PETE 693—EXPERIMENTAL METHODS IN PETROLEUM ENGINEERING

Course Information

Title:	Experimental Methods in Petroleum Engineering
Course Number:	PETE 693
Semester:	Fall 2013
Credits:	3
Prerequisite:	Familiarity with basic statistical concepts and knowledge of linear algebra
Class Meetings:	5.30-8.30PM, Thursday
Room:	DUCK 344

Instructor Information

Instructor Name:	Dare Awoleke
Office location:	DUCK 407
Office hours:	4-5.30PM, Tuesdays and Wednesdays
Telephone:	(907) 474-7574
Email:	dare2029@gmail.com

Course Readings/Materials

Note: The class slides are designed to be self-sufficient. However, the student might need to refer to the books described below for personal study. Also, problems might be assigned to students from these books.

- Statistical Analysis of Designed Experiments: Theory and Applications [electronic resource @ UAF library], Tamhane, Ajit C., 1st ed.
- Introduction to linear regression analysis [electronic resource @ UAF library], Montgomery, Douglas C., 1st ed.

Recommended Reading

- Applied Statistics and Probability for Engineers, Douglas C. Montgomery, George C. Runger,5th ed.

Handouts (if necessary) and slides will be provided
It is expected that students will extensively reference technical papers for data throughout the course duration.

Software used: MATLAB or R

Reference Materials

Dimensional Analysis

- Dimensional analysis, A, Bridgman, P.W., 1st ed.
- Hydrodynamics: A study in logic, fact and similitude, Birkhoff G., 1st ed.
- Dimensional analysis and intelligent experimentation, Andrew C. Palmer, 1st ed.

Machine Learning

- Machine Learning, Tom Mitchell, 1st ed.
- Neural Networks, A Comprehensive Foundation, Simon Haykin, 2nd ed.

Experimental Design

- Experiment—Planning, Analysis, and Parameter Design Optimization by Jeff Wu and Michael Hamada, 1st or 2nd editions
- Design and Analysis of Simulation Experiments, Kleijnen, Jack P.C., 1st ed.

Course Description

The course will emphasize the application of statistics and to a more limited extent machine learning techniques to aid in the development of empirical models in petroleum engineering. It will involve the study of datasets drawn from petroleum engineering literature. Topics covered include dimensional analysis, fundamental statistical concepts, regression analysis, neural networks, and the design and analysis of factorial and fractional factorial designed experiments.

Course Goals

In a narrow sense, this class can be seen as a course on how to design and analyze experiments in a petroleum engineering context. In a broader sense, it is a class on proper data analysis. The goals of this course are:

1. To give you an appreciation of the importance of statistics in general and experimental design in particular to the development of empirical models in petroleum engineering.
2. To give you an idea of what it takes to follow through on a research project from the beginning to the end.
    a. You may be asked to focus on an area of petroleum engineering. This will ideally be an area you are not familiar with.
    b. Based on the technical area chosen in part a, you will collate experimental data from petroleum engineering literature.
    c. You will analyze the data and reach statistically sound conclusions based on the analysis. You will achieve this goal by either:
        i. Testing an hypothesis AND/OR
        ii. Developing an empirical model based on what you have learnt in class AND/OR
        iii. Developing your own objective and discussing it with the instructor to ensure that it aligns with class objectives.
    d. You will identify common errors engineers make while analyzing data.
3. To improve your writing and oral presentation skills. You will be required to write a project report that will follow the SPE Technical Style Guide regulations. You will also be required to give an oral presentation to summarize your work.

Student Learning Outcomes

At the end of this class, the student will be able to:

1. Understand the thought-process that goes into experimental research.
2. Use subject matter knowledge and dimensional analysis to be able to identify key parameters in a given problem.
3. Develop and test hypotheses based on experimental data.
4. Develop a test schedule for multi-factor experiments using factorial and fractional factorial experiments.
5. Develop empirical models from data. Be able to test for model adequacy. Also, be able to provide confidence intervals for parameter estimates.
6. Collate, analyze and interpret data.
7. Do research with minimal supervision on any of the covered subject materials.

Instructional Methods
Three-hour lecture per week

Tentative Course Calendar

Week 1 (~Sept 05)	Course Introduction and Matlab Tutorial
Week 2 (~Sept 12)	Dimensional Analysis
Weeks 3 & 4 (~Sept 19 & 26)	Basic Statistical Concepts, Least squares estimation
Weeks 5 & 6 (~Oct 3 & 10)	Experiments with more than one factor
Weeks 7 & 8 (~Oct 17 & 24)	Full factorial experiments
Weeks 9 & 10 (~Oct 31 & Nov 7)	Fractional factorial experiments
Week 11 (~Nov 14)	*Design and Analysis of Simulation Experiments
Week 12 (~Nov 21)	Linear Regression
Week 13 (~Nov 28)	*Neural Networks
Week 14 (~Dec 05)	Presentations

*Whether these topics are covered depends on class progress.

Grade Policy and Distribution

Midterm	25% (tentatively scheduled for the week of Oct 21st)
Homework	25% (5 assignments)
Final Project and Presentation	50% (tentatively due December 19th)

Letter grade cut-offs
A>=90; 75<=B<=89; 60<=C<=74; 45<=D<=59; F—Otherwise

Final Project
The purpose of the final project is to evaluate your ability to apply the techniques learnt in class to experimental data in petroleum engineering. At the beginning of the class, you will be expected to focus on experimental research in an area of petroleum engineering. You will collate and analyze the data related to this area by scouring relevant technical literature. You will report your findings to the instructor by **October 10th**. Thereafter, you will decide on a hypothesis you want to test or an empirical model that you want to develop. Your project report must comply with the guidelines in the **SPE Technical Style Guide** and it must be at most 10 pages long (10 pts font size, single spaced including tables and figures). There is no minimum report length but reports that are sub-standard will receive poor grades. For examples of ideal reports, check the content, style and formatting of any of the SPE journals. The report is due tentatively on **December 19th.** If your work is considered to be of sufficient quality, the instructor may submit an abstract based on the work to a SPE conference. In case of acceptance, you will be the first author.

A few of the important milestones are:

- September 19th—decide on area of focus
- October 10th —complete collation of data.
- October 24th—define problem and present solution approach.
- November 7th—review 1
- November 21st—review 2
- December 19th—project report due

Attendance

Attendance in class is your responsibility. Students are responsible for making up any missed work (lectures and homework). Students are encouraged to arrive to class on time because late-coming disrupts the flow of the class for both the instructor and the other students.

Homework Policy

Homework is due at the end of class on the designated date. Late homework will be docked at the rate of 10 points per day after due date. You can discuss the homework problems with your peers but you must work out the problem **independently** and turn in a **personal** solution. **A duplicate of someone else's solution/work is cheating.** If you want your work re-graded, inform the instructor within **a week** of when the work was returned to you.

Make-up Exam Policy

There will be no early, late or make-up exams unless the student obtains prior approval of the instructor. Approval for make-up exams will only be granted for family and medical emergencies. In case a student misses a test or exam, the student needs to provide legitimate documentation related to the incident no later than the next class after the test. If the absence is determined to be a non-excused absence, the student will receive a score of zero for the exam that was missed.

Academic Dishonesty

We follow the university guidelines for plagiarism/academic integrity as outlined in the link given below: http://www.alaska.edu/bor/policy/09-02.pdf. The student is encouraged to read this document.

Disability Services

The Office of Disability Services implements the Americans with Disabilities Act (ADA), and insures that UAF students have equal access to the campus and course materials. We will work with the Office of Disabilities Services (203 WHIT, 474-7043) to provide reasonable accommodation to students with disabilities in accordance with the following link: http://www.alaska.edu/bor/policy/09-06.pdf