Brigham Young University
Department of Mechanical Engineering

Course Title: **Fluid Mechanics**
Course: **ME EN 312**
Course Time: Section 1 MWF 10:00 – 10:50 a.m.
Class Room: CB 230
Section 2 MWF 1:00 – 1:50 p.m
Class Room: CB 254

Final Schedule: Section 1: Tuesday, December 16th, 7:00 – 10:00 a.m.
Section 2: Monday, December 15th, 11:00 a.m. – 1:00 p.m.

Professor: Dr. Daniel Maynes
Office: 360K EB
Office Hours: MTuWTh 2-3, TuW 3-4
Email: maynes@byu.edu

TAs: Dallin Rummler, Porter Nelson
Office: 350 CB
Office Hours: TBD – check LS
Email: Check LS

Course Meeting Structure: This course is an "in-person" course. Students are expected to be in attendance. Student success is strongly correlated with regular class attendance. Students who feel sick (fever; cough; shortness of breath/difficulty breathing; chills; muscle pain; sore throat; new loss of taste or smell; etc.) should not attend class and should work with the instructor to develop a study plan for the duration of the illness.

Office Hours: The course TAs and Instructor will hold in-person office hours where you can ask questions. If preceded by reasonable personal effort, requests for help on all homework problems will always be cordially received by both the professor and the course TA.

Prerequisites: ME EN 312 must be preceded by ME EN 321, ME EN 335, and Math 334. Any exceptions must be approved by the instructor.

Text: 1. Munson, Young, and Okiishi's Fundamentals of Fluid Mechanics, 9th edition, by Gerhart, Gerhart, and Hochstein, 2021. Use of either the 7th or 8th editions of the text is also acceptable. You may choose to use an electronic version of the text. Note that any hard or electronic copies of the text that are used should be legal versions that have been paid for.
2. ME EN 312 Course Packet, by D. Maynes. This packet is available at the Bookstore at the cost of printing. It is also located on Learning Suite. The packet should be brought to each class session since it includes several examples that we will work together.

Overview: The study of fluid mechanics is exciting and insightful into the phenomena that exist in the world around us. It is also a subject that is rigorous and mathematical intensive. Thus, we will utilize the multivariable calculus, differential equations, and linear algebra you have already learned. Our approach will involve class discussions, text readings, working problems, special projects, and hands-on laboratory experiences. What you learn from this course will depend on your attitude and commitment to becoming an independent learner and your willingness to work with others. *Recall that for each hour you spend in class, the expectation is that the average student will need to spend two hours outside of class on that subject*. More time will be required to achieve excellence in a particular subject.

Objectives: The objective of this course is to provide an understanding and ability to mathematically model fluid dynamics phenomena. Specifically, the course content is broken into the 10 core topics listed below. For each topic there are certain competencies that you should be able to perform upon completion of the course. These are also listed under the corresponding topic.

Topics: Competencies (What you should be able to do upon completion of 312):

1. Fluid Properties
   Understand viscosity as a fluid property and be able to compute shear stress involving Newtonian fluids. Understand the phenomena of surface tension and cavitation.
2. Pressure in Fluids
   Understand variation in pressure in a static gas or liquid, and be able to compute hydrostatic forces and moments.
3. Flowing Fluids

Be able to evaluate the local, convective, and total acceleration and understand pressure distributions normal to and parallel to streamlines. Be able to appropriately apply Bernoulli's principle and recognize the limitations of it.

4. Conservation of Mass
   Be able to apply the integral form of the conservation of mass for steady and unsteady flow situations with uniform or two-dimensional velocity distributions. Recognize and be able to utilize the differential form of conservation of mass.
5. Global Force/Momentum Balances
   Be able to apply the integral form of the linear momentum principle and apply global force/momentum balances for stationary and constant velocity frames of reference with uniform or two-dimensional velocity distributions. Recognize the Navier-Stokes equations and solve them for simplified viscous flows.
6. Dimensional Analysis
   Be able to determine appropriate dimensionless variables for a given dynamical situation and predict prototype behavior based on similitude, and understand the pitfalls of modelling.
7. Mechanical Energy Equation
   Understand the mechanical energy equation and be able to apply it to laminar and turbulent flow with minor and major losses through pipe networks.
8. Velocity Distributions, Form Drag and Flow Separation
   Be able to model velocity distributions in flat plate boundary layers in laminar and turbulent flows and to predict skin friction drag. Understand the phenomena of flow separation and its impact on the total drag.
9. Real World Problem Solving
   Be able to utilize the principles of fluid dynamics to analyze and solve real world flow phenomena. Be able to use structured techniques (e.g. The 5 Ps of problem definition) to develop an engineering problem statement based on real-world applications of fluid mechanics and apply structured problem-solving techniques (e.g. SAFER) to solve fluids engineering problems.
10. Investigate Phenomena and Communicate Results
    Be able to present results of fluid dynamic phenomena graphically in terms of appropriate dimensionless variables and effectively communicate results.

Email/BYU Learning Suite: I will use email and the BYU Learning Suite to relay information relating to the class. Check your email and Learning Suite messages regularly. All assignments will be posted on the BYU Learning Suite with the due date specified.

Homework: Homework will be due weekly on Wednesday by 11:59 p.m. and should be submitted electronically to Learning Suite. Homework assigned from the Munson text can be found on Learning Suite under the "Content" tab. Note that some assigned problems have a "R" number (i.e. 5.1.3R). These problems are not found in some versions of the printed textbook, but are located on LS with the uploaded Munson problem sets. The purpose of the homework is to solidify the principles discussed in class and the text so that mastery of the topic can be achieved. Some of the homework problems will be considered *practice problems* (answers will be available) and each week there will be a few *mastery* problems assigned. All homework will be turned in electronically through Learning Suite. Solutions to the practice problems should be prepared using an abbreviated SAFER method you learned in ME EN 101 on paper of your choice. Working with others on practice problems is encouraged as long as all contribute equally, copying another person's work (or online solutions) is not acceptable. Students will complete an assessment on Learning Suite for each set of practice problems. *Homework mastery problems should be completed without discussion with other members of the class*. Communicating solutions to real-world engineering problems is a critical skill and is foundational to becoming an influential engineer. Thus, a significant portion of your score on homework mastery problems will be based on the professional nature of your solution. Solutions to all homework mastery problems should be prepared using the complete SAFER method and the problem-solving template available for purchase from the bookstore (shelved under author "Mechanical Engineering Department"), or downloaded from the course Learning Suite site. All mastery problems will be graded and returned. If preceded by reasonable personal effort, requests for help on all homework problems will always be cordially received by both the professor and the course TA. Late homework will be accepted only until 5:00 p.m. the day (Thursday) after the homework is due with a penalty of 15%.

Reading: It is not possible to cover all relevant material in class, thus reading of the assigned material is expected before class time. This will not only increase your exposure to the subject, but it will also prompt questions and class discussion on items needing clarification. The reading you should read prior to each lecture period is shown on Learning Suite.

Lectures: Just as we cannot cover in class all of the information in the text, we will cover in class much information that is not found in text. Thus, it is most prudent to be an active participant in class in addition to being well-versed in the text. The topic for each lecture is shown on the schedule posted on Learning Suite.

Labs and Special Problems: There will generally be one real-world problem, do-at-home experiment, laboratory exercise or other special problem assigned each week. The due date and deliverables for each will be specified when they are assigned.

Quizzes: Approximately 10-12 quizzes will be given in-class during the semester; generally there will be at least one quiz/week. The quizzes will generally consist of conceptual questions derived from the text, lecture, homework assignments, viewed videos, and laboratory. The time requirement for each quiz will be typically about 5 minutes and the lowest two quiz scores will be dropped before the final grade is determined. When quizzes are returned, they can be picked up in the "Return Work" box located in the south hallway on the 3rd floor of the EB. When completing the quiz, do not write your name on the quiz, instead each student will put their chosen 4-digit identifier on the exam. To choose your 4-digit identifier, complete the extra-credit quiz assignment that is due on Friday September 5th.

Exams: Two mid-term exams are scheduled in addition to a comprehensive final exam. All midterms will be administered in the Testing Center and will have a time limit of 90 minutes. The format of all exams will be closed book and closed note. An equation sheet will be provided in addition to any relevant information that is needed.

Citizenship: As a student at BYU you are expected to adhere to the honor code. Academic dishonesty in any form will be justification for a failing grade in the class and has no place in the engineering profession. Class attendance and participation by asking and responding to questions is expected. Specific examples of good citizenship are: 1) asking well thought questions, 2) respectful response to questions, 3) respectfully addressing fellow classmates, the TA, and the Professor, 4) assisting others with difficult concepts, etc. Specific examples of bad citizenship include but are not limited to: 1) talking or texting with others during lecture, 2) arriving late to class, 3) cell phone interruption of class, etc. A citizenship record will be kept throughout the semester by the instructor.

Grading Procedures:

Homework Practice Problems	60
Homework Mastery Problems	60
Quizzes	100
Special Problems/Laboratories	60
Two Mid-Term Exams (100 pts. each)	200
Comprehensive Final Exam	150
Total	630 pts

If performance on the final exam is greater than the lowest midterm or composite quiz score, the final score will replace this score. If everyone scores in the 90-100 range I will award everyone A's. However, I reserve the right to curve the grades if the class average lies below 80%.

Extra Credit: A few opportunities for extra credit will be given throughout the semester.

Honor Code Standards: In keeping with the principles of the BYU Honor Code, students are expected to be honest in all of their academic work. Academic honesty means, most fundamentally, that any work you present as your own must in fact be your own work and not that of another. Violations of this principle may result in a failing grade in the course and additional disciplinary action by the university. Students are also expected to adhere to the Dress and Grooming Standards. Adherence demonstrates respect for yourself and others and ensures an effective learning and working environment. It is the university's expectation, and my own expectation in class, that each student will abide by all Honor Code standards. Please call the Honor Code Office at 422-2847 if you have questions about those standards.

Preventing Sexual Discrimination or Harassment: Sexual discrimination or harassment (including student-to-student harassment) is prohibited both by the law and by Brigham Young University policy. If you feel you are being subjected to sexual discrimination or harassment, please bring your concerns to the professor. Alternatively, you may lodge a complaint with the Equal Employment Office (D-240C ASB) or with the Honor Code Office.

Students with Disabilities: If you have a disability that may affect your performance in this course, you should get in touch with the office of Services for Students with Disabilities (1520 WSC). This office can evaluate your disability and assist the professor in arranging for reasonable accommodations.

Aims of a BYU Education: The mission of Brigham Young University is "to assist individuals in their quest for perfection and eternal life" (hereafter Mission Statement). To this end, BYU seeks to develop students of faith, intellect, and character who have the skills and the desire to continue learning and to serve others throughout their lives.

Mechanical Engineering Department's BIG: "To be recognized as the best undergraduate mechanical engineering program in the world and the alma mater for the world's most *influential engineers*."

Influential Engineers Develop:
CHARACTER: Influential engineers have integrity and strong desires to serve their community and their profession. They do the right thing, even when no one is watching or when others oppose it. Their influence is derived from strong moral principles and mutual respect. Their sphere of influence expands as others recognize and trust their character.

RESILIENCE: Influential engineers are resilient and learn from their failures. They persevere in pursuit of long-term goals. They embrace challenge and recognize effort is the path to mastery.

TECHNICAL EXCELLENCE: Influential engineers are innovative experts in their field. They solve significant, real-world problems by building models based on basic concepts and fundamental laws. They use state-of-the-art engineering practices and technologies to solve their models and obtain results.

COMMUNICATION SKILLS: Influential engineers communicate results and conclusions clearly and concisely. They persuasively present recommendations that prevent and solve problems. They are collaborative and always civil, particularly when others have differing viewpoints.

LEADERSHIP: Influential engineers lead in ethical behavior regardless of their position. They focus more on the greater good than on personal achievement. They make tough decisions when necessary. They inspire with genuine praise, correct with kindness when necessary and generously recognize the contributions and accomplishments of colleagues.

LIFELONG LEARNING AND SERVICE: Influential engineers consistently develop new skills and use their abilities and resources to enhance the lives of others.

"Nothing in the world can take the place of persistence. Talent will not; nothing is more common than unsuccessful men of talent. Genius will not; unrewarded genius is almost a proverb. Education will not; the world is full of educated derelicts. Persistence and determination alone are omnipotent." – President Calvin Coolidge

"And as all have not faith, seek ye diligently and teach one another words of wisdom; yea, seek ye out of the best books words of wisdom; seek learning, even by study and also by faith." - D&C 88:118

Homework, Labs, Special Problems/Videos

Assignment #1 (Sept 10)

Practice problems Reading: (1.1-1.7) - 25 pages 1.6.14: 20°C: $1.765x10^{-5}$ N-s/m^2 (Eq.), $1.76x10^{-5}$ N-s/m^2 (Table); 90°C: $2.13x10^{-5}$ N-s/m^2 (Eq.), $2.14x10^{-5}$ N-s/m^2 (Table); 1.6.22: Non-Newtonian 1.6.36: T = 0.0772 ft-lb 1.7.5: Volume decrease of 0.0163 m^3
Mastery Problems 1.6.27 1.6.34
Special Problems/Videos/Laboratories Navigate to the following website and watch the video "Surface Tension" in its entirety. Identify at least four new things you learned about surface tension and report these as part of the Learning Suite Video Quiz. Note that the video quality is much better if you select the "TechTV" link instead of the "YouTube" link. http://web.mit.edu/hml/ncfmf.html

Assignment #2 (Sept 17)

Practice Problems Reading: (1.8-1.10, 2.1-2.9) – 29 pages 1.9.10: D_{max} = 0.061 in. 2.6.9: $P_A = P_B$ = 15.0 psia, P_C = 15.5 psia 2.8.22: 1060 kN, 1010 kN, 1.37 x 10^6 N-m 2.8.43: 1.88 ft
Mastery Problems 2.6.17 2.8.23
Special Problems/Videos/Laboratories Navigate to the following website and watch the video "Cavitation" in its entirety. Identify at least four new things you learned about cavitation and report these as part of the Learning Suite Video Quiz. Note that the video quality is much better if you select the "TechTV" link instead of the "YouTube" link. http://web.mit.edu/hml/ncfmf.html

Assignment #3 (Sept 24)

Practice Problems Reading: (2.10-2.12, 3.1-3.5) – 24 pages 2.10.11: 64.4 kN 3.2.3: (b) 39.9 psi 3.6.9: 1248 lb/ft^2 3.3.3: 12 kPa, -20.1 kPa
Mastery Problems 2.10.17 3.5.13
Special Problems/Videos/Laboratories Cavitation Demo walk-in lab. Lab #1 assigned.

Assignment #4 (Oct 1)

Practice Problems

Reading: (3.6-3.9, 4.1-4.3) - 37 pages

3.6.21: 11.4 m^3/s

4.1.10: $x^2 + y^2 = \text{constant}$

4.2.11: $a_x = V_0\left(1-\frac{x}{\ell}\right)ce^{-ct} + V_0^2(1-e^{-ct})^2\left(1-\frac{x}{\ell}\right)\left(-\frac{1}{\ell}\right)$ $c = 0.49$ 1/s

4.2.28: $3.13\text{x}10^{-5}$ m/s^2, $2\text{x}10^{-3}$ m/s^2

Mastery Problems

3.6.40

4.2.15

Special Problems/Videos/Laboratories

Lab #1 Due

Assignment #5 (Oct 8)

Practice Problems

Reading: (4.4-5.1)

5.1.4: 3.66 slugs/s

5.1.22: 1.78 ft/s

3.6.73: 36.5 s

HWP5.1. A slow leak develops in a tank of constant volume containing air. The pressure, P, in the tank is initially 60 psig. However, after three hours the pressure is 30 psig. The tank volume is 2 ft^3 and the temperature in the tank remains constant at 60°F. The mass-flow rate of air is given by

$$\dot{m} = 0.68\frac{PA}{\sqrt{RT}}$$

where P is the tank pressure as a function of time, A is the area of the hole, R is the ideal gas co or air, and T is the tank temperature in Rankine. Determine the size of the hole in the tank.

Answer: hole diameter = 0.0052 in

Mastery Problems

4.4.11

5.1.3R ("R" problems are not found in some versions of the text, but can be found on LS)

Special Problems/Laboratories

Working in a group of not more than three individuals conduct an experiment to determine the time required for a 2-L pop bottle to drain when oriented in the normal vertical position. The bottle should drain through a small hole that you will drill into the bottle (put the hole near the bottom of the bottle but still in the constant diameter portion of the bottle). Measure the time to drain from some initial known volume to a final volume (where the only remaining fluid is just above the level of the drain hole). Repeat your experiment with the same initial volume 2-3 times to minimize your uncertainty and conduct the experiment for at least three different initial volumes (i.e. full, 2/3 full, and 1/3 full). Also perform a control volume analysis to predict the drain time utilizing the conservation of mass and Bernoulli's principles we have learned in class. To do this you will need to make very careful measurements of all relevant variables (i.e. drain hole diameter, bottle inside diameter, total volume drained, initial and final water levels above the drain hole, etc.). Further, you will recall from your previous experiments with this 2-liter bottle that to obtain the correct mass flow rate from the bottle you need to use a contraction coefficient. For a thin-wall orifice and free-jet, the contraction coefficient is known to be 0.61. Compare your experimental results with the prediction graphically and comment on the discrepancy, if any.

Assignment #6 (Oct 15) (Reduced set this week – Exam 1 10/14-10/16)

Practice Problems
Reading (5.1-5.2)
5.2.4: 7.01 ft^3/s and 674 lb
5.2.5: 106 N
5.2.13: 693 kN and 298 kN
5.2.30: 66.6 N
Mastery Problems
5.2.32
Special Problems/Laboratories
Nothing due this week – Exam week

Assignment #7 (Oct 22)

Practice Problems
Reading (5.3 and 6.1-6.2)
5.3.12: 926 ft-lb/slug and 200 ft-lb/slug
5.3.20: 0.052 m^3/s
5.3.33: solution in problem statement
6.1.2: $a_x = x$, $a_y = 2x^2z + x^2yz$, $a_z = x^2z^2 + y^2z$,
6.1.4: dilatation rate = 0, $\boldsymbol{\omega} = -\left(\frac{y}{2} + z\right)\hat{\mathbf{i}} + \frac{5z}{2}\hat{\mathbf{j}} - \frac{y}{2}\hat{\mathbf{k}}$, not irrotational
Mastery Problems
5.3.29
6.1.2
Special Problems/Laboratories
Nothing due this week. Lab #2 assigned.

Assignment #8 (Oct 29)

Practice Problems
Reading (6.3-6.4.4, 6.8-6.10)
6.2.2: irrotational, conservation of mass is satisfied
6.9.1: 4.21 x 10^{-4} m^2/s, 60 N/m^2 in the flow direction, 0.158 m/s
6.9.2: 43.2 lb/ft^3, 0.75 ft/s
6.9.12: 0.759 in
Mastery Problems
6.2.1R
6.9.10
Special Problems/Laboratories
Lab #2 Due

Assignment #9 (Nov 5)

Practice Problems Reading: Chapter 7 7.3.4: $\omega\sqrt{\frac{\ell}{g}} = \phi\left(\frac{h}{\ell}\right)$ 7.3.16: $\dot{W}/\rho\omega^3 D^5$, $Q/\omega D^3$, $\mu/\rho\omega D^2$ 7.7.3: $\Delta P/\rho V^2$ and D/d gives $\frac{\Delta P}{\rho V^2} = 0.505\left(\frac{D}{d}\right)^{3.99}$ 7.8.2: 29.3 ft/s and 75 rpm
Mastery Problems 7.3.15 7.8.3R
Special Problems/Laboratories You previously conducted experiments in the wind tunnel and measured the drag on five objects at five different speeds. Use this data and for each case compute the drag coefficient ($C_d = \frac{2F_d}{\rho U^2 A}$) and Reynolds number ($Re = \frac{\rho U D}{\mu}$). F_d is the drag force you measured in the lab, A is the frontal area of the shapes used ($\pi D^2/4$), D is the diameter of the objects, U is the fluid speed, ρ is the air density in the wind tunnel, and μ is the air viscosity. Then plot your C_d vs. Re data on a single graph. It will be important for to make sure that your values for C_d and Re are truly dimensionless. *Deliverables:* 1) Your plot showing C_d vs. Re for the five different shapes. This plot should be a high-quality graphic and you should follow the instructions for preparing such a graph here: https://www.me.byu.edu/00000173-9298-d205-aff3-daddfc530000/how-to-make-a-figure-pdf 2) A brief paragraph that accompanies your plot and describes whether the drag coefficient for each shape varies with Re and the implication of your observation. Based on your data predict for each shape the drag you think that would exist if water was flowing past these shapes at a speed of 1 m/s.

Assignment #10 (Nov 12)

Practice Problems Reading Sections 8.1-8.3 from the course text 7.9.1: 27.8 psi 8.1.3: viscosity 1000x is unmixed blue and yellow, viscosity 10x is green 8.2.3: -7.4 lb/ft^3, -69.8 lb/ft^3, 55.0 lb/ft^3 8.3.2: 0.707 R, 0.750 R
Mastery Problems 7.9.6 8.2.14
Special Problems/Laboratories Real World Problem 1 – TBD *Deliverables:* 1. Your work showing how you used the 5 Ps to consider the real-world problem and develop a problem statement. 2. A complete and coherent engineering problem statement that you are confident that you could solve using principles learned in this class. 3. A solution to your problem statement.

Assignment #11 (Nov 19)

Practice Problems Reading: The remainder of Chapter 8 8.4.12: 21.0 8.5.10: 520 hp, 147 psig 8.5.15: 36.6 psi 8.5.28: 0.29 ft^3/s 8.5.39: 0.535 to 0.563 ft or so 8.5.53: 0.0180 m^3/s
Mastery Problems 8.4.21 8.5.34
Special Problems/Laboratories None this week – extra practice problems

Assignment #12 (Nov 26) (Reduced set this week – Exam 2 11/19-11/22, Thanksgiving)

Practice Problems Reading: Sections 9.1-9.2 9.2.4: 0.00718 m/s, 0.00229 m/s 9.2.10: $\frac{1}{2}\rho u^2 = 14.4\left(\frac{y}{360}\right)^{0.56} \frac{lb}{ft^2}$
Mastery Problems 9.2.14
Special Problems/Laboratories None this week

Assignment #13 (Dec 3)

Practice Problems Reading: None 9.3.17: 0.0296 N 9.3.22: 23.9 ft-lb
Mastery Problems 9.3.23
Special Problems/Laboratories Real World Problem 2 – TBD *Deliverables:* 1. Your work showing how you used the 5 Ps to consider the real-world problem and develop a problem statement. 2. A complete and coherent engineering problem statement that you are confident that you could solve using principles learned in this class. 3. A solution to your problem statement.

Assignment #14 (Dec 10)

Practice Problems
Reading: Sections 9.3-9.4 9.3.11: 0.10 9.3.15: 1.88×10^{-4} lb, 33.3% reduction 9.3.60: 53.5 kW, 4.46 kW, 42.0 kW 9.4.4: 65.9 hp
Mastery Problems 9.1.4 9.3.64
Special Problems/Laboratories Static pressure measurements on the surface of a smooth cylinder (Diameter – 1.5 inches) were obtained in the wind tunnel in the basement of the CB. The static pressure was measured as a function of the angular location, θ, where $\theta = 0$ corresponds to the stagnation point on the cylinder. The wind tunnel speed was $U_\infty = 26$ m/s, the atmospheric pressure was 86 kPa and the air temperature was 298 K. The data are tabulated below. P_s is the static pressure on the surface and P_∞ is the static pressure far from the cylinder. For this data, determine the following: a. Is the boundary layer on the cylinder laminar or turbulent? Explain how you know. b. Plot the pressure coefficient, C_P, as a function of θ b. Determine the drag coefficient using the data provided and compare it to values that are given in the Munson et al. text. (numerical integration will be required)

INSTRUCTIONS FOR PRACTICE PROBLEMS

For all homework practice problems, you are encouraged to work with other students and ask questions of the course instructor. Solutions to these problems should follow the abbreviated SAFER method and can be done on paper of your choice. Your work should be clear and easily followed. Submit images of your work through the Mastery Problems link. YOU NEED TO ALSO COMPLETE THE LEARNING SUITE QUESTIONNAIRE RELATED TO THESE PROBLEMS (DUE ONLINE AT THE TIME INDICATED ABOVE). Numerical answers to even numbered problems can be found on Learning Suite under the "Content" tab.

All HW solutions (both practice and mastery) should be uploaded through the HW Mastery Problem (Launch External Plug-in) link. work should be submitted as a single file in .pdf format. Place the Mastery problems at the front, with the practice problems placed following the mastery problems. You may scan your work using any device that works for you. The SwiftScan app can be downloaded for free and is a quick effective method to use your phone to scan all of your work into a single file following the instructions for submitting HW found under the content tab on LS.

INSTRUCTIONS FOR MASTERY PROBLEMS

For homework mastery problems you are NOT to work with other students in developing your solution and they are to be solved following the complete SAFER method using the ME EN department problem solving template. A significant portion of the grade on mastery problems will be related to your following the complete SAFER approach. You can (and are encouraged to) ask questions of the course TA's and instructor. However, these questions should be specific and aimed at helping you understand concepts you are struggling with. Questions that are simply checking to see if you got the "right" number will not be answered. Images of your solutions to these problems should be submitted to by the due date/time noted above.

All HW solutions (both practice and mastery) should be uploaded through the HW Mastery Problems #1 link. Your work should be submitted as a single file in .pdf format. Place the Mastery problems at the front, with the practice problems placed following the mastery problems. You may scan your work using any device that works for you. The SwiftScan app can be downloaded for free and is a quick effective method to use your phone to scan all of your work into a single file.