3-days' lift

- went over 1999 exam (on web site)
- went over handout
  Pepper & Heinrich
  on upwinding.

Transient problems, pg 324
section 7.5.3
Same system of eqns.

\( \text{eqn. 7.7a} [C] \mathbf{\dot{\phi}} + [K]\{\phi\} = \{R(t)\} \)
\[ \mathbf{\dot{\phi}} = \left( \frac{d\phi}{dt} \right) = \begin{bmatrix} \frac{d\phi_1}{dt} \\ \frac{d\phi_2}{dt} \\ \vdots \\ \frac{d\phi_n}{dt} \end{bmatrix} \]

Note: \([C]\) and \([K]\) may depend on time and/or \(\phi\). But we will linearize problem by taking these constant.

let \( [C] = [C_n] \) and \( [K] = [K_n] \)
\[ n = \text{present time} \quad \text{current time} \]
To solve eqn 7.77a, let

\[ \phi = \frac{\phi_{n+1} - \phi_n}{\Delta t} \]

Substitute into 7.77a

\[ \phi_{\theta} = (1-\theta)\phi_n + \theta \phi_{n+1} \]

\[ R_{1\theta} = (1-\theta)R(t_n) + \theta R(t_{n+1}) \]

Get 7.78 "a"

\[ \left[ \frac{\partial \Phi}{\partial t} \right] \left[ \phi_{n+1} \right] = \left[ (1-\theta)[k] + \left[ \frac{C}{\Delta t} \right] \phi_n \right] + \left[ \left( -1 \left[ k \right] + \left[ \frac{C}{\Delta t} \right] \right) \phi_n \right] \]

Reurrence relation
new lamps = for old \[ \Theta \] integral

if \[ \Theta = 1 \] \[ \Rightarrow \] analogous to "fully implicit calculation"

if \[ \Theta = \frac{1}{2} \] \[ \Rightarrow \] analogous to "crank nicolson" scheme

if \[ \Theta = 0 \] \[ \Rightarrow \] analogous to explicit scheme (node-by-node evaluation)

But look at eqn

\[
\frac{[C]}{\Delta t} \{ \Phi_{n+1} \} = \left[ -[K] + \frac{[C]}{\delta t} \right] \{ \Phi_n \} + \{ R_n \}
\]

[\[ C \] matrix is not diagonal]

\[ [C] \] is diagonal then node-by-node evaluation is possible