Structural Analysis III

Revised Semester 2 Exam Information

Semester 2

2008/9

Dr. Colin Caprani

1. Exam Format

Introduction

The exam format is being altered this year from previous Semester 2 exam formats. However, the change is superficial: the questions asked will be of the same standard, and no new or extra knowledge is required. This change is being implemented to better reflect the content of the Semester 2 course, and the time put into each topic. In addition, it is hoped that the paper will be easy to sit and plan time for, given that all questions will now have equal marking.

Layout

There will be 4 questions and you are to answer all 4.

Marking

Each question has equal weighting: Questions 1 to 4 are worth 25 marks each.

Timing

The exam is 2 hours in duration which converts to 30 minutes per question.

Format

The format is:

- Question 1 will examine Macaulay's Method;
- Question 2 will examine Virtual Work;
- Question 3 will examine Virtual Work;
- Question 4 will examine Plastic Analysis.

In addition, questions may include aspects of qualitative analysis, corresponding to Question 1(c) of pre-semesterized exams.

The standard and style of questions will be as for previous semesterized and pre-semesterized exams.

Exam Handout

The handout is as attached to the sample exam paper.

2. Relevant Past Exam Questions

The following table indicates questions (or parts thereof) from previous years' exam papers as they correspond to the revised Semester 2 exam.

<table>
<tr><th rowspan="2">Past Summer Exam by Year*</th><th colspan="4">Semester 2 Exam Questions</th></tr>
<tr><th>Question 1*
Macaulay's Method</th><th>Question 2*
Virtual Work</th><th>Question 3*
Virtual Work</th><th>Question 1*
Plastic Analysis</th></tr>
<tr><td>2008</td><td>Q3(b)</td><td>Q2(a)</td><td>Q2(b)</td><td>Q3(a)</td></tr>
<tr><td>2007</td><td>Q4(b)</td><td colspan="2">Q3</td><td>Q5</td></tr>
<tr><td>2006</td><td>-</td><td colspan="2">Q4</td><td>Q5</td></tr>
<tr><td>2005</td><td>-</td><td colspan="2">-</td><td>Q4</td></tr>
<tr><td>2004</td><td>Q4(b)</td><td colspan="2">Q3</td><td>Q5</td></tr>
<tr><td>2003**</td><td>Q2(b)**</td><td colspan="2">Q3 & Q4</td><td>-</td></tr>
<tr><td>2002**</td><td>Q4(c)</td><td colspan="2">Q3</td><td>Q5</td></tr>
<tr><td>2001</td><td>-</td><td colspan="2">Q3</td><td>Q5</td></tr>
<tr><td>2000</td><td>-</td><td colspan="2">Q3</td><td>Q5</td></tr>
<tr><td>1999</td><td>-</td><td colspan="2">Q3</td><td>Q5</td></tr>
<tr><td>1998</td><td>-</td><td colspan="2">Q3</td><td>Q5</td></tr>
<tr><td>1997</td><td>-</td><td colspan="2">Q3</td><td>Q5</td></tr>
</table>

* Problems similar to Q1 of 2008 and Q1 (c) of ≤ 2007 may be included as part of Questions 1 to 4.

** In these years the exam format and style of question was altered considerably.

DUBLIN INSTITUTE OF TECHNOLOGY
BOLTON STREET, DUBLIN 1

Bachelor of Engineering (Honours) in Structural Engineering

THIRD YEAR: MAY 2009
SEMESTER 2

STRUCTURAL ANALYSIS III

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Someday, XXth May, 09.30 a.m. to 11.30 p.m.

Answer ***all*** of the following ***four*** questions.

All question carry equal marks.

Time Allowed : 2 Hours

Given:

QUESTION 1

Using *Macaulay's Method*, determine the deflection at *C* for the frame shown in Fig. Q1.

(25 marks)

Note:
Take $E = 200$ kN/mm^2 and $I = 15 \times 10^7$ mm^4 for all members.

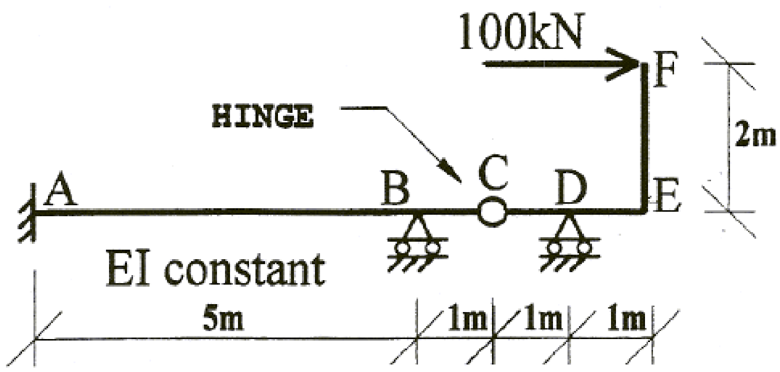


FIG. Q1

QUESTION 2

(a) Using *Virtual Work*, for the truss shown in Fig. Q2(a), determine the horizontal deflection of joint *C*.

(15 marks)

Note:

- Take $E = 200$ kN/mm^2 for all members.
- Take the areas as 100 mm2 for all members except BC and BD where the area is 100√2 mm2

(b) For the structure shown in Fig. Q2(b), provide the following:

(i) show the direction of the reactions;

(ii) bending moment diagram;

(iii) shear force diagram;

(iv) axial force diagram;

(v) deflected shape.

(10 marks)

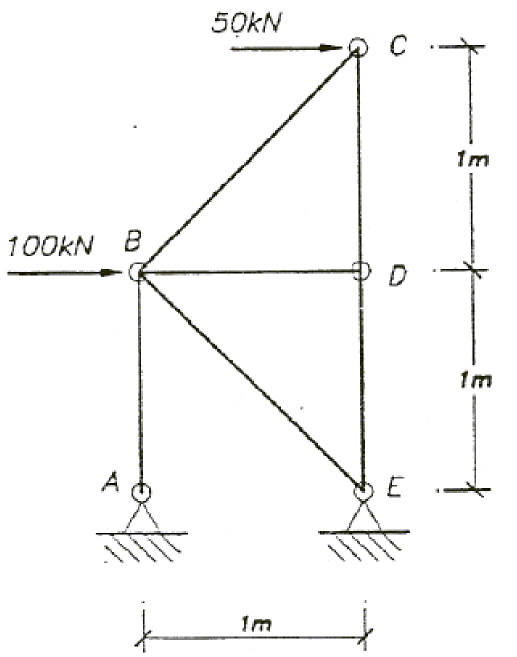


FIG. Q2(a)

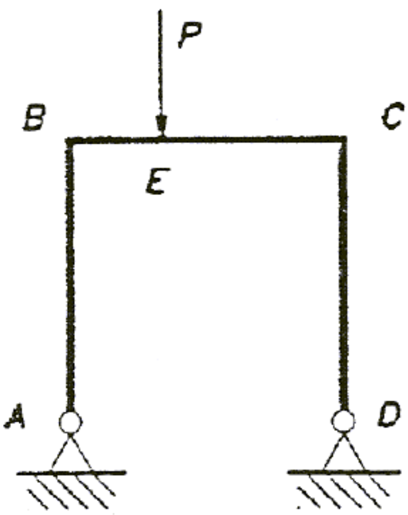


FIG.Q2(b)

QUESTION 3

An additional member *DF* is introduced to the truss of Fig. Q2(a), as shown in Fig. Q3; calculate the new horizontal deflection of joint *C*.

(25 marks)

Note:

- Take $E = 200$ kN/mm^2 for all members.
- Take the areas as 100 mm^2 for all members except *BC*, *BD* and *DF* where the area is 100√2 mm^2
- You may use any relevant results from your workings for Q2, but in doing so acknowledging their source.

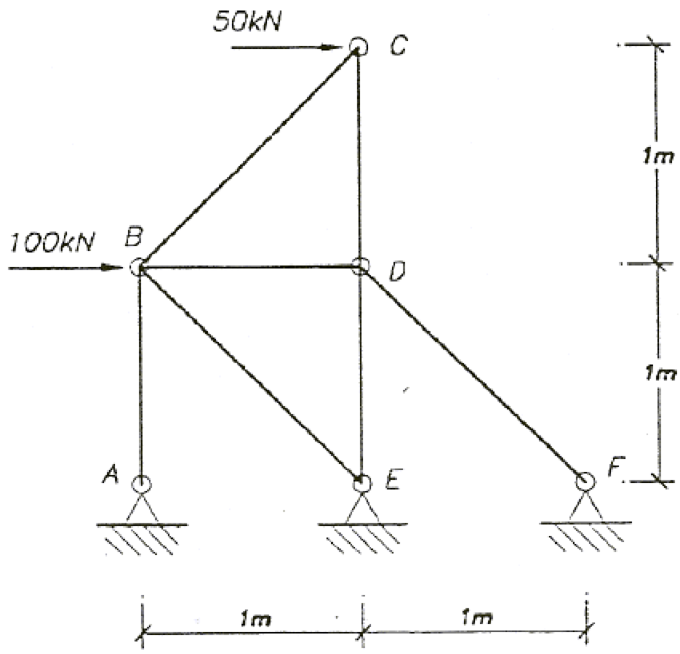


FIG. Q3

QUESTION 4

For the rigid-jointed frame of Fig. Q4, loaded with the working loads shown, do the following:

(a) Find the load factor which causes collapse of the frame, given that $M_P = 120$ kNm ;

(b) Show that your solution is the unique solution;

(c) Sketch the bending moment diagram at collapse, showing all important values.

(25 marks)

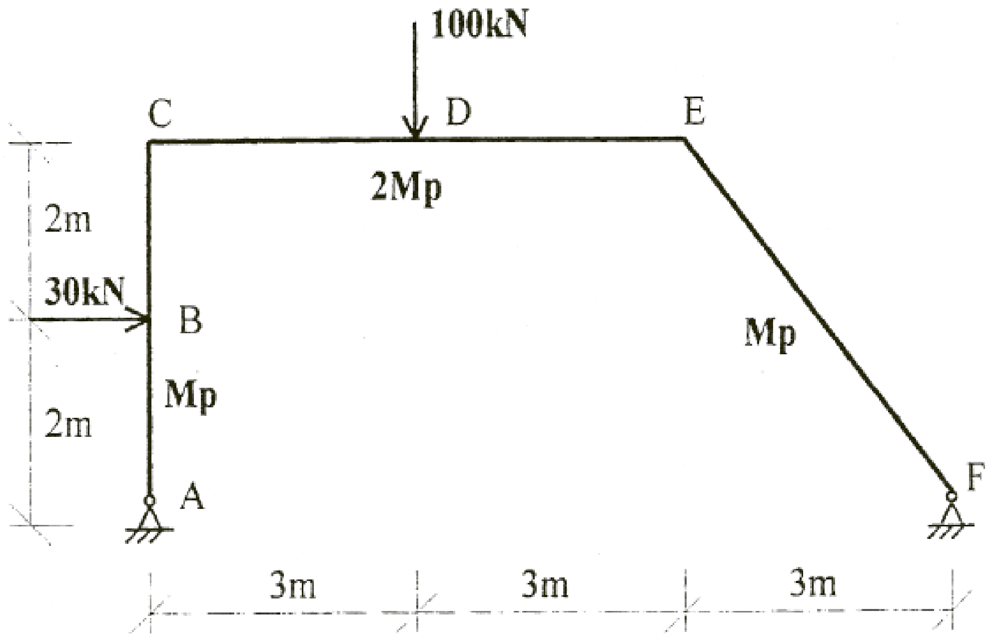
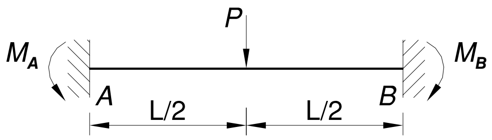
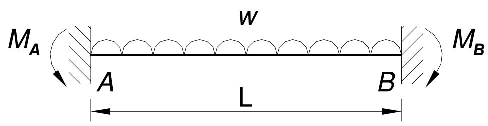
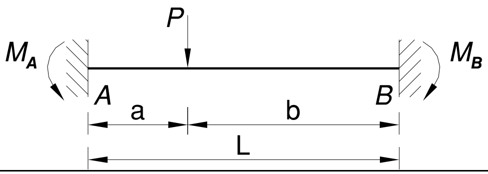
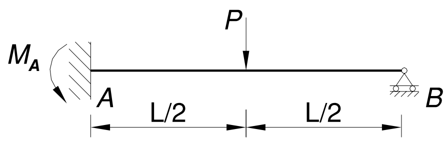
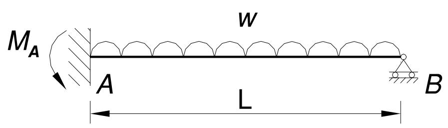
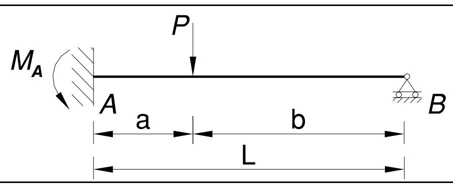


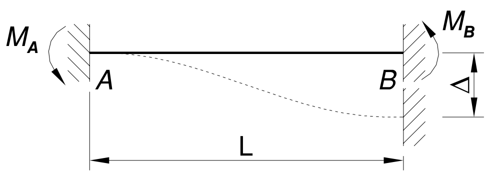
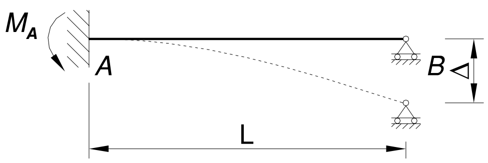
FIG. Q4

Fixed-End Moments

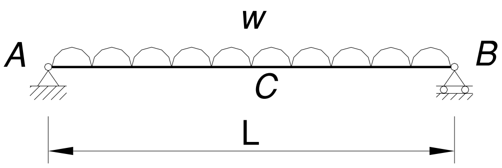
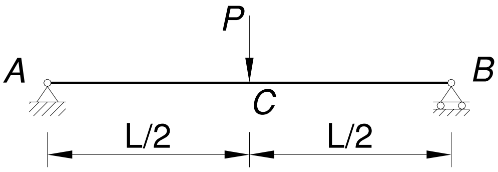
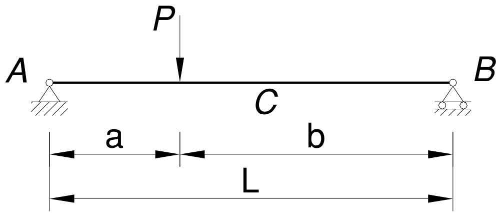
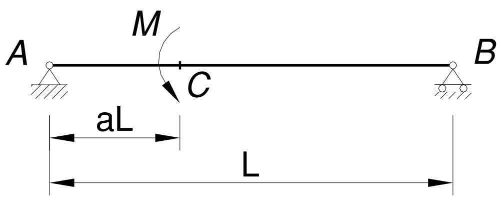
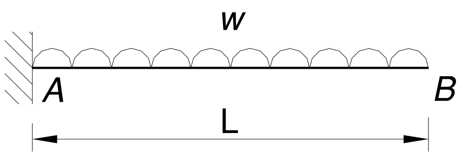
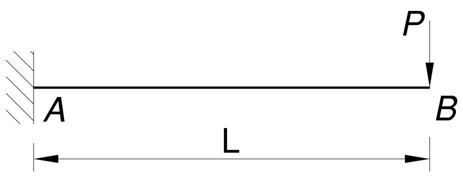
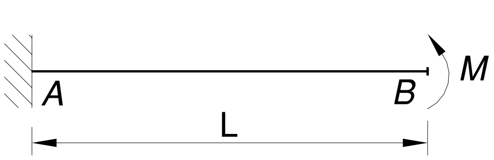
Loading

M_A	Configuration	M_B
$+\dfrac{PL}{8}$		$-\dfrac{PL}{8}$
$+\dfrac{wL^2}{12}$		$-\dfrac{wL^2}{12}$
$+\dfrac{Pab^2}{L^2}$		$-\dfrac{Pa^2b}{L^2}$
$+\dfrac{3PL}{16}$		-
$+\dfrac{wL^2}{8}$		-
$+\dfrac{Pab(2L-a)}{2L^2}$		-

Displacements

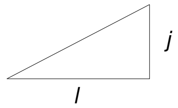
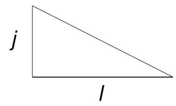
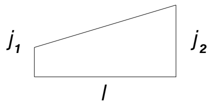
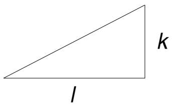
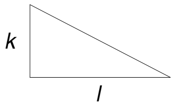
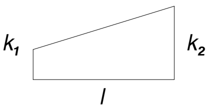
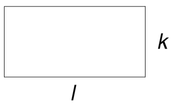
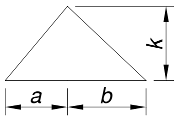
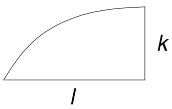
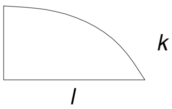
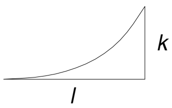
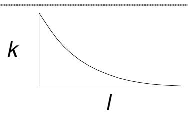
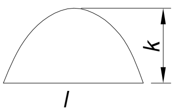
M_A	Configuration	M_B
$+\dfrac{6EI\Delta}{L^2}$		$+\dfrac{6EI\Delta}{L^2}$
$+\dfrac{3EI\Delta}{L^2}$		-

Displacements

Configuration	Translations	Rotations
	$\delta_C = \dfrac{5wL^4}{384EI}$	$\theta_A = -\theta_B = \dfrac{wL^3}{24EI}$
	$\delta_C = \dfrac{PL^3}{48EI}$	$\theta_A = -\theta_B = \dfrac{PL^2}{16EI}$
	$\delta_C \cong \dfrac{PL^3}{48EI}\left[\dfrac{3a}{L} - 4\left(\dfrac{a}{L}\right)^3\right]$	$\theta_A = \dfrac{Pa(L-a)}{6LEI}(2L-a)$ $\theta_B = -\dfrac{Pa}{6LEI}(L^2 - a^2)$
	$\delta_C = \dfrac{ML^2}{3EI}a(1-a)(1-2a)$	$\theta_A = \dfrac{ML}{6EI}(3a^2 - 6a + 2)$ $\theta_B = \dfrac{ML}{6EI}(3a^2 - 1)$
	$\delta_B = \dfrac{wL^4}{8EI}$	$\theta_B = \dfrac{wL^3}{6EI}$
	$\delta_B = \dfrac{PL^3}{3EI}$	$\theta_B = \dfrac{PL^2}{2EI}$
	$\delta_B = \dfrac{ML^2}{2EI}$	$\theta_B = \dfrac{ML}{EI}$

Virtual Work

Volume Integrals

				
	$\frac{1}{3}jkl$	$\frac{1}{6}jkl$	$\frac{1}{6}(j_1+2j_2)kl$	$\frac{1}{2}jkl$
	$\frac{1}{6}jkl$	$\frac{1}{3}jkl$	$\frac{1}{6}(2j_1+j_2)kl$	$\frac{1}{2}jkl$
	$\frac{1}{6}j(k_1+2k_2)l$	$\frac{1}{6}j(2k_1+k_2)l$	$\frac{1}{6}\left[j_1(2k_1+k_2)+ j_2(k_1+2k_2)\right]l$	$\frac{1}{2}j(k_1+k_2)l$
	$\frac{1}{2}jkl$	$\frac{1}{2}jkl$	$\frac{1}{2}(j_1+j_2)kl$	jkl
	$\frac{1}{6}jk(l+a)$	$\frac{1}{6}jk(l+b)$	$\frac{1}{6}\left[j_1(l+b)+ j_2(l+a)\right]k$	$\frac{1}{2}jkl$
	$\frac{5}{12}jkl$	$\frac{1}{4}jkl$	$\frac{1}{12}(3j_1+5j_2)kl$	$\frac{2}{3}jkl$
	$\frac{1}{4}jkl$	$\frac{5}{12}jkl$	$\frac{1}{12}(5j_1+3j_2)kl$	$\frac{2}{3}jkl$
	$\frac{1}{4}jkl$	$\frac{1}{12}jkl$	$\frac{1}{12}(j_1+3j_2)kl$	$\frac{1}{3}jkl$
	$\frac{1}{12}jkl$	$\frac{1}{4}jkl$	$\frac{1}{12}(3j_1+j_2)kl$	$\frac{1}{3}jkl$
	$\frac{1}{3}jkl$	$\frac{1}{3}jkl$	$\frac{1}{3}(j_1+j_2)kl$	$\frac{2}{3}jkl$

[P.T.O.