.มหาวิทยาลัยสงขลานครินทร์

คณะวิศวกรรมศาสตร์

สอบกลางภาค ประจำภาคการศึกษา 1 ปีการศึกษา 2559

วันที่ 10/10/ 2559 เวลา 13.30-16.30 น.

วิชา 220-501 *Matrix Structural Analysis*

ห้องสอบ S203

ชื่อ-สกุล..... รหัส.....

คำชี้แจง

1.ข้อสอบทั้งหมดมี 6 ข้อ คะแนนรวม 240 คะแนน ดังแสดงในตารางข้างล่าง

2.ข้อสอบมีทั้งหมด 6 หน้า ผู้สอบต้องตรวจสอบว่ามีครบทุกหน้าหรือไม่ (ก่อนลงมือทำ) และห้ามแกะหรือฉีกข้อสอบออกจากเล่ม

3.ให้ทำหมดทุกข้อลงในสมุดคำตอบ

4. **ทุจริตจะได้ E**

5.อนุญาตให้ใช้เครื่องคิดเลขได้ทุกชนิด

6.กระดาษทดที่แจกให้ไม่ต้องส่งคืน ถ้าไม่พอขอเพิ่มที่อาจารย์คุมสอบ

7.ห้ามหยิบ หรือยืมสิ่งของใดๆ ของผู้อื่นในห้องสอบ

8. อนุญาตให้นำ ***Dictionary*** เข้าห้องสอบได้

9. **All books allowed**

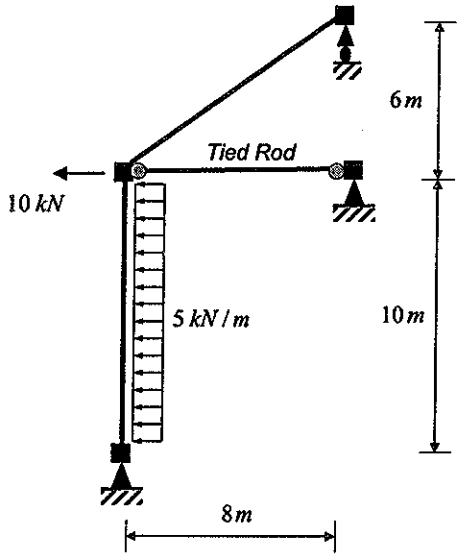
10. ***GOOD LUCK***

ตารางคะแนน

ข้อที่	คะแนนเต็ม	ได้
1	40	
2	40	
3	40	
4	40	
5	40	
6	40	
รวม	240	

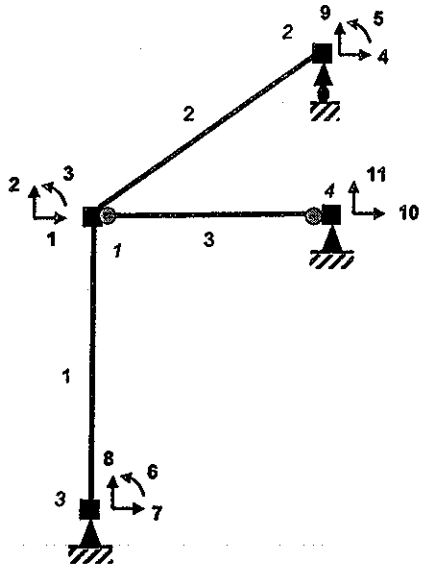
Lecturer: Assoc. Prof. Dr. Suchart Limkatanyu

Problem 1: (40 points)

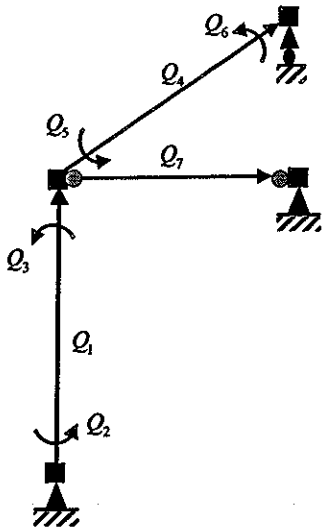


For the frame structure with tied rod shown above, you are asked to

(a) Formulate the equilibrium equations at unconstrained degrees of freedom corresponding to the given numbering systems.



Member, node, and DOFs numbering systems



Basic Member Force numbering system

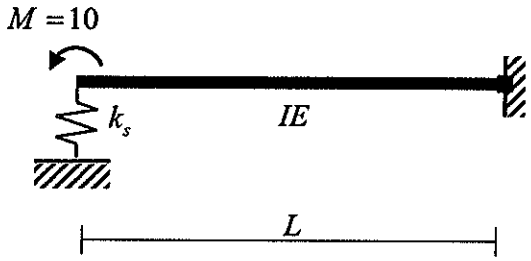
(b) Given the axial force in the tied rod with value of 38.1 kN. Use this given basic force to solve the other unknown forces and support reactions.

Problem 2: (40 points)

Consider the beam shown.

(a) Write down all essential and natural boundary conditions

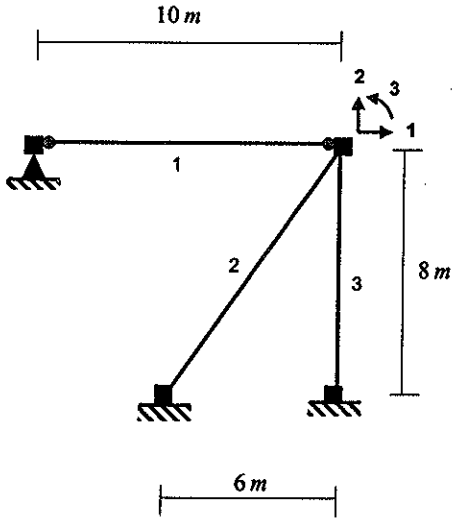
(b) Use the strong form of the problem (beam differential equation + boundary conditions) to find the transverse displacement, transverse shear force, and moment fields as well as support reactions.



$$IE = 100; L = 10; k_s = 10;$$

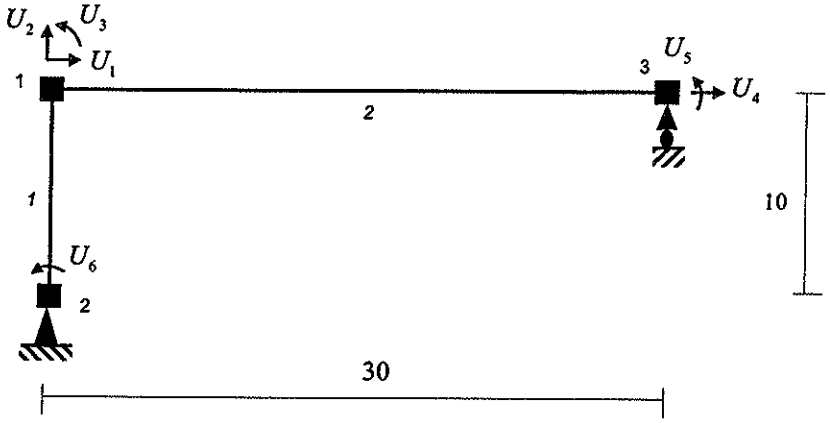
Problem 3: (40 points)

Assume that axial deformations are significant in all members. Identify the basic member deformations based on the simply-supported beam model and set up the structural compatibility equations associated with free degrees of freedom.

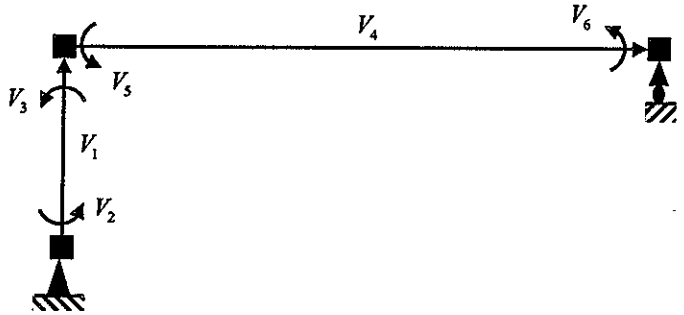


Problem 4: (40 points)

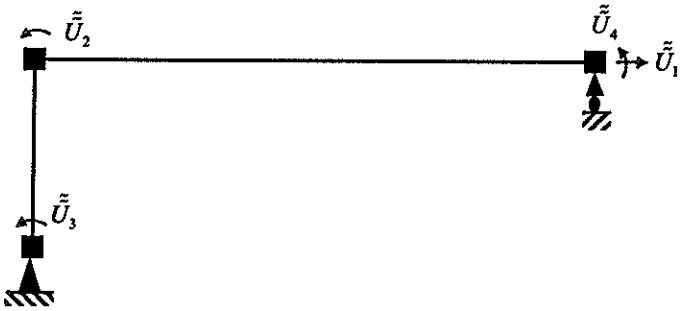
For the frame structure shown,



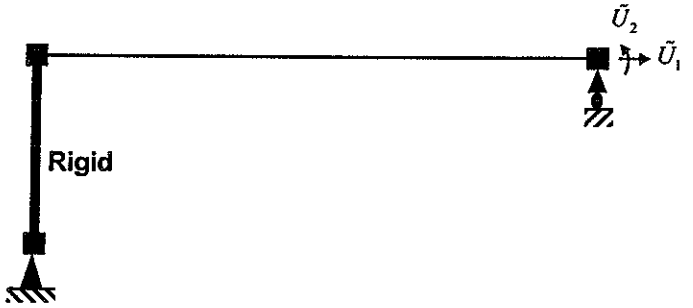
(a) With the given basic member deformation system, set up the structural compatibility equations associated with free degrees of freedom.



(b) If members 1 and 2 have very large axial stiffness and can be assumed as inextensible, show that the degree-of-freedom number can be reduced from 6 to 4 using the inextensible constraints and modify the structural compatibility equations obtained in (a) to account for the inextensible constraints.



(c) When member 1 is rigid and member 2 is inextensible, show that there are only two free degrees of freedom and modify the structural compatibility equations obtained in (b) to account for the inextensible constraint of member 1.

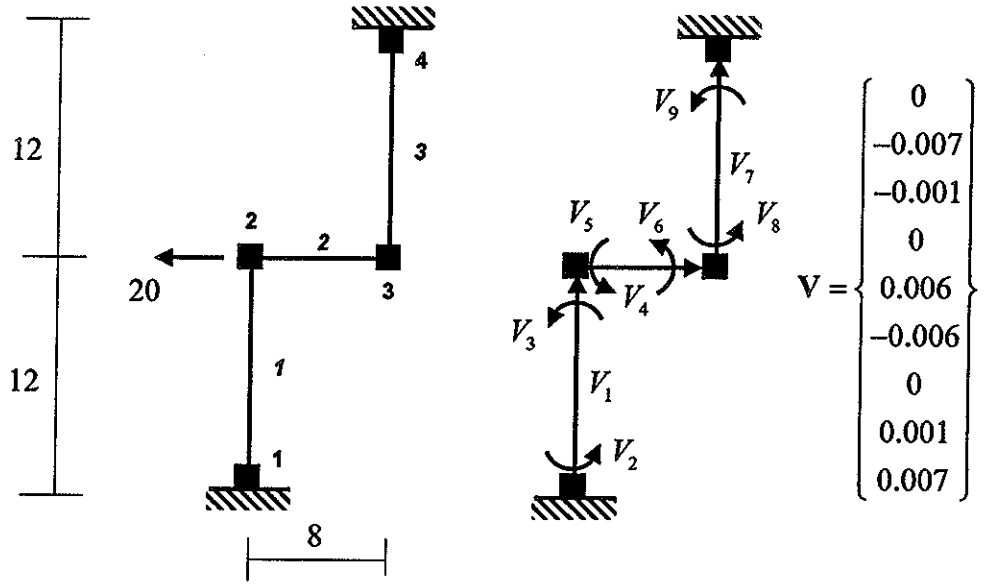


Problem 5: (40 points)

The inextensible frame shown is subjected to a horizontal force of 20 units at node 2. All basic member deformations are collected in $\mathbf{V}$. Use the virtual force principle to compute:

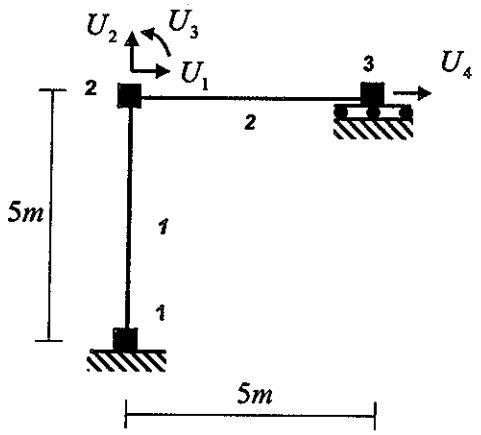
(a) The horizontal displacement at node 2

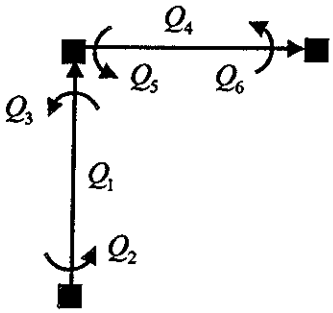
(b) The rotation at node 3



Problem 6: (40 points)

The frame structure shown below is applied by a horizontal force at node 2. Given the basic member forces $\mathbf{Q}$, determine the magnitude of the horizontal force at node 2 by the virtual displacement principle.





$$\mathbf{Q} = \begin{Bmatrix} 59.914\,kN \\ 300.108\,kN-m \\ 199.892\,kN-m \\ 0 \\ -199.892\,kN-m \\ -99.676\,kN-m \end{Bmatrix}$$