

**For question 3d, what are the normal operating conditions for linearizing?**

Use steady-state conditions (derivatives are all equal to zero), and then find the voltage and current through the nonlinear resistor under those conditions. The normal operating point for linearising is  $(\bar{e}_c, \bar{i}_2)$ . Using incremental variables, find

$$i_2 \approx \bar{i}_2 + \hat{i}_2 = \bar{i}_2 + m\hat{e}_c$$

where  $m$  is the slope  $di/de$  evaluated at the normal operating point. Of course what is really needed is the linearised constitutive relationship in terms of the regular variables  $(e_c, i_2)$ , not the incremental variables. The expression

$$e_c = \bar{e}_c + \hat{e}_c,$$

can be rewritten as

$$\hat{e}_c = e_c - \bar{e}_c,$$

which is substituted into the first equation above to get the linearised constitutive relationship for the element:

$$i_2 \approx \bar{i}_2 + m(e_c - \bar{e}_c).$$

The governing equation has to be rewritten using this linearised constitutive relationship for the element in place of the original nonlinear constitutive relationship. This substitution will yield the linearised form of the governing equations, because there is only one nonlinearity in the system. (Take a look at lab #5 for some hints on the linearisation procedure, or the course text). (Feb 22, 2010)