มหาวิทยาลัยสงขลานครินทร์

คณะวิศวกรรมศาสตร์

สอบกลางภาค ประจำภาคการศึกษา 2 ปีการศึกษา 2555

วันที่ 20/2/2013 Room S817: 9-12

วิชา **CE 220-504: Introduction to Finite Element Method**

ชื่อ-สกุล.....

รหัส.....

คำชี้แจง

1.ข้อสอบทั้งหมดมี 5 ข้อ คะแนนรวม 140 คะแนน ดังแสดงในตารางข้างล่าง

2.ข้อสอบมีทั้งหมด 5 หน้า (รวมปก) ผู้สอบต้องตรวจสอบว่ามีครบทุกหน้าหรือไม่ (ก่อนลงมือทำ)

3.ให้ทำหมดทุกข้อลงในสมุดคำตอบ

4.อนุญาตให้ใช้เครื่องคิดเลขได้ทุกชนิด

5.ห้ามหยิบ หรือยืมสิ่งของใดๆ ของผู้อื่นในห้องสอบ

6. ***Open Books***

7. ***GOOD LUCK***

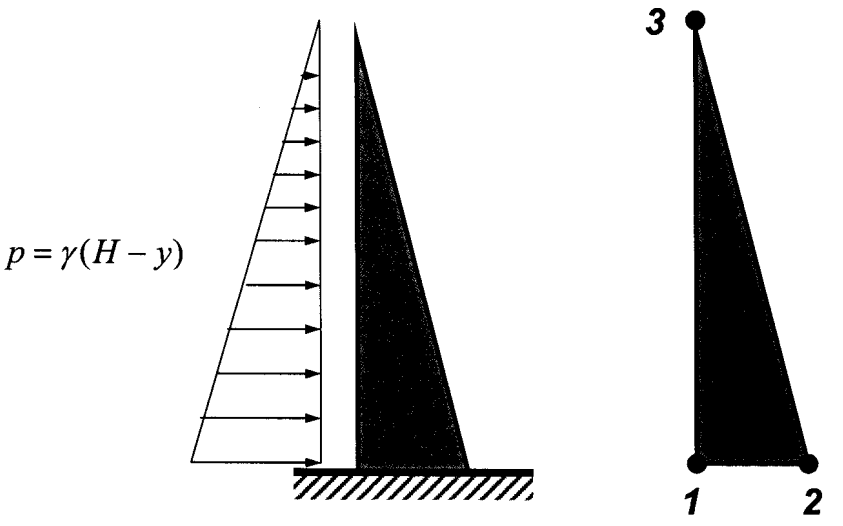
ตารางคะแนน

ข้อที่	คะแนนเต็ม	ได้
1	20	
2	20	
3	20	
4	20	
5	20	
รวม	100	

Problem 1: (20 Points)

A concrete dam is modeled with only ***one triangular*** element as shown in the figure. The vertical face is subjected to water pressure that varies linearly with the height. The height of dam H = 10 m and the base width is 1 m. Use the following numerical data.

$$E = 10\,GPa; \quad \upsilon = 0; \quad \rho = 1\,Mg/m^3; \quad g = 10\,m/s^2$$



(i) Derive the equivalent nodal load vector due to the water pressure

(ii) Would you model the situation as a plane stress or plane strain?

(iii) Determine the nodal deflections. Regardless of your answer to (i), assume that the load vector is as follows.

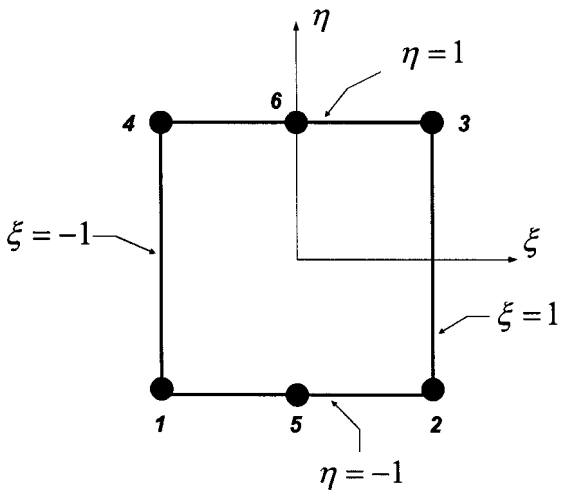
$$\mathbf{f} = \gamma H^2 \lfloor 2 \quad 0 \quad 0 \quad 0 \quad 1 \quad 0 \rfloor^T$$

(iv) Compute the stress components at node 2. Regardless of your answer to (ii), assume that the nodal displacements (in meters) are as follows.

	x-coordinate	y-coordinate	u	v
1	0	0	0	0
2	1	0	0	0
3	0	10	1/250	1/500

Problem 2: (20 Points)

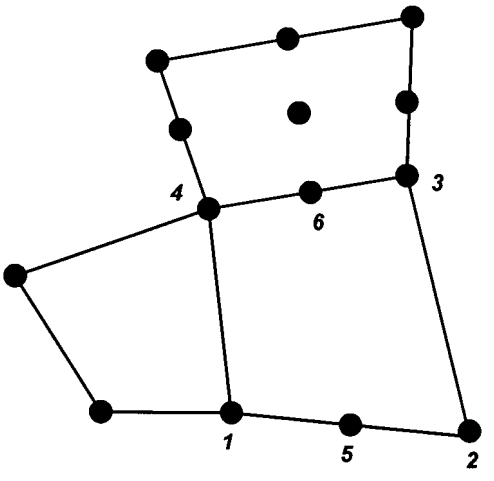
The plane stress isoparametric quadrilateral element shown in figure below has 6 nodes: four at the corners and two at the midpoint of the sides 1-2 and 3-4, respectively. The quadrilateral coordinates of nodes 5 are $\xi = 0$, $\eta = -1$ and that of node 6 are $\xi = 0$, $\eta = 1$.



(a) Following the shape function magic, construct the interpolation functions for this element.

(b) Check whether the $\psi_1^e(\xi,\eta)$ constructed in (a) satisfies C^0 continuity along the sides that contain node 4, namely 1-4 and 4-6-3 in the sense that the polynomial variation along those sides has sufficient number of nodes to define its variation.

(c) Suppose that this element is connected to a 4-node bilinear quadrilateral along side 1-4 and to a 9-node biquadratic quadrilateral along side 4-6-3 as shown below. Will compatibility be satisfied along those two sides ?



Problem 3: (20 Points)

(a) Who is the German scientist shown in the figure below?

(b) What is the relevant of his work in the context of the finite element method? State his contribution using the mathematical language.

Problem 4: (20 Points)

(i) The virtual displacement principle is a particular case of the virtual work principle (true (T) or false (F)).

(ii) In the virtual displacement principle, the material may be linear, nonlinear elastic, or inelastic (true (T) or false (F)).

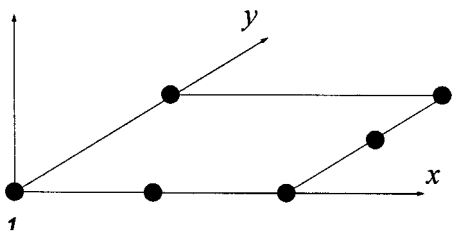
(iii) The virtual displacement principle assures that approximate solutions satisfy the differential equations of equilibrium everywhere (true (T) or false (F)).

(iv) We have complete freedom about the choice of a virtual displacement field (true (T) or false (F)).

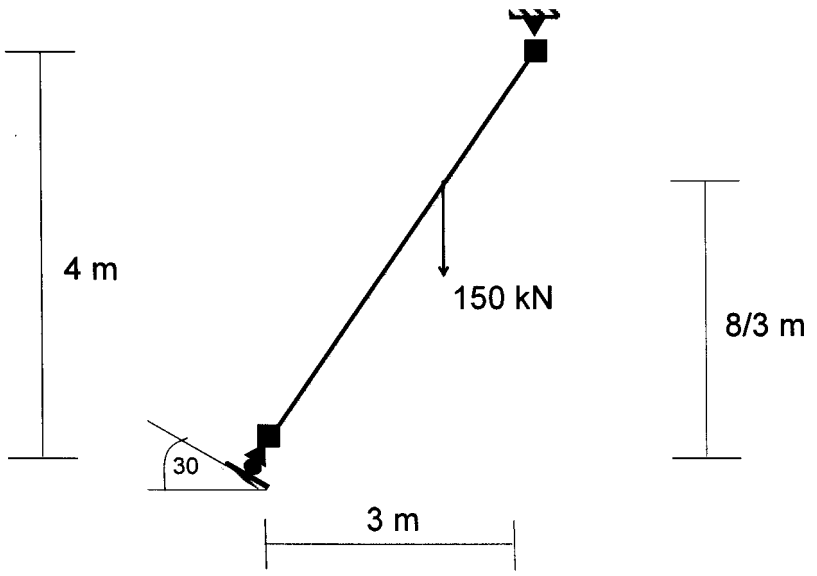
(v) A 1–point Gauss quadrature is always satisfactory for a 4-node, 2D isoparametric element (true (T) or false (F)).

(vi) A 2x2 Gauss quadrature is always satisfactory for a 8-node, 2D isoparametric element (true (T) or false (F)).

(vii) Sketch the shape function for node 1 of the 6-node, 2D isoparametric element.



Problem 5: (20 Points)



A 300 mm-wide and 100 mm-thick bar is supported and loaded as shown in the above figure. Compute displacements and rotations at both ends with respect to the global axes, shear force, and bending moment. Assume E = 10 GPa.