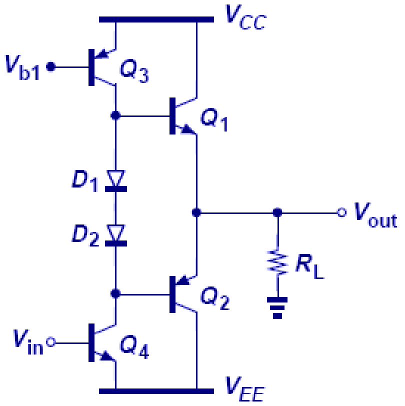
Quiz 9	Subject	Professor	Student ID#	Student Name	Score
Date: 2009.11.11	Microelectronics 2	Jong-Ho Lee			

1. Following figure depicts improved push-pull stage to reduce crossover distortion. Turn-on voltages of Q_1 and Q_2 are V_{BE1} and V_{BE2}, respectively. Answer for the following questions.



(a) Two diodes (D_1 and D_2) are used to avoid thermal runway in above power amplifier stage. How can we solve the thermal runaway problem? Briefly explain the principle. (3)

Answer)

1)If the diodes experience the same temperature change as the output transistors, Thus $V_{D1}+V_{D2}$ will decrease at the same rate as $V_{BE1}+V_{BE2}$, with the result that the bias current remain constant.

(If the collector current is held constant, a rise in temperature in transistor results in a decrease in its V_{BE}.($\approx$ -2mV/°C)

Alternately, if V_{BE} is held constant and the temperature increases, the collector current increases.)

2)Using diode biasing prevents thermal runaway since the currents in Q_1 and Q_2 will track those of D_1 and D_2 as long as there I_s's track with temperature.

Following equations show this accurately.

$$V_{D1}+V_{D2}=V_T\ln\frac{I_{D1}I_{D2}}{I_{S,D1}I_{S,D2}}$$

$$V_{BE1}+V_{BE2}=V_T\ln\frac{I_{C1}I_{C2}}{I_{S,Q1}I_{S,Q2}}$$

$$\therefore \frac{I_{D1}I_{D2}}{I_{S,D1}I_{S,D2}}=\frac{I_{C1}I_{C2}}{I_{S,Q1}I_{S,Q2}}\ (I_{D1}\approx I_{D2}, I_{C1}\approx I_{C2})$$

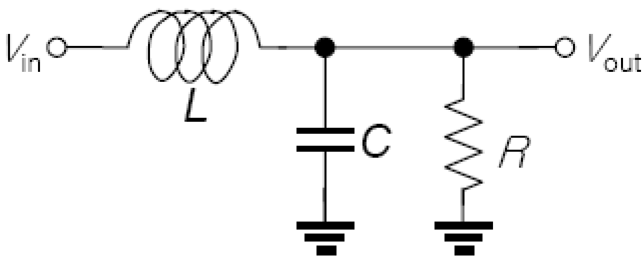
(b) Briefly explain the thermal runaway when a dc bias V_B (=V_{BE1} + V_{BE2}) substitutes the two diodes.(3)

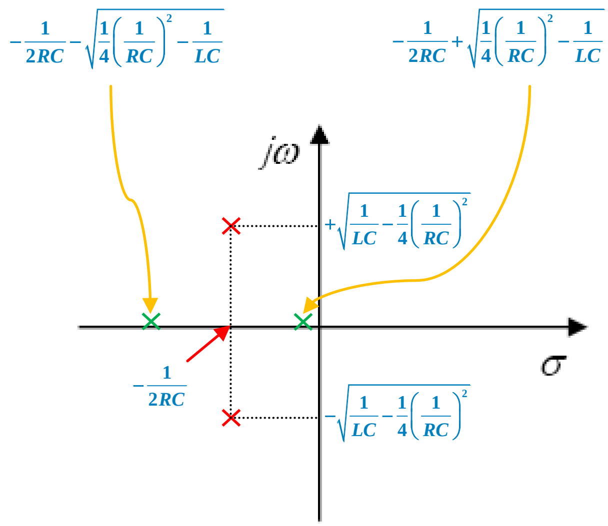
Answer)

For a given base-emitter voltage, the collector current increases with temperature. Thus, with a constant V_B, Q_1 and Q_2 carry increasingly larger currents, dissipating greater power.

The higher dissipation in turn further raises the junction temperature and hence the collector currents, etc. The resulting positive feedback continues until the transistors are damaged.

2. Following figure shows a filter with passive component. Derive the transfer function and construct the pole-zero diagram. (4)





Answer)

$$H(s)=\frac{R\,\|\,\frac{1}{Cs}}{Ls+R\,\|\,\frac{1}{Cs}}=\frac{R}{LCRs^2+Ls+R}=\frac{1/LC}{s^2+\frac{1}{RC}s+\frac{1}{LC}}$$

If $\left(\frac{1}{RC}\right)^2-\frac{4}{LC}\geq 0$,

$$P_{1,2}=-\frac{1}{2RC}\pm\sqrt{\frac{1}{4}\left(\frac{1}{RC}\right)^2-\frac{1}{LC}}\ \text{(green two points)}$$

If $\left(\frac{1}{RC}\right)^2-\frac{4}{LC}<0$,

$$P_{1,2}=-\frac{1}{2RC}\pm j\sqrt{\frac{1}{LC}-\frac{1}{4}\left(\frac{1}{RC}\right)^2}\ \text{(red two points)}$$

Use front side only