

Exam booklet

Name:

Student number:

Notes:

1. Write down your name and ID.
2. This is close-book exam, only 1 piece of formula sheet can be brought to the exam. Calculators are allowed.
3. The exam last 1.5 hours.
4. This is the **Exam Booklet**. Write your answer in the **Answer Booklet**. Any answer in the Exam Booklet will NOT be read and checked.
5. Hand in both the Answer Booklet and Exam Booklet.
6. Try to solve the easy problems first, then the difficult ones.

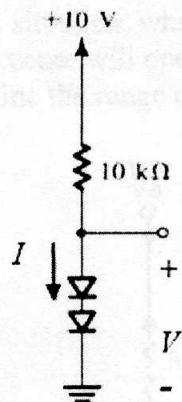
Section 1 (15 points): Multiple choices, select the most appropriate one. Each problem weights 1 point.

1. What kind of a device is a diode?
a. Bilateral b. Linear c. Nonlinear d. Unipolar
2. What is the most popular and useful semiconductor material?
a. silver b. Germanium c. aluminum d. silicon
3. The light-emitting diode (LED) is commonly made by which of the following materials?
a. Germanium b. GaAs c. aluminum d. silicon
4. If the input line frequency is 60 Hz, the output frequency of a full-wave rectifier is
a. 30 Hz b. 60 Hz c. 120 Hz d. 240 Hz
5. In a silicon diode, the reverse current is usually
a. Very small b. Very large c. Zero d. In the breakdown region
6. With the same secondary voltage and filter, which has the most Peak Inverse Voltage (PIV)?
a. Half-wave rectifier b. Full-wave rectifier
c. Bridge rectifier d. Impossible to say
7. Which of these is the best description of a zener diode?
a. It is a rectifier diode b. It is a constant-voltage device
c. It is a constant-current device d. It works in the forward region
8. What is the input impedance of an ideal op amp?
a. Zero b. Unknown
c. Infinity d. 100 Ω
9. What is the open loop gain for an ideal op amp?
a. Zero b. Unknown
c. Infinity d. 1
10. A difference amplifier does NOT have the following capability:
a. amplify the difference of the inputs
b. reduce the difference of the inputs
 c. amplify the common-mode signal of the inputs
d. small output impedance

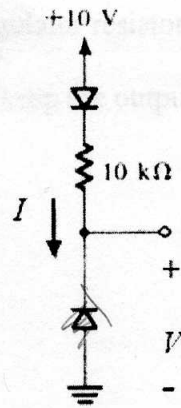
Peak Inverse Voltages
For: $V_s - V_D$
 $\frac{1}{2} V_s$
Full: $2V_s - V_D$

Section 2 (85 points): Calculations.

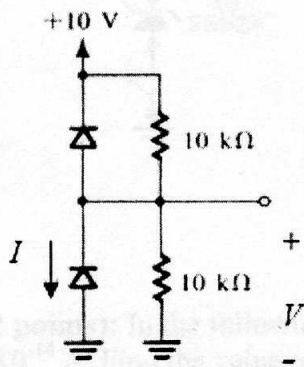
Problem 1 (10 points): For the circuits shown in the following schematics, assume diodes are ideal and find out the values of I and V indicated.



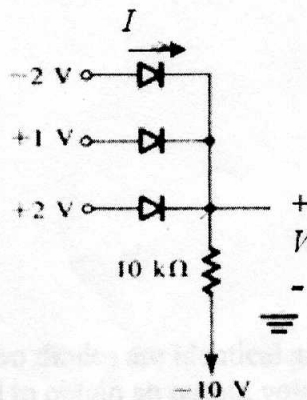
(A)



(B)



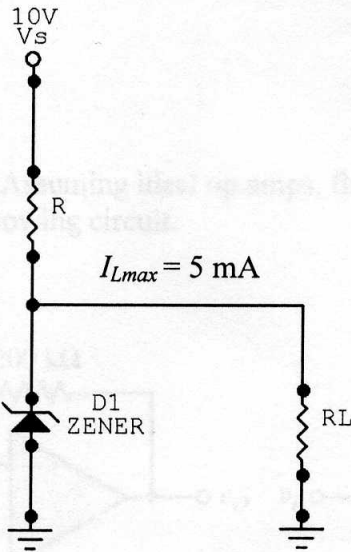
(C)



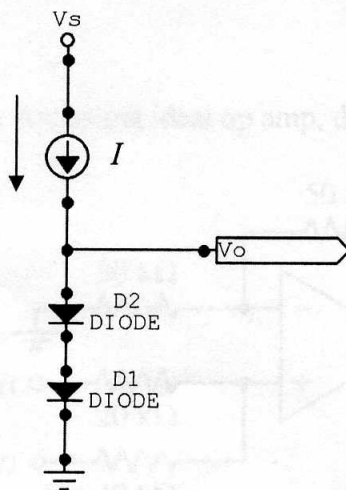
(D)

Problem 2 (12 points): A zener diode specified to have $V_z = 6.8$ V when $I_{ZT} = 10$ mA, and a knee current $I_{ZK} = 100$ μ A, $r_z = 10$ Ω as shown in the flowing diagram. It is used in a shunt regulator connected to a power source V_S whose lowest value is 10 V and to a load whose maximum current $I_{Lmax} = 5$ mA.

- (1) For this situation, what is the largest value of the regulator resistor R that ensures that the zener will operate in the breakdown region?
- (2) Determine the range of the load resistance that will keep the output regulated.



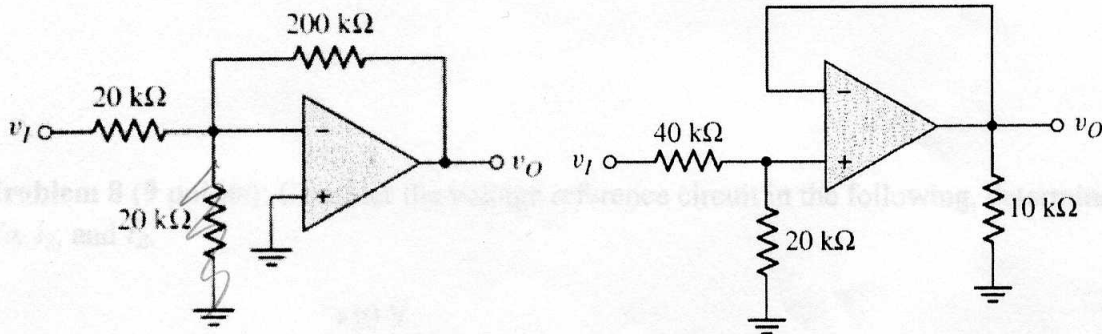
Problem 3 (12 points): In the following diagram, the two diodes are identical and have $n = 1$ and $I_S = 10^{-14}$ A. Find the value of current I needed to obtain an output voltage of $V_o = 1.7$ V. Hint: use exponential model for the diodes.



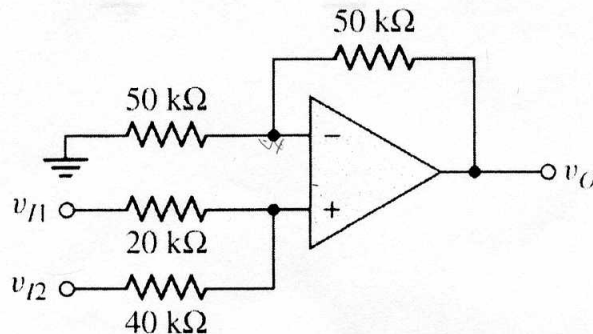
Problem 4 (12 points): A bridge-wave bridge rectifier operating at 60 Hz with a $5\text{ k}\Omega$ load operates from a 120-V (rms) 60-Hz household supply through a 10-to-1 step-down transformer having a single secondary winding. It uses four diodes, assuming that the diode voltage drop is 0.7 V.

- (1) What is the peak value of the rectified voltage across the load?
- (2) What is the average DC voltage across the load?
- (3) If a capacitor is utilized to smooth the output, find the value of the capacitor required to reduce the ripple voltage to 10% of the output peak voltage.

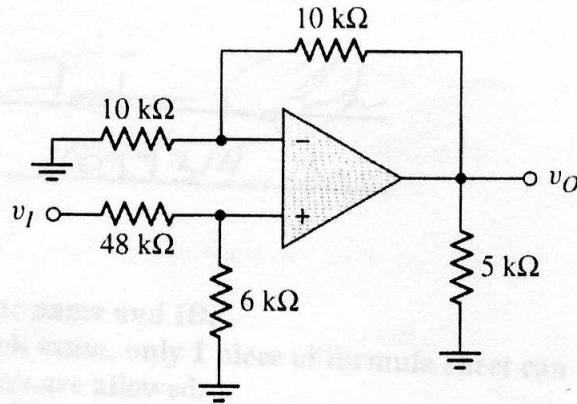
Problem 5 (10 points): Assuming ideal op amps, find the voltage gain V_o/V_i and input resistance R_{in} for the following circuit.



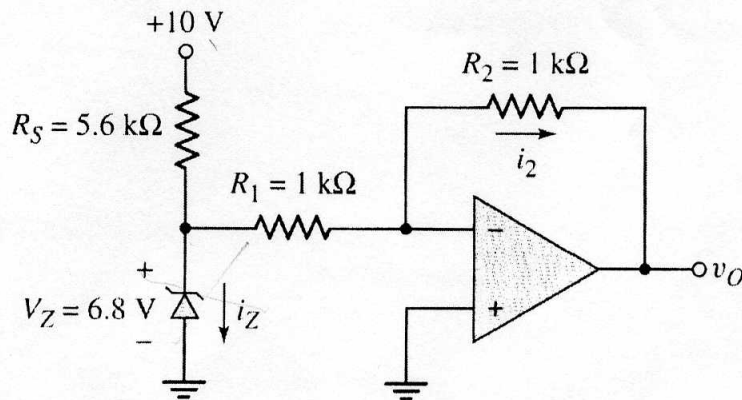
Problem 6 (10 points): Assuming ideal op amp, determine V_o as a function of V_{I1} and V_{I2} .



Problem 7 (10 points): The input voltage is $V_i = 6$ V. Assuming ideal op amp, determine output V_o .



Problem 8 (9 points): Consider the voltage reference circuit in the following, determine V_o , i_2 , and i_z .



Mult. Choice

1. C ✓ 2. d ✓ 3. ✓ B 4. ✓ C
 5. A ✓ 6. A x 7. B ✓ 8. C ✓
 9. C ✓ 10. C ✓
- 13.5/15

Problem 1:

- Ideal diodes - All answers w-RT $\frac{1}{2}$

- A) $V = 0V, I = 1mA$ B) $V = 10V, I = 0mA$
 C) $V = 5V, I = 0mA$ D) $V = 2V, I = 0mA$ 10

Problem 2:

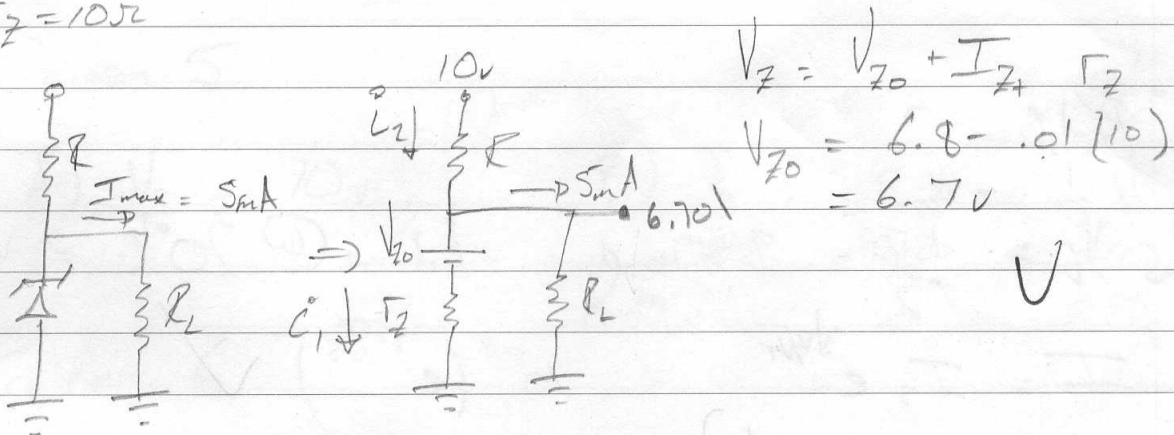
Given:

$$V_Z = 6.8V$$

$$I_{ZT} = 10mA$$

$$I_{ZK} = 100\mu A$$

$$R_Z = 10\Omega$$



a) $I_L = 5mA$

$$V_Z = 6.7 + .0001(10) = 6.701V$$

$$\Rightarrow \text{Drop across } R = 10 - 6.701V = 3.299V$$

$$I_Z = 10mA + 5mA = 15mA$$

$$\Rightarrow R = \frac{3.299}{.0015} = 2199.3\Omega$$

