# CE EN 332 Hydraulics and Fluid Flow Theory Fall Semester 2011

406 CB MWF 9 – 9:50 AM; Sec 001 Lab M 393 CB 3:00 – 3:50 PM; M 171 CB 4:00 – 5:50 PM; Sec 002 Lab T 393 CB 3:00 – 3:50 PM; T 171 CB 4:00 – 5:50 PM

**Course Description:** Fluid properties, fluid statics and dynamics, viscous flow, boundary layers, concepts of pipe and open-channel flow***.***

**Prerequisites:** CE EN 270, CE EN 204 (all may be taken concurrently)

**Course Objectives:** To gain a sound understanding of the properties of fluids and fluid forces in static and dynamic applications. To apply understanding to the solution of a wide variety of engineering fluids problems. To internalize a systematic method for solving problems.

**Professional Component Coverage**: Engineering Topics

**Program Objective Coverage:**

**1(p)** Be able to setup, perform, evaluate and report on several elementary hydraulic experiments, including: static pressure force, impulse forces from a fluid jet, energy losses in pipe flow, minor energy losses in pipe systems, and flow over weirs in open channels.

**2(a)** Be able to perform basic calculations for static pressures and forces in fluids.

**3(a)** Understand conservation of mass, energy, and momentum principles as applied to fluid flow situations, and be able to apply them to flow analysis problems.

**4(e)** Understand the concepts of drag and lift and be able to apply both to solve introductory problems of forces and dynamics.

**5(e)** Understand alternate standard approaches and formulas, and be able to analyze and design pressure pipe systems.

**6(p)** Understand standard approach and formulas, and be able to analyze and design open-channel flow systems.

**7(p)** Understand the basic elements of pump and turbine flow, and be able to analyze and select the pump needed for situations involving fluid pumping.

**Assignment Rules:** Homework is due at the beginning of class two class periods after the assignment unless otherwise stated. You may work together, but turn in separate assignments. Copying will not be tolerated and will result in a zero for all suspected parties for the assignment. Late homework is marked down 50% for every class period overdue. Use engineering paper or computer printouts for your homework, follow format in class handout, and staple multiple sheets.

**Laboratory exercises and reports**: Instructions will be given for each laboratory exercise.

**Exam Policy**: Students will have a one- to three-day block to take the exams at the testing center.

**Assessment of Student Performance**

 **Grading:** Exams 1, 2, and 3 15% each for 45%

 Laboratory reports 15%

 Homework 15%

 In-class quizzes 5%

 Final 20%

 **Workload**: At least 2-3 hours outside of class for every hour of lecture. READ AHEAD!

 In-class quizzes: each "off lecture day" you will receive 4-6 questions by email treating material recently covered and to be covered in the next lecture. At the beginning of each class period, random students will be asked to answer the questions. BE PREPARED!

**Final Exam**: Monday, 12 December 7:00 – 10:00 AM

**Final grading:**  Percent Grade Percent Grade

 100 - 93.0 A 92.9 - 90.0 A-

 89.9 - 87.0 B+ 86.9 - 83.0 B

 82.9 - 80.0 B- 79.9 - 77.0 C+

 76.9 - 73.0 C 72.9 - 70.0 C-

 69.9 - 67.0 D+ 66.9 - 60.0 D

 < 60 E

*Note: Dr. Hotchkiss reserves the right to adjust the grading scale at the end of the semester.*

**Textbook:** A Brief Introduction to Fluid Mechanics 5th edition by Young, Munson, and Okiishi

 **Instructor**: Rollin H. Hotchkiss 242J CB

 **Phone**: 422-6234 **Office Hours**: TTh 9-11 AM

 **Email**: rhh@byu.edu Also: if my door is open, come in!

 **T.A (grader).**: Suzie Monk, suji.monk@gmail.com;

 **Laboratory T.A.:** Bill Ashman bill\_ashman@byu.edu

 **Office Hours**: Please see the website at [www.et.byu.edu/groups/ce332](http://www.et.byu.edu/groups/ce332)

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| # | Date | Topic | Reading (due that day) |
| 1 | Aug 29 | Introduction | - |
|  | 29, 30 | Make appointments to see Dr. Hotchkiss | - |
| 2 | 31 | Dimensions and fluid properties | 1.1 - 1.5 |
| 3 | Sep 2 | Viscosity and compressibility | 1.6, 1.7 |
| 4 | 7 | Vapor pressure and surface tension | 1.8, 1.9 |
| 5 | 9 | Pressure field and atmospheric pressure | 2.1 - 2.4 |
| 6 | 12 | Measuring pressure | 2.5 - 2.7 |
|  | 12, 13 | *Lab 1 Fluid Properties* |  |
| 7 | 14 | Forces on plane surfaces | 2.8, 2.9 |
| 8 | 16 | Forces on curved surfaces | 2.10 |
| 9 | 19 | Buoyancy and floatation | 2.11 |
|  | 19, 20 | *Lab 2 Hydrostatic Forces* |  |
| 10 | 21 | Newtons 2nd law | 3.1 - 3.3 |
| 11 | 23 | Interpretation and pressure | 3.4, 3.5 |
| 12 | 26 | Examples **and Exam 1 (exact dates TBA)** | 3.6 and **Covers through #9** |
|  | *26, 27* | *Review for Exam 1* |  |
| 13 | 28 | Energy grade line and hydraulic grade line | 3.7 |
| 14 | 30 | Restrictions in use and assumptions | 3.8 |
| 15 | Oct 3 | Velocity and acceleration | 4.1, 4.2 |
|  | 3, 4 | *Lab 3 Bernoulli Equation* |  |
| 16 | 5 | Reynolds transport theorem | 4.3, 4.4 |
| 17 | 7 | Continuity equation | 5.1 |
| 18 | 10 | Examples | 5.1 |
|  | 10, 11 | *Lab 4 Orifice Equation and Error Analysis* |  |
| 19 | 12 | Momentum equation | 5.2 |
| 20 | 14 | Examples | 5.2 |
| 21 | 17 | Energy equation | 5.3 |
|  | 17, 18 | *Lab 5 Impact of Water Jets & Storyboard Ideas Due* |  |
| 22 | 19 | Examples | 5.3 |
| 23 | 21 | Dimensional analysis, modeling and similitude | 7.1 - 7.8 |
| 24 | 24 | Laminar flow in pipes and **Exam 2 (exact dates TBA)** | 8.1, 8.2 and **Covers through #22** |
|  | *24, 25* | *Review for Exam 2 and Storyboard Workshop* |  |
| 25 | 26 | Fully Developed Turbulent Flow  | 8.3.1, 8.4.1 |
| 26 | 28 | Minor losses | 8.4.2 |
| 27 | 31 | Single pipelines | 8.5.1 |
|  | 31, Nov 1 | *Lab 6 Hydraulic Modeling* |  |
| 28 | 2 | Single pipelines | 8.5.1 |
| 29 | 4 | Pipes in series and parallel | 8.5.2 |
| 30 | 7 | Pipeline systems | Handout |
|  | 7, 8 | *Lab 7 Friction Loss in Pipes & Storyboard Sketches, draft documentation due* |  |
| 31 | 9 | Pipeline systems | Handout |
| 32 | 11 | Flow over immersed bodies | 9.1, 9.2 |
| 33 | 14 | Drag and Lift and **Exam 3 (exact dates TBA)** | 9.3, 9.4 and **Covers thru #31** |
|  | 14, 15 | *Review for Exam 3* |  |
| **34** | 16 | Drag and Lift  | 9.3, 9.4  |
| 35 | 18 | Pumps | 11.1, 11.4 (intro) |
| 36 | 21 | Centrifugal Pumps | 11.4.2, 11.4.3 |
| 37 | 22 | Open-Channel Flow | 10.1 – 10.2 |
| 38 | 28 | Energy in open-channel flow | 10.3 |
|  | 28, 29 | *Lab 8 Field Trip-Drag and Lift* |  |
| 39 | 30 | Uniform flow | 10.4 |
| 40 | Dec 2 | Gradually varied flow | 10.5 |
| 41 | 5 | Rapidly varied flow | 10.6 |
|  | *5, 6* | *Lab 9 Open Channel Flow and Storyboard Display* |  |
| 42 | 7 | Review | - |

**Information about Laboratory Exercises**

**Teams**: You will work in teams of three students each. Think of a creative name for your team and turn in your lab reports with your team name and individual names.

**Report**: You will be given a sample cover sheet to reproduce for each laboratory report. Place your team name and individual names on the cover. Each team member will receive the same score for the report. Reports are due one week after the lab exercise. Your report will consist of:

 1. Answers to the questions in the lab handout.

 2. Photos of your lab – a camera will be made available to you.

 3. Raw data – append the actual sheet with your collected data on it to the end of the report.

**Contest**: We will be continuing a contest this semester to see which lab group can develop the most effective storyboard for teaching a process in fluid mechanics. The winning storyboard will produced into a video that will be posted to the web. More details to follow in your labs.