American University of Beirut

Department of Electrical and Computer Engineering

EECE 310 – Electronics
Quiz 1 – November 5, 2010
Closed Book – No Programmable Calculators

90 minutes

There are 20 problems. All problems are equally graded.

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: ________________________________ 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 input voltage to an amplifier is 0.1 V peak-to-peak. Its output voltage is 10.5 V peak-to-peak. The amplifier current gain is 32 dB. Find the amplifier output power (in W) if the amplifier input power is 1 mW.

a) 4.2 b) 3.8 c) 2.6 d) 3.0 e) 3.4

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2. A voltage amplifier is powered by a 12 V battery. The amplifier is loaded by a 16 Ohm resistor. For a sinusoidal output with a frequency of 1 kHz and a peak value of 5 V (and no DC), the efficiency of the amplifier is 25%. Find the power lost in the amplifier (in W). The input signal power is negligible.

a) 1.6 b) 1.3 c) 2.9 d) 2.3 e) 1.9

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3. An amplifier has a linear transfer characteristic passing through the origin (0, 0) and with output voltage saturation at L+ = 9 V and L– = –11 V. The amplifier gain is 200 V/V. What is the amplitude (in mV) of the largest sine-wave input *having no dc component* that can be applied without causing output voltage distortion?

a) 30 b) 50 c) 45 d) 40 e) 35

4. In the previous question, the input voltage now consists of a sine-wave component superimposed over a DC component. The input is adjusted to have the largest possible undistorted sine-wave voltage at the output (around the bias point). What is the value of the input DC component (in mV)?

a) 0 b) –15 c) –25 d) 15 e) –5

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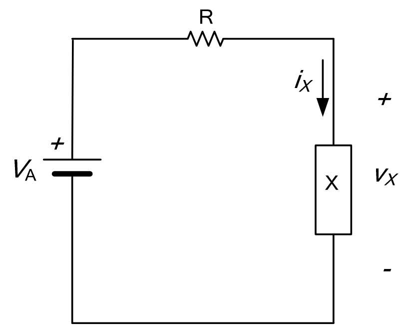
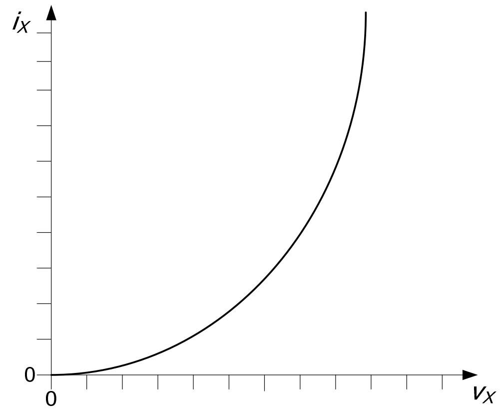
5. Using the load line graphical method, find the operating (bias) point for the diode-like device X in the circuit shown below. The current-voltage characteristics of device X are shown on the i_x–v_x plot. The *x*-axis division is 1 V, and the *y*-axis division is 50 μA. Assume V_A = 5 V and R = 16.67 kΩ. If V_A increases from 5 V to 7 V, what is the corresponding *increase* (in μA) in the i_x current?

a) 170 b) 100 c) 0 d) 235 e) 45





6. In the previous problem, find the small-signal resistance (in kΩ) of device X at the operating (bias) point, corresponding to $V_A = 5$ V.

a) 6.6 b) 3.3 c) 33 d) 330 e) 125

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7. An amplifier has the transfer characteristic $v_O = 5 - 10^{-10} e^{40 v_I}$, where $v_I > 0$, $v_O \geq v_I$, and both voltages are expressed in V. If the voltage gain is –80 V/V, what is output voltage (in V) at the corresponding operating (bias) point?

a) 2.75 b) 2.50 c) 2.00 d) 2.25 e) 3.00

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8. The free electron concentration in a *n*-type silicon sample is described by:
$n(x) = 10^4 + 10^{17} \exp(-x / L_n)$ free electrons per cm^3, where L_n = 1 µm and D_n = 28 cm^2/sec. The cross sectional area A of the sample is 200 µm^2. Find the diffusion current magnitude (in mA) at $x = L_n$.

a) 3.30 b) 3.06 c) 2.83 d) 2.35 e) 2.59

9. Find the hole density (in cm^{-3}) at $x = 0.4L_n$ in the previous problem.

a) 5007 b) 3357 c) 3710 d) 4100 e) 4531

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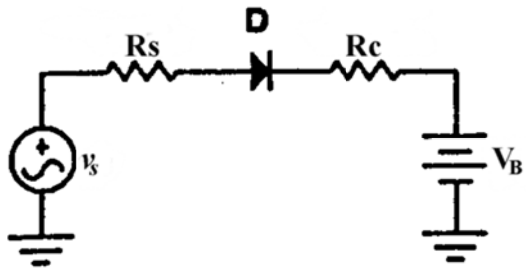
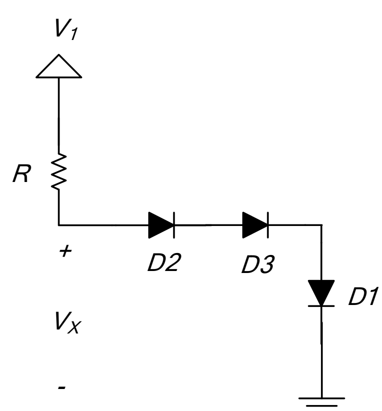
In the battery-charger circuit shown below, the sine-wave input v_S has an amplitude of $8\times\sqrt{2}$ V, the battery voltage V_B is 6 V, and Rs = 10 Ω. The diode is modeled by a fixed 0.7 V drop when conducting, and by an open circuit when OFF. Refer to this circuit for questions 10 and 11.



10. Find the peak inverse voltage (PIV) of the diode (in V).
a) 18.7 3 b) 20.14 c) 17.31 d) 22.97 e) 21.56

11. If the peak diode current is 100 mA, find the value of Rc (in Ω).
a) 92.70 b) 36.14 c) 50.28 d) 64.42 e) 78.56

In the circuit shown below, the power supply V_1 has a DC value of 9 V on which a small sinusoidal signal is superimposed. Assume R = 1.6 kΩ.
D2 and D3 have n = 1, and negligible reverse saturation current, while D1 has n = 1.5, and negligible reverse saturation current. The DC characteristics of diodes D2 and D3 can be modeled by a fixed voltage drop of 0.7 V when conducting, and an open circuit when OFF, while D1 can be modeled by a fixed voltage drop of 0.8 V when conducting, and an open circuit when OFF.



12. Find the incremental small-signal resistance r_{d1} for diode D1 (in Ohms).
a) 8.8 b) 9.9 c) 5.5 d) 6.6 e) 7.7

13. In the previous problem, find the peak-to-peak variation (in mV) in voltage V_X when the sinusoidal variation in V_1 is 1.1 V peak-to-peak.
a) 6.35 b) 8.89 c) 11.43 d) 13.97 e) 16.51

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14. A silicon diode is found to conduct 1 mA at 0.70 V and 10 mA at 0.78 V. Find the value of *n*.

a) 1.74 b) 1.56 c) 1.39 d) 1.04 e) 1.22

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15. The load resistor in a half-wave rectifier with capacitor filter is 200 Ω. The source is sinusoidal, with 12 V RMS, and 50 Hz frequency. Find the required capacitance value (in mF) in order to limit the ripple voltage to 0.5 V. Assume that the diode drops 0.7 V when conducting.

a) 3.26 b) 2.41 c) 2.69 d) 2.98 e) 3.54

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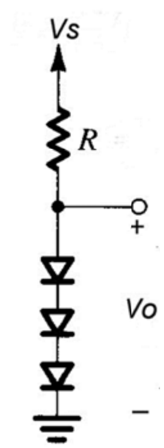
16. A series string of 3 identical diodes is connected through a resistor *R* to a 5 V supply as shown below. Each diode has a current of 1 mA at 0.7 V and its voltage drop changes by 0.1 V for every decade change in current. Find *R* (in Ω) required to establish *Vo* = 2.4 V.



a) 560 b) 460 c) 160 d) 260 e) 360

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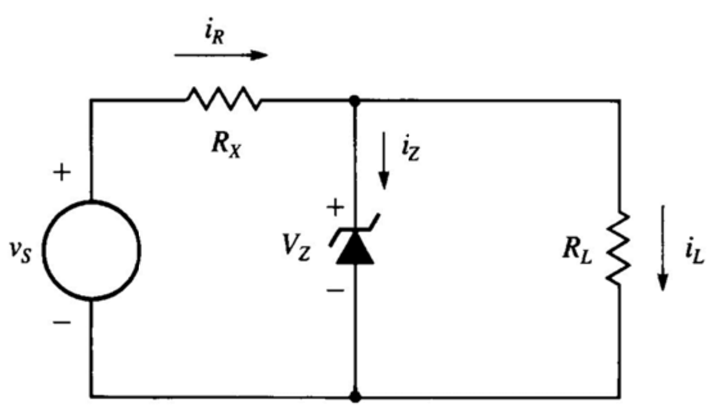
The Zener diode shown below has $V_Z = 6.8\,\text{V}$ at $I_Z = 5\,\text{mA}$, with $r_Z = 20\,\Omega$ and $I_{ZK} = 0.3\,\text{mA}$. Assume $R_X = 580\ \Omega$. Refer to this circuit for questions 17 and 18.



17. At no load (R_L is disconnected), what is the value of the lowest supply voltage v_S (in V) for which the Zener diode remains in the breakdown region?

a) 7.24 b) 6.88 c) 6.97 d) 7.06 e) 7.15

18. For v_S = 16 V, what is the value of the maximum load current i_L (in mA) for which the Zener diode remains in the breakdown region?

a) 5.97 b) 7.57 c) 4.92 d) 15.72 e) 10.26

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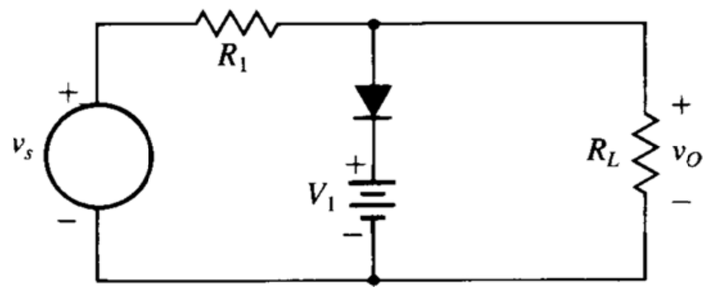
19. In the circuit shown below, $R_1 = R_L = 1$ kΩ and $V_1 = 1.8$ V. The diode is modeled by a fixed 0.6 V drop when conducting, and by an open circuit when OFF. Find the value of the source voltage v_s (in V) for which the diode conducts 1 mA.

a) 5.8 b) 5.6 c) 6.0 d) 5.2 e) 5.4



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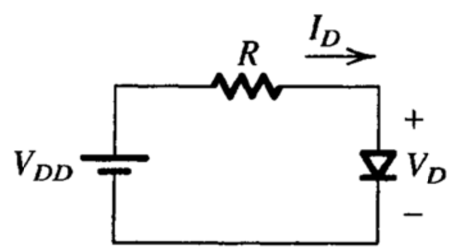
20. In the circuit shown below R = 480 Ω and the *power* supplied by the DC source (V_{DD}) is 36.8 mW. The diode is modeled by V_{D0} = 0.6 V, r_D = 20 Ω, when conducting, and by an open circuit when OFF. Find the value of I_D (in mA).

a) 9 b) 8 c) 5 d) 6 e) 7



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