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100-1期中.

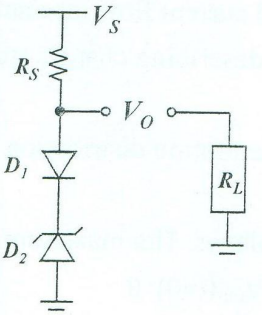
1001 Microelectronic Circuits I (Midterm)

date: 2011/11/10 (Thur)

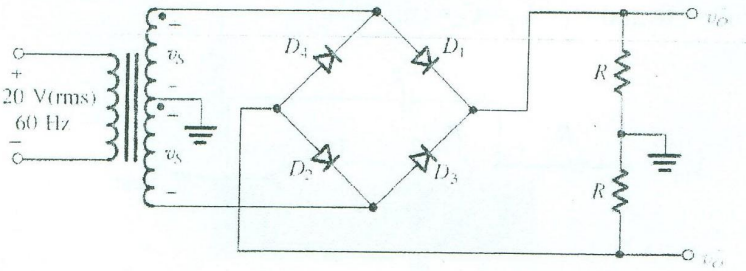
time:15:30 ~ 17:20

ps. 試題可帶回，可使用計算機。

1. In Figure shown below, a regular diode (D_1) is in series with a Zener diode (D_2) to form a voltage regulator. The Zener diode, D_2, is specified to have $V_Z = 5.9$ V at $I_Z = 10$ mA, $r_Z = 10\Omega$, and $I_{ZK} = 0.2$ mA. The supply voltage (V_S) is 12 V, but can vary by ±1 V. $R_S = 600\Omega$. The regular diode, D_1, has a voltage drop of 0.7 V across the diode at a current of around 9 mA. The thermal voltage V_T is assumed to be 25 mV.
   (1) If no load ($R_L = \infty$) and V_S is at the nominal value (12 V), find the voltage V_O, and the current flows through the diodes. (5 %)
   (2) Considering the small-signal and the incremental resistance of the diodes, find the line regulation of this circuit. (5 %)
   (3) Considering the small-signal and the incremental resistance of the diodes, find the load regulation of this circuit. (5 %)
   (4) If a load resistor $R_L = 4$ kΩ is connected to the circuit, and $V_S = 12$ V, what is the voltage V_O? (5 %)



2. The circuit shown below implements a complementary-output rectifier. Sketch and clearly label the waveforms of v_O^+ and v_O^-. Assume a 0.7-V drop across each conducting diode. If the magnitude of the average of each output is to be 15V, find the required amplitude of the sine wave across the entire secondary winding, What is the PIV of each diode?

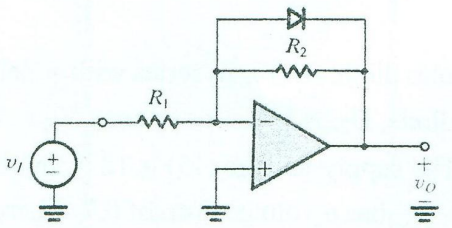


3.

(1) For $v_I(t) = 3 + \cos(\omega t)$ V, find the output voltage $v_O(t)$. Given that $R_1 = R_2 = 1$ kΩ, $I_S = 1\text{x}10^{-14}$ A and n = 1.2. (10%)

(2) Repeat (1) by using constant-voltage-drop model for the diode. (5%)

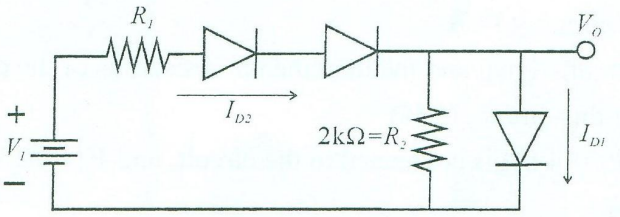
(3) For $v_I(t) = -3$ V, find the output voltage of the circuit. (10%)



4. Assume each diode in the circuit shown below has a turn-on voltage of 0.65V.

(1) If the input voltage V_I is 5V. Determine the value of R_I required such that I_{D1} is one-half the value of I_{D2}. (5%)

(2) If $V_I = 8$V and $R_I = 2$kΩ, determine I_{D1} and I_{D2}. (5%)



5. Please list the charge carrier types and current flow mechanisms in semiconductors. (4%)

6. Please draw the charge density curve describing charges stored within the depletion region of a pn junction. (3%)

7. Please draw the minority-carrier concentration distribution outside the depletion region of a forward-biased pn junction. (3%)

8. An op amp-based filter is shown as follows. The maximum/minimum output of the op amp are 5V/0V, respectively. Assume $V_{out}(t=0)=0$.

(1) Assume the gain and the bandwidth of the op amp are infinite. Derive $H(\omega)= V_{out}(\omega)/V_{in}(\omega)$ (6%)

(2) Based on the answer in (1), what is $|H(\omega=0)|$ and $|H(\omega=\infty)|$. (6%)

(3) Repeat part (1) if the gain of the op amp is finite and is equal to A_v. (8%)

(4) Assume $V_{in}(t)=6*\sin(2\pi(10\text{ Hz})t)$ and sketch $V_{out}(t)$ as a function of time. Note that $R_1= R_2=1$K and $C_1= C_1= C_2=1$nF. (5%)