SAULT COLLEGE OF APPLIED ARTS AND TECHNOLOGY

SAULT STE. MARIE, ONTARIO

COURSE OUTLINE

COURSE TITLE: HYDRAULICS

CODE NO. : WTR330 **SEMESTER:** THREE

PROGRAM: ENVIRONMENTAL TECHNICIAN - WATER

AUTHOR: MARK SEELER

DATE: September 2012 **PREVIOUS OUTLINE DATED:**

APPROVED:

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CHAIR **DATE**

TOTAL CREDITS: FIVE

PREREQUISITE(S): PHY100 – Applied Physics I

HOURS/WEEK: FOUR

I. COURSE DESCRIPTION:

This course is an introduction to fluids their properties and coherent units of measurement, pressure, vapour pressure, vacuum, Pascal's Law with an emphasis on pressure measuring devices; buoyancy, Bernoulli's equation, flow of fluids, velocity and flow measuring instruments.

II. LEARNING OUTCOMES AND ELEMENTS OF THE PERFORMANCE:

Upon successful completion of this course, the student will demonstrate the ability to:

1. Introduction To Fluid Mechanics/Fluid Properties

Potential Elements of the Performance:

- Demonstrate an understanding of unit conversions related to fluids, extensive and intensive properties, homogeneous and non-homogeneous fluids and fluid characteristics such as:
  a. Unit Conversions related to fluids
  b. Extensive and intensive properties of fluids
  c. Homogeneous and non-homogeneous fluids
  d. Properties and characteristics of fluids such as mass / weight, flow of heat, viscosity, surface tension, vapour pressure and elasticity

2. Fluid Statics

Potential Elements of the Performance:

- Define and calculate pressure; absolute, gauge and vacuum.
- Analyze pressure variation with elevation
- Utilize the basic differential equation (equation of equilibrium) to solve complex problems
- Demonstrate an understanding of uniform density
- Demonstrate an understanding of the characteristics of compressible fluids and solve related problems
- Utilize manometers and other pressure measuring devices (Bourdon/Strain/Quartz gauges) and have a full understanding of how these devices work
- Illustrate understanding of hydrostatic forces on both plane and curved surfaces
- Demonstrate an understanding of Buoyancy and Stability of Immersed and Floating Bodies

3. Fluids in Motion

Potential Elements of the Performance:

- Define and understand velocity and flow including concepts such as Lagrangian and Eulerian viewpoints, streamlines and flow patterns, laminar and turbulent flow
- Utilize alternate methods to develop flow patterns: Analytical, Numerical and Experimental
- Define and illustrate understanding of volume rate of flow, as well as mean and average velocity
- Explain the concept of acceleration including normal and tangential components, Cartesian components, convective and local acceleration
- Define system, control volume and control surface in reference to the basic control volume approach
- Identify and differentiate between extensive and intensive properties
- Derive the control volume equations and illustrate understanding of the control volume equation for steady state flow
- Explain and utilize the general form of the continuity equation and the continuity equation for steady one dimensional flow in a conduit
- Explain the concept of rotation and vortices

4. Pressure Variation in Flowing Fluids

Potential Elements of the Performance:

- Explain the basic causes of pressure variation in a flowing fluid using examples that include pressure variation due to weight and acceleration
- Illustrate understanding and application of the Bernoulli Equation along a streamline and for irrotational flow
- Demonstrate problem solving skills utilizing the Bernoulli equation for complex problems

5. Momentum Principle

Potential Elements of the Performance:

- Derive and Utilize the momentum equation
- Illustrate the ability to interpret the momentum equation including the force terms, momentum accumulation, momentum flow, momentum diagrams
- Utilize the momentum equation for Cartesian coordinates
- Explain and demonstrate knowledge of the systematic approach
- Explain typical applications such as fluid jets, nozzles, vanes and pipes

- Utilize and understand the moment of momentum equation and the Navier-Stokes equation

III. TOPICS:

1. Introduction to Fluid Mechanics and Fluid Properties
2. Fluid Statics
3. Fluids in Motion
4. Pressure Variation in Flowing Fluids
5. The Momentum Principle

IV. REQUIRED RESOURCES/TEXTS/MATERIALS:

Crowe, Clayton T., Engineering Fluid Mechanics, 7th Ed., John Wiley and Sons, Inc, ISBN 0-471-38482-8

V. EVALUATION PROCESS/GRADING SYSTEM:

Type of Grading	Duration	Mark Breakdown	Topics
Term Test 1	**2.0 hours**	**20%**	**Introduction to Fluid Mechanics and Fluid Statics**
Term Test 2	**2.0 hours**	**20%**	**Fluids in Motion/Pressure Variation in Flowing Fluids**
Final Exam	**2.0 hours**	**30%**	**All course Material**
Quiz	**0.5 hours x4**	**10%**	**All course Material**
Homework, Laboratory Work, Attendance	**8.0 hours**	**20%**	**All Experiment assignments and attendance**

The following semester grades will be assigned to students:

Grade	Definition	*Grade Point Equivalent*
A+	90 – 100%	4.00
A	80 – 89%	
B	70 - 79%	3.00
C	60 - 69%	2.00
D	50 – 59%	1.00
F (Fail)	49% and below	0.00

CR (Credit)	Credit for diploma requirements has been awarded.
S	Satisfactory achievement in field /clinical placement or non-graded subject area.
U	Unsatisfactory achievement in field/clinical placement or non-graded subject area.
X	A temporary grade limited to situations with extenuating circumstances giving a student additional time to complete the requirements for a course.
NR	Grade not reported to Registrar's office.
W	Student has withdrawn from the course without academic penalty.

VI. SPECIAL NOTES:

Attendance:
Sault College is committed to student success. There is a direct correlation between academic performance and class attendance; therefore, for the benefit of all its constituents, all students are encouraged to attend all of their scheduled learning and evaluation sessions. This implies arriving on time and remaining for the duration of the scheduled session.

VII. COURSE OUTLINE ADDENDUM:

The provisions contained in the addendum located on the portal form part of this course outline.

APPENDIX

SAULT COLLEGE

ENVIRONMENTAL TECHNICIAN – WATER (5062)
Hydraulics – WTR330

DISTRIBUTION OF HOURS

Sequence/Type	Topics	# of Hours
Lecture	Introduction/Fluid Properties	4
Experiment	Experiment 1A/1B	4
Lecture	Fluid Statics	10
Lab	Lab #1 (Presentation of Measuring Devices)	2
Experiment	Experiment 2A	2
Experiment	Experiment 2B	2
Lab	Lab #2 - Review Solving Problems from Chapter 1 and 2	2
Test	Term 1 Test	2
Lecture	Fluids in Motion	8
Experiment	Lab #3	2
Experiment	Lab #4	2
Lab	Review – In Class Lab Solving Problems from Chapter 3	2
Test	Term 2 Test	2
Lecture	Momentum Principle	8
Lab	Lab 5A/5B	4
Lab	Lab 6A/6B	4
Lab	Final Review of all course material	2
Testing	Final Exam	2
	Sub-Totals	
	Lectures	30
	Labs/Experiments	28
	Testing	6
	TOTAL HOURS	**64**

ENVIRONMENTAL TECHNICIAN – WATER (5062)
Hydraulics – WTR330

COURSE PLAN – Based on the text **Engineering Fluid Mechanics**, 7th ed., by Crowe, Roberson and Elger)

Week/Hours	Topic/Chapter	Concepts Covered	In Class Lab (equipment needed)
Week 1/2 (4 hours Lecture and 4 hours Lab)	**Introduction to the Course; Chapter 1/2 :** Dimensions and Units, Methods of Description	1. Characteristics of a fluid/Fluid as a continuum. 2. Units and conversions (SI/BG Units) 3. Extensive and Intensive properties 4. Homogeneous and non-homogeneous/Consistent and Inconsistent Formulas 5. Properties of fluids involving the mass or weight 6. Properties of fluids involving the flow of heat 7. Viscosity 8. Newtonian vs. non-Newtonian Fluids 9. Surface tension, vapour pressure, Elasticity,	Experiment 1A and 1B (4 hours) Fluid
Week 3 (4 Hours Lecture)	**Chapter 3: Fluid Statics:** Basic Equation, Pressure Variation in a Static Fluid	1. Pressure: definition, transmission and difference between absolute/gauge/vacuum 2. Pressure Variation with Elevation: Basic Differential Equation (equation of equilibrium), uniform density, Compressible Fluids	
Week 4 (2 Hour Lecture and 2 hour lab)	**Fluid Statics:** Pressure Measurement	1. Manometry 2. Pressure Measurement	Lab #1 – suggest 2 hours Presentation on metering devices with examples of metering devices in lab

Week 5 (2 Hour Lecture and 2 hour lab)	**Fluid Statics:** Forces on Submerged Surfaces	1. Hydrostatic Forces on plane surfaces 2. Hydrostatic forces on curved surfaces	Experiment 2A – 2 hours
Week 6 (2 Hours Lecture and 2 hours lab)	**Fluid Statics:** Buoyancy/Stability	1. Buoyancy 2. Stability of Immersed and Floating Bodies	Experiment 2B – 2 hours
Week 7 (4 Hours)	Review and Term Test 1		Lab #2 - Home Work Review Lab
Week 8 (2 Hours Lecture)	**Chapter 4: Fluids in Motion**	1. **Velocity and flow visualization:** Lagrangian and Eulerian Viewpoints, Streamlines and flow patterns, Laminar and Turbulent Flow, Methods to develop flow patterns (Analytical/Numerical/Experimental) 2. **Rate of Flow**: volume rate of flow, mean or average velocity 3. **Acceleration**: Normal and Tangential components, Cartesian components, convective and local acceleration	Experiment 3 - (2 Hours)
Week 9 (4 Hours Lecture)	**Chapter 4: Fluids in Motion**	1. **Basic Control – Volume Approach:** System, control volume and control surface, Review of extensive and Intensive properties, Derivation of Control Volume Equations, Control Volume Equation for Steady Flow	
Week 10 (2 Hours Lecture and 2 hour Experiment)		1. **Continuity Equation:** General Form of the continuity equation, continuity equation for steady one-dimensional flow in a conduit, continuity at a point 2. **Rotation and Vorticity:** Concept of rotation, Vortices,	Experiment 4 (2 Hours)
Week 11 (4 Hours)	Review and Term Test 2		Lab #3 – Home Work Review

Week 12/13 (4 Hours Lecture and 4 hours lab)	**Chapter 5: Pressure Variation in Flowing Fluids**	1. **Basic Causes of Pressure Variation in a Flowing Fluid:** pressure variation due to weight and acceleration, examples of pressure variation resulting from acceleration, rotation of a tank liquid 2. **Bernoulli Equation:** along a streamline, for irrotational flow 3. **Application of the Bernoulli Equation:**	Experiment 5A and 5B (4 hours)
Week 14/15 (4 Hours Lecture and 4 hours lab)	**Chapter 6: Momentum Principle**	**1. Momentum Equation:** Derivation **2. Interpretation of the Momentum Equation:** force terms, momentum accumulation, momentum flow, momentum diagram, momentum equation for Cartesian Coordinates, systematic approach **3. Typical Applications:** Fluid Jets, Nozzles, Vanes, Pipes, **4. Moment of Momentum Equation** **5. Navier-Stokes Eqaution**	Experiment 6A and 6B (4 hours)
Week 16 (4 Hours)	Final Review and Exam		Lab #4 - Home Work Review Lab