Twinning Engineering Programmes (TEP) &

Thammasat English Programme of Engineering (TEPE)

Faculty of Engineering

Thammasat University

Undergraduate Examination	1st Semester of 2015 (Mid-term)
CE495 Special Topics	Section 750001
Date 9 December, 2015	Time : 13.00 – 14.30
Instructor: Dr Krisada Chaiyasarn	

Name :________________________________ ID no._______________Seat no._______

Instructions :

1. The test contains 3 problems, 4 pages (this page inclusive). All necessary formula are given in exam questions.
2. Do all the problems in a book provided. Remember to print your name, identification number (ID), and seat number clearly on your workbook.
3. Scientific calculator is allowed to be used for the test provided that it must be initially reset and have visual checks by a proctor. Note that the use of an inappropriate calculator will be considered as misconduct.
4. No program in any form may be taken into the examination room. Also, calculators with facilities for storing and retrieving text, graphical calculators, personal organizers, dictionaries, thesauruses, computer are not allowed.
5. Other communicating devices such as mobile phones, pagers, etc. are not permitted in the examination.
6. Textbooks, short notes and relevant material are not permitted in the test room.
7. There are marks allocated for working towards final answers, ***hence write and explain your answers clearly.***

Before entering the examination room, make sure that you do not to bring any disallowable materials into the examination room, intentionally or unintentionally. If proctors have found them in your occupation, **you will be seriously punished by suspending your study for one year and receiving a Fail(F) grade in this subject.**

1. Figure 1 is an indeterminate beam with supports at A and D, the load at B and moment at D. The beam has the moment of inertia of 20 mm^2 and 60 mm^2 as shown in the figure. Answer the following questions, use the equations and diagram as shown in Figure 2 as a guideline to answer the question.

   (a) State 3 assumptions used in applying Finite Element method in Figure 1 (2 marks)
   (b) Sketch a diagram as a Finite Element model of Figure 1 (1 mark)
   (c) Write a Force Vector in Matlab (2 marks)
   (d) Find stiffness matrix of each element and hence find a global stiffness matrix (3 marks)
   (e) Write a boundary condition in a matrix form (2 marks)

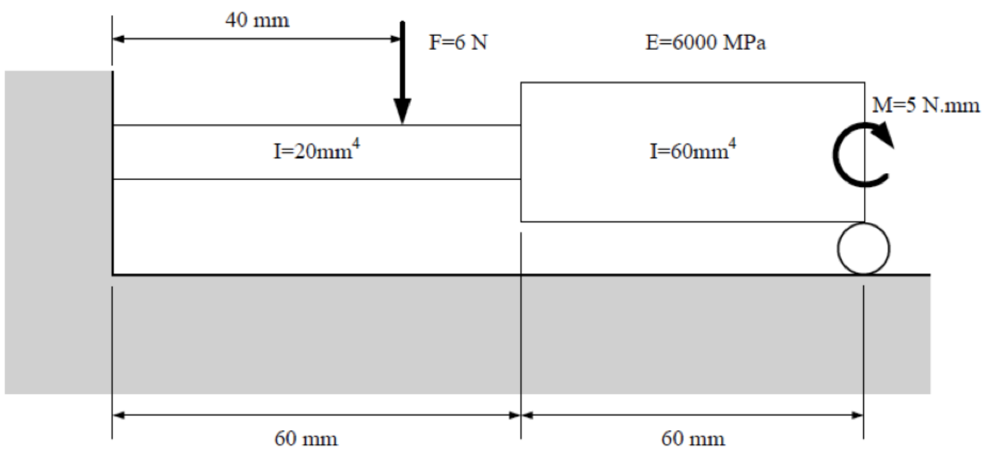

Figure 1: An indeterminate beam

$$\frac{EI}{L^3}\begin{bmatrix} 12 & 6L & -12 & 6L \\ 6 & 4L^2 & -6L & 2L^2 \\ -12 & -6L & 12 & -6L \\ 6L & 2L^2 & -6L & 4L^2 \end{bmatrix}\begin{bmatrix} y_1 \\ \theta_1 \\ y_2 \\ \theta_2 \end{bmatrix} = \begin{bmatrix} R_1 \\ M_1 \\ R_2 \\ M_2 \end{bmatrix}$$

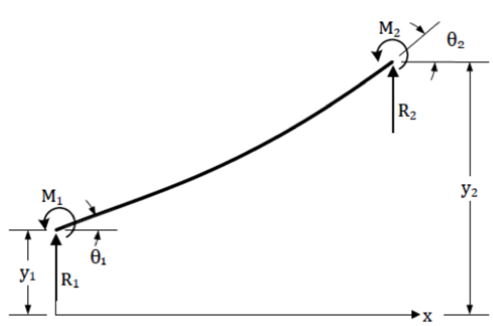

Figure 2: Finite Element equation for a beam element

2. Answer the following questions

(a) Let $a = \begin{bmatrix} 1 & 2 & 6 & -1 & 5 \\ 2 & 4 & -8 & 2 & -9 \\ 3 & 6 & 3 & 3 & 3 \\ 4 & 3 & 2 & 4 & 2 \end{bmatrix}$ and $b = \begin{bmatrix} 4 & 1 & 4 & 3 & 4 \\ -9 & 3 & 1 & 2 & 6 \\ 6 & 3 & 5 & 3 & -2 \\ 4 & -8 & 4 & 0 & 2 \end{bmatrix}$

i. $\texttt{size}(\texttt{a}, 2)$ (0.5 marks)

ii. $\texttt{a}(:, 2). * \texttt{b}(:, 3)$ (0.5 marks)

iii. $\texttt{a}\hat{\ }2$ (1 marks)

(b) Write the output of the following code

i. $\texttt{zeros}(3, 4)$ (0.5 marks)

ii. $\texttt{10} : -\texttt{1} : \texttt{2}$ (0.5 marks)

iii. $\texttt{linspace}(0, 9, 10)$ (1 marks)

(c) From the function in Algorithm 1, let $\texttt{x} = \texttt{0} : \texttt{10}$ and $\texttt{t\_0} = \texttt{1}$, answer the following questions,

i. if $\texttt{y} = \texttt{ustep}(\texttt{x}, \texttt{t\_0})$, sketch a graph according to the Matlab command $\texttt{plot}(\texttt{x}, \texttt{y})$ (2 marks)

ii. if $\texttt{t\_1} = 2$ and $\texttt{y} = \texttt{ustep}(\texttt{x}, \texttt{t\_1}) - \texttt{ustep}(\texttt{x}, \texttt{t\_0})$ sketch a graph according to the Matlab command $\texttt{plot}(\texttt{x}, \texttt{y})$ (2 marks)

iii. Explain the line $[\texttt{m}, \texttt{n}] = \texttt{size}(\texttt{t})$ in Algorithm 1 and what output will you get if $\texttt{x} = 1$, and you use the Matlab command $\texttt{ustep}(\texttt{x}, \texttt{t\_0})$ (2 marks)

Algorithm 1

```
function y = ustep(t, t0)
%USTEP(t, t0) unit step at t0
%   A unit step is defined as
%         0 for t <  t0
%         1 for t >= t0
[m,n] = size(t);
% Check that this is a vector, not a matrix i.e. (1 x n) or (m x 1)
if m ~= 1 & n ~=1
   error('T must be a vector');
end
y = zeros(m, n); %Initialise output array
for k = 1:length(t)
  if t(k) >= t0
    y(k) = 1;  %Otherwise, leave it at zero, which is correct
  end
end
```

3. A cantilever has a distributed load as shown in Figure 3, and the closed form solution of the deflection is shown in the figure.

   (a) The shear force can be found as $\int ydx$ and the bending moment can also be found as $\int\int ydxdx$, adapt the equation shown in Figure 3 to find the shear force and bending moment of the beam shown in Figure 3 (2 marks)

   (b) Algorithm 2 is incomplete, complete the rest of the code in step 2-5 (6 marks)

   (c) Explain what the benefits of Matlab over compiled programming languages and spreadsheet (2 marks)

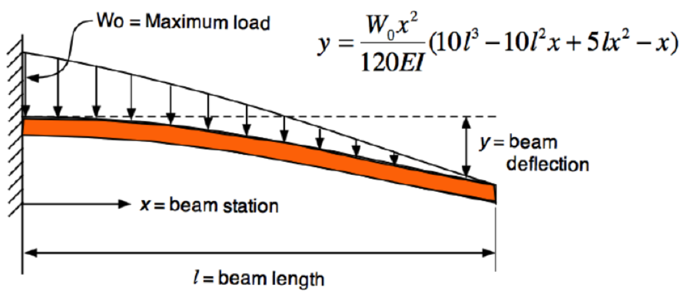

Figure 3: A diagram showing a simple cantilever with a distributed force

Algorithm 2

```
% W = load at station x (N/m)
% Wo = maximum load at station x=0 (N/m)
% E = Modulus of elasticity (N/m-m)
% I = Moment of inertia (m-m-m-m)
% x = beam station = distance from datum point (wall) to any point on the
%       beam (m)
% l = beam length (m)
% y = beam deflection at any station (m)


% Beam properties

Wo = 6000;   % Newtons/m
E = 200e9;   % N/m-m - value for Steel = 200e9
I = 0.001;   % meters to the fourth power
L = 9;        % meter

%1.Use linspace to create x
x = linspace (0,L ,100)

%2.Calculate deflection to the beam at any point in the beam length

%3.Calculate the shear force along the beam length

%4.Calculate the bending moment along the beam length

%5.plot the graph of deflection, shear force, and bending moment, and also
%label the axis
```