NUCL350: NUCLEAR THERMAL-HYDRAULICS I
Fall 2019, Mon, Wed, Fri: 11:30pm-12:20pm, 134 GRIS

Course Description: 3 cr. hrs. The first of an integrated two-course sequence introducing the concepts of nuclear reactor thermal transport and associated hydraulics with applications to design and safety.

Course Objectives: To provide Nuclear Engineering students with sufficient background to (a) basic concepts in fluid kinematics and dynamics, (b) macroscopic formulation for balances of mass, momentum and energy of fluid flow, (c) integral and differential analysis of fluid flow, (d) applications of fluid equations to practical systems including nuclear power reactor, (d) fundamentals of Navier-Stokes equations, and (e) basic concepts on two-phase flow and compressible fluid flow analyses.

Prerequisites: ME200, ME274

Instructor: Dr. Seungjin Kim, 4032 Wang Hall
Email: seungjin@purdue.edu
Office Hours: By appointment

Teaching Assistant: TBA

Textbook (Optional): Cengel, Y., and Cimbala, J. M., *Fluid Mechanics: Fundamentals and Applications*, McGraw-Hill.

References:

- Munson, B., Young, D., and Okiishi, T., *Fundamentals of Fluid Mechanics,* J. Wiley & Sons, Inc.
- Fox and McDonald, *Introduction to Fluid Mechanics*, J. Wiley & Sons Inc.
- White, F., *Fluid Mechanics,* McGraw Hill
- Van Dyke, M., *An Album of Fluid Motion* (ISBN #: 0-915760-02-9)
- N. E. Todreas and M. S. Kazimi, Nuclear Systems Vol I, CRC Press.

Policies:

- Course policies will be strictly observed as part of maintaining integrity of the course.
- Attendance is considered mandatory. Students who miss classes are expected to be responsible for material discussed during the missed lectures.
- Practice Problems:
  - Practice problems are provided to enhance learning, and students are expected to work on the practice problems. No grading on the practice problems will be performed.
  - Solutions for the problems will be made available to students one week from the day assigned, and it is the student's responsibility to check his/her work with the solution for accuracy.
  - A student can earn up to extra 3% points (in 100% scale) by submitting his/her work in '*acceptable*' form.
  - For the work to be considered 'acceptable'; one must (a) prepare neatly organized handwritten solutions (unless instructed otherwise) showing logical and detailed working steps, (b) must present work for ALL the problems listed in the given problem set, and (c) submit the work one week from the day assigned by 5pm of the due day. It can be handed-in in hard copies or submitted in PDF file via Blackboard. No other formats will be considered for extra points.
  - Healthy collaboration/discussion on the practice problems are not only allowed but encouraged, as it can enhance learning. If there are any collaborators in preparing the

solutions, list the names of all collaborators in the solution cover page and submit one common solution. Up to three people is allowed for collaboration.
    - No late submission will be accepted
- Quizzes:
    - Quizzes will be given without prior notice during the class period.
    - No make-up quizzes will be given.
    - TWO quizzes with lowest scores will be dropped.
- Exams:
    - FOUR exams will be given (3 midterm & 1 final exams).
    - No make-up exam will be allowed.
    - A student who earns an A grade after the third exam (accounting for the homework assignments, quizzes and the first two exams) may opt out of the Final Exam with an A grade. Otherwise, students MUST take all four exams.
    - Three best exam scores (out of four) will be used in calculating the final exam grade.
    - Important Note*:* If a student does not show up in the final exam (without opting out with an A grade) or shows up but submit an exam solution with a score of less than 50%, ALL four exam scores will be used in calculating the final grade.
- Course Materials including solutions for practice problems are intended for personal use only by authenticated users who are enrolled for NUCL350 in Fall 2019. Release of course material to any other people without obtaining written permission from the instructor will be regarded as a violation of academic integrity.
- Recording and/or photographing of the lectures are not allowed.
- Grade Proportion
    - Exams: 25% each of best three exams out of four exams taken; or 18.75% each if all four exams need to be accounted for.
    - Quizzes: 25%;
    - Practice Problems: Up to 3% points.
    - The grade will be partitioned as shown in the Table below:

Final Avg. Score	**Grade**
$93 \leq$ Avg.	A
$90 \leq$ Avg. < 93	A-
$87 \leq$ Avg. < 90	B+
$83 \leq$ Avg. < 87	B
$80 \leq$ Avg. < 83	B-
$77 \leq$ Avg. < 80	C+
$70 \leq$ Avg. < 77	C
$60 \leq$ Avg. < 70	D
Avg. < 60	F

Extenuating circumstances: Exceptions may be considered for exams and homework assignments under some limited extenuating circumstances, such as: official Purdue approved activities; military obligations; religious observances; government duties; personal reasons beyond his/her control etc. In such cases,

students are required to provide the instructor with proof of evidence prior to the expected absences. For the official university policy, refer to:
http://www.purdue.edu/studentregulations/regulations_procedures/classes.html

Academic Integrity: Academic misconduct of any kind will not be tolerated in any course offered by the School of Nuclear Engineering. Information on Purdue's policies with regard to academic misconduct can be found at https://www.purdue.edu/purdue/about/integrity_statement.php You should familiarize yourself with these policies, particularly if you are new to US academic institutions. All apparent violations of these policies will be referred to the Office of the Dean of Students (ODOS).

Emergency Preparedness: In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to changes that may be necessitated by a revised semester calendar or other circumstances. Students may consult the class Blackboard site or e-mail or phone the instructor to obtain information about changes in the course.

Non-discrimination Policy: Purdue University's non-discrimination policy will be upheld in this classroom. Purdue University is committed to maintaining a community which recognizes and values the inherent worth and dignity of every person; fosters tolerance, sensitivity, understanding, and mutual respect among its members; and encourages each individual to strive to reach his or her own potential. More information can be found at http://www.purdue.edu/purdue/ea_eou_statement.html

Lecture Schedule for NUCL350
(Fall 2019)

Week	Lecture	Date	Topics	Reading / Remarks
1	1	08/19	Introduction to Basic Concepts and Fluid Properties	Chapters 1- 3
	2	08/21		
	3	08/23		
2	4	08/26	Fluid Statics: Pressure Measurements	
	5	08/28		
	6	08/30		
3	-	09/02	**Labor Day**	No Class
	7	09/04	Fluid Statics: Other Forces	Chapter 3
	8	09/06		
4	9	09/09	Fluid Kinematics	Chapter 4
	10	09/11		
	11	09/13	Integral Analysis: Reynolds Transport Theorem and Control Volume	Chapter 5
5	12	09/16	Conservation Equations of Mass, Momentum and Energy	Chapter 5
	13	09/18	Review for Exam 1	-
	-	**09/19**	**Exam 1 (Night Exam @ WTHR 104, 8PM-10PM)**	**Lectures 1 through 13**
	14	09/20	Bernoulli Equation	Chapter 5
6	15	09/23	Applications of Bernoulli Equation	Chapter 5
	16	09/25		
	17	09/27	Control Volume Analysis: Mass Conservation	Chapters 5 & 6
7	18	09/30	Control Volume Analysis: Momentum Conservation	Chapters 5 & 6
	19	10/02		
	20	10/04	Differential Analysis of Fluid Flow	Chapter 9
8	-	10/07	**Fall Break**	No Class
	21	10/09	Differential Analysis: Conservation Equations	Chapter 9
	22	10/11		
9	23	10/14	One-dimensional Formulation and Single-phase Flow Analysis on Pressurized Water Reactor	Chapter 9 and Class Notes
	24	10/16		
	25	10/18		
10	26	10/21	Navier-Stokes Equations	Chapter 10
	27	10/23	Review for Exam 2	
	-	**10/24**	**Exam 2 (Night Exam @ WTHR 104, 8PM-10PM)**	**Lectures 14 through 27**
	28	10/25	Analytical Solutions to Navier-Stokes Equations	Chapter 10
11	29	10/28	Analytical Solutions to Navier-Stokes Equations	Chapter 10

	30	10/30	Dimensional Analysis: Buckingham PI Theorem	Chapter 7
	31	11/01		
12	32	11/04	Dimensional Analysis on Field Equations	Class Notes
	33	11/06		
	34	11/08	Internal Flow: General Characteristics	Chapter 8
13	35	11/11	Internal Flow: Pressure Loss	Chapter 8
	36	11/13	Internal Flow: Turbulent Flow	
	37	11/15		
14	38	11/18	External Flow: Boundary Layers / Drag Forces	Chapters 10 & 11
	39	11/20	Review for Exam 3	-
	-	11/21	**Exam 3 (Night Exam @ WTHR 104, 8PM-10PM)**	Lectures 28 through 39
	40	11/22	External Flow: Boundary Layers / Drag Forces	Chapters 10 & 11
15	41	11/25	Potential Flow Analysis	Chapter 10
	42	11/27	**Thanksgiving Holidays**	No Class
	43	11/29		
16	44	12/02	Basics on Two-phase Flow & Compressible Fluid Flow	Chapter 12 and Class Notes
	45	12/04		
	46	12/06		
17		TBA	**Final Exam**	**Comprehensive**

Lecture schedule is tentative and is subject to change