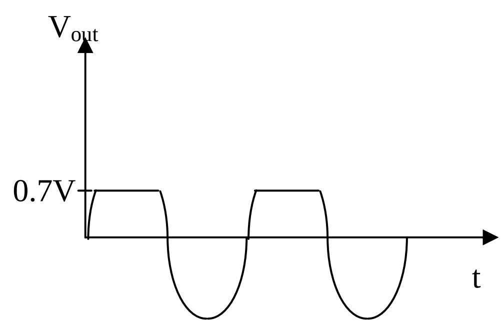




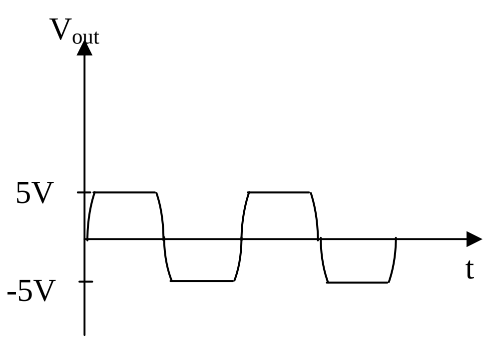
(1)



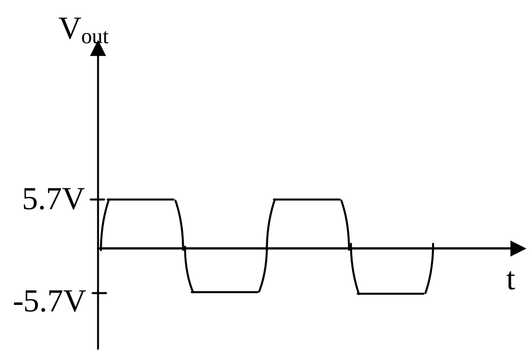
(2)

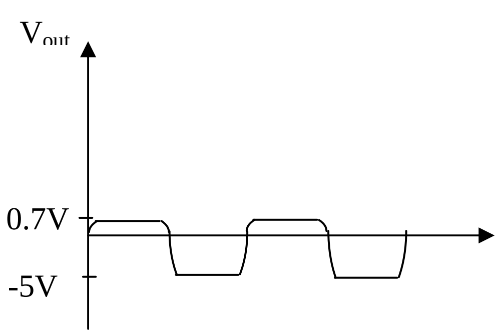


(3)

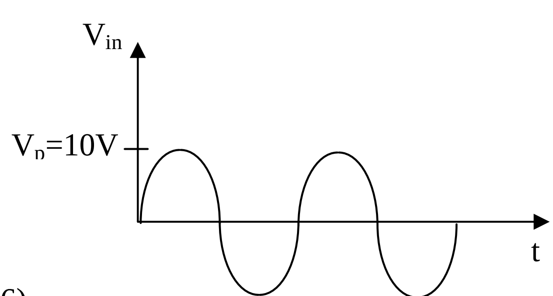


(4)





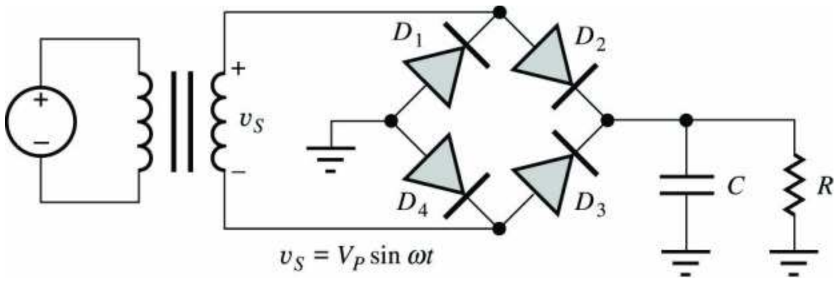
(5)



(6)

(7) None of these

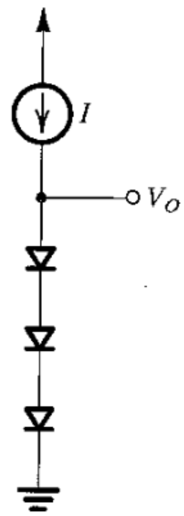
(8) A full wave bride rectifier is shown below



D_1, D_2, D_3, and D_4 have turn on voltages of 0.7 volt (R_D=0). If V_p=10V, What value capacitance you need to choose for a ripple voltage of 0.1V if the input frequency is 1 KHz and R=10kΩ?

(1) 9.3μF
(2) 4.65μF
(3) 4.75μF
(4) 2.15μF
(5) 4.3μF
(6) 1 μF
(7) None of the above

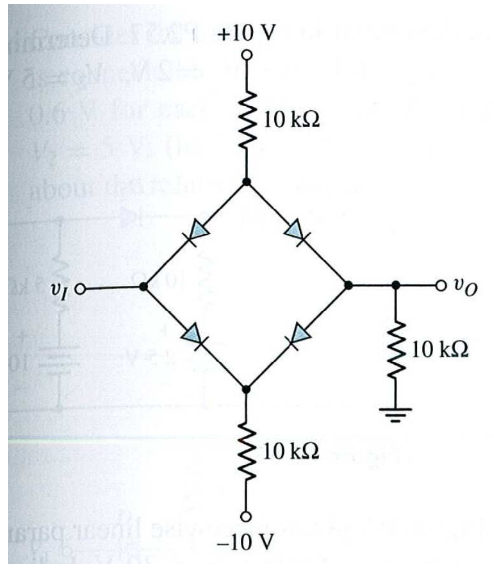
(9) In the circuit shown below all three diodes are identical, and $I_s=10^{-14}$A, The value of I required for an output voltage of 2V is? (Assume $R_D=0$)



(1) 1mA
(2) 3.8mA
(3) 7.6mA
(4) For all values of I the output will be 2.1V
(5) 2mA
(6) 0.5 mA
(7) None of the above

(10) For the circuit shown below, what is v_o if v_i=0V? Assume V_{on}=0.7V, R_D=0.

(1) 0 V
(2) 0.7 V
(3) 1.4 V
(4) -0.7 V
(5) 9.3 V
(6) 18.6 V
(7) None of the above



$$j_n^T = q\mu_n nE + qD_n \frac{\partial n}{\partial x}$$

$$j_p^T = q\mu_p pE - qD_p \frac{\partial p}{\partial x}$$

Drift diffusion currents

$$\phi_j = V_T \ln\left(\frac{N_A N_D}{n_i^2}\right)$$

Junction voltage

$$w_{d0} = \sqrt{\frac{2\varepsilon_s}{q}\left(\frac{1}{N_A} + \frac{1}{N_D}\right)\phi_j}$$

Depletion layer width at zero bias

$$w_d = w_{do}\sqrt{1 + \frac{v_R}{\phi_j}}$$

Depletion layer width at reverse bias (v_R)

$$C_j = \frac{C_{jo}}{\sqrt{1 + \frac{v_R}{\phi_j}}}$$

Junction capacitance at reverse bias of (v_R)