**DUBLIN INSTITUTE OF TECHNOLOGY**
**BOLTON STREET, DUBLIN 1**

# Bachelor of Engineering (Honours) in Structural Engineering

**THIRD YEAR: JANUARY 2008**
**SEMESTER 1**

## STRUCTURAL ANALYSIS III

John Turner, B.E., M.Eng.Sc., M.I.E.I.
Joseph Kindregan, BE
Colin Caprani, Ph.D., B.Sc.(Eng.), Dip.Eng., C.Eng., M.I.E.I., M.I.A.B.S.E., M.I.Struct.E.

**Someday, XXth January, 09.30 a.m. to 12.30 p.m.**

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

Question 1 carries 20 marks; Questions 2 and 3 carry 40 marks each.

Time Allowed : 2 Hours

*Given:*



 **[P.T.O.**

**1.** (a) Classify each of the structures shown in Fig. Q1(a), indicating whether the structure is unstable or stable and statically determinate or indeterminate (giving the degree of indeterminacy).

(*10 marks*)

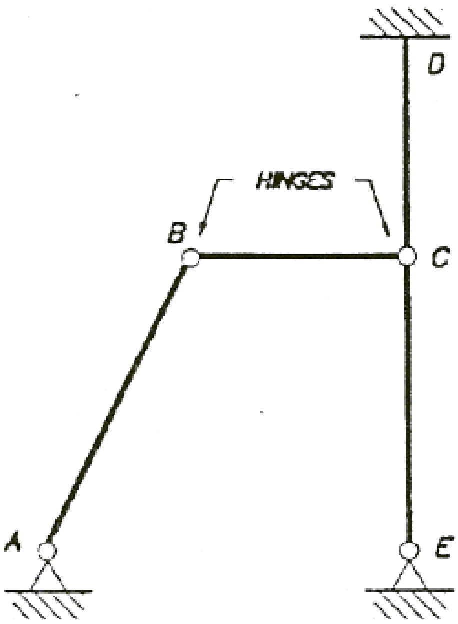



FIG Q1(a)(i)

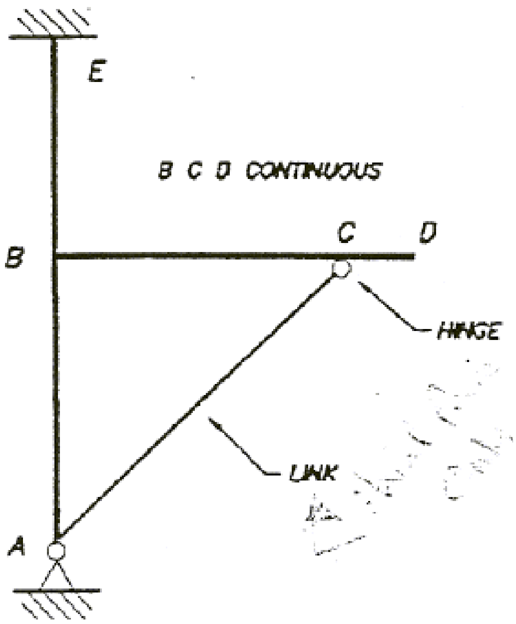



FIG Q1(a)(ii)

(*b*) Determine the degree of kinematic indeterminacy of the structures shown in Fig. Q1(b), stating briefly reasons for your answer and any assumptions made about axial deformations.

(*10 marks*)

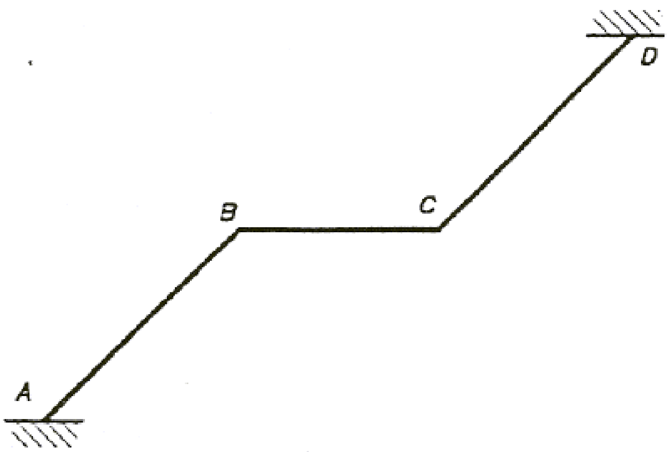



FIG Q1(b)(i)

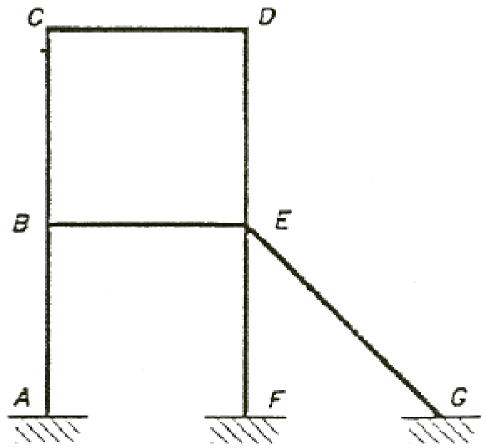



FIG Q1(b)(ii)

**2.** Using *Moment Distribution*:

(i) Determine the bending moment moments for the frame in Fig. Q2;

(ii) Draw the bending moment diagram for the frame, showing all important values;

(iii) Draw the deflected shape diagram for the frame.

(*40 marks*)

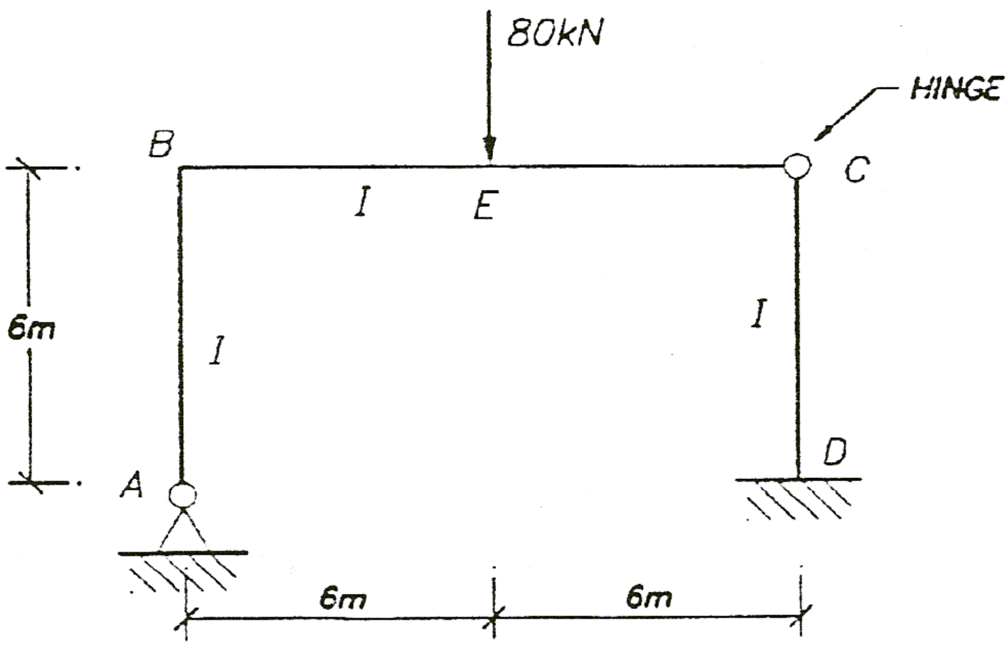



FIG Q2

**3.** For the frame shown in Fig. Q3, using the *Moment-Area Method* (*Mohr's Theorems*):

(i) Draw the bending moment diagram;

(ii) Determine the horizontal deflection of joint *D*;

(iii) Draw the deflected shape diagram for the frame.

**Note:**
You may neglect axial effects in the members.
Take $EI = 4\times10^3\ \text{kNm}^2$ for all members.

*(40 marks)*

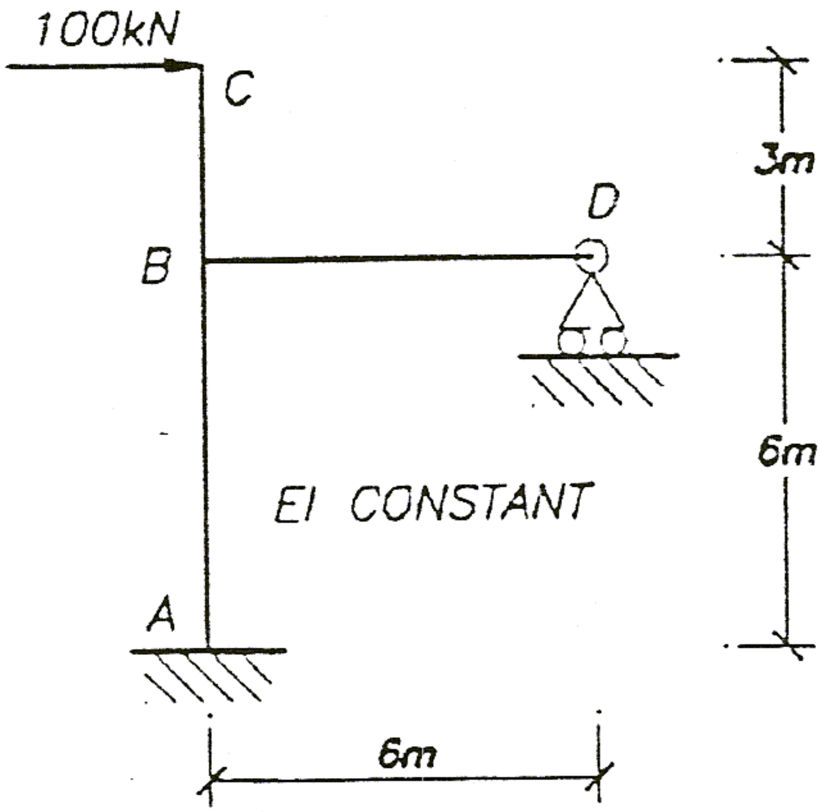
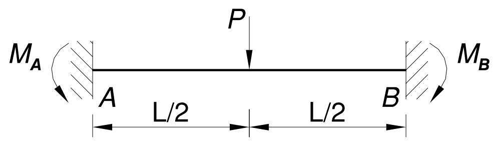
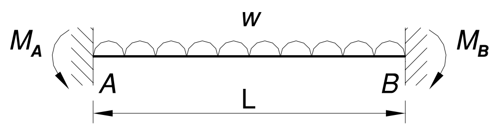
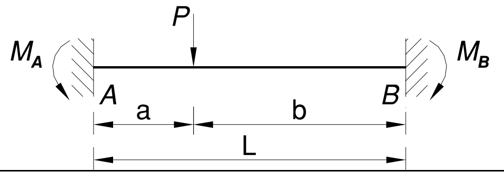
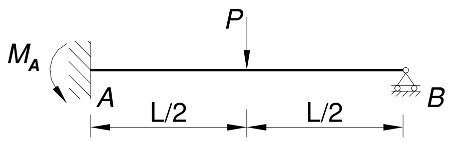
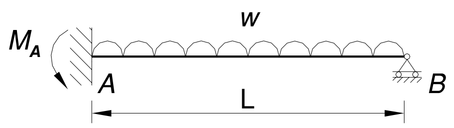
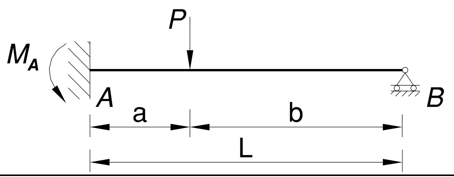



***FIG. Q3***

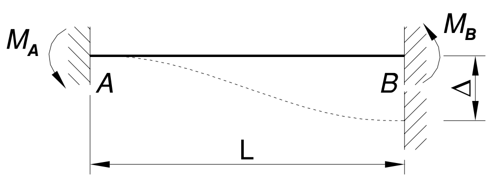
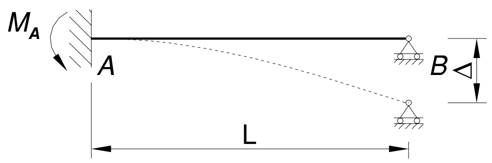
 

# Fixed-End Moments

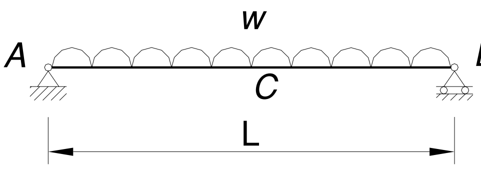
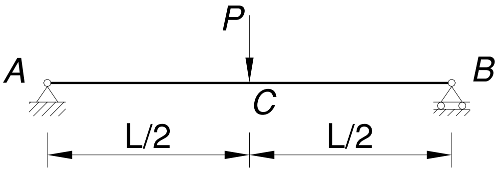
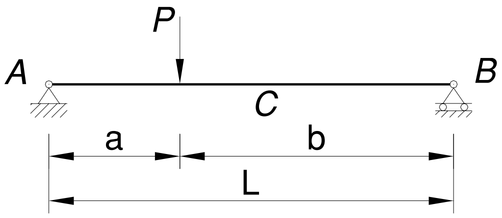
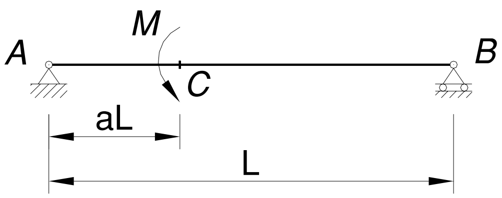
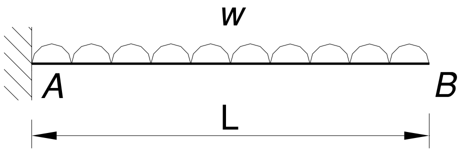
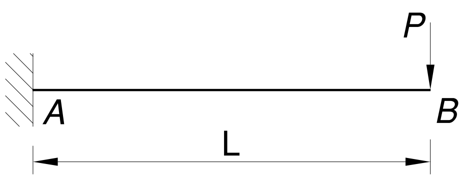
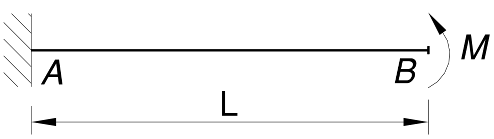
## Loading

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