S-55.3230 Circuit simulation

15.12.2011

Do questions 1 and 2 during the first hour without any reference material. Return the answers to questions 1 and 2 before starting problem 3–5. You can use reference material to do problems 3–5. **Return all your simulation files as part of your answer to the memory stick circulating in the exam hall (APLAC .i files and MWO .emp and .vin files).**

1.

a. Why are S parameters used in RF engineering? (2p)

b. What approaches can be used to model a component? (2p)

c. An analysis gives -150 dB with respect to the excitation as the value of a current. Is the result reliable? Why? (2p)

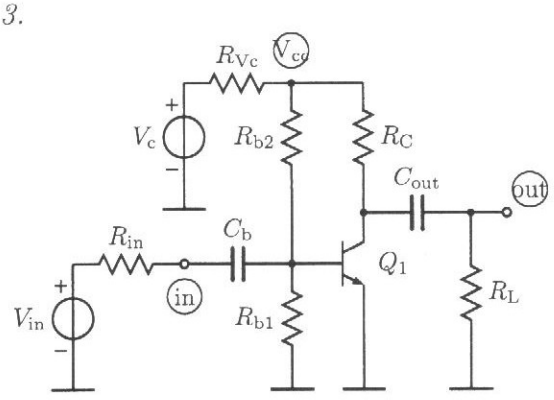
d. How does design progress from given specifications to production? (2p)

e. What is optimisation used for in circuit simulation? (2p)

2. AC and HB analyses are frequency domain analyses. How do they differ from each other? (10p)

Return the answers to questions 1 and 2 before starting on the simulation problems.

3.



a. Determine the bandwidth and the cut-off frequencies of the amplifier. (4p)

b. What is the amplifier's maximum gain? (1p)

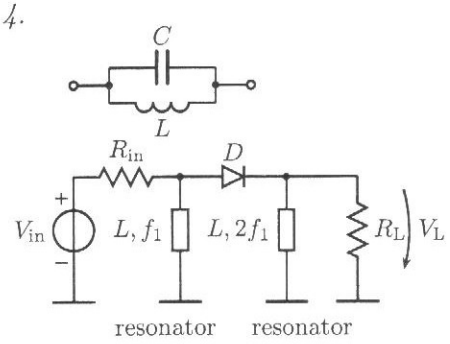
c. Use in succession a sine and a cosine signal whose amplitude is V_{in} and estimate the time taken for the circuit to reach the steady state in its operating range. Give reasons for your answer. (5p)

Use the MWO simulator and the `BJT_AP` transistor model with the parameters $I_s = 25\,\text{fA}$, $\beta_f = 120$, $V_{AF} = 40\,\text{V}$, $C_{JC} = 20\,\text{pF}$, $C_{JE} = 20\,\text{pF}$.

$R_{b1} = 20\ \text{k}\Omega$ $R_{b2} = 170\ \text{k}\Omega$ $R_L = 4\ \text{k}\Omega$
$C_b = 10\ \mu\text{F}$ $V_c = 12\ \text{V}$ $R_{Vc} = 1\ \Omega$
$V_{in} = 1\ \text{mV}$ $R_{in} = 1\ \Omega$.

Please turn over

4.



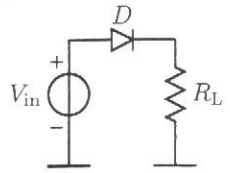
a. Create a model of the LC resonator whose parameters are the inductance L and the resonsnce frequency f_0 of the resonator. (3p)

b. Write an APLAC input file that performs a harmonic analysis of the diode circuit. Draw (i) the spectrum (DC, fundamental frequency and 6 harmonics) of the voltage V_L and (ii) two cycles of voltage V_L when the source frequency f_1 is 50 Hz. Use the diode parameter `IS=1n`. (6p)

c. What does the diode circuit do? (1p)

$$L = 1 \text{ mH} \quad R_{in} = 100\ \Omega \quad R_L = 100\ \Omega.$$

5.



Use APLAC to do a transient analysis of the circuit. Plot four periods of the voltage across the load resistance R_L. Use the transient analysis result to draw the voltage spectrum. (10p)

$$V_{in} = 2 \text{ V (peak-to-peak)} \quad R_L = 1\ \text{k}\Omega \quad f = 50 \text{ Hz}.$$