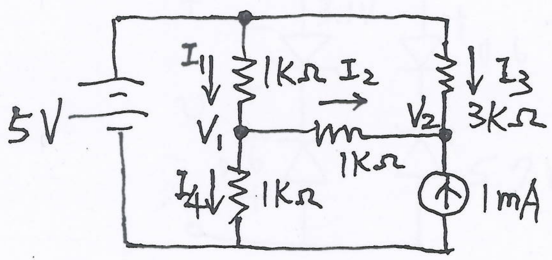
CS2101 Circuits and Electronics

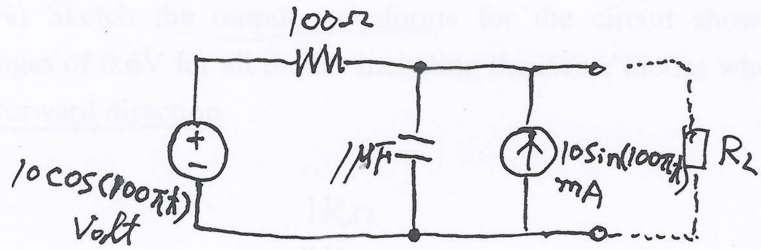
Final Exam, 10:10-11:50, Monday, June 21, 2010

NOTE: 每一題都要寫出計算過程

1. (10%) Find V_1, V_2, I_1, I_2, I_3, and I_4 using Node-Voltage Analysis.

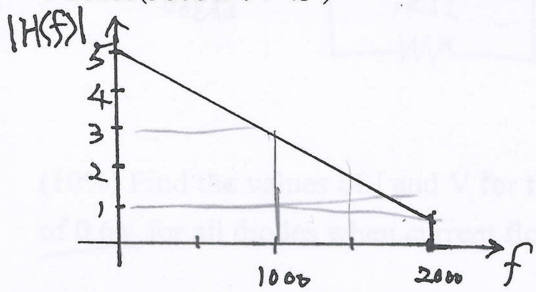


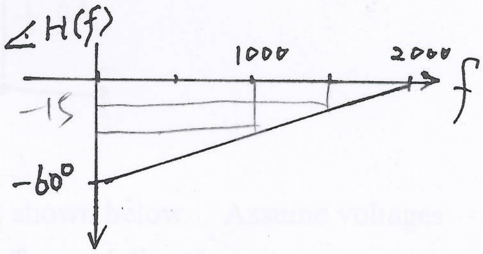
2. (10%) Find the Thevenin equivalent circuit for the following circuit.



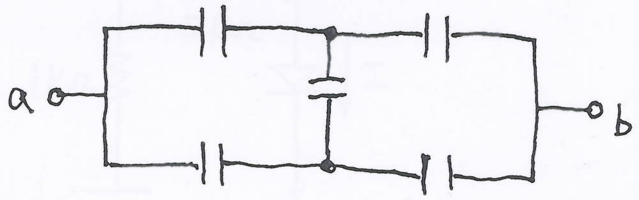
Voltage Source:
10cos(100πt) volts
Current Source:
10sin(100πt) mA

3. (10%) A circuit is characterized by the following transfer function. Find its output $v_{out}(t)$ for an input $v_{in}(t) = 10 + 5\sin(2000\pi t + 30^\circ) + 10\cos(3000\pi t - 45^\circ) + 20\cos(5000\pi t + 45^\circ)$



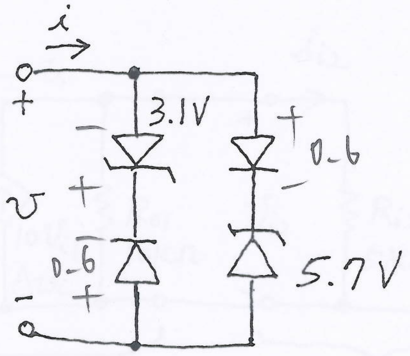


4. (10%) Find equivalent capacitance C_{ab} for the following circuit assuming every capacitor is 1 μF.

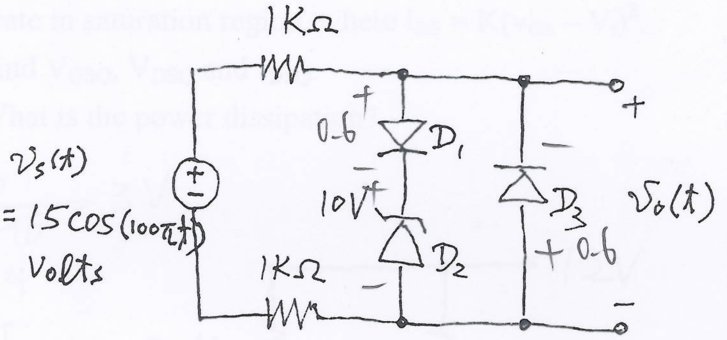


$C_{ab} = 1\mu F$

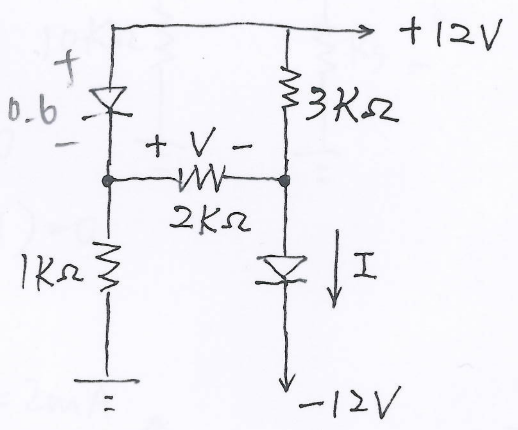
5. (10%) Sketch i versus v for the circuit shown below. Assume voltages of 0.6V for all diodes including the Zener diodes when current flows in the forward direction.



6. (10%) Sketch the output waveforms for the circuit shown below. Assume voltages of 0.6V for all diodes including the Zener diodes when current flows in the forward direction.



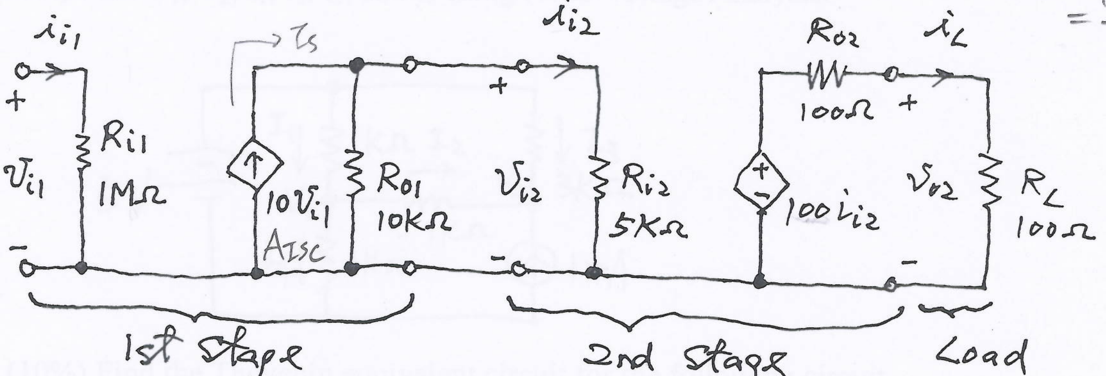
7. (10%) Find the values of I and V for the circuit shown below. Assume voltages of 0.6V for all diodes when current flows in the forward direction.



$$A_{isc} = A_{voc} \times \frac{R_i}{R_L} \Rightarrow A_{voc} = A_{isc} \times \frac{R_L}{R_i} = 10 \times \frac{5k}{1M}$$

8. (20%) Calculate voltage gain ($A_v = v_{o2}/v_{i1}$), current gain ($A_i = i_L/i_{i1}$) and power gain (A_p or G) for the following two-stage cascaded amplifiers.

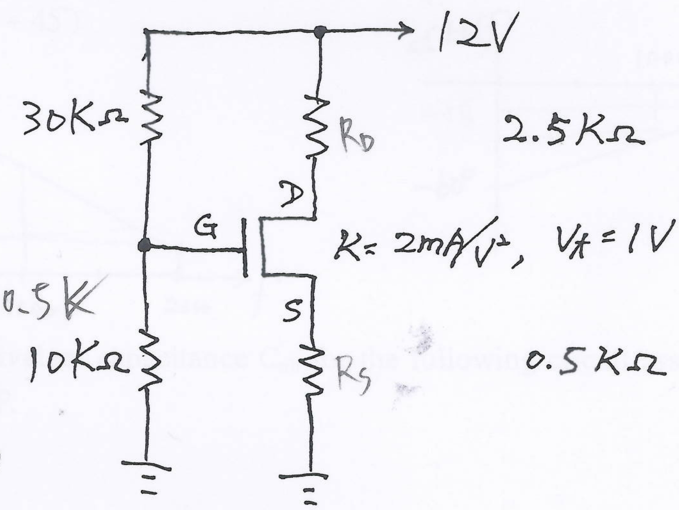
$$A_{v1} = \frac{10 \cancel{v_{i1}} \times \frac{R_{o1}}{R_{o1}+R_{i2}} \times R_{i2}}{\cancel{v_{i1}}} = 10 \times \frac{50k^2}{10k+5k} = \frac{500k}{15} \qquad A_{i1} = A_{v1} \times \frac{R_i}{R_L} = \frac{\cancel{500k}^{100}}{15} \times \frac{1M}{5k} = \frac{100M}{15}$$



$$A_{i2} = \frac{100 \cancel{i_{i2}} \times \frac{1}{200}}{\cancel{i_{i2}}} = \frac{1}{2}. \quad A_{v2} = A_{i2} \times \frac{R_L}{R_i} = \frac{1}{\cancel{2}} \times \frac{\cancel{100}^{50}}{5k} = 10m$$

9. (20%) Assume the following N-type MOSFET has K = 2mA/V², and it is biased to operate in saturation region, where $i_{DS} = K(v_{GS} - V_t)^2$. $V_t = 1V$,
   - A. Find V_{GSQ}, V_{DSQ} and I_{DSQ}.
   - B. What is the power dissipation?

$$V_G = 12 \times \frac{10}{\cancel{30+10}_{4}} = 3V$$



$$3 = V_{GSQ} + 0.5k\, I_{DSQ}$$

$$I_{DSQ} = 2m \times (V_{GSQ} - 1)^2$$

$$\Rightarrow (V_{GSQ}^2 - 2V_{GSQ} + 1) \times 2\cancel{m} \times 0.5\cancel{k} + V_{GSQ} = 3$$

$$\Rightarrow V_{GSQ}^2 - V_{GSQ} \cancel{+1}^{-2} = \cancel{3}\,0$$

$$\Rightarrow (V_{GSQ} - 2)(V_{GSQ} + 1) = 0$$

$$V_{GSQ} = 2V_*$$

$$I_{DSQ} = 2m \times (2-1)^2 = 2mA_*$$

$$V_{DSQ} = 12 - 2\cancel{m} \times (\cancel{2.5}^{\,3} \cancel{+0.5})\cancel{k} = 12 - 6 = 6V_*$$