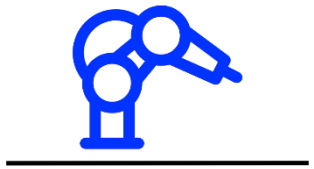
Proposal Presentations

STRUCTURES-COMPUTER INTERACTION LABORATORY

- Monday 12 – 2 pm, **November 6**, 2023 (In-person)
- 5-minute presentation (~5 slides), 2-minute Q/A
- You are required to use one of the following two templates:
  - LaTeX template (highly recommended) http://ras.papercept.net/conferences/support/tex.php
  - MS Word template http://ras.papercept.net/conferences/support/word.php

  It is acceptable to modify the template (e.g., one column instead of two)
- At a minimum, your proposal and progress report should include 5 references.

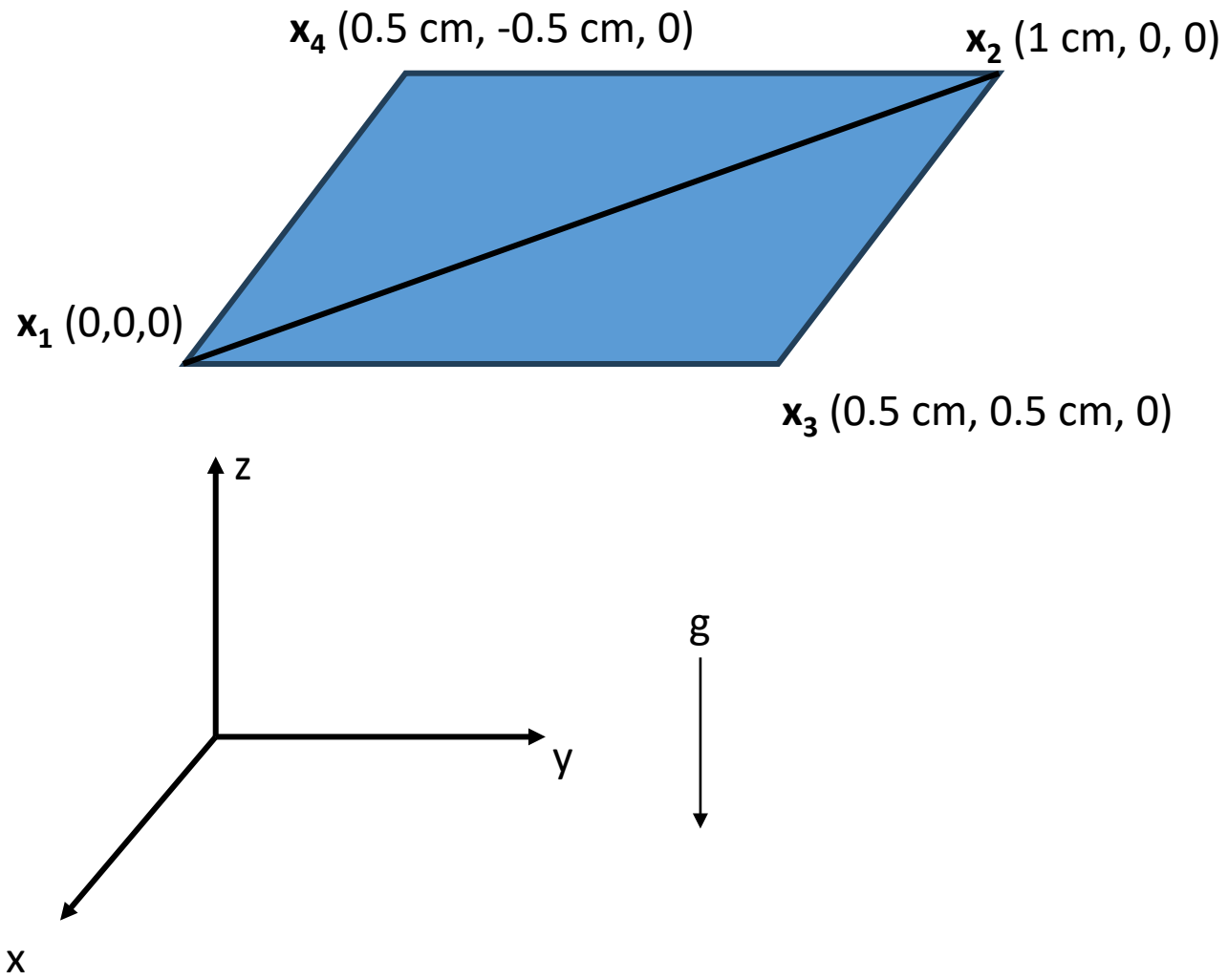


Module : Plate Example

Discrete Elastic Plates (DEP) Algorithm

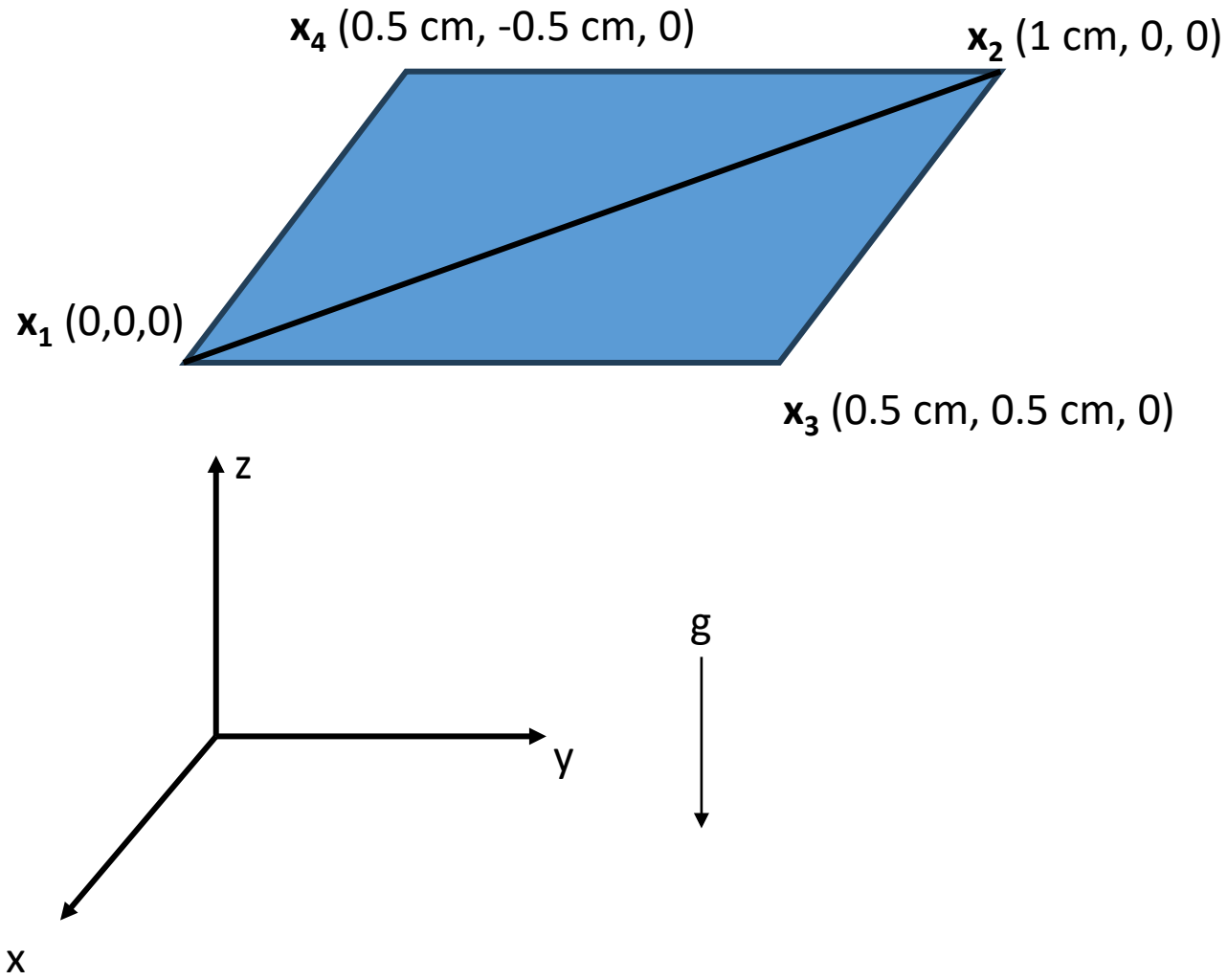
Problem Setup

- 4 nodes
- 3 nodes are fixed, one is free
- What is the deformed shape under gravity?



Parameters

- Thickness = 1 mm
- Young's modulus = 10 MPa
- Total mass = 10 g
- Gravity = -9.81 m/s^2
- Total time = 5 seconds
- Time step size = 0.01 second



Problem Setup

STRUCTURES-COMPUTER INTERACTION LABORATORY

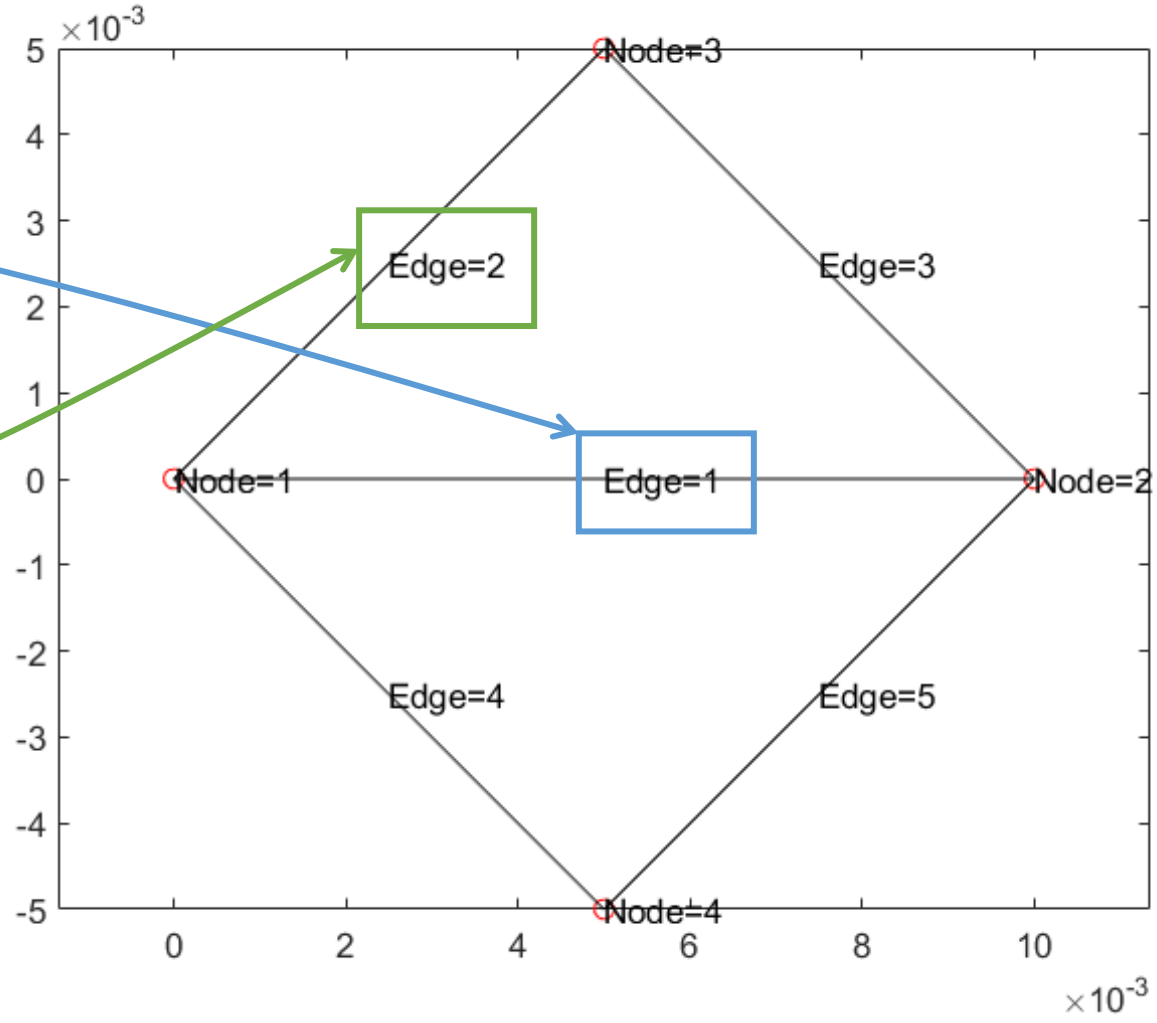
Edges: 5x (Stretching)

Edges =

1	1	3	1	4
2	3	2	4	2

Edge between nodes 1 and 2

Edge between nodes 1 and 2




```
%% Stretching: calculate lk and ks
lk = zeros(1,Nedge);

for c=1:Nedge
    node1 = Nodes(Edges(1,c), :);
    node2 = Nodes(Edges(2,c), :);
    lk(c) = norm(node1 - node2);
end

ks = sqrt(3)/2 * Y * h *lk.^3;
```

Problem Setup

Edges: 5x (Stretching)

```
Edges =

     1     1     3     1     4
     2     3     2     4     2
```

Hinges: 1x (Bending)

```
Hinges =

     1
     2
     3
     4
```

```
function [dF, dJ] = gradEb_hessEb_Shell(x0, x1, x2, x3, thetaBar, kb)

% //          x2
% //          /\
% //         /  \
% //     e1/    \e3
% //      /  t0  \
% //     /        \
% //    /    e0    \
% //  x0------------x1
% //    \          /
% //     \   t1   /
% //      \      /
% //     e2\    /e4
% //        \  /
% //         \/
% //         x3
```

```
%% Parameters and bending stiffness
h = 0.001; % Thickness in meter
Y = 10^7; % Young's modulus in Pa
kb = 2/sqrt(3) * Y *(h^3)/12;
theta_bar = zeros(1, Nhinge); % Zero in our case
```

Time Stepping

STRUCTURES-COMPUTER INTERACTION LABORATORY

```
for t=1:1:Nsteps
    [q,v] = DiscreteElasticPlates(q,v);
end
```

Algorithm 1 Discrete Elastic Plates

Require: $\mathbf{q}(t_j), \dot{\mathbf{q}}(t_j)$ ▷ DOFs and velocities at $t = t_j$
Require: `free_index` ▷ index of the free DOFs
Ensure: $\mathbf{q}(t_{j+1}), \dot{\mathbf{q}}(t_{j+1})$ ▷ DOFs and velocities at $t = t_{j+1}$

function DISCRETE_ELASTIC_PLATES($\mathbf{q}, \dot{\mathbf{q}}(t_j)$)
  Guess: $\mathbf{q}^{(1)}(t_{j+1}) \leftarrow \mathbf{q}(t_j)$
  $n \leftarrow 1$
  while `error` $>$ `tolerance` **do**

    Compute $\mathbf{f}$ and $\mathbb{J}$

    $\mathbf{f}_{\text{free}} \leftarrow \mathbf{f}$ `(free_index)`
    $\mathbb{J}_{\text{free}} \leftarrow \mathbb{J}$ `(free_index, free_index)`
    $\Delta\mathbf{q}_{\text{free}} \leftarrow \mathbb{J}_{\text{free}} \backslash \mathbf{f}_{\text{free}}$
    $\mathbf{q}^{(n+1)}$ `(free_index)` $\leftarrow \mathbf{q}^{(n)}$ `(free_index)` $-\Delta\mathbf{q}_{\text{free}}$
    `error` $\leftarrow$ `sum ( abs(` f_{free} `) )`
    $n \leftarrow n + 1$
  end while

  $\mathbf{q}(t_{j+1}) \leftarrow \mathbf{q}^{(n)}(t_{j+1})$
  $\dot{\mathbf{q}}(t_{j+1}) \leftarrow \frac{\mathbf{q}(t_{j+1}) - \mathbf{q}(t_j)}{\Delta t}$

  return $\mathbf{q}(t_{j+1}), \dot{\mathbf{q}}(t_{j+1})$
end function