Cube with two different walls with variable meshgrid

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

Objectives:
- Obtain variable meshgrids.
- 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:

```
38 -      Gc = lamc/wc*Sc; Cc = Sc*wc*rhoccc; %concrete
39 -      Gcm = 2*nc*Gc*ones(1,2*nc);          %meshed concrete
40 -      Ccm = Cc/nc*mod(0:2*nc-1,2);
41
42 -      Gi = lami/wi*Si; Ci = Si*wi*rhoici; %insulation
43 -      Gim = 2*ni*Gi*ones(1,2*ni);          %meshed insulation
44 -      Cim = Ci/ni*mod(0:2*ni-1,2);
```

There are n meshes, each one formed by two resistances and a capacity.
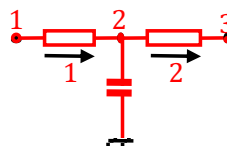
The two conductances are equal and their value is the double of the conductance of the mesh. The first node does not have a capacity; the second node has the capacity of the mesh; the third node is not in the mesh (it is in the next mesh).

The whole model has the conductance matrix:

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

and the capacity matrix:

```
80        C = diag([Ccm Cim 0 0 Ca Cg]);
81 -    % 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,

$$[\min(-1./\text{eig}(As)) \quad \max(-1./\text{eig}(As))]$$

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

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

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