มหาวิทยาลัยสงขลานครินทร์

คณะวิศวกรรมศาสตร์

สอบกลางภาค ประจำภาคการศึกษา 1 ปีการศึกษา 2549

วันที่ 2/8/ 2549 เวลา 9.00 — 12.00 น.

วิชา 220-501 *Matrix Structural Analysis*

ห้องสอบ A400

ชื่อ-สกุล.................................. รหัส.............................

คำชี้แจง

1.ข้อสอบทั้งหมดมี 6 ข้อ คะแนนรวม 165 คะแนน ดังแสดงในตารางข้างล่าง

2.ข้อสอบมีทั้งหมด 6 หน้า ผู้สอบต้องตรวจสอบว่ามีครบทุกหน้าหรือไม่ (ก่อนลงมือทำ) และห้ามแกะหรือฉีกข้อสอบออกจากเล่ม

3.ให้ทำหมดทุกข้อลงในสมุดคำตอบ

4.ห้ามนำเอกสารใดๆ เข้าห้องสอบ **ทุจริตจะได้ E**

5.อนุญาตให้ใช้เครื่องคิดเลขได้ทุกชนิด

6.กระดาษทดที่แจกให้ไม่ต้องส่งคืน ถ้าไม่พอขอเพิ่มที่อาจารย์คุมสอบ

7.ห้ามหยิบ หรือยืมสิ่งของใดๆ ของผู้อื่นในห้องสอบ

8. อนุญาตให้นำ ***Dictionary*** เข้าห้องสอบได้

9. **One Page of Note**

10. ***GOOD LUCK***

ตารางคะแนน

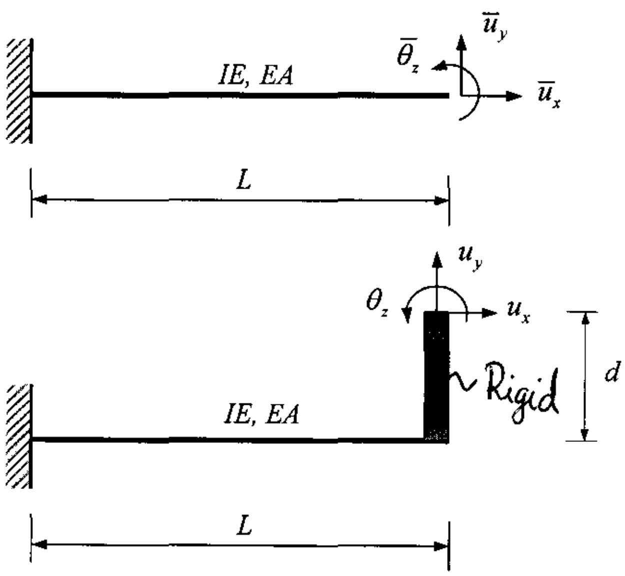
ข้อที่	คะแนนเต็ม	ได้
1	30	
2	15	
3	30	
4	30	
5	30	
6	30	
Bonus	30	
รวม	165	

Lecturer: Asst. Prof. Dr. Suchart Limkatanyu

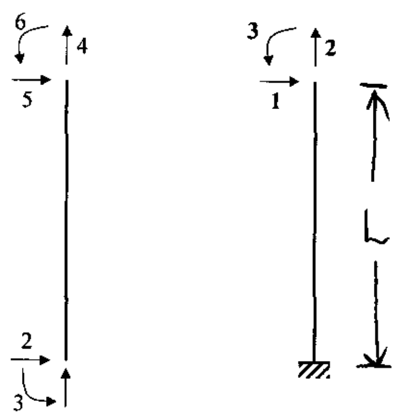
รหัส............................

Problem 1. (30 points) Consider the cantilever beam with the rigid end zone shown. Using the matrix displacement method, find the stiffness matrix of the structure with the rigid end zone (with respect to dofs u_x, u_y, θ_z).

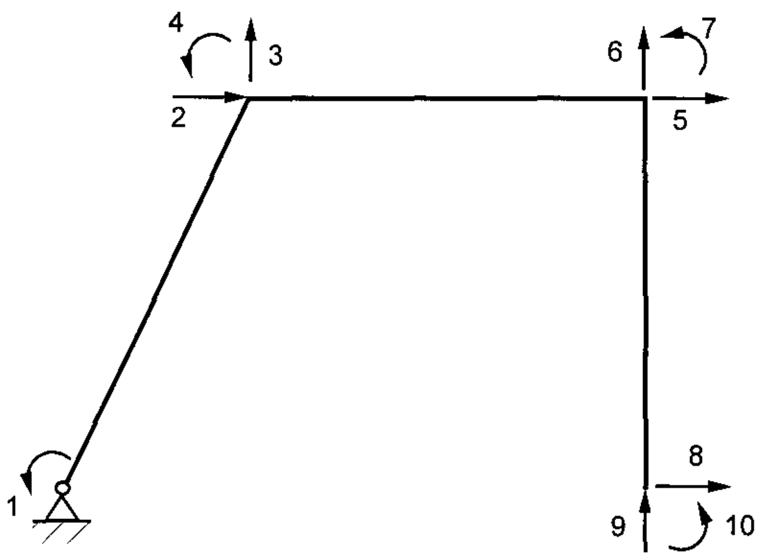
Suggestion: find the stiffness matrix for the simple cantilever to the right, then use the REZ transformation matrix to find the stiffness matrix for the beam with the rigid end.



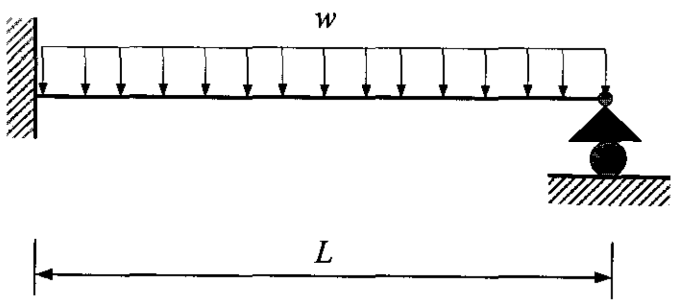
Problem 2. (30 points) Consider the two elements in the figure. The one to the left has rigid body modes; the one to the right is without rigid body modes. Find the transformation matrix Γ_{RBM} that governs the transformation between the two systems with the degrees of freedom numbered as in the figure.



Problem 3. (15 points) Consider the structure shown below. (**a**) If you assembled the 10 x 10 stiffness matrix of the 10 unrestrained degrees of freedom and tried to invert it, what would happen? Why? (**b**) If you found the eigenvalues and eigenvectors (mode shapes) of the 10x10 stiffness matrix of the 10 unrestrained degrees of freedom, can you give one "easy" eigenvalue and sketch the corresponding mode shape?



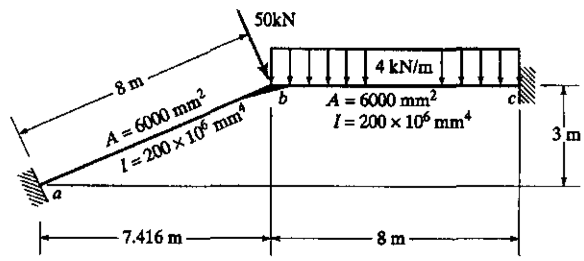
Problem 4: (30 points) Consider the beam shown. Using the strong form of the problem (beam differential equation + boundary conditions), find the end shears V_1 and V_2 and the end moment M_1.



Problem 5: (30 points) The structure shown below was solved using the matrix displacement method ($E = 200{,}000\ MPa$). The resulting unknown displacements were found to be:

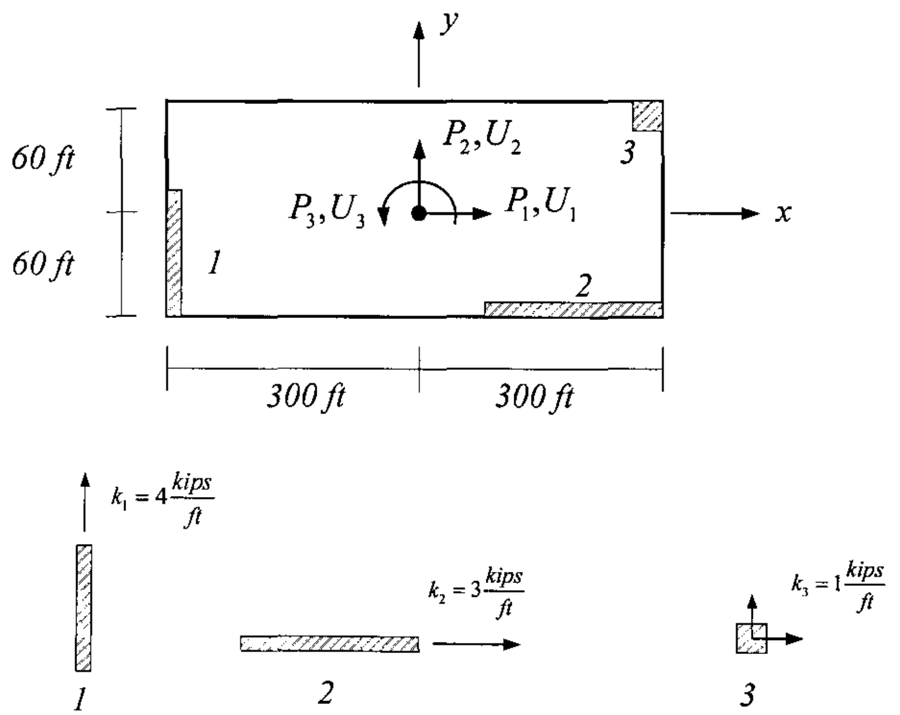
$$\begin{Bmatrix} u_b \\ v_b \\ \theta_b \end{Bmatrix} = \begin{Bmatrix} 0.09982\ mm \\ -4.996\ mm \\ -0.000534\ rad \end{Bmatrix}$$

Write down the matrix expression for the element end forces of element bc. Write down the expressions for the six element forces as a function of E, A, I, L, w, u_b, v_b, θ_b, **but do not substitute the numerical values.**



Problem 6: (30 points)

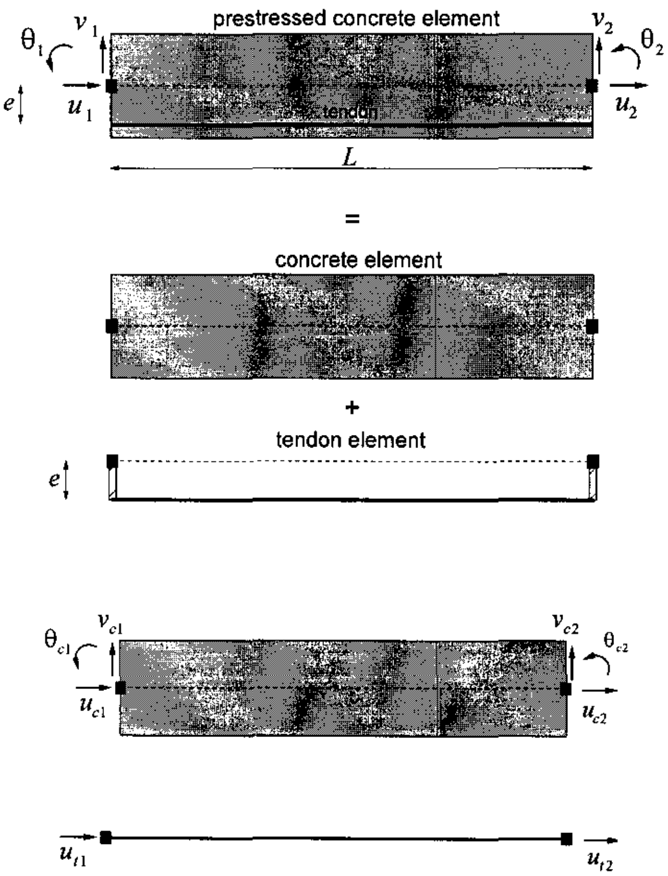
Consider the roof slab that is supported by two walls and one column. The walls only have stiffness in their plan; the column has equal stiffness in the two directions. The walls and column have no stiffness when twisted. The roof is loaded in the transverse direction by a load $P_2 = 20\,kips$. Determine the translations and rotation of the roof and the forces in the walls and column.



Bonus (30 points) Consider the 2-node prestressed concrete element below. It has a total of six degrees of freedom, three per node. The tendon has a constant eccentricity e. The element can be seen as the sum of two elements: 1) a concrete element and 2) a tendon (bar) element with two rigid end zones. You are given the stiffness matrices of the concrete element and of the bar element without the rigid end zones. Derive:

a) the stiffness matrix for the tendon element with rigid end zones;

b) the stiffness matrix of the prestressed concrete element.



$$
\mathbf{k}_c = \begin{bmatrix}
\frac{EA_c}{L} & 0 & 0 & -\frac{EA_c}{L} & 0 & 0 \\
0 & \frac{12EI_c}{L^3} & \frac{6EI_c}{L^2} & 0 & -\frac{12EI_c}{L^3} & \frac{6EI_c}{L^2} \\
0 & \frac{6EI_c}{L^2} & \frac{4EI_c}{L} & 0 & -\frac{6EI_c}{L^2} & \frac{2EI_c}{L} \\
-\frac{EA_c}{L} & 0 & 0 & \frac{EA_c}{L} & 0 & 0 \\
0 & -\frac{12EI_c}{L^3} & -\frac{6EI_c}{L^2} & 0 & \frac{12EI_c}{L^3} & -\frac{6EI_c}{L^2} \\
0 & \frac{6EI_c}{L^2} & \frac{2EI_c}{L} & 0 & \frac{6EI_c}{L^2} & \frac{4EI_c}{L}
\end{bmatrix}
\qquad
\mathbf{k}_t = \begin{bmatrix}
\frac{EA_t}{L} & -\frac{EA_t}{L} \\
-\frac{EA_t}{L} & \frac{EA_t}{L}
\end{bmatrix}
$$