University of Oklahoma
Gallogly College of Engineering
School of Industrial and Systems Engineering

ISE/DSA 5133: Energy Analytics

Tuesdays/Thursdays, 3:15 p.m.-4:30 p.m.
This course will be online
Fall 2020

Instructor: Dr. Talayeh Razzaghi
Office: Zoom Video Conferencing
Email: talayeh.razzaghi@ou.edu
Virtual Office Hours: Tuesdays/Thursdays, 4:30 p.m.- 5:30 p.m. [or by appointment]. Please join Zoom Meeting (Passcode: H2A4x701):
https://oklahoma.zoom.us/j/96425633233?pwd=V2g2cCtvTjdYZ0hEd1JPUTR5NkdkQT09
Learning Management System: https://learn.ou.edu
Join Zoom Meeting for online class on Tue/Thu at 3:15 pm **(**Passcode: 695uyzJ9):
https://oklahoma.zoom.us/j/97821830822?pwd=Y2RSODRYODZHR1Y4SGJKSmplc2lUZz09

Course Description:
In today's data-driven world, the ability to extract knowledge and create successful future energy projections is critical for the energy sectors. In this regard, data science body of knowledge promises a strong set of analytical tools that can be used for demand/supply forecasting and price prediction. This course aims at teaching the students the fundamentals of data analysis and interpretation with emphasis on various forms of datasets including time series, images, etc. Concepts taught in the course will be illustrated with examples/case studies drawn from energy applications.

Course Goals:
Upon successfully finishing the course, students will:

1. understand basic concepts of analytics with an emphasis on forecasting and predictive models;
2. be exposed to applications of analytics in the energy industry;
3. know how to use advanced statistical and open source tools such as R language or Python and its associated libraries with applications in energy analytics;
4. know how to perform critical tasks such as data collection and preprocessing as well as energy data visualization; and
5. know how to make data-driven decisions under uncertainties of energy markets.

Suggested Textbook:
Rob J. Hyndman and George Athanasopoulos (2019) *Forecasting: Principles and Practice*. 3rd edition, OTexts: Melbourne, Australia (https://otexts.com/fpp3/).

Other course material derived from:
I will discuss few papers from leading journals in the areas of data science and its applications in energy sector. Examples of journals are IEEE Transactions on Smart Grid, Energy Systems, IEEE Transactions on Sustainable Energy, etc. Here is the tentative list of papers.

- Amini, M. H., Kargarian, A., & Karabasoglu, O. (2016). ARIMA-based decoupled time series forecasting of electric vehicle charging demand for stochastic power system operation. Electric Power Systems Research, 140, 378-390.

- Ediger, V. Ş., & Akar, S. (2007). ARIMA forecasting of primary energy demand by fuel in Turkey. Energy policy, 35(3), 1701-1708.
- Nybø, R. (2010). Fault detection and other time series opportunities in the petroleum industry. Neurocomputing, 73(10-12), 1987-1992.
- Sagheer, A., & Kotb, M. (2019). Time series forecasting of petroleum production using deep LSTM recurrent networks. Neurocomputing, 323, 203-213.
- Bo-Juen Chen, Ming-Wei Chang and Chih-Jen Lin (2004). Load forecasting using support vector Machines: a study on EUNITE competition 2001. IEEE Transactions on Power Systems.

Expectations:

1. Attendance to the class sessions is mandatory. This is a graduate-level course; the students are responsible for all material covered in the lectures as well as reading assignments and are expected to actively participate in class discussions.

2. Students are supposed to bring their laptops to class to work on class problems.

Final Grade:

- *Assignments: 10%*

There will be 5 assignments in this class. The details about the due-date and late-submission penalty will be announced in the homework description. The assignments may include both written and programming problems. Students must perform the majority of statistical and analytic work in R and/or Python; however, the work can be supplemented with other tools (e.g., Microsoft Access, Microsoft Excel, LaTeX, etc.).

- *Midterm Exam: 25%*

The actual exam date/time will be announced throughout the semester.

- *Individual In-Class Paper Presentation: 30%*

Students should find a topic related to data analytics with applications in energy and select a related paper from peer-reviewed journals to present in class. More instructions will be given throughout the semester.

- *Discussion Quizzes: 5%*

  Quizzes will be taken in-class and should take around 15-20 minutes to be completed. They will usually be administered at the end of Discussion Sessions, so plan your attendance accordingly. Be prepared for articles assigned for discussion during class time.

- *Final Project (30%):*
  - *Project Team Selection and Proposal*
  - *Project: Initial draft (15%)*
  - *Project: Peer critique (10%)*
  - *Project: Presentation (30%)*
  - *Project: Final draft (45%)*

Grading Scale

There is a grade guarantee of 90% = A, 80% = B, 70% = C, 60% = D. Grades may be curved at the end of the semester.

Course Policies

Make-up Policy

There will be no make-up homework in case a student cannot submit his or her own homework before the due-date (although extension may be given based on the situation). Make-up exams will be administered only to students with a documented health/family emergency. Students with an extreme, unavoidable circumstance that will prevent them from attending a scheduled exam must appeal to the instructor (via email) at least one week before the exam date. Each appeal will be considered on a case-by-case basis. Again, no alternative exam scheduling arrangements are guaranteed for non-emergency non-documented reasons (such as (but not limited to) conflict with your schedule).

University Policies

Academic Integrity

Academic integrity means honesty and responsibility in scholarship. Academic assignments exist to help students learn; grades exist to show how fully this goal is attained. Therefore, all work and all grades should result from the student's own understanding and effort. Accordingly, cheating, plagiarism, or any act of dishonesty is strictly prohibited at the University of Oklahoma. To name a few examples, copying from another student's paper, from one of previous semesters or other courses, or from published writings are all treated as violation of academic integrity. If occurred, the disciplinary consequences are applied to all parties involved. Again, as a member of the OU community, it is your responsibility to protect your educational investment by knowing and following the rules and by reporting any violations of those rules that you witness.

Non-Discrimination Policy

OU guarantees equality of opportunity in education and strives to provide an academic environment that is free from any form of discrimination. Discrimination or harassment of any person based on race, color, religion, creed, gender, national origin, age, disability, veteran status, sexual orientation, or gender identity is a violation of state and federal laws and/or OU policies and will not be tolerated. Retaliation against any person who complains about discrimination is also prohibited. Be advised that all students, faculty, and staff are required to report instances of sexual harassment, sexual assault, or discrimination to the appropriate offices within the university. Information regarding non-discrimination policies and reporting guidelines can be found at http://www.ou.edu/eoo.

Pregnancy/Childbirth

Should you need modifications or adjustments to your course requirements because of documented pregnancy-related or childbirth-related issues, please contact your instructor as soon as possible. Also, see http://www.ou.edu/eoo/faqs/pregnancy-faqs.html for answers to commonly asked questions.

Religious holidays

It is the policy of the University to excuse absences of students that result from religious observances and to provide without penalty for the rescheduling of examinations and required class work that may fall on religious holidays. Notification must be provided sufficiently in advance, and every effort should be made to submit required work in advance.

Reasonable Accommodation Policy

Any student in this course who has a disability that may prevent him/her from fully demonstrating his/her abilities should contact me personally as soon as possible so we can discuss accommodations necessary to ensure full participation and facilitate your educational opportunities.

Title IX Resources and Reporting Requirement

For any concerns regarding gender-based discrimination, sexual harassment, sexual assault, dating/domestic violence, or stalking, the university offers a variety of resources. To learn more or to report an incident, please contact the Sexual Misconduct Office at smo@ou.edu. Incidents can also be reported confidentially to OU Advocates at 405/615-0013 (24 hours a day, 7 days a week). Be advised that an instructor/TA is required to report instances of sexual harassment, sexual assault, or discrimination to the Sexual Misconduct Office.

Accommodations for Disabilities

Reasonable accommodations will be made for students with disabilities. To take advantage of available resources, please contact the Disability Resource Center for detailed information and procedures. Registration instructions are available at http://www.ou.edu/drc/drc-registration. Please inform the instructor if you have a disability that may prevent you from fully demonstrating your abilities so that accommodations can be made to ensure your full participation in the course and safeguard your educational opportunities at OU.

Course Schedule and Important Deadlines

Please refer to pages 5 and 6.

Communication

All enquiries should be sent through Canvas (at http://Learn.ou.edu) and I will reply back your questions in Canvas. I will send urgent and regular communication to all students using the Announcements tool in Canvas. It is a requirement in this class that you set your New Announcements in Notifications to "Right Away" to ensure that you receive any announcements. (Go to Profile>Notifications, find for new announcements and set to Right Away).

Announcements

I will use Announcements to send time sensitive information to the entire class. Because you can set your own notification preferences in Canvas, you will need to make sure you receive announcements daily. You are required to set your notifications for New Announcements to be Right Away.

Students are responsible for any changes/additions to this syllabus announced in class.

Tentative Calendar

Week	Date	Lecture	Topics
1	Aug 25	1	Course Introduction
	Aug 27	2	Ch1-Introduction to Energy Analytics
2	Sep 1	3	Ch2-Time series Graphics
	Sep 3	3,4	Ch2-Time series Graphics, Ch3-Forecaster's Toolbox
3	Sep 8	4	Ch3-Forecaster's Toolbox
	Sep 10	4	Ch3-Forecaster's Toolbox
4	Sep 15	5	Ch5-Time series regression models
	Sep 17	5	Ch5-Time series regression models
5	Sep 22	5	Ch5-Time series regression models
	Sep 24	6	Ch6-Time series decomposition
6	Sep 29	6	Ch6-Time series decomposition
	Oct 1	7	Ch7-Expoential smoothing
7	Oct 6	7	Ch7-Expoential smoothing
	Oct 8	8	Ch8-ARIMA models
8	Oct 13	8	Ch8-ARIMA models
	Oct 15	-	Midterm
9	Oct 20	8	Ch8-ARIMA models
	Oct 22	8	Ch8-ARIMA models
10	Oct 27	8	Ch8-ARIMA models
	Oct 29	-	Instructor paper presentation (applications in energy)
11	Nov 3	9	Machine Learning
	Nov 5	10	SVM
12	Nov 10	11	ANN
	Nov 12	12	ANN
13	Nov 17	13	CNN
	Nov 19	-	Instructor paper presentation (applications in energy)
14	Nov 24	-	Student paper presentation
	Nov 26	-	Thanksgiving Holiday
15	Dec 1	-	Student paper presentation
	Dec 3	-	Student paper presentation
16	Dec 8	-	Student paper presentation
	Dec 10	-	Final Day of Full-Term Fall Classes
	Dec 15	1:30pm - 3:10pm	Final Project Presentation

Homework Due Dates

HW	Due	Topics
1	Sep 8	Time series data visualization
2	Sep 19	Time series benchmark forecasting models
3	Oct 3	Time series regression forecasting models
4	Oct 15	Decomposition and Exponential Smoothing models
5	Nov 3	ARIMA models, machine learning methods

Online submissions are due at 11:59 PM. **SCHEDULE AND DUE DATES ARE SUBJECT TO CHANGE. Changes will be communicated through Canvas!**