ID # ______________________

NAME ______________________

EE-255 EXAM 1 February 2, 1999

Instructor (circle one) Nyenhuis Talavage

This exam consists of 12 multiple choice questions and two workout problems. Record all answers to the multiple choice questions on this page. You must turn in the entire exam. There will be no partial credit for the multiple choice questions, but there will be partial credit for the workout problems. You MUST show your work on the workout problems.

Circle the one best answer for each question. Five points per question.

Do not open and begin until you are instructed to do so!

1) a b c d e

2) a b c d e

3) a b c d e

4) a b c d e

5) a b c d e

6) a b c d e

7) a b c d e

8) a b c d e

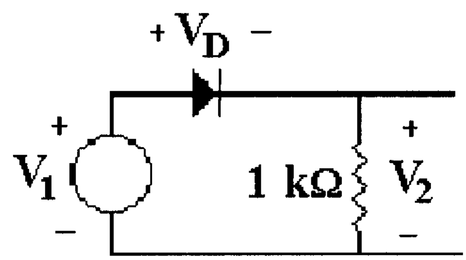
9) a b c d e

10) a b c d e

11) a b c d e

12) a b c d e

1) The diode has $I_S = 10^{-8}$ A, $V_T = 26$ mV and $n = 2$. The output voltage, V_2, is 2 volts. The diode voltage, V_D, is most nearly



(a) 0.16 V (b) 0.32 V (c) 0.64 V (d) 0.72 V (e) 1.15 V

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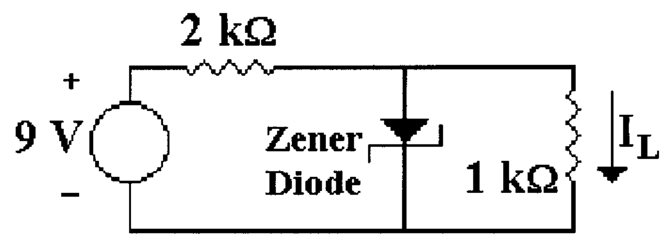
2) The zener diode has parameters $V_{Z0} = 4.0$ V, $r_Z = 0.0\ \Omega$, $V_O = 0.7$ V, $R_O = 4\ \Omega$. The current I_L is most nearly



(a) 0.0 mA (b) 0.7 mA (c) 1.5 mA (d) 3.0 mA (e) 4.0 mA

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3) A silicon diode is observed to exhibit $I_D = 1$ mA at $V_D = 600$ mV and $I_D = 5$ mA at $V_D = 650$ mV, all at T = 300 K. What is the value of n?

(a) 1.0; (b) 1.2; (c) 1.4; (d) 1.7; (e) 2.0

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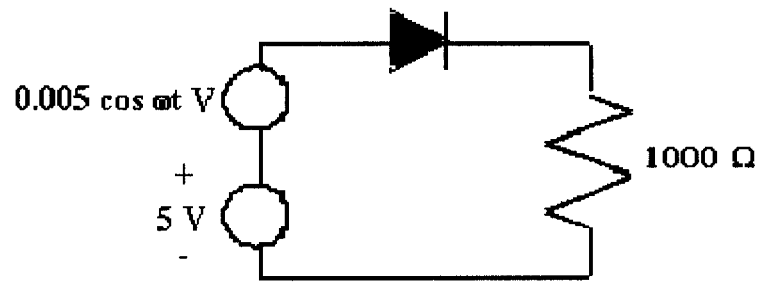
4) The diode in the circuit below may be modeled for dc analysis by piecewise-linear values $V_O = 0.68$ V and $R_O = 12\ \Omega$, and is found to have n=1.6. Find the AC small signal conductance, $g_d = ?$



(a) 0.083 mhos; (b) 0.103 mhos; (c) 0.164 mhos; (d) 6.10 mhos; (e) 9.74 mhos

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5) In the above case, what is the AC voltage across the diode, v_d?

(a) 0.51 cos ωt μV; (b) 15 cos ωt μV; (c) 30 cos ωt μV;
(d) 48 cos ωt μV; (e) 60 cos ωt μV

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6) A silicon diode with $V_{bi} = 0.6$ V and N = 0.5 is observed to have $C_j = 0.5$ pF at $V_D = -1.8$ V. What is C_j when $V_D = -4.8$ V?

(a) 0.23 pF; (b) 0.33 pF; (c) 0.50 pF; (d) 0.73 pF; (e) 1.1 pF

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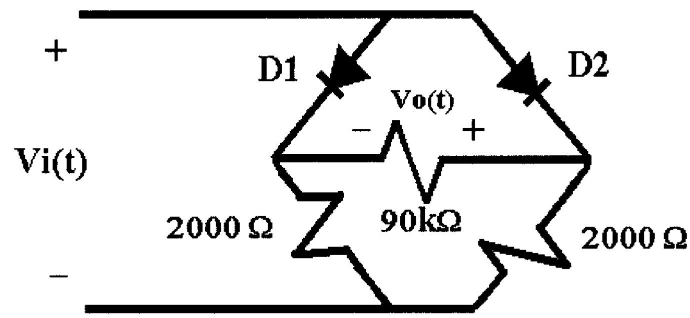
7) In the following circuit D_1 and D_2 both have $V_\gamma = 0.7$ V and $I_S = 10^{-6}$ A. If the input voltage, $v_i(t) = 5 \sin \omega t$ V, what is $v_o(max)$ = ?



(a) 0.0 V (b) 0.7 V (c) 1.4 V (d) 4.3 V (e) 5 V

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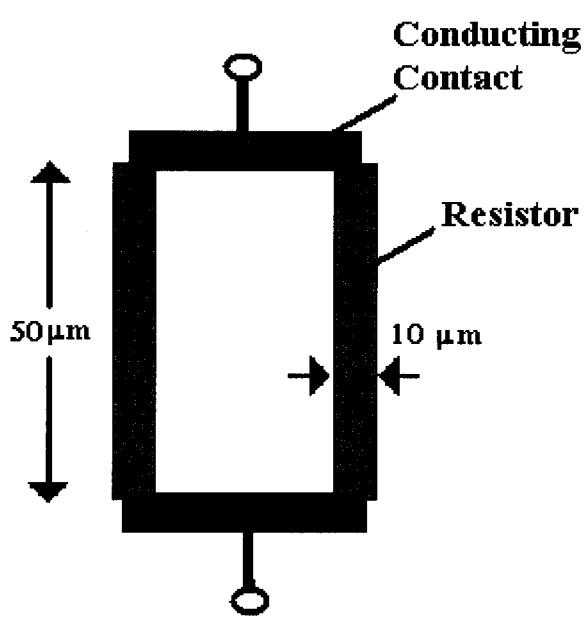
8) Consider the integrated circuit resistor structure shown. The black terminals are made of aluminum, a relatively good conductor. If $R_\square = 100\ \Omega/\square$, what is the resistance of this composite element?



(a) 100 Ω (b) 250 Ω (c) 500 Ω (d) 1000 Ω (e) 2500 Ω

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9) Which best describes the physical origin of diffusion capacitance in a diode?

(a) Separation of static charge inside the depletion region in reverse bias
(b) Minority carrier charge inside the depletion region in forward bias
(c) Avalanche breakdown
(d) Minority carrier charge outside the depletion region in forward bias
(e) Electric field in the depletion region

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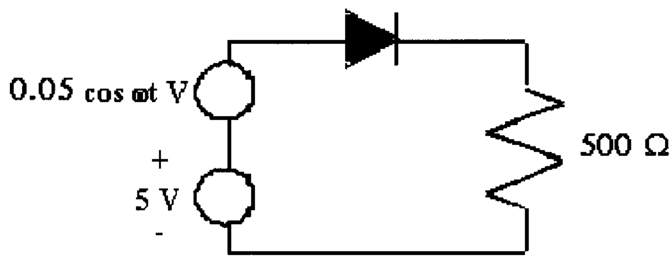
10) In the circuit below, the amplitude of the AC voltage across the diode, v_d, is observed to be 0.45 mV. Determine the value of n for this diode ($V_\gamma = 0.7$).



(a) 1.1 (b) 1.3 (c) 1.5 (d) 1.7 (e) 1.9

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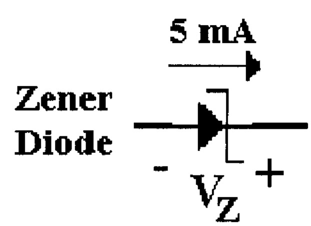
11) What is the most likely *zener voltage* (V_Z) across the diode?



(a) -10 V (b) +10 V (c) 0.0 V (d) +0.7 V (e) –0.7 V

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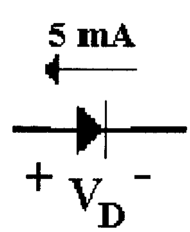
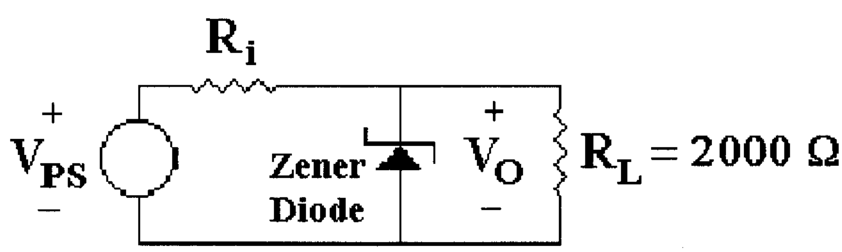
12) What is the most likely bias voltage, V_D, across the diode?



(a) -100 V (b) +100 V (c) 0.0 V (d) +0.7 V (e) –0.7 V

SHOW ALL WORK FOR PROBLEM 13 ON THIS SHEET

13) (20 pts) Consider the Zener diode circuit shown. V_{PS} may range from 9 – 11 V and it is required that V_O be regulated in the range 4.9 – 5.1 V. The Zener diode may be modeled in breakdown by V_{Z0} = 4.7 V and r_Z = 5 Ω.



(a) As a first attempt on the design, choose R_i such that V_O = 5 V when V_{PS} = 10 V.

(10 pts)

R_i [ ]

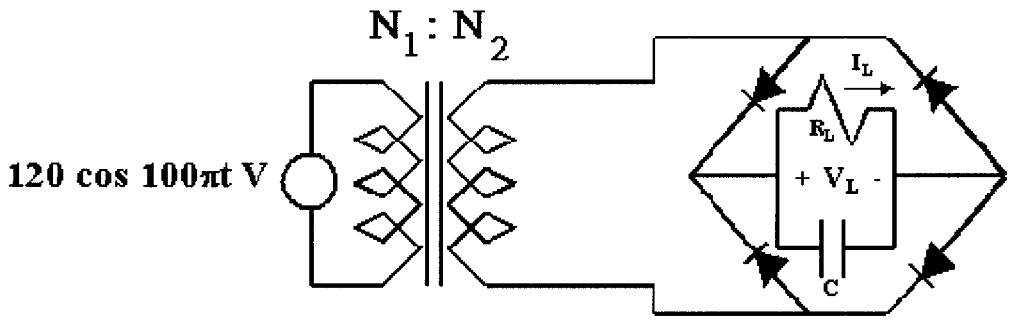
(b) Compute the power dissipated in the Zener diode for V_{PS} = 10 V and V_O = 5 V.

(10 pts)

P_D [ ]

SHOW ALL WORK FOR PROBLEM 14 ON THIS SHEET

14) (20 pts) In the bridge rectifier below, assume that the diodes are characterized by a piecewise-linear model with $V_O = 0.7$ V and $R_O = 3\ \Omega$. Peak V_L is to be 24 V.



a) Determine an appropriate turns ratio (N_1/N_2) (5 pts)

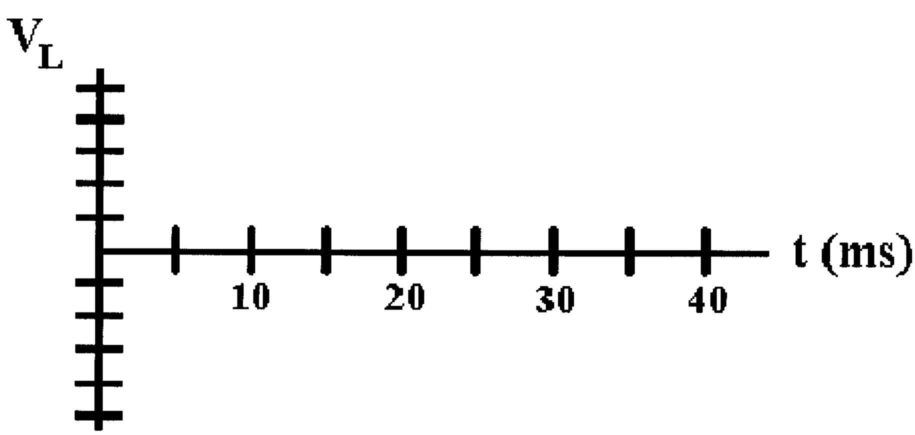
Turns Ratio

b) Determine a value for the load resistance (R_L) and filter capacitance (C) such that the load power dissipation is between 50-100 mW and the ripple voltage is less than 4 V. (10 pts)

R_L

C

c) Sketch V_L as a function of time. Place numerical values on the V_L axes. (5 pts)



EE-255 Formula Sheet: Exam 1

Data:

$At\ 25^{\circ} C (R.T.) \quad V_T = kT/q = 0.026\ V \qquad k = 1.3806 \times 10^{-23}\ J/K$

$q = 1.6022 \times 10^{-19}\ C \qquad 0^{\circ} C = 273.16K$

Formulas:

$$e^x = 1 + x + x^2/2 + \cdots$$

Diodes:

$$I_D = I_0\left(e^{V_D/nV_T} - 1\right) \qquad V_D = V_0 + I_D R_0 \qquad C_j = \frac{C_{j0}}{\left(1 - V_D/V_{bi}\right)^N} \qquad nV_T = \frac{V_{D2} - V_{D1}}{\ln\left(I_{D2}/I_{D1}\right)}$$

$$r_d = \left.\frac{d\upsilon_D}{di_D}\right|_Q = \frac{nV_T}{I_D + I_0} \qquad v_D = V_D + v_d$$

$$V_r = \frac{V_M}{2fRC} \text{ (full wave)}$$

Other Equations:

$$R = R_{\square} \times (L/W)$$

$$N_1/N_2 = V_1/V_2$$