Assignment-1: EE5325 – Power Management Integrated Circuits

Submission due date: August 21, 2017

Exercise-1

In the figure shown below, derive the open and closed loop transfer functions. Find poles and zeroes of the open loop transfer function.

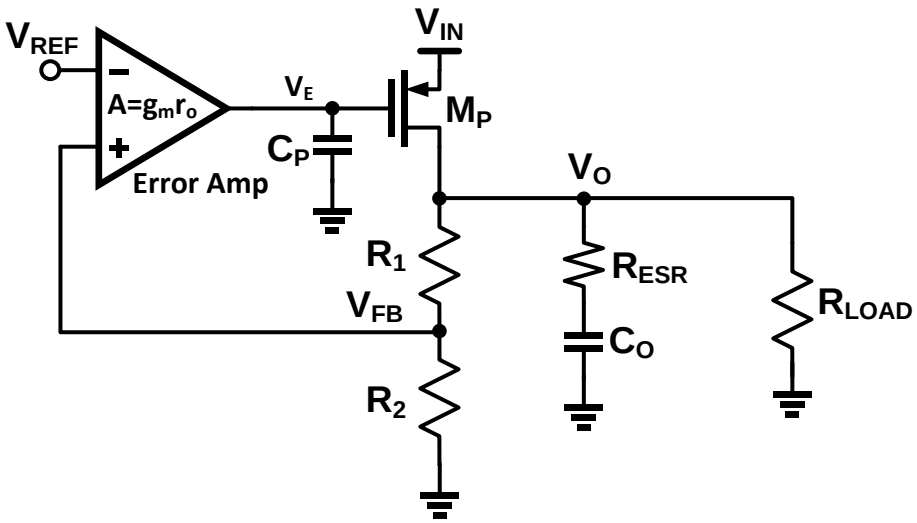

Figure-1

Considering following parameters:

V_{REF}=0.6V, V_{IN}=1.8V to 2.5V, V_O=1.5V, R_2=100kΩ

Error amplifier gain, A=60dB and g_m=100uA/V

g_m of PMOS transistor M_P, g_{mp}= 1mA/V and output resistance, r_{op}=∞

C_P=1pF, C_O=1uF, R_{ESR}=10mΩ, R_{LOAD} = 1kΩ

a) Calculate the locations of poles and zeroes of the loop gain. Draw the bode plot for magnitude and phase with phase margin. Determine if the loop is stable or not.
b) If op-amp has offset of -10mV, find error in the output voltage, V_O.
c) Suppose measured V_O was 1.55V, find the input referred offset.
d) Find error in the output voltage due to finite gain.

Exercise-2

Figure-2 shows the conceptual circuit of a PTAT voltage reference:

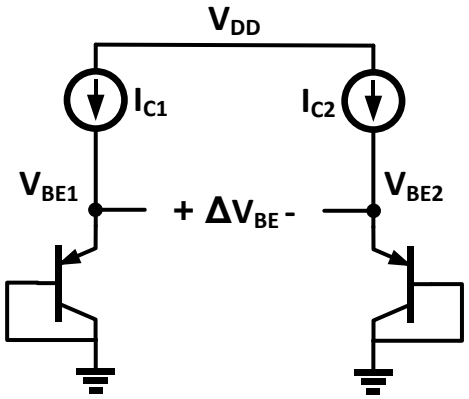

Figure-2

a) Assuming Q1 and Q2 identical (m=1) and I_{C1}=3xI_{C2}, plot V_{BE1}, V_{BE2} and Δ_{VBE} w.r.t. Temperature from -40ºC to 120ºC. What is the temperature coefficients (dV/dT) for the three voltages? Plot the temperature coefficients w.r.t. temperature and comment on non-linearity if there is any.
b) Assuming Q1 and Q2 non-identical (m=20) and I_{C1}=I_{C2}, plot V_{BE1}, V_{BE2} and Δ_{VBE} w.r.t. Temperature from -40ºC to 120ºC. What is the temperature coefficients (dV/dT) for the three voltages? Plot the temperature coefficients w.r.t. temperature and comment on non-linearity if there is any.
c) Assuming Q1 and Q2 non-identical (m=5) and and I_{C1}=2xI_{C2}, plot V_{BE1}, V_{BE2} and Δ_{VBE} w.r.t. Temperature from -40ºC to 120ºC. What is the temperature coefficients (dV/dT) for the three voltages? Plot the temperature coefficients w.r.t. temperature and comment on non-linearity if there is any.

Note:

- For Exercise-2, circuit should be analyzed and plotted on simulator (Cadence, LTSpice, etc.). You can use bipolar transistor model if available or a p-n diode. If size of bipolar or diode can't be changed in the parameter then use multiple devices in parallel.