Spring 1-1-2020

MET 304-002: Applied Fluid Mechanics

Sahidur Rahman

COURSE NUMBER	MET 304
COURSE NAME	Applied Fluid Mechanics
COURSE STRUCTURE	(2-2-3) (lecture hr/wk - lab hr/wk – course credits)
COURSE COORDINATOR/ INSTRUCTOR	Dr. S. Rahman
COURSE DESCRIPTION	An introduction to fluid statics and the basic laws of fluid flow; conservation of mass, momentum and energy. Applications of the basic laws to internal and external incompressible flow, including specific topics in pipe flow systems, centrifugal pumps and fans, streamlining, and fluid flow meters.
PREREQUISITE(S)	Math 309, Physics II, Calculus (AAS level), C++ or BASIC.
COREQUISITE(S)	None.
REQUIRED, ELECTIVE OR SELECTED ELECTIVE	Required.
REQUIRED MATERIALS	TEXT: **A Brief Introduction to Fluid Mechanics – 5th Edition,** by Young, Munson, Okiishi, Huebsch – John Wiley & Sons, Inc. [IBSN: 978-0470-59679-1]
COMPUTER USAGE	Word, Excel
COURSE LEARNING OUTCOMES (CLO)	By the end of the course students should be able to: 1. Apply Pascal's law to lift large weight by a small force. 2. Determine hydrostatic force on a submerged plane surface, buoyant force on floating and submerged bodies, density of liquid and solid by using the concept of buoyant force. 3. Generate an analytical expression for the flow streamlines if two-dimensional velocity field is given. 4. Determine power generation potential and efficiency of a hydraulic turbines, pumps, turbine-generator and pump-motor combinations. 5. Apply Bernoulli Equation and Pitot formula to calculate flow velocity. 6. Determine anchoring force on a pipe by using linear momentum equation. 7. Apply Buckingham Pi Theorem to develop the functional relationship between parameters in fluid mechanics problems. 8. Measure flow rates in pipes by using obstruction flow meters: Orifice, Venturi and Nozzle. 9. Determine the drag and lift force on a streamlined body or a blunt/bluff body moving in a fluid. 10. Apply Manning equation to calculate open channel flow. 11. Conduct laboratory experiments, analyze data and present results.

12. Write effective laboratory reports according to acceptable criteria.

CLASS TOPICS

Introduction/Fluid Properties/Pressure, Hydrostatic Forces, Buoyancy, Classification of Flows, Conservation of Mass, Energy, and Momentum, Centrifugal Pumps, Dimensional Analysis and Similitude, Flow Over Immersed Bodies, Drag and Lift Forces, Flow in Pipes/Non-Circular Conduits, Open Channel Flow. Lab Experiments: Lab E1 - Calibration of Flow Meters, Lab E2 - Centrifugal Pump Performance, Lab E3 - Drag & Lift Characteristics of an Airfoil, Lab E4 - Drag and Pressure Distribution on a Cylinder

STUDENT OUTCOMES

The Course Learning Outcomes support the achievement of the following MET Student Outcomes and TAC of ABET Criterion 9 requirements:

Student Outcome a - an ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly-defined engineering technology activities
Related CLO – 11, 12

Student outcome b - an ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies;
Related CLO – 4

Student outcome c - an ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes;
Related CLO – 11

Student outcome e - an ability to function effectively as a member or leader on a technical team
Related CLO – 11, 12

Student outcome f - an ability to identify, analyze, and solve broadly-defined engineering technology problems
Related CLO – 6

Student Outcome g - an ability to communicate effectively regarding broadly-defined engineering technology activities
Related CLO – 12

Student Outcome l - technical expertise in dynamics, fluid mechanics, and thermodynamics
Related CLO – 9

GRADING POLICY

Note: Grading Policy may be modified by Instructor for each Section in the Course)

Homework	15 %
Lab reports	30%
Tests (2x15%)	30 %
Final Exam	25 %

Note: You may not pass the course if you are having failing grades (<50%) on the midterm tests and the final exam.
There are two midterm tests and one final exam during the semester.

ACADEMIC INTEGRITY

NJIT has a zero-tolerance policy regarding cheating of any kind and student behavior that is disruptive to a learning environment. Any incidents will be immediately reported to the Dean of Students. In the cases the Honor Code violations are detected, the punishments range from a minimum of failure in the course plus disciplinary probation up to expulsion from NJIT with notations on students' permanent record. Avoid situations where honorable behavior could be misinterpreted. For more information on the honor code, go to http://www.njit.edu/academics/honorcode.php

STUDENT BEHAVIOR

- No eating or drinking is allowed at the lectures, recitations, workshops, and laboratories.
- Cellular phones must be turned off during the class hours – if you are expecting an emergency call, leave it on vibrate.
- No headphones can be worn in class.
- Unless the professor allows the use during lecture, laptops should be closed during lecture.
- During laboratory, if you are finished earlier, you must show the professor your work before you leave class
- Class time should be participative. You should try to be part of a discussion

MODIFICATION TO COURSE

The Course Outline may be modified at the discretion of the instructor or in the event of extenuating circumstances. Students will be notified in class of any changes to the Course outline.

PREPARED BY

Dr. S. Rahman

COURSE COORDINATED BY

Dr. A. Sengupta

COURSE OUTLINE

WEEK	TOPICS	SECTIONS	ASSIGNMENTS(May be different from these)
1	Introduction	1.1, 1.2, 1.4 to 1.9	1.20, 22, 24, 34, 36, 40, 52, 62, 70
2	Pressure/Hydrostatic Forces/Buoyancy	2.1, 2.3, 2.5, 2.6, 2.8 - 2.11	2.22, 24, 26, 34, 40, 54, 72, 74, 80
3	Elementary Fluid Dynamics – the Bernoulli Equation	3.1 to 3.6	3.32, 40, 42, 58, 76, 78
4	Turbomachinery – The Centrifugal Pump	11.1 to 11.5	11.12, 24, 26
5	**Midterm Exam 1**	Chapters 1, 2 & 3	
6	Lab E1 – Calibration of Flow Meters		
7	Lab E2 - Centrifugal Pump Performance		
8	Fluid Kinematics Flow Over Immersed Bodies, Drag and Lift Forces	4.1, 4.2 9.1, 9.2.1, 9.3, 9.4	4.2, 6 (Equation of streamlines only), 12
9	Lab E3 - Drag & Lift Characteristics of an Airfoil		
10	Lab E4 - Drag and Pressure Distribution on a Cylinder		
11	**Midterm Exam 2**	Chapters 4, 9 & 11 and all the Labs	
12	Dimensional Analysis, Similitude and Modeling	7.1 to 7.3, 7.6, 7.8 (7.8.1, 7.8.2), 7.9.2	7.10, 18a, 20
13	Finite Control Volume Analysis -- Conservation of Mass/Conservation of Energy/Conservation of Momentum	5.1, 5.2 (5.5.1, 5.2.2), 5.3 (5.3.1 - 5.3.3)	From the handout
14	Open Channel Flow + Review	10.4 to 10.5	
15	**FINAL EXAM (Cumulative)**		

CLASS HOURS (MET 304-102)

Friday	05:45 PM – 9:55 PM	CKB 126 & ME 110

CLASS HOURS (MET 304-002)

Tuesday	02:30 PM – 04:35 PM	CKB 126
Thursday	10:00 AM – 12:05 PM	ME 110

OFFICE HOURS (GITC 2105)

Monday	2:00 PM – 04:30 PM (by appointment only)
Tuesday	1:00 PM – 02:20 PM
Wednesday	1:00 PM – 02:20 PM
Friday	10:45 AM – 02:20 PM (by appointment only)

by appointment contct: **(973) 596-6072** or **rahman@njit.edu**

HOMEWORK - IMPORTANT

Homework is **due the week following the date they are assigned, and must be submitted to the instructor.**

LABORATORY:

The laboratory experiments will be performed in Room 110-MEC. When an experiment is not scheduled, a lecture on the laboratory experiments or a problem session will be scheduled.

Experiment E1 - Calibration of Flow Meters
Experiment E2 - Centrifugal Pump Performance
Experiment E3 - Drag & Lift Characteristics of an Airfoil
Experiment E4 - Drag and Pressure Distribution on a Cylinder

Laboratory Reports (25% of final grade)

1. All laboratory reports must be written on a word processor. Equations, calculations, graphs and figures must also be performed via appropriate software, e.g., MathCAD, AutoCAD, etc. Only rough sketches can be done freehand, but must be neat.

2. EXPERIMENTS E1, E2, E3 and E4 (30% of final grade)
   a. The written report for each of these experiments is due about 2 weeks after the experiment is completed. Late reports will be penalized 0.5 points per week out of a possible 10 total points.
   b. The written reports are to be concise (approximately 10 pages) and consist of the following:

      LAB REPORTS (will be discussed more in detail)

      i. **Abstruct, Theory, Summary of Procedure and Sample Calculations (35% of report grade)**
      ii. **Data Tables and Results (15% of report grade)**
      iii. **Graphs, Discussion of Results and conclusions (30% of report grade)**
      iv. **Grammar, Spelling and overall appearance (20% of report grade)**

   c. Each student must submit his or her own laboratory reports.