

---

# **Advanced Environmental Engineering in River**

**2010.3**

**Norio Tanaka  
Graduate School of Science and Engineering,  
Saitama University**

## **Chapter 1 Fundamental equations (1) Equation of motion and conservation**

### **law of mass**

----- 1 - 9

- 1-1 Equations of motion
- 1-2 Lagrange differentiation (or substantial derivative)
- 1-3 Euler's equation of motion
- 1-4 Conservation law of mass (Continuity equation)
- 1-5 Depth-averaged continuity equation (velocity is constant at each height)
- 1-6 Kinematic wave approximation and Diffusion wave approximation coupling with the continuity equation

## **Chapter 2 Fundamental equations (2): Navier-Stokes equation and Reynolds equation**

----- 10 - 15

- 2-1 Navier-Stokes equation
- 2-2 Reynolds decomposition

## **Chapter 3 Fundamental equations (3)**

----- 16 - 35

- 3-1 Modeling of the Reynolds stress
- 3-2 Depth averaged momentum equation
- 3-3 Diffusivity term in horizontal plane
- 3-4 Introduction of the depth averaged equation in orthogonal grid system with vegetation
- 3-5 Derivation of the depth-averaged continuity equation in orthogonal grid system
- 3-6 Derivation of the depth-averaged momentum equation in orthogonal grid system

## **Chapter 4 Fundamental equations (4) Analytical solutions of wave motion equation in bay and lake: Oscillation problem**

----- 36 - 40

- 4-1 One-dimensional wave motion equation
- 4-2 Two-dimensional wave motion equation
- 4-3 Oscillation of a lake (Seiche)
- 4-4 Oscillation of a Bay

## **Chapter 5 Turbulence and the modeling of turbulent flow**

----- 41 - 55

- 5-1 d'Alembert's paradox, viscosity, drag force, boundary layer**
- 5-2 General law**
- 5-3 The stability of laminar flows and onset of turbulence**
- 5-4 Simple models of turbulent flow**
- 5-5 Eddy viscosity**
- 5-6 Turbulent-viscosity models**

## **Chapter 6 Introduction to environmental engineering in river and lake (1)**

----- 56 - 64

- 6-1 Fick's law, Fourier's law, Newton's viscosity law**
- 6-2 Turbulent diffusion (Reynolds decomposition, time-averaging, turbulent diffusion equation, turbulent diffusion coefficient)**
- 6-3 How to solve the differential diffusion equation: Example of the finite difference method**

## **Chapter 7 Steady flow in open channels**

----- 65 - 70

## **Chapter 8 Unsteady flow in open channels**

----- 71 - 86

- 8-1 Fundamental equations**
- 8-2 Differentiation of the fundamental equations**
- 8-3 How to solve the system equations**
- 8-4 Programming**

## **Chapter 9 Sediment transport and sediment properties**

----- 87 - 92

- 9-1 Production and transportation of sediment**
- 9-2 Bed formation**
- 9-3 Fall velocity of sediment particles**
- 9-4 Inception of sediment motion, occurrence of bed-load motion**
- 9-5 Inception of suspended load motion**
- 9-6 Bed-load transport**
- 9-7 Suspended-load transport**
- 9-8 Sediment budget**