

Advanced Petrophysics

PGE 381L, Fall 2023
Unique Number: 20215

SYLLABUS

Instructor

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Course Description

Measurement, interpretation, and analysis of petrophysical properties of petroleum reservoir rock: Advanced concepts in petrophysics will be discussed for assessment of static and dynamic petrophysical properties of rocks in the laboratory and in-situ condition. Multi-scale data sets are used to describe the connection between pore-scale, core-scale, and reservoir-scale petrophysical properties and how these properties affect production and development of hydrocarbon reserves.

Credit: 3 hours

Prerequisites: Graduate standing or consent of instructor

Class Schedule

Lecture: TTH 9:30 AM – 11:00 AM

Location: GLT 1.102

Instructor Office Hours

Students are encouraged to use office hours during the semester. The instructor's office hours are as follows:

Office hours: Tuesdays and Thursdays 11:15 AM-12:30 PM

Location: Hybrid Mode (Zoom Meetings and In-person Meetings at GLT 4.246)

The instructor encourages all students to attend office hours in teams to benefit from the discussions and learn from their peers. Additional office hours can be scheduled in advance upon request from students based on instructor's availability. Technical discussions and questions by e-mail should be kept



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at a minimum. The instructor will not answer e-mails on weekends, holidays, or after 6:00 PM on weekdays.

Course Website, CANVAS

All the homework/project assignments, homework solutions, lecture notes will be posted on the CANVAS website designed for this course. Students are responsible to check their e-mails and the course website at least once a day for announcements and any required action for the course.

Teaching Assistant

Mr. Sabyasachi Dash

E-mail: sdash@utexas.edu

Office hours: Mondays and Wednesdays 2:00 PM – 3:30 PM

Location: Hybrid Mode (Zoom Meetings and In-person Meetings, Location will be announced)

Responsibilities of the teaching assistants include:

- a. To help students with conceptual and technical questions outside the classroom.
- b. To guide students in homework and project assignments.
- c. To help students in preparation for exams.

Suggested References

- **Required textbook:** Peters, E. J., 2012, Advanced Petrophysics. Live Oak Book Company.
- Zinszner, B. and Pellerin, F. M., 2007, A Geoscientist's Guide to Petrophysics. Editions Technip.
- Mavko, G., Mukerji, T., and Dvorkin, J., 2009, Rock Physics Handbook. Cambridge University Press.
- Gueguen, Y. and Palciauskas, V., 1994, Introduction to the Physics of Rocks. Princeton University Press.

Handouts and PowerPoint Presentations

PowerPoint presentations and handouts will be posted on the course website in PDF format. Additional handouts might be distributed in the class. Handouts including field examples might not be posted on the course website.

Additional Instructional Materials

- The instructor will distribute field/laboratory examples in the class or on the course website.
- The instructor will upload additional reading assignments and references on the course website.

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Grading Policy

The distribution of the final grade will be as follows:

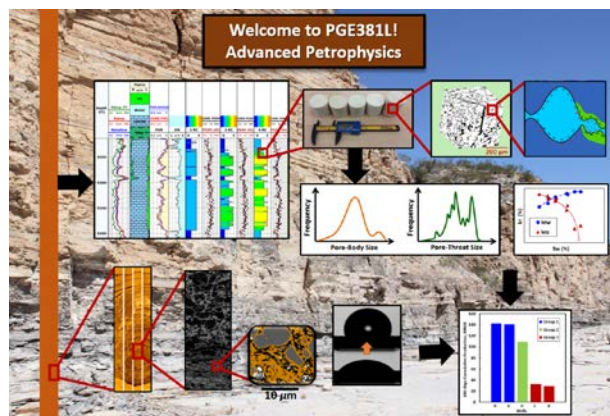
Item	Weight (%)	Due Date
Homework/Project Assignments	25	Thursdays before 11:00 PM
Class Contribution and Quizzes	5	
Midterm Exam	35	Thursday, October 26, 2023, 5:00 PM-7:00 PM, GLT 1.102
Final Exam	35	Monday, December 11, 2023, 1:00 PM-3:00 PM
Total	100	

The cutoff values for assigning letter grades (plus/minus grading system) will be decided by the instructor after the final exam.

Course Objectives and Outcomes

At the end of the semester, students will able to:

- Understand petroleum reservoir rocks and the impacts of geological environment on rock properties
- Quantify porosity in the laboratory and in-situ conditions
- Quantify water/hydrocarbon saturation in the laboratory and in-situ conditions
- Quantify hydrocarbon reserves using multi-scale and multi-physics formation data
- Quantify permeability in the laboratory and in-situ conditions
- Quantify heterogeneity of the formation
- Quantify spatial continuity in formation petrophysical properties and use that to estimate formation properties where data is not available
- Understand the impacts of rock-fluid interfacial interactions and wettability on rock physics and fluid flow properties
- Quantify wettability in the laboratory and in-situ conditions
- Quantify capillary pressure in the laboratory and in-situ conditions
- Understand and quantify the impact of capillary pressure on spatial distribution of fluids in porous media
- Quantify relative permeability in the laboratory condition
- Evaluate the parameters affecting porosity, water saturation, permeability, capillary pressure, and relative permeability and quantify their impacts
- Understand the origins of dispersion in porous media
- Quantify dispersion coefficient and dispersivity in porous media



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Topical Outline

1. Introduction to petrophysics, geology, and formation data
2. Porosity
3. Fluid saturations
4. Permeability
5. Quantification of heterogeneity, spatial data analysis, and geostatistics
6. Interfacial phenomena and wettability
7. Capillary pressure
8. Relative permeability
9. Tentative: Dispersion in porous media
10. Tentative: Introduction to petrophysics of unconventional reservoirs

Course Policies

- **Class Attendance:** Students are expected to attend every session of the class. Active participation in class activities, problem solving, and discussions is very important for learning the course materials. There is always the possibility of having pop quizzes and solving examples in the class, which will not be repeated later.
- **Course Plan:** This course is planned to be offered on face-to-face instruction mode. I will do my best to keep recording the face-to-face lectures, if the classroom technology allows me to do so. However, I emphasize that you are expected to attend the class in-person. I also plan to upload some pre-recorded lectures, which gives us the opportunity to spend more time during our class time to practice the course materials. I consider this as an amazing opportunity to work with you during class time to practice course materials through solving interesting examples, working on homework/projects problems, and participating in discussions. Although I highly encourage you to watch the pre-recorded lectures to be ready for class discussions, it is not a mandatory action unless I instruct otherwise for a specific lecture. I will have office hours in addition to our class time. Please use the office hours dedicated to you.
- **Teamwork and Individual Performance:** Collaboration on examinations and assignments is forbidden except when specifically authorized. See Policy on Academic Integrity (<http://deanofstudents.utexas.edu/conduct/academicintegrity.php>). However, students are encouraged to study in teams.
- **Class Recordings:** Class recordings are reserved only for students in this class for educational purposes and are protected under FERPA. The recordings should not be shared outside the class in any form. Violation of this restriction by a student could lead to Student Misconduct proceedings.
- **Homework and Project Assignments:** Homework and project assignments will be uploaded on the course website every other week on Fridays. The deadline for the assignments will be in one week after posting the assignment, on Thursdays before 11:00 PM (US central time zone) on the course website. Homework assignments will be considered late if they are not turned in before 11:00 PM on the due date. **Late or not, all assignments must be turned in.** Late homework assignments should be e-mailed to the instructor. The e-mailed/late assignments will only receive partial credit, if submitted before the solution is posted online. A course grade of “Incomplete” might be given if

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any assignment is missing, and this grade will be changed only after all required work has been submitted.

- **Exams and pop quizzes:** The students who miss any of the exams will not be given any additional exam. The final grade will be re-distributed for the students who miss the midterm exam with valid excuses without including the exam that they missed. Valid excuses include only university-approved reasons. Pop quizzes can be taken any time during lecture hours.

Students with special needs, including those who require special time and space accommodations for exams should let the instructor know preferably within the first week of classes but no later than two weeks before a given exam so that the instructor can secure the pertinent accommodations recommended by UT Austin.

- **Grading and Regrading:** The policies regarding grading and regarding of exams and homework/project assignments are as follows:
 - a. It is the general policy for this class that homework assignments and exams shall be graded on the basis of answers only — partial credit, if given, is given solely at the discretion of the instructor.
 - b. All work requiring calculations shall be properly and completely documented for credit.
 - c. All grading shall be done by the instructor, or under the instructor's direction and supervision, and the decision of the instructor is final.
 - d. Only in very rare cases will exams be considered for regrading; e.g., when the total number of points deducted is not consistent with the assigned grade. Partial credit (if any) is not subject to appeal.
 - e. Work which cannot be followed, will be considered incorrect and will not be considered for a grade change.
 - f. The request for homework and project regrading should be submitted to the instructor within one week from the date returned.
 - g. If regrading is necessary for the exams, the student should submit a regrading request to the instructor within one week from the date returned.
 - h. According to The University of Texas at Austin regulations, the grades and the exams/assignments results will only be disclosed to the students. The instructor will not discuss/negotiate students' grades with their parents, friends, or significant others.
- **University Regulations Concerning Attendance, Grades, and Academic Dishonesty:** Each student should review the University Regulations concerning attendance, grades, and scholastic dishonesty. In particular, anyone caught cheating on an examination or homework assignment will be removed from the class roster, given an F (failure grade) in the course, and reported to the Dean of Judicial Affairs. **Academic dishonesty will not be tolerated.** An explanation of what constitutes plagiarism can be found at the following website:
<http://catalog.utexas.edu/general-information/the-university/>
- **Accommodations for Religious Holidays:** By The University of Texas at Austin policy, the students must notify the instructor of their pending absence at least fourteen days prior to the date of observance of a religious holy day. If any student must miss a class, an examination, a work assignment, or a project in order to observe a religious holy day, he/she will be given an opportunity to complete the missed work within a reasonable time, decided by the instructor, after the absence.

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- **Resources for Students with Disabilities:** Students with disabilities may request appropriate academic accommodations from the Division of Diversity and Community Engagement, Disability and Access (D&A). For more information, contact the Office of the Dean of Students at 512-471-6259 or the College of Engineering Director of Students with Disabilities at 512-471-4321. Additional information can be found in the following website:
<https://diversity.utexas.edu/disability>
- **Safety in the Classroom:** Students are expected to review the following recommendations regarding emergency evacuation from the Office of Campus Safety and Security, 512-471-5767.
 - a. Occupants of buildings on The University of Texas at Austin campus are required to evacuate buildings when a fire alarm is activated or an official announcement is given.
 - b. Familiarize yourself with all exit doors of each classroom and building you may occupy. Remember that the nearest exit door may not be the one you used when entering the building.
 - c. Students requiring assistance in evacuation shall inform their instructor in writing during the first week of class.
 - d. During an evacuation, follow the instructions of faculty or class instructors.
 - e. Do not re-enter a building unless given instructions by the following: Austin Fire Department, The University of Texas at Austin Police Department, or the Fire Prevention Services.
 - f. Link to information regarding emergency evacuation routes and emergency procedures can be found at www.utexas.edu/emergency
 - g. Behavior Concerns Advice Line (BCAL): 512-232-5050

Additional safety-related information can be found at <https://safety.utexas.edu/>

- **Coursework Copyright:** No materials used in this class, including, but not limited to, syllabus, lecture hand-outs, videos, assessments (quizzes, exams, papers, projects, homework assignments), in-class materials, review sheets, solution sets, laboratory problems, workshop materials, PowerPoint presentations, and additional problem sets, may be shared online or with anyone outside of the class unless you have my explicit, written permission. Because these materials are copyrighted, students do not have the right to copy them, reproduce them (including digital reproductions), post them on the web, or share them with anyone by either manual or electronic means unless you are expressly granted permission by the instructor.

Unauthorized sharing of materials promotes cheating. It is a violation of the University's Student Honor Code and an act of academic dishonesty. I am well aware of the sites used for sharing materials, and any materials found online that are associated with you, or any suspected unauthorized sharing of materials, will be reported to Student Conduct and Academic Integrity in the Office of the Dean of Students. These reports can result in sanctions, including failure in the course.

- **Title IX Policy:** Title IX is a federal law that protects against sex and gender-based discrimination, sexual harassment, sexual assault, sexual misconduct, dating/domestic violence and stalking at federally funded educational institutions. UT Austin is committed to fostering a learning and working environment free from discrimination in all its forms. When sexual misconduct occurs in our community, the university can:

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1. Intervene to prevent harmful behavior from continuing or escalating.
2. Provide support and remedies to students and employees who have experienced harm or have become involved in a Title IX investigation.
3. Investigate and discipline violations of the university's [relevant policies](#), which can be found at <https://titleix.utexas.edu>

Faculty members and certain staff members are considered "Responsible Employees" or "Mandatory Reporters," which means that they are required to report violations of Title IX to the Title IX Coordinator. **Your instructor is a Responsible Employee and must report any Title IX related incidents** that are disclosed in writing, discussion, or one-on-one. Before talking with a faculty or staff member about a Title IX related incident, be sure to ask whether they are a responsible employee. If you want to speak with someone for support or remedies without making an official report to the university, email advocate@austin.utexas.edu. For more information about reporting options and resources, visit titleix.utexas.edu or contact the Title IX Office at titleix@austin.utexas.edu.

The Department and the University of Texas at Austin has a zero-tolerance policy for Title IX infractions. For more information about Title IX policies and concerns you can visit the following websites:

<https://titleix.utexas.edu/what-is-title-ix>
<https://titleix.utexas.edu/support-resources>

- **Academic Integrity:** A fundamental principle for any educational institution, academic integrity is highly valued and seriously regarded at The University of Texas at Austin. More specifically, the students are expected to maintain absolute integrity and a high standard of individual honor in scholastic work undertaken at the University. This is a very basic expectation that is further reinforced by the University's Honor Code. At a minimum, you should complete any assignments, exams, and other scholastic endeavors with the utmost honesty, which requires you to:
 - a. acknowledge the contributions of other sources to your scholastic efforts;
 - b. complete your assignments independently unless expressly authorized to seek or obtain assistance in preparing them;
 - c. follow instructions for assignments and exams, and observe the standards of your academic discipline; and
 - d. avoid engaging in any form of academic dishonesty on behalf of yourself or another student.

For the official policies on academic integrity and scholastic dishonesty, please refer to Chapter 11 of the *Institutional Rules on Student Services and Activities*.

- **Acceptable Use of ChatGPT and Similar AI Tools:** ChatGPT or similar AI Tools must not be used to generate output that would be considered non-public. Examples include, but are not limited to generating proprietary or unpublished research; completion of academic work and homework assignments; creation of non-public instructional materials; and grading. Course materials are considered as copyrighted materials and cannot be shared with ChatGPT and Similar AI Tools.

The following link takes you to the available policy-based resource, from the Information Security Office (ISO) at UT-Austin:

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<https://security.utexas.edu/ai-tools>

It provides guidance on how to use generative AI Tools safely, without putting institutional, personal, or proprietary information at risk.

- **Land Acknowledgment:** I would like to acknowledge that we are meeting on Indigenous land. Moreover, I would like to acknowledge and pay our respects to the Carrizo & Comecrudo, Coahuiltecan, Caddo, Tonkawa, Comanche, Lipan Apache, Alabama-Coushatta, Kickapoo, Tigua Pueblo, and all the American Indian and Indigenous Peoples and communities who have been or have become a part of these lands and territories in Texas, here on Turtle Island.
- **University Code of Conduct and Student Honor Code:** The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the university is expected to uphold these values through integrity, honesty, trust, fairness, and respect toward peers and community.

“As a student of The University of Texas at Austin, I shall abide by the core values of the University and uphold academic integrity.”

For more information and resources about how to uphold the Honor Code, visit the website of the Office of the Dean of Students - Student Judicial Services.

- **Final Words:** Please take care of yourselves. I will do my best to provide the guidance and help you need to be successful in my class. Please feel free to reach out to me, if you have any questions or concerns. I look forward to getting to know each and every one of you.

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About the Instructor



Zoya Heidari is an associate professor in the Hildebrand Department of Petroleum and Geosystems Engineering at The University of Texas at Austin. Before joining The University of Texas at Austin, she was an assistant professor at Texas A&M University in College Station and the Chevron Corporation faculty fellow in Petroleum Engineering from September 2011 to August 2015. Zoya was the founder and the director of the Texas A&M Joint Industry Research Program on “Multi-Scale Formation Evaluation of Unconventional and Carbonate Reservoirs” from 2012 to 2015. She has been the founder and the director of the University of Texas at Austin Industrial Affiliates Research Program on “Multi-Scale Rock Physics” since 2016. She received a Ph.D. (2011) in Petroleum Engineering from The University of Texas at Austin. Zoya was one of the recipients of the 2023 SPE (Society of Petroleum Engineers) International Formation Evaluation Award, the 2021 SPWLA Distinguished Technical Achievement Award, the 2020 SPWLA Young Professional Technical Award, the 2019 EAGE (European Association of Geoscientists and Engineers) Arie van Weelden Award, the 2019 AIIME Rossiter W. Raymond Memorial Award, the 2019 SPE Distinguished Membership Award, the 2019 departmental teaching award from the Hildebrand Department of Petroleum and Geosystems Engineering, the 2017 SPE Cedric K. Ferguson Medal, the 2016 SPE regional Formation Evaluation award, the 2015 SPE Innovative Teaching Award, the 2014 TEES (Texas A&M Engineering Experiment Station) Select Young Faculty Fellows Award from the College of Engineering at Texas A&M University and the 2012 SPE Petroleum Engineering Junior Faculty Research Initiation Award. She has been the holder of Anadarko Petroleum Corporation Centennial Fellowship #1 in Petroleum Engineering at UT Austin since 2016. Zoya has supervised 31 graduate students since 2011 and published more than 218 papers in peer-reviewed journals and conference proceedings as well as 2 patents. Her research interests include Petrophysics, Borehole Geophysics, Well Logging, Formation Evaluation, Rock Physics, Inverse Problems, Integrated Reservoir Characterization of Carbonates and Unconventional Resources, and Completion Petrophysics. Zoya has served on the SPE reservoir advisory committee, technical committees for the SPWLA annual symposium, the SPWLA education committee, the local organizing committee of the Society of Engineering Science (SES) conference, and the SPWLA Unconventional Resources Special Interest Group (URSIG), and steering committees for SPWLA topical conferences on “Completion Petrophysics” and “Educating the Petrophysicist” as well as unconventional reserves task force summit. She has served as an executive editor for the SPE Journal since 2022 and an associate editor for the SPE Reservoir Evaluation & Engineering Journal (2017 – 2022) and for Geophysics Journal since 2019. She served as the Vice President of Education for SPWLA from 2016 to 2018.