Postgraduate Studies Program
«ENVIRONMENTAL ENGINEERING»

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| Code: GEnvE 884 | Course: Computational Hydraulics |

Instructor: Professor I. K. Tsanis
Computer Lab Assistant: Dr. Anthi-Eirini Vozinaki

Course Objective

The main objective of this course is to train students to use scientific principles and tools in order to understand and solve problems in computational and applied hydraulics. Advanced mathematical/numerical concepts are applied in solving examples in hydraulics such as:

- Calculation of normal depth in a trapezoidal channel
- Velocity distribution of a steady turbulent flow in an open channel
- Flow velocity calculation in specific depth from field measurements
- Reservoir overflow weir calculation for various water levels
- Water volume calculation collected in an upstream dam
- Surface profile calculation in a trapezoidal channel
- Reservoir inflow hydrograph calculation
- Calculating the time required to empty the water from a cylindrical tank
- Calculate flow distribution in a steady flow
- Velocity profile evolution between two plates with an explicit shape
- Propagation of a function that satisfies the color equation

Numerical analysis and hydraulics issues are examined and applied in FORTRAN programming language.

Course Content

1st Week:
Mathematical models and simulation of hydraulic systems. Introduction to FORTRAN. Error transition theory.
Computational hydraulics Exercises (Exercise 1)

2nd Week:
Computational hydraulics exercises (Exercise 2)

Computer Project CP1: Calculation of normal depth in a trapezoidal channel by using partitioning method and Newton-Raphson method (H/Y) (Non-linear algebraic equation)
3rd Week:

**Computer Project CP2:** Solving a system of linear equation with Gauss elimination method and iterative Gauss-Seidel method (H/Y) (Linear algebraic equations)

4th Week:

Computational hydraulics exercises (Exercises 3, 4, 5, 6)

5th Week:

**Computer Project CP3:** Flow velocity distribution in permanent turbulent flow in an open channel (H/Y)  
Computational hydraulics exercises (Exercises 7, 8, 9) (Curve fitting: regression)

6th Week:

**Computer Project CP4a:** Flow velocity computation in specific depth from field measurements (H/Y)  
**Computer Project CP4b:** Reservoir overflow calculation for various water levels (H/Y)  
Computational hydraulics exercises (Exercise 10) (Interpolation)

7th Week:

**Computer Project CP5:** Water volume calculation collected in an upstream dam reservoir (H/Y)  
Computational hydraulics exercises (Exercises 11, 12, 13)  
(Numerical integration)

8th Week:

**Computer Project CP6a:** Surface profile calculation in a trapezoidal channel (H/Y)  
**Computer Project CP6b:** Reservoir inflow hydrograph calculation (H/Y)  
**Computer Project CP6c:** Calculating the time required to empty a cylindrical tank (H/Y)  
(Ordinary differential equations)

9th Week:

**Computer Project CP7:** Calculate speed dynamics in permanent flow (H/Y)  
(Elliptical partial differential equations)

10th Week:

**Computer Project CP8a:** Velocity profile changes calculation between two plates with an explicit shape (H/Y)  
**Computer Project CP8b:** Velocity profile changes calculation in relation to time using Crank-Nicolson method (H/Y) (Parabolic partial differential equations)

11th Week:

**Computer Project CP9:** “Color” equation calculation using explicit shape method and Lax – Wendroff method (H/Y) (Hyperbolic partial differential equations)

12th Week:

Computational hydraulics exercises (Exercises 14, 15, 16, 17)

13th Week:

Exercises in groups of 2-3 students. Presentation of technical reports

**Evaluation**

1. Reports for each one of the Computer Projects in FORTRAN programming language (40%)
2. Computational hydraulics exercises in student groups (60%)