

SCHOOL OF ENGINEERING  
UNIVERSITY OF GUELPH  
**WATERSHED SYSTEMS DESIGN**  
**ENGG \*4250**  
COURSE OUTLINE  
Winter 2009  
Instructor: Doug Joy

**Calendar Description**

Hydrological analysis of watershed systems including stream flow for design of structures and channels, flood warning, flood plain mapping, low-flow characteristics. Hydraulic analysis applied to design of dams, reservoirs, control structures, energy-dissipation structures, bridges and culverts. Analysis of steady-flow profiles, flood waves, and sediment transport, for design of natural and constructed channels, and protective works for rivers to achieve environmentally sustainable land use in watershed systems.

**Prerequisites** ENGG\*2230 and ENGG\*3650

**Detailed Objectives**

At the successful completion of this course, the student will have demonstrated ability to:

- (i) Apply hydrological techniques to obtain flow volumes and flow rates for design of conveyance and storage systems used in management of watershed flows.
- (ii) Apply the laws of conservation of mass, energy and momentum to the analysis of hydraulic conditions in conduits, open channels, control structures and storage facilities.
- (iii) Translate water-related needs into system performance criteria for design purposes.
- (iv) Design open channel networks for water conveyance and storage.
- (v) Employ standard software in the solution of flow problems and in design calculations.

**Subject Matter**

*Hydrological Calculations* - modelling of flowrates and flow volumes from watersheds for design.

*Application of Fluid Fundamentals* - viscosity, surface tension, pressure force, buoyancy; flow, energy head and head loss.

*Open Channel Flow* - flow classification, energy and momentum principles, uniform flow, gradually varied flow, geomorphological features of natural channels.

*Hydraulic Structures* - dams and reservoirs, weirs and flumes, spillways and chutes, stilling basins and sediment traps, culverts, low-flow pipes and valves, pumps and turbines.

*Management of Watershed Systems* - flood warning, reservoir operations, operational procedures for optimum performance.

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**GTA:** Jennifer Drake email: jdrake@uoguelph.ca

### **Class time and Locations**

Lectures	Tue	8:30-9:50	MACK 235
	Thu	8:30-9:50	MACK 235
Laboratory	Thu	14:30 - 16:20	MACK 233

### **Textbooks and Reference Books**

The prescribed text is “Open Channel Hydraulics” by Sturm. In addition you will need to use a fluid mechanics text and a hydrology text such as those used in the prerequisite courses ENGG\*2230 and ENGG\*3650.

Reference books on reserve at the library are:

Bedient, P. B. 1992. *Hydrology and floodplain analysis*. McGraw-Hill New York.

Bureau of Reclamation. 1987. *Design of Small Dams*. 3rd Edition, U.S. Department of the Interior Denver.

Chow, V.T. 1959. *Open-Channel Hydraulics*. McGraw-Hill, New York.

Chow, V. T. 1988. *Applied hydrology*. Mc Graw-Hill.

Henderson, F.M. 1966. *Open Channel Flow*. Macmillan Publishing New York.

Hwang. N.C. 1986. *Fundamentals of Hydraulic Engineering Systems*. Prentice Hall New York.

Petersen, M.S. 1986 *River Engineering*. Prentice-Hall Toronto

## **Course Organization**

The proposed schedule of lecture topics is shown in Table 2. Lectures will be used for the presentation of new material while the tutorial/lab periods will be used for the assignments and questions relating to these and the projects.

There will be three design projects throughout the semester. Each of these projects will be completed in groups of two and each group will need to make a presentation to the class on one of the projects. You may select your own groups must be selected by January 12<sup>th</sup>, after that time groups will be assigned.

It is expected that students will devote a minimum of five hours per week (in addition to the scheduled time) to the course. Preparation for examinations will require additional time.

## **Examinations**

The final examination date is April 17<sup>th</sup>.

## **Basis of Course Grade**

Laboratory/tutorial assignments	-	15%
Projects (3 @ 15% each)	-	45%
Final examination	-	40%

You must obtain a passing grade (>50%) on the final exam to pass the course. If you do not, your final exam mark will be your final grade.

## **Individual Computational/Laboratory Assignments**

During the semester there will be approximately five laboratory/tutorial assignments. These will typically be available on Tuesday of the week they are assigned, discussed on the Thursday tutorial and be due the following Tuesday.

## Design Projects

Each of the three design reports will be presented in a suitable format such as that specified for course ENGG\*3100. Important dates for the projects are outlined in Table 1. With three design projects each group will be required to present their design solution to the class and be prepared to defend their design solution and calculations. Your presentation and ability to handle technical questions will make up part of your grade on the design report.

**Table 1: Project Dates**

<b>Design Project</b>	<b>Due Date</b>	<b>Presentation Date</b>
#1	Jan 30	Feb 5
#2	Feb 27	Mar 5
#3	Mar 27	Apr 2

**TABLE 2: Approximate Lecture schedule for ENGG\*4250 - Watershed Systems Design.**

<i>Lectures</i>	<i>Subject Matter</i>
6	Coverage in Fluid Mechanics and Hydrology of fluid properties, pressure forces, Bernoulli equation with headloss, runoff generation, hydrograph modelling, routing calculations.
9	Flow in channels (uniform flow, Chezy and Manning's equation, specific energy and specific force, subcritical, supercritical flow, hydraulic jump, flow profiles in gradually varied flow, optimal hydraulic shape, and computation for complex channels)
3	Geometry of natural channels, sediment transport equations, design of channels for natural function
5	Hydraulic structures and machinery (weirs, flumes, culverts, bridge openings, spillways, stilling basins, low-flow pipes, valves, pumps, turbines)
6	System operations (reservoir outlet sizing, operation rules for gated and ungated structures, flood forecasting, flood wave behaviour)
6	Watershed management including flood-zone mapping, flood damage mitigation by combinations of structural interventions and land-use regulation, conjugate use of surface and groundwater, mitigation of non-point-source pollution in channels and receiving water.