Cube with two different walls with variable mesh grid

MATLAB / Octave files:
t04Cube2wFB.m;
fTC2SSa.m
fSolRadTiltSurf.m
fReadWeather.m

Objectives:

- Obtain variable mesh grids.
- Study the influence of the space discretization on the model dynamics.

1 Physical analysis and mathematical model

The mathematical model is similar to Tutorial no. 3. The main difference is that the wall can be discretized in a number of meshes given by the user in lines 8 and 9:

```
8  nc = 3;                % number of concrete meshes
9  ni = 2;                % number of insulation meshes
10 dt = 3600              % [s] simulation time step
```

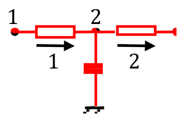
2 Implementation

The discretization of the concrete wall and insulation is done in:

```
Gc = lamc/wc*Sc; Cc = Sc*wc*rhoccc; %concrete
Gcm = 2*nc*Gc*ones(1,2*nc);         %meshed concrete
Ccm = Cc/nc*mod(0:2*nc-1,2);

Gi = lami/wi*Si; Ci = Si*wi*rhoici; %insulation
Gim = 2*ni*Gi*ones(1,2*ni);         %meshed insulation
Cim = Ci/ni*mod(0:2*ni-1,2);
```

There are *n* meshes, each one formed by two resistances and a capacity.



The two conductances are equal and their value is the double of the conductance of the mesh. The first node does not have a capacity; the second node has the capacity of the mesh; the third node is not in the mesh (it is in the next mesh).

The whole model has the conductance matrix:

```
G = diag([Gwo Gcm Gim GLW Gwi Ggi Ggs 2*Gg Gv Kp]');
```

and the capacity matrix:

```
C = diag([Ccm Cim 0 0 Ca Cg]);
% C = diag([Ccm Cim 0 0 0 0]);
```

if the capacities of air and glass are considered, or

```
80 -    % C = diag([Ccm Cim 0 0 Ca Cg]);
81      C = diag([Ccm Cim 0 0 0 0]);
```
if they are not considered.

3 Numerical experiments and discussion

3.1 Number of meshes

Neglect the air capacity:
```
80 -    % C = diag([Ccm Cim 0 0 Ca Cg]);
81      C = diag([Ccm Cim 0 0 0 0]);
```

Use the same discretization as in Tutorial 3.
```
 7 -    Kp = 1e4;                  % P-controller gain: large for precision
 8 -    nc = 1;                    % number of concrete meshes
 9 -    ni = 1;                    % number of insulation meshes
10 -    dt = 5                     % [s] simulation time step
```
Compare the results with those from tutorial 3.

Change the discretization:
```
 8 -    nc = 3                     % number of concrete meshes
 9 -    ni = 1;                    % number of insulation meshes
10 -    dt = 3600                  % [s] simulation time step
```
and discuss its influence on the maximum simulation time step.

Consider the heat capacity of the air:
```
80 -    C = diag([Ccm Cim 0 0 Ca Cg]);
81      % C = diag([Ccm Cim 0 0 0 0]);
```

Discuss the maximum simulation time step.

3.2 Time constants

Find the time constants,

```
[min(-1./eig(As)) max(-1./eig(As))]
```

for 1 mesh and 3 meshes of the concrete layer, with and without indoor air heat capacity. Observe the values in different situations.

3.3 Controller amplification

On line 6
```
6 -    Kp = 1e-1;                 %P-controller gain: large for precision
```

change the controller proportional constant Kp: 1e4, 1e3, 1e2, 1e1, 1e0, 1e-1.

Discuss the significance of these values and their connection with the time step dt.
```
 7 -    Kp = 1e4;                  % P-controller gain: large for precision
 8 -    nc = 3;                    % number of concrete meshes
 9 -    ni = 1;                    % number of insulation meshes
10 -    dt = 3600                  % [s] simulation time step
```

3.4 Implicit Euler integration

Change the script

```
for k = 1:n-1
  th(:,k+1) = (eye(nth) + dt*As)*th(:,k) + dt*Bs*u(:,k);
end
```

in order to integrate with implicit Euler. Discuss the results.