Structural Dynamics
構造動力学
(1)

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INTRODUCTION

- Structural dynamics is basis for the analysis of structures under non-static loads, that is, dynamic loads.

- The structural dynamics is applied for analysis of structures subjected to earthquake loads, wind loads, vibration control, blasting loads.

- In particular, because earthquake loads control construction of structures in earthquake prone countries including Japan, structural dynamics is essential for mitigating damage of structures and loss of lives.

- In this lecture, basics of structural dynamics is introduced with emphasis on application to seismic design of structures.

SCHEDULE

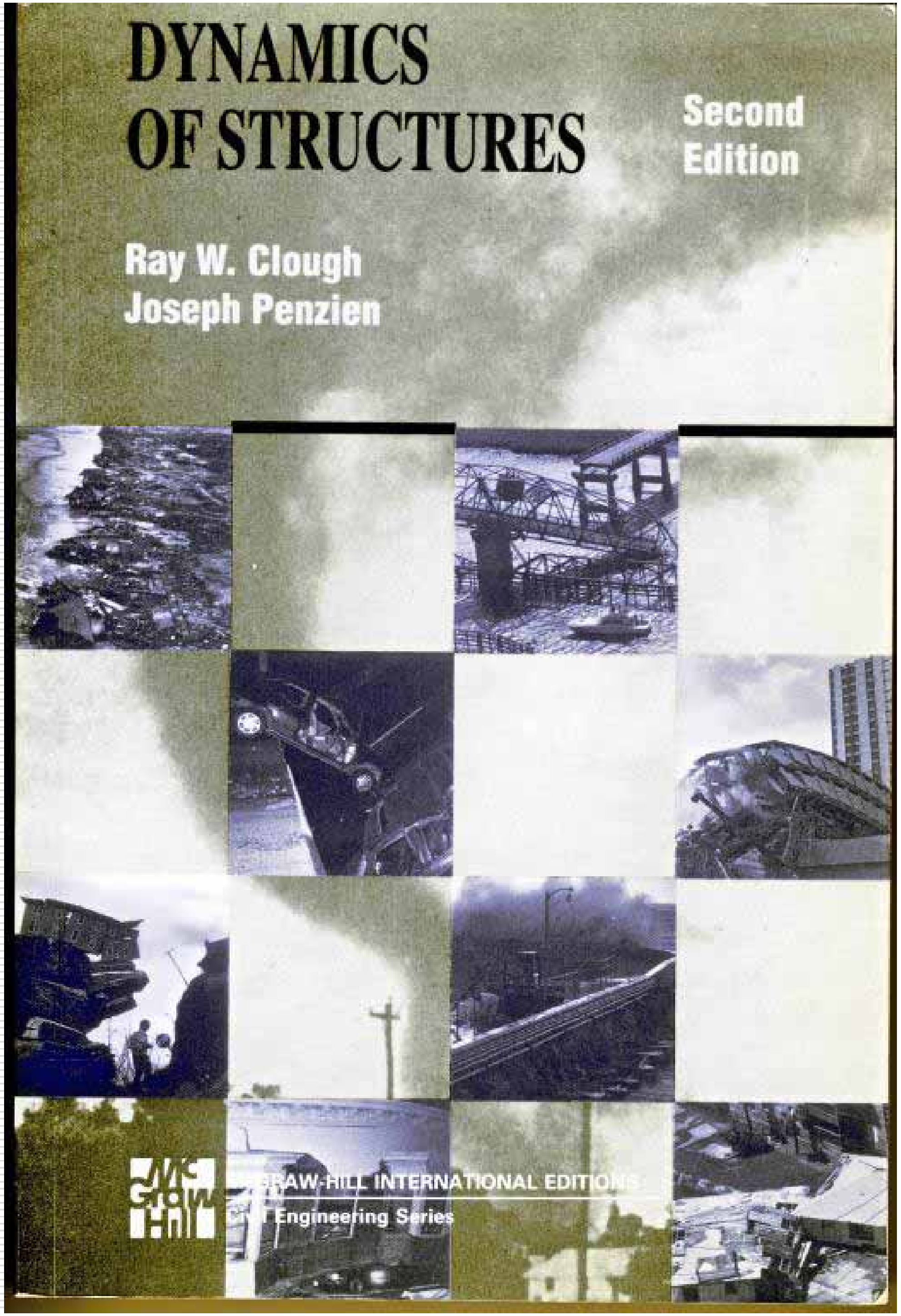
- 1st: April 10 (Tue)
- 2nd: April 17 (Tue)
- 3rd: April 24 (Tue)
- 4th: May 1 (Tue)
- 5th: May 8 (Tue)
- 6th: May 15 (Tue)
- 7th: May 22 (Tue)

- 8th: May 29 (Tue)
- 9th: June 5 (Tue) , Mid-term evaluation
- 10th: June 12 (Tue)
- 11th: June 19(Tue)
- 12th: June 26 (Tue)
- 13th: July 3(Tue)
- 14th: July 10(Tue)
- 15th: July 24 (Tue)
- Final Exam: Scheduled on July 31(Tue)

All classes are provided at 13:20-14:50.

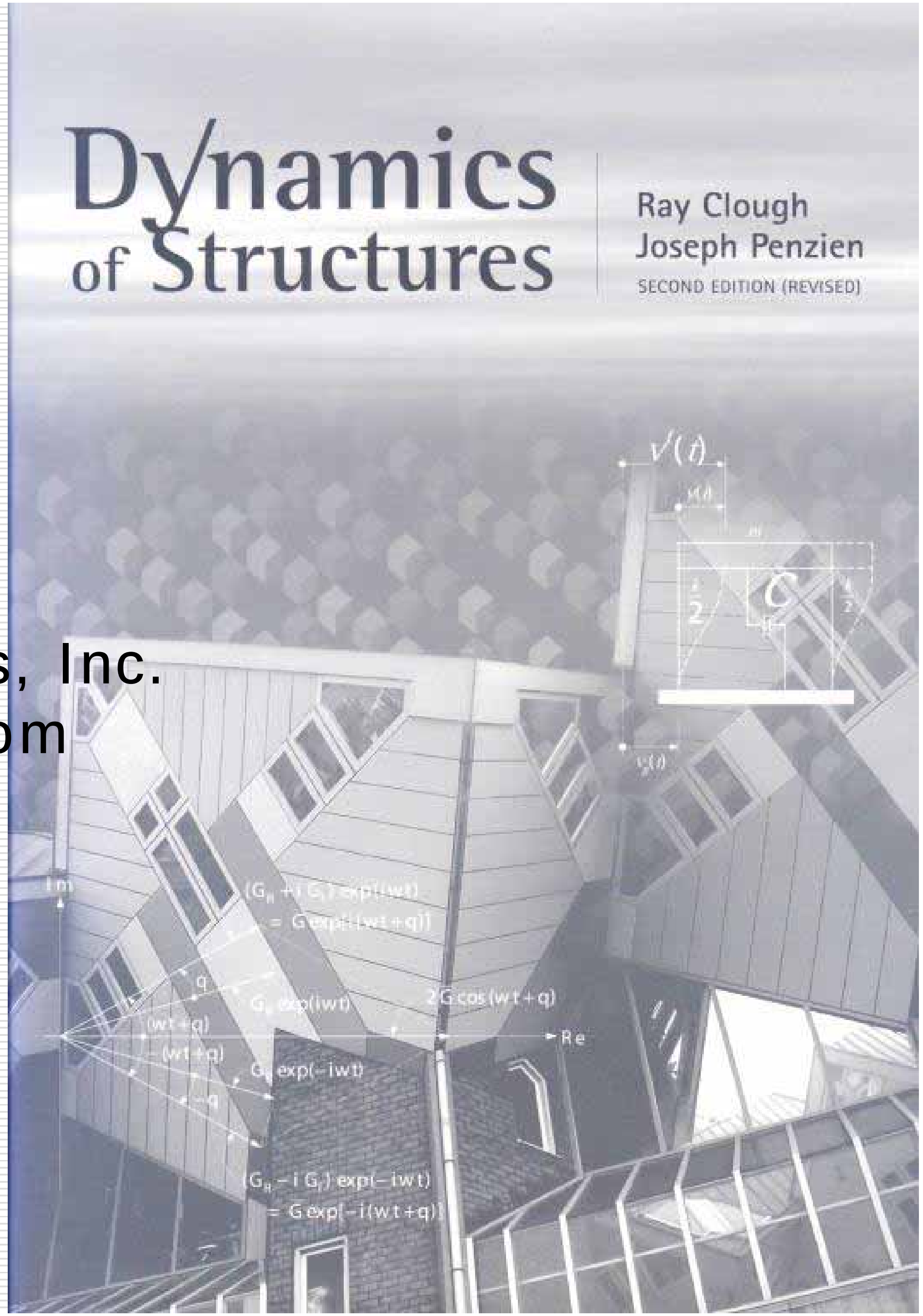
TEXT

Dynamics of Structures
by
Ray W. clough
and Joseph Penzien
University of California,
Berkeley



Revised version

Computers and Structures, Inc.
http://www.csiberkeley.com



Structural Dynamics

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3.3 Resonance Response

Chapter 4 Response to General Dynamic Loading: Superposition Methods一般的な荷重に対する応答 (重ね合わせ法に基づく) (4,5)

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4.3 Response of SDOF System to Earthquake Ground Motions (地震動を受ける1自由度系の応答)

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6.2 Equations of Motion for Multi-Degree-of-Freedom System without Damping (多自由度系（非減衰系）の運動方程式)

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7.4 Accuracy of Computed Responses (**解析結果の精度**)

7.5 Improvement of Accuracy of Solutions

CHAPTER 1 OVERVIEW OF STRUCTURAL DYNAMICS

1.1 FUNDAMENTAL OBJECTIVE OF STRUCTURAL DYNAMICS ANALYSIS

- Earthquake loading
- Wind loading
- Bombing
- Vibration and noise pollution
- ….

1.5 DIRECT EQUILIBRIUM USING d'ALEMBERT's PRINCIPLE (ダランベールの法則)

●The equations of motion of any dynamic system can be represented by Newton's second law of motion, which states that the rate of change of momentum of any mass particle m is equal to the force acting on it.

●The Newton's second law of motion is expressed mathematically by the differential equation as

$$\mathbf{p}(t) = \frac{d}{dt}\left(m \frac{d\mathbf{v}}{dt} \right) \qquad (1\text{-}3)$$

where, **p**(t) is the applied force vector and **v**(t) is the position vector of particular mass m.

● For most problems in structural dynamics, it may be assumed that mass does not vary with time, in which case Eq. (1.3) may be written

$$\mathbf{p}(t) = m\frac{d^2\mathbf{v}}{dt^2} = m\ddot{\mathbf{v}}(t) \qquad (1.3a)$$

where the dots represent differentiation with respect to time.

●Eq. (1.3a), indicating that force is equal to the product of mass and acceleration, may be written in the form

$$\mathbf{p}(t) - m\ddot{\mathbf{v}}(t) = 0 \qquad (1.3b)$$

in which, the second term $m\ddot{\mathbf{v}}(t)$ is called the inertial force (**慣性力**) resisting the acceleration of the mass.

- The concept that a mass develops an inertia force proportional to its acceleration and opposing is known as d'Alembert's principle (**ダランベールの法則**).
- The d'Alembert's principle is a very convenient concept in problems of structural dynamics because it permits the equations of motion to be expressed as equations of dynamic equilibrium.
- The force **p**(t) may be considered to include many types of force acting on the mass such as
  - ✓Elastic constraints which oppose displacements
  - ✓Viscous forces which resist velocities
  - ✓Independently defined external loads

- Thus if an inertia force which resists acceleration is introduced, the equation of motion is merely an expression of equilibration of all forces acting on the mass.

- In many simple problems, the most direct and convenient way of formulating the equations of motion is by means of such direct equilibrium.