มหาวิทยาลัยสงขลานครินทร์

คณะวิศวกรรมศาสตร์

สอบกลางภาค ประจำภาคการศึกษา 2 **ปีการศึกษา 2549**

วันที่ 18/12/ 2549 **เวลา 13.30 – 16.30 น.**

วิชา 220-602 *Earthquake Engineering*

ห้องสอบ A401

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

คำชี้แจง

1.ข้อสอบทั้งหมดมี 5 ข้อ คะแนนรวม 150 คะแนน ดังแสดงในตารางข้างล่าง

2.ข้อสอบมีทั้งหมด 5 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. **All books allowed**

10. ***GOOD LUCK***

ตารางคะแนน

ข้อที่	คะแนนเต็ม	ได้
1	30	
2	30	
3	30	
4	30	
5	30	
รวม	150	

Lecturer: Asst. Prof. Dr. Suchart Limkatanyu

Problem 1. (30 points)

Answer the following questions in a very concise manner (no more than 50 words for each question). You may employ diagrams if needed.

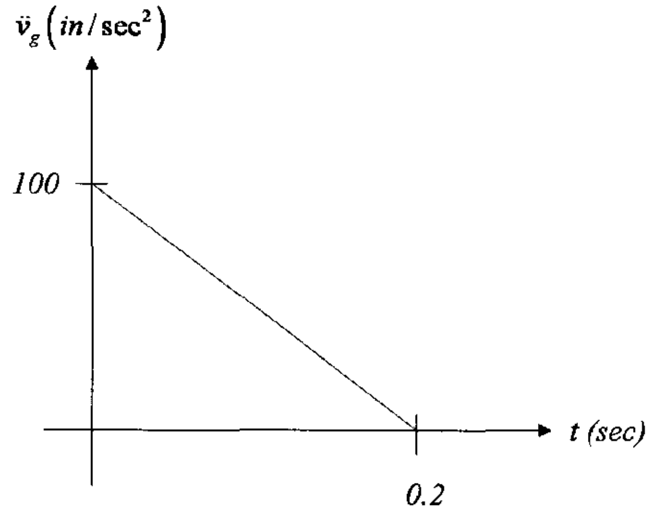
(a) Why does one need to define an effective peak ground acceleration rather than using the actual peak acceleration?

(b) The return period of a design earthquake is 800 years. What is the probability of exceedance for an earthquake of this level in 100 years?

(c) The damage of a structure induced by an earthquake depends very much on the properties of the earthquake ground motion. List four parameters of an earthquake ground motion which you think are most influential on damage and explain why.

Problem 2. (30 points)

A single-story shear frame has $m = 2\,\frac{kips - \sec^2}{in}$, $k = 400\,\frac{kips}{in}$, and damping equal to zero. The frame has zero initial displacement and velocity and is subjected to the ground acceleration shown below. Derive a closed-form expression for the displacement response of the frame for $t \le 0.2\sec$.



Problem 3. (30 points)

The explicit form of the Newmark Integration scheme is given as follows.

$$m\ddot{v}_{i+1} + kv_{i+1} = f_{i+1}$$

$$v_{i+1} = v_i + \Delta t\dot{v}_i + \frac{(\Delta t)^2}{2}\ddot{v}_i$$

$$\dot{v}_{i+1} = \dot{v}_i + \Delta t\left[(1-\gamma)\ddot{v}_i + \gamma\ddot{v}_{i+1}\right]$$

(a) Explain in algorithmic form how you will solve the equation of motion with the above method.

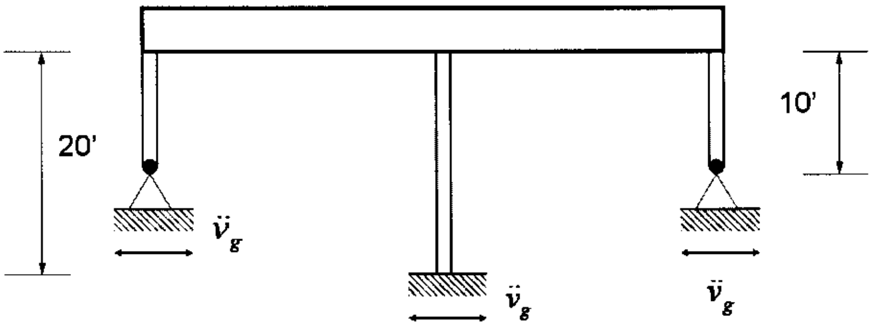
(b) If you want to solve Problem 2 with this method, what is the γ value you will choose and explain why. What are the main considerations in choosing Δt?

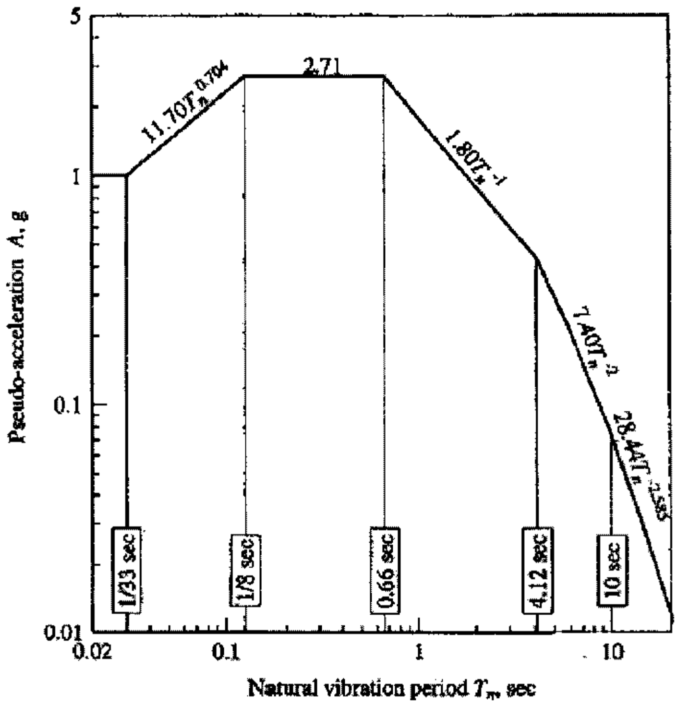
(c) With the value of γ picked in part (b) and $\Delta t = 0.02$ sec, compute the displacement response of the structure in Problem 2 at $t = 0.04$ sec. Tabulate all relevant numerical results obtained in each step of your computation.

Problem 4. (30 points)

In the structure shown below, the columns are made from steel members W14×82 sections ($E = 30000\ ksi; I = 882\ in^4$). The boundary conditions are as shown (exterior columns pinned and center column fixed), and the beam may be assumed to be rigid ($I_{beam} = \infty$). The weight of the structure, lumped at the beam level, is 1000 kips. Assuming that the structure remains elastic, compute the peak horizontal displacement u_0 of the beam and bending moments in the columns (draw the bending moment diagram). Use the elastic design spectrum shown below, scaled to PGA = 0.5 g

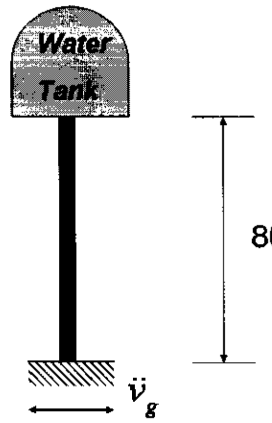
Hint: The bending moment at the base and top of the center column may be computed as $M = \left(6\frac{IE}{L^2}\right)u_0$.





Elastic Pseudo-Acceleration Design Spectrum ($\ddot{u}_{go} = 1g$)

Problem 5. (30 points)



(a) A full water tank is supported on an 80-ft-high cantilever tower. It is idealized as an SDOF system with weight $w = 100\,kips$ and lateral stiffness $k = 4\,kips/in$. The tower supporting the tank is to be design for ground motion characterized by the design spectrum of **Problem 4**, scaled to 0.5 g peak ground acceleration. Determine the design value of the lateral deformation and base shear.

(b) The deformation computed for the system in Part (a) seemed excessive to the structural designer so he decided to stiffen the tower by increasing its size. Determine the design value of the lateral deformation and base shear for the modified system if its modified lateral stiffness $k = 8\,kips/in$. Comment on how stiffening the system has affected the design requirements. What is the disadvantage of stiffening the system?