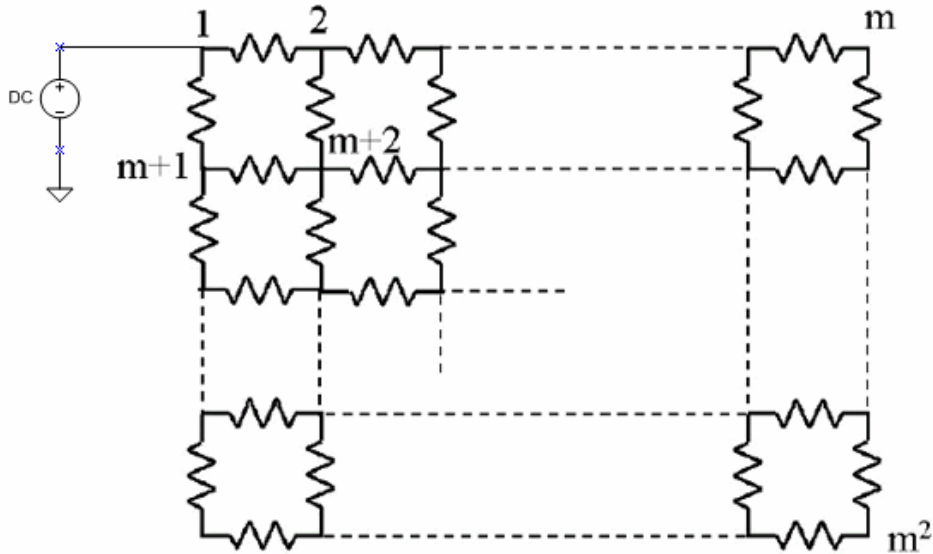


CSE245 Computer Aided Circuit Simulation and Verification

Homework #3. Due 11/2/2004

1. Sparsity of Circuit Matrix

a) For the following $m \times m$ resistor grid with a current source as input, calculate the number of non-zeros in the resulting MNA matrix in terms of m . What's the zero/non-zero ratio for $m = 5$ and $m = 500$?



b) Suppose now we add a shunt resistor to each node in the above circuit (i.e. each node is also connected to ground through a resistor). What's the number of non-zero elements in the resulting MNA matrix in terms of m ? What's the zero/non-zero ratio for $m = 5$ and $m = 500$?

2. Routh-Hurwitz Criterion and Stability

For the following transfer function of a system:

$$H(s) = (a_0 + a_1s + a_2s^2) / (3s^3 + 27s^2 + s + k)$$

If the system is stable, use Routh-Hurwitz Criterion to determine the range of K . (for example, $c_1 < K < c_2$. you need to find c_1 and c_2)

3. Pade Approximation and Stability:

Consider a transfer function:

$$H(s) = (s+2) / (s^2+9s+20)$$

a). Write the first order Pade approximation to $H(s)$:

$$\hat{H}(s) = \frac{b_0 + b_1s + \dots + b_{q-1}s^{q-1}}{1 + a_1s + \dots + a_qs^q} \quad (q=1)$$

b) Is the original system $H(s)$ stable? Is the Pade approximated system $\hat{H}(s)$ stable? Why?

4. Matrix Block Triangular Form.

For the following matrix, find its upper block triangular form (two steps, first unsymmetric permutation for a zero-free diagonal, then symmetric permutation to block triangular form).

A =

```
[
0  x  x  x  0  0  0  0  0
x  0  x  0  0  0  0  0  0
0  0  x  0  0  0  0  0  x
0  x  0  x  0  0  0  x  0
x  0  0  0  x  x  x  0  0
x  0  0  0  0  0  0  0  x
0  0  x  0  0  x  x  0  0
0  0  0  x  x  0  0  x  0
0  0  0  0  0  x  x  0  0
]
```