Concordia UNIVERSITY

Faculty of Engineering and Computer Science

ENGR 242/2 X Statics Fall 2005

Class Test 3 (Nov 25, 2005)

Instructions:

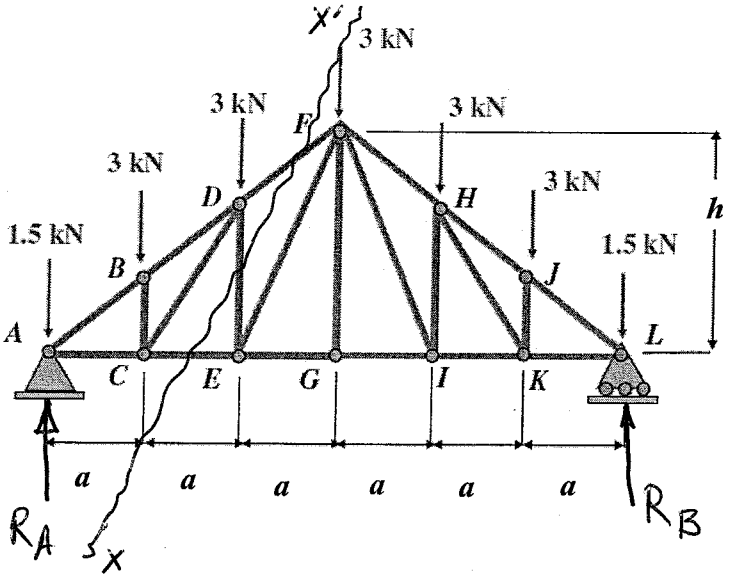
(a) Write on both sides of the test. There is an extra sheet at the end. If you need extra papers to write, please ask the test supervisor.
(b) Answer all three questions.
(c) Scientific calculator is permitted
(d) Books, notes and programmable calculator are not permitted
(e) Keep your Student ID available.
(f) There are 5 (five) pages in this test.
(g) If there is any data missing, make a reasonable assumption with sufficient explanation

Name (print) SOLUTION

Student ID _____

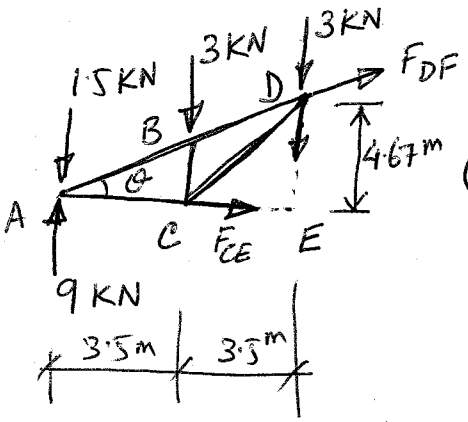
Signature _____

Problem 1 (30 marks)
A Pratt roof truss is loaded as shown. Using the method of sections, determine the forces in Members **CE** and **DF**. Given that: $h = 7$ m and $a = 3.5$ m.



From Symmetry $R_A = R_B = \frac{1}{2}(1.5\times 2 + 3\times 5) = 9$ KN

consider the left side of the section x-x'



$\theta = \tan^{-1}\left(\frac{7}{3\times 3.5}\right) = 33.69^\circ$

$\circlearrowleft +\Sigma M_D = 0$ gives,

$F_{CE}(4.67) + 3\times 3.5 + 1.5\times 7 - 9\times 7 = 0$

$F_{CE} = 8.99$ KN (T)

$\Sigma F_x = 0$ gives,

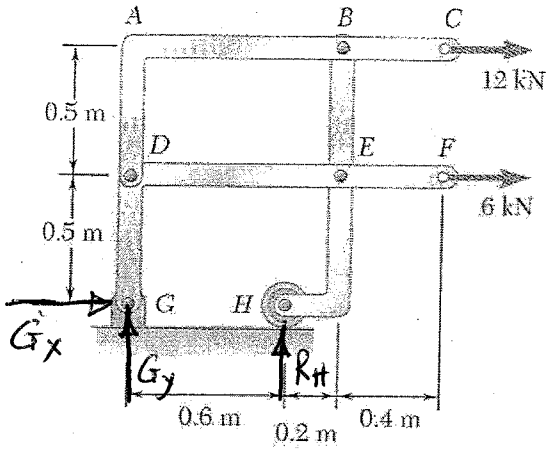
$+\rightarrow$

$F_{DF}\cos(33.69^\circ) + F_{CE} = 0$

$F_{DF} = -\frac{8.99}{\cos 33.69^\circ} = -10.80$ KN (C)

Problem 2 (30 marks)

For the frame and loading shown, determine the forces acting on DABC at B.



FIND THE REACTIONS

$\circlearrowleft +\Sigma M_G = 0$ gives,

$R_H(0.6) - 6(0.5) - 12(1.0) = 0$

$R_H = 25\ kN$

$\Sigma F_x = 0$ gives,

$\rightarrow +$

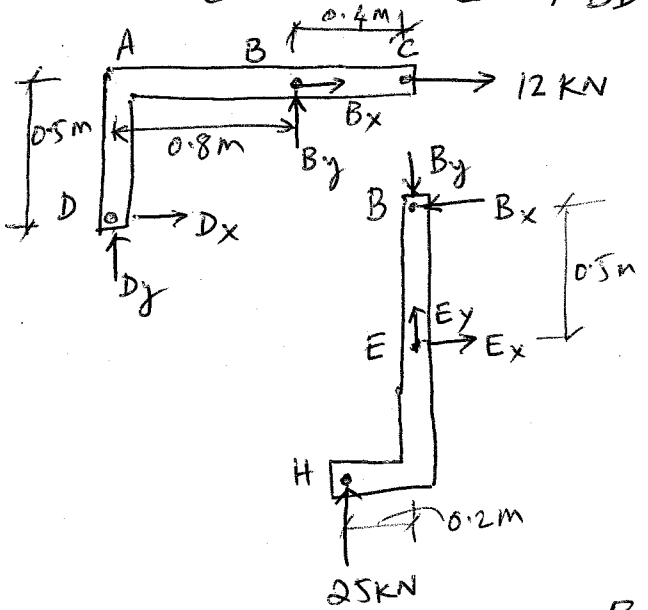
$G_x + 12 + 6 = 0$

$G_x = -18\ kN$

$+\uparrow \Sigma F_y = 0$ gives, $G_y + R_H = 0$

$G_y = -25\ kN$

Now consider the FBD of DABC and BEH



For BEH $\circlearrowleft +\Sigma M_E = 0$ gives,

$-25(0.2) + B_x(0.5) = 0$

$B_x = 10\ kN$

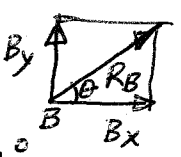
For DABC $\circlearrowleft +\Sigma M_D = 0$ gives,

$-12(0.5) - B_x(0.5) + B_y(0.8) = 0$

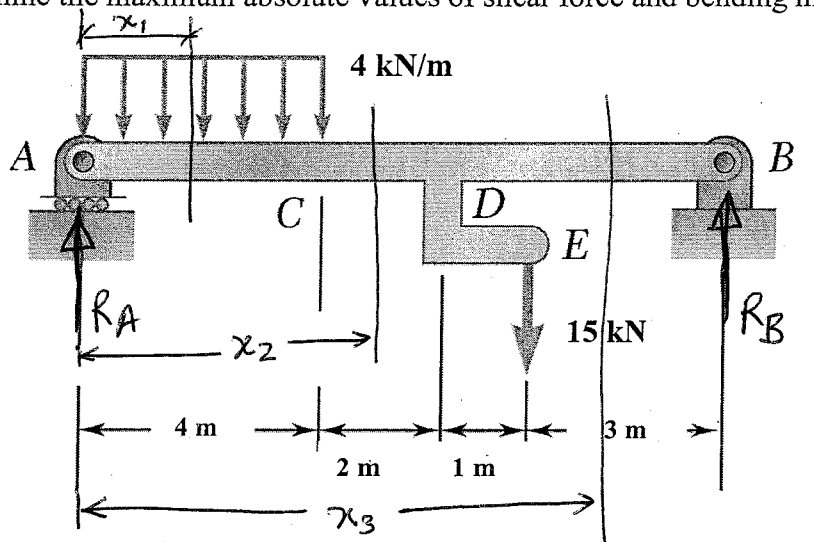
$B_y = \dfrac{12 \times 0.5 + 10 \times 0.5}{0.8} = 13.75\ kN$

$R_B = \sqrt{10^2 + 13.75^2} = 17.0\ kN$

$\tan\theta = \dfrac{13.75}{10} \Rightarrow \theta = 53.97^\circ$



Problem 3 (40 marks)
For the beam ACDB as shown below,
(a) draw the shear force and bending moment diagrams, and
(b) determine the maximum absolute values of shear force and bending moment.



(1) FIND THE REACTIONS

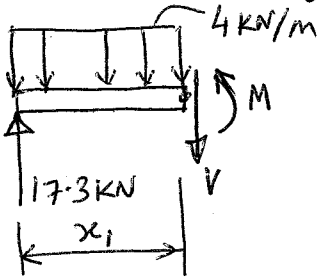
$\circlearrowleft +\Sigma M_A = 0$ gives, $R_B(10) - 15(7) - 4\times4(2) = 0$

$R_B = 13.7$ KN

$\uparrow +\Sigma F_y = 0$ gives. $R_A + R_B - 4\times4 - 15 = 0$

$R_A = 16 + 15 - 13.7 = 17.3$ KN

(2) Consider the left side of section x_1 $(4m \geq x_1 \geq 0)$



$\uparrow +\Sigma F_y = 0$ gives,

$17.3 - V - 4(x_1) = 0$

$V = 17.3 - 4x_1$ (linear)

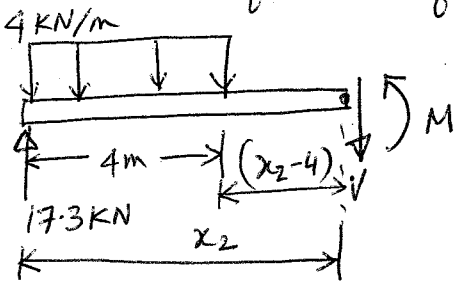
$\circlearrowleft +\Sigma M_{x_1} = 0$ gives $M - 17.3(x_1) + 4(x_1)\left(\frac{x_1}{2}\right) = 0$

$M = 17.3x_1 - 2x_1^2$ (quadratic)

at $x_1 = 0$, $V = 17.3$ KN and $M = 0$

at $x_1 = 4m$, $V = 1.3$ KN and $M = 37.2$ KN·m

(3) consider the left side of section x_2 $(6m \geq x_2 \geq 4m)$



$+\uparrow \Sigma F_y = 0$ gives,

$17.3 - 4(4) - V = 0$

$V = 1.3\ KN$ (constant)

$\circlearrowleft^{+} \Sigma M_{x_2} = 0$ gives,

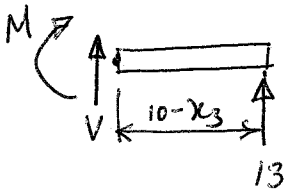
$M - 17.3(x_2) + (4)(4)(x_2-2) = 0$

$M = 17.3x_2 - 16(x_2-2)$ (linear)

at $x_2 = 4m$ $V = 1.3\ KN$ and $M = 37.2\ KN.m$

at $x_2 = 6m$ $V = 1.3\ KN$ and $M = 39.8\ KN.m$

(4) consider the right side of section x_3 $(10^m \geq x_3 \geq 6m)$



$+\uparrow \Sigma F_y = 0$ gives $V + 13.7 = 0$

$V = -13.7\ KN$ (constant)

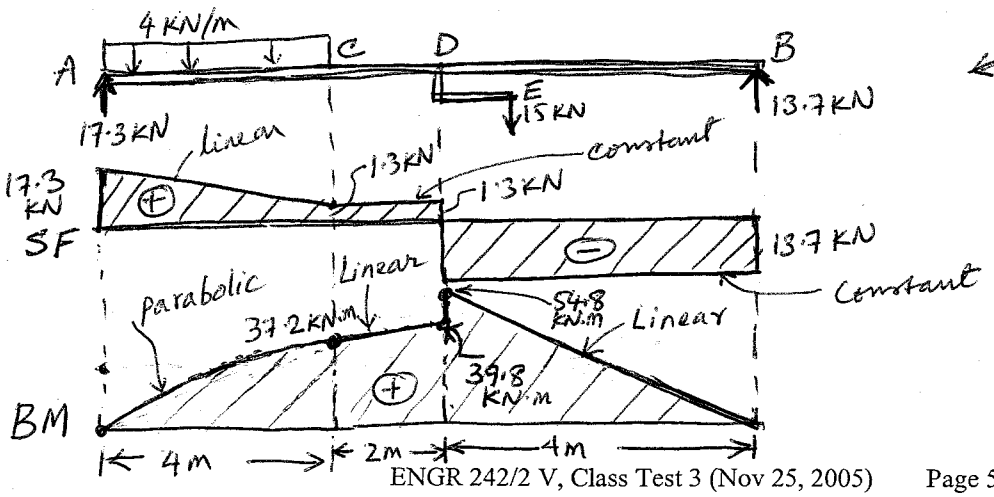
$\circlearrowleft^{+} \Sigma M_{x_3} = 0$ gives $-M + 13.7(10-x_3) = 0$

$M = 13.7(10-x_3)$ (linear)

at $x_3 = 6m$, $V = -13.7\ KN$ and $M = 54.8\ KN.m$

at $x_3 = 10\ m$, $V = -13.7\ KN$ and $M = 0$

BM and SF Diagrams



Maximum SF $= 17.3\ KN$

Maximum BM $= 54.8\ KN.m$