Advanced Hydraulics 2013
VVRN01
Water Resources Engineering, Lund University

(In order to become registered for the course you have to sign up on the attendance list available at the lectures during the first two weeks. If you are unable to do this, please contact the course responsible)

Information about the course is available through various files in pdf-format at: http://www.tvrl.lth.se/utbildning/courses/vvrn01/

Teachers
Professor Magnus Larson (ML) (Magnus.Larson@tvrl.lth.se) - course responsible
Professor Lars Bengtsson (LB) (Lars.Bengtsson@tvrl.lth.se)
Professor Magnus Persson (MP) (Magnus.Persson@tvrl.lth.se)

Objectives
After the course the student should be able to apply the basic hydrodynamic equations to solve practical problems. The governing equations should be formulated for different physical problems by considering relevant terms. The emphasis is on hydrodynamic processes in nature, although the knowledge acquired is equally applicable to technical systems.

Requirements
In order to pass the course the student should be able to:

- explain the factors of importance for different flow phenomena and processes
- adapt the basic flow equations to describe these phenomena and processes
- evaluate the applicability and limitations of the theoretical solutions
Contents
Basic hydrodynamic equations in finite control volume and differential forms, boundary layers, special flows in nature, turbulence theory, free-surface flows with shallow-water equations, and groundwater.

Assignments
Two assignments that are compulsory are included in the course:

- 1-D model of the flow in a channel of varying cross section
- Water exchange in a small, shallow lagoon with tides and freshwater supply

Literature
Handwritten notes and excerpts from:


Different handouts and examples may be found on the home page for the course.

Structure of the course
Eight lecture blocks covering different topics and two sessions for the assignments.

Lecture and assignment room
Class room R1 in the V-building (Civil Engineering).

Lecture and assignment times
Lectures are always on Tuesdays and Thursday 8-10 in room R1 (except the first week when the Thursday lecture has been moved to Friday 8 Nov, 8-10, room R1.) Assignment sessions are also in R1 8-10 on the 29th of November and 6th of December.

Examination
There is a written exam at the end of the course, which constitutes the base for the grade. The exam contains five examples and no books are allowed. A list of formulas and equations are provided. The exam is given on the 20th of December between 9.00 and 12.00 in Room N1. Examples of old exams may be found on the home page.
Detailed Course Content (Lecture Blocks)

1. **Basic equation, mass conservation** (29 Oct and 5 Nov; Magnus Larson, ML)
   *Vardy Chapter 6 + Handouts Continuity and Kinematic wave*
   - Control volume form - compressible and incompressible flows
   - Differential form - compressible and incompressible flows
   - Applications to different flow situations
   - Eulerian and Lagrangian description of fluid flow
   - Kinematic wave theory
   - Applications of kinematic wave theory

2. **Basic equation, momentum conservation** (7 Nov and 8 Nov; ML)
   *Vardy Chapter 7 + Chapter from Schlichting*
   - Control volume form
   - Differential form
   - Applications to different flow situations
   - Newton’s viscosity law, shear force, briefly turbulence
   - Navier-Stokes equations
   - Solutions to Navier-Stokes equations

3. **Special flows in nature** (12 Nov and 14 Nov; Lars Bengtsson, LB)
   *Handout Special flows*
   - Examples from meteorology
   - Examples from oceanography
   - Special flow phenomena
   - Seiching
   - Lake circulation

4. **Shallow water equations** (19 Nov; ML)
   *Chapter from Liggett, Handout Shallow water equations*
   - Integration over flow cross section (Leibniz rule)
   - Governing equations (one- and two-dimensions in space)
   - Examples of shallow water equations
   - Applications to different flow situations

5. **Energy equation** (21 Nov; LB)
   *Handout Energy equation*
   - Control volume form
   - Differential form
   - Applications to different flow situations
6. **Open channel flow** (26 Nov and 28 Nov; ML)  
*Chapter from Miller and Cunge + Chapter from Dean and Dalrymple*
   a. Simplified equations  
   b. Non-uniform flow  
   c. Dynamic and kinematic equations  
   d. Routing methods  
   e. Flow between lakes  
   f. Coastal lagoons

7. **Turbulence** (3 Dec and 5 Dec; LB)  
*Handout Turbulence*
   a. Eddy viscosity  
   b. Mixing length theory  
   c. Velocity profiles  
   d. Shear dispersion  
   e. Longitudinal dispersion  
   f. Entrainment in stratified flow  
   g. Atmospheric boundary layers

8. **Groundwater** (10 Dec; Magnus Persson, MP)  
*Handout Groundwater*
   a. Darcy law and applications  
   b. Transient flow

9. **Repetition** (12 Dec; ML)