American University of Beirut

Department of Electrical and Computer Engineering

EECE 310 – Electronics
Quiz 1 – November 13, 2009
Closed Book – No Programmable Calculators

90 minutes

Penalty is 5 to 1

(1 to 4 wrong answers do not result in a penalty; 5 to 9 wrong answers cancel one correct answer; 10 to 14 wrong answers cancel two correct answers; and so on)

Name: _____ ANSWERS ARE HIGHLIGHTED _____ ID number: _____

Unless otherwise specified, assume that:

V_T = 25 mV **n = 1** **$n_i = 1.5\times10^{10}$ cm^{-3}** **$q = 1.6\times10^{-19}$ C**

$$J_p = -qD_p \frac{dp}{dx} \qquad J_n = qD_n \frac{dn}{dx}$$

$$J_d = \left(qp\mu_p + qn\mu_n\right)E$$

$$I = J \times A$$

$$V_0 = V_T \ln\left(\frac{N_A N_D}{n_i^2}\right)$$

1. The voltage gain of an amplifier is 100. Its current gain is 550.
Find the amplifier power gain, in dB.

a) 46.0 b) 47.4 c) 41.8 d) 43.0 e) 44.8

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2. A voltage amplifier is powered by a single 10 V DC supply. The average DC supply current is 100 mA. The amplifier is loaded by a 50 Ohm resistor. Find the peak-to-peak sinusoidal output voltage across the load (in V) if the efficiency of the amplifier is 9%.

a) 6.0 b) 6.6 c) 7.2 d) 4.5 e) 5.3

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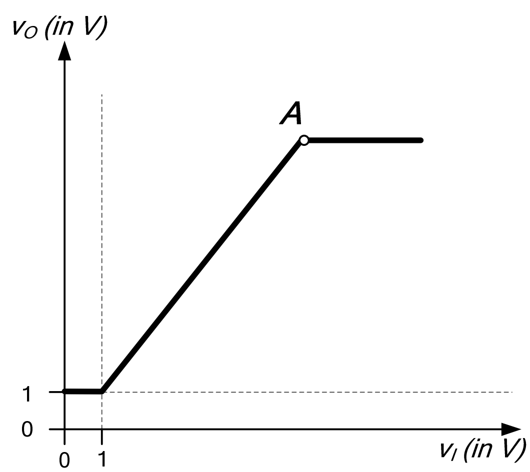
3. The transfer characteristics of a voltage amplifier are shown below. The coordinates of point A are $V_{IA} = 6$ V, $V_{OA} = 6$ V. What is the best choice for a bias point (V_{IQ}, V_{OQ}) for this amplifier in order to get large gain and maximum undistorted sinusoidal output swing?

a) (2.5,2.5) b) (3,3) c) (3.5,3.5) d) (4,4) e) (4.5,4.5)



4. What should be the coordinates (V_{IA}, V_{OA}) of point A on the amplifier characteristics shown above in order to have 5 V peak-to-peak undistorted output voltage and a voltage gain of 3.5?

a) (3.5,6) b) (3,6) c) (2.43,6) d) (2,6) e) (1.67,6)

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5. A circuit consists of a 3 V DC source, a 5 kΩ resistor, and a forward-biased diode. The diode has $I_S = 10^{-12}$ A. Starting with an initial guess for the diode current of 0.2 mA, find the value of the diode current (in mA) after completing two iterations.

a) 0.623 b) 0.500 c) 0.314 d) 1.238 e) 0.829

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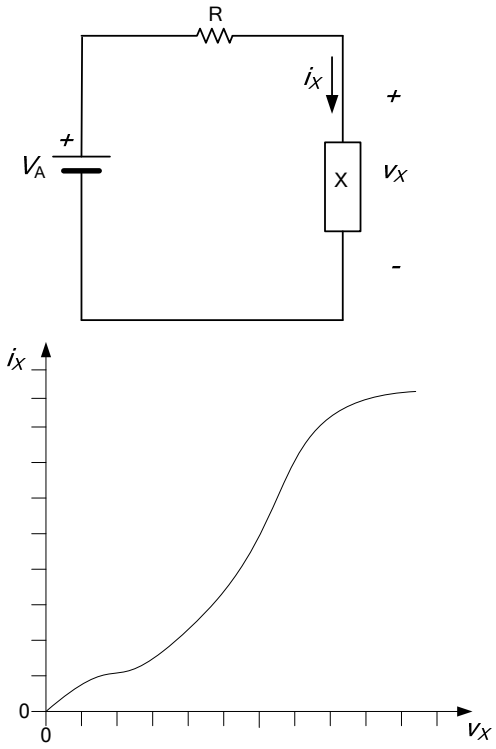
6. Using the load line graphical method, estimate the current i_x (in μA) in device X in the circuit shown below. The current-voltage characteristics of device X are shown on the i_x–v_x plot. The x-axis division is 0.2 V, and the y-axis division is 20 μA. Assume $V_A = 2$ V and $R = 12.5$ kΩ.

a) 375 b) 75 c) 150 d) 225 e) 300



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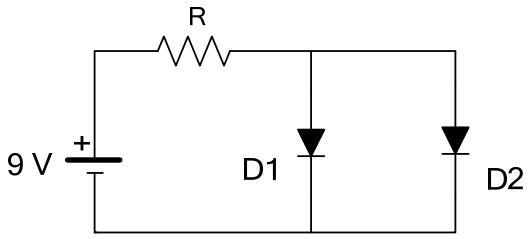
7. The two diodes in the circuit shown below are modeled by $V_{D0} = 0.6$ V, $r_D = 30$ Ohms, when conducting, and by an open circuit when OFF. Determine the current in diode D2 (in mA), when $R = 500$ Ohms.



a) 3.8 b) 8.2 c) 6.8 d) 5.9 e) 4.6

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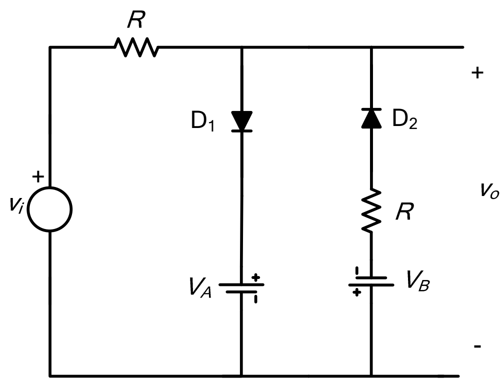
8. Find the maximum value of the output voltage v_O (in V) in the circuit shown below. Assume that the diodes are ideal, that $R = 10$ kΩ, and that $V_A = V_B = 5$ V. The input voltage is –10 V for 50% of the time, and +10 V for the other 50% of the time.

a) 7 b) 6 c) 3 d) 4 e) 5



9. Find the average (DC) value of the output voltage (in V) in the previous problem.
a) -1.75 b) -1.5 c) -1.25 d) -1 e) -0.75

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10. A drift current density of 5 mA/cm^2 results due to the application of a 1000 V/cm electric field to a volume of intrinsic semiconductor. Find the mobility of free electrons in the semiconductor (in cm^2/V.s), given that it is three times larger than the mobility of holes.
a) 1563 b) 938 c) 1094 d) 1250 e) 1406

11. The hole density in an N-type semiconductor is 400 cm^{-3}. What is the type of impurity atoms?
a) Donors b) Acceptors c) Boron d) Carbon e) Silicon

12. What is the density of impurity atoms (in cm^{-3}) in the previous problem?
a) 7.5×10^{17} b) 5.63×10^{17} c) 4.5×10^{17} d) 3.75×10^{17} e) 1.13×10^{18}

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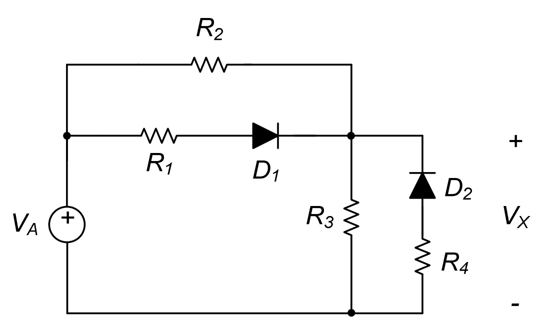
13. In the circuit shown below, R_1 = 900 Ohms, R_2 = 1000 Ohms, R_3 = 2000 Ohms, R_4 = 1000 Ohms, and V_A = 20 V. The diodes are modeled by a fixed 0.7 V drop when conducting, and an open circuit when OFF. Find the power dissipated in R_4 (in mW).
a) 0.6 b) 0.9 c) 0 d) 0.7 e) 0.8



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14. A forward-biased diode is conducting a current of 1 mA at a diode voltage of V_{D1} V. An increase in the diode voltage such the new voltage is 1.5 times V_{D1} results in an increase in the diode current by a factor of 1000. Find V_{D1} for this diode (in mV) if n is 2.
a) 863 b) 691 c) 576 d) 531 e) 461

15. The same diode of the previous problem is now connected in series with a 10 kΩ resistor and a sinusoidal voltage source with an amplitude of 3 V and zero average. Find the peak inverse voltage (PIV) across the diode (in V).

a) 3 b) 6 c) 4 d) 2.5 e) 5

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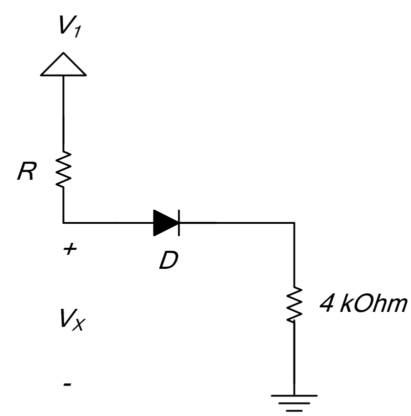
In the circuit shown below, the power supply V_1 has a DC value of 10 V on which a sinusoidal signal of 0.5 V *peak* is superimposed. Assume R = 4850 Ohms and that the DC characteristics of the diode are modeled by a fixed voltage drop of 0.75 V when conducting, and an open circuit when OFF.



16. Find the incremental small-signal resistance r_d for the diode (in Ohms).

a) 23.9 b) 21.2 c) 13.1 d) 15.8 e) 18.5

17. Find the peak-to-peak variation (in V) in voltage V_X.

a) 0.45 b) 0.83 c) 0.68 d) 0.58 e) 0.51

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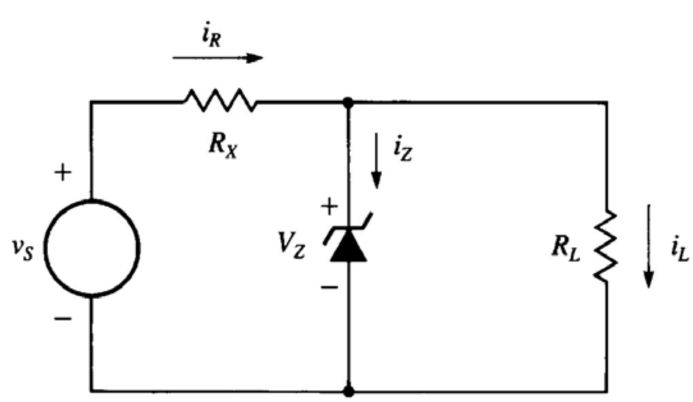
The Zener diode shown below has V_Z = 9.1 V at $I_Z = 9\,\text{mA}$, with $r_Z = 30\Omega$ and $I_{ZK} = 0.3\,\text{mA}$. Assume $R_X = 300\Omega$ and v_S = 15 V.



18. If the load consists of a fixed resistor $R_L = 1\,\text{k}\Omega$, find the value of the Zener current i_Z (in mA).
a) 13.0 b) 14.2 c) 18.1 d) 9.2 e) 10.4

19. What is the minimum value of R_L (in Ω) for which the diode still operates in the Zener breakdown region.
a) 288.5 b) 404.6 c) 436.8 d) 332.6 e) 254.2

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20. A full-wave bridge rectifier circuit with a 1 kΩ load operates from a 200 V (rms) 60 Hz sinusoidal wave supply through a 10-to-1 step-down transformer having a single secondary winding. It uses four diodes each of which can be modeled to have a 0.7 V drop for any forward current. What is the average (DC) voltage across the load (in V)?
a) 16.6 b) 20.2 c) 27.4 d) 34.6 e) 13.0

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Consider a half-wave peak rectifier fed with a voltage v_S having a triangular waveform with 10 V *peak-to-peak*, zero average, and 1 kHz frequency. Assume that the diode has 0.7 V drop when conducting. The load draws a constant current of 120 mA and the filter capacitance is C = 200 μF.

21. Find the maximum diode current (in A).
a) 6.58 b) 5.76 c) 3.30 d) 4.12 e) 4.94

22. Compute the output ripple voltage (in V).
a) 0.9 b) 0.5 c) 0.6 d) 0.7 e) 0.8