Texas A&M University  
Departmental Request for a New Course  
Undergraduate ∙ Graduate ∙ Professional  
Submit original form and attach a course syllabus.

1. This request is submitted by the Department of Geology and Geophysics

2. Course prefix, number and complete title of course: GEOP 661 Reservoir Rock Physics

3. Course description (not more than 50 words): Poroelasticity and electrodynamics of porous media; Biot Theory, Gassmann fluid substitution and advanced rock physics models; relationships between seismic/electromagnetic properties and multiphase reservoir properties such as porosity, saturation, permeability, wettability, connectivity and other pore-structure parameters; computer-based rock physics modeling; application to reservoir characterization; time-lapse reservoir monitoring.

4. Prerequisite(s) Approval of instructor. (Spring, alternate years.) Cross-listed with

5. Is this a variable credit course? □ Yes ☑ No If yes, from _____ to _____.

6. Is this a repeatable course? □ Yes ☑ No If yes, this course may be taken _____ times. Will the course be repeated within the same semester/term? □ Yes ☑ No

7. Has this course been taught as a 289/489/689? □ Yes ☑ No If yes, how many times? ______ Indicate the number of students enrolled for each academic period it was taught.

8. This course will be:
   a. required for students enrolled in the following degree program(s) (e.g., B.A. in history)
   b. an elective for students enrolled in the following degree program(s) (e.g., M.S., Ph.D. in geography) M.S., Ph.D. in geophysics, geology, petroleum engineering.

9. If other departments are teaching or are responsible for related subject matter, the course must be coordinated with these departments. Attach approval letters.

10. Prefix Course # Title (excluding punctuation)  
G E O P 6 6 1 R E S E R V O I R R O C K P H Y S I C S  
<table>
<thead>
<tr>
<th>Lect.</th>
<th>Lab</th>
<th>SCH</th>
<th>Subject Matter Content Code</th>
<th>Admin. Unit</th>
<th>Acad. Year</th>
<th>FICE Code</th>
<th>Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 3 0 2 0 4 4 0 0 6 0 3 0 0 0 2 1 3 0 5 0 8 - 0 9</td>
<td>0 0 3 6 3 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Approval recommended by:

Head of Department Date

Head of Department (if cross-listed course) Date

Submitted to Coordinating Board by:

Director of Academic Support Services Date

Effective Date

Questions regarding this form should be directed to Sandra Williams at 845-8836.
OAR/AS – 04/07 1 of 5 B14
GEOP 661  Reservoir Rock Physics

Instructor:  Dr. Y. F. Sun
Office: Halbouty Geosciences Building, Room 63
Phone: (979) 845-0635
Email: sun@geo.tamu.edu

Office Hours:  Directly after class or by appointment

Lecture/Lab Schedule: Tuesdays and Thursdays: 9:35 am – 10:50 am
Lecture/Lab Location: Halbouty Geosciences Building, Room 174 (Lecture), 65 (Lab)

COURSE DESCRIPTION
Reservoir rock physics plays an important role in successful applications of geophysical methods to modern-day reservoir characterization and reservoir management decision-making, e.g., topical emerging technology of time-lapse or 4D seismics. This course, which is designed for graduate students in geophysics, geology, and engineering, covers both fundamentals and timely topics in these areas. Course subjects include poroelasticity and electrodynamics of porous media; Biot theory, Gasmann fluid substitution, and advanced rock physics models, including the Eshelby model, the Hertz-Mindlin contact theory, the Kuster-Toksöz model, and other effective-medium models; relationships between seismic/electromagnetic properties and multiphase reservoir properties such as porosity, saturation, permeability, wettability, connectivity, and other pore-structure parameters; application to reservoir characterization; and time-lapse reservoir monitoring. Throughout the course, laboratory exercises on computer-based rock physics modeling will supplement lectures and offer practical experience with concepts and methods. (3-2). Credit: 4.

PREREQUISITES
Differential equations or approval of instructor.

COURSE TEXTBOOKS AND/OR OTHER REQUIRED MATERIALS
Required textbook: None.

Reading from lecture notes, journal articles and selected texts will be assigned. Students will be expected to participate in class discussions.

COURSE OBJECTIVES
Traditionally, many geophysicists and geologists have been equipped with only a minimal knowledge of reservoir rock physics in the worldwide curricula of higher education. With declining petroleum production in the world’s giant reservoirs, practicing
geoscientists often lack the increasingly vital ability to translate geophysical measurements such as seismic attributes to reservoir property parameters and internal reservoir heterogeneity. This course is intended to fill the gap in the existing curricula by providing the fundamentals of reservoir rock physics for graduate students. After completing this course, students will be able to:

- Understand the fundamentals of poroelasticity and electrodynamics of porous media.
- Understand the assumptions of various state-of-the-art reservoir rock physics models and their limits of application.
- Acquire in-depth knowledge of the physical properties of reservoir rocks and fluids and their relationships to geophysical measurements.
- Perform independent computer-based rock physics modeling and fluid substitution for advanced reservoir characterization and time-lapse seismic/electromagnetic reservoir monitoring.

**COURSE FORMAT**
The course meets two times per week. Class interaction, active learning, and critical thinking are strongly encouraged. Computer-based interactive lab sessions will also be given for computational implementation and practice of the theoretical models covered in the lectures. Internationally renowned experts from the industry may be invited to present the most recent progress in fields relevant to the course.

**Grades:**

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attendance and participation</td>
<td>10%</td>
</tr>
<tr>
<td>Lab</td>
<td>40%</td>
</tr>
<tr>
<td>Midterm Exam</td>
<td>25%</td>
</tr>
<tr>
<td>Final Exam</td>
<td>25%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
</tr>
</tbody>
</table>

Two exams (midterm and final) will be two hours long. Examination materials and coursework are assessed on the clarity of writing and presentation, originality, scientific logic, and technical accuracy.

**LAB DESCRIPTION AND SOFTWARE**
Computer-based lab sessions are an integral part of this course. Students are expected to write computer programs in either FORTRAN or C/C++ so that they will be able to implement the theoretical models and relationships learned from lecture sessions and perform 1-D, 2-D, 3-D and 4-D seismic/electromagnetic modeling. Commercial software Fugro-Jason’s JGW, Landmark’s SeisVision, or Schlumberger’s GeoFrame under TAMU’s academic licenses will be used for synthetic rock-physics modeling, depending on the student’s own preference. Advanced software packages for synthetic modeling may also be provided by the instructor.
TOPICS COVERED
This is a tentative schedule of the topics to be covered.

Week 1
1. Introduction
   Syllabus;
   Energy resources and field redevelopment in the 21st century;
   Challenges in petroleum exploration, development and production in the 21st century;
   Seismic attributes, reservoir rock physics and reservoir production monitoring
2. Review of continuum mechanics and electrodynamics

Week 2
3. Fundamental equations of continuum mechanics for a medium with a single inclusion
4. Pore Structure

Week 3
5. Surface forces in porous media
6. Topological characterization of porous media

Week 4
7. The connectivity tensors

Week 5
8. Fundamental laws of poromechanics of fractured porous media
9. Constitutive equations of fractured porous media

Week 6
10. Extended Biot Theory

Weeks 7 and 8
11. Biot Theory and squirt flow

Weeks 9 and 10
12. Gassmann model and fluid substitution

Week 11
13. Effective-medium theories

Week 12
14. Physical properties of reservoir fluids
15. Physical properties of sandstone reservoir rocks
16. Physical properties of carbonate reservoir rocks
17. Physical properties of shale

Week 13
18. Numerical comparison of rock physics models and their impact on time-lapse reservoir monitoring

Week 14
19. Seismic attributes and reservoir properties
20. Reservoir rock and fluid properties and AVO analysis

Week 15
21. Extracting permeability from seismic data
22. Reservoir rock physics, infill well drilling and reservoir management decision-making
The Americans with Disabilities Act (ADA): is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, please contact the Department of Student Life, Services for Students with Disabilities in Room B118 of Cain Hall or call 845-1637.

Each student has the responsibility to be fully acquainted with and to comply with the Texas A&M University Student Rules. Please see http://student-rules.tamu.edu

AGGIE HONOR CODE:
"An Aggie does not lie, cheat, or steal or tolerate those who do."
Academic integrity is an essential force in the academic life of a university. It enhances the quality of education and celebrates the genuine achievements of others. It is, without reservation, a responsibility of all members of the Texas A&M University Community to actively promote academic integrity. Apathy or acquiescence in the presence of academic dishonesty is not a neutral act -- failure to confront and deter it will reinforce, perpetuate, and enlarge the scope of such misconduct. For more information, see Honor Council Rules and Procedures. http://www.tamu.edu/aggiehonor

PLAGIARISM: As commonly defined, plagiarism consists of passing off as one's own the ideas, words, writings, etc., which belong to another. In accordance with this definition, you are committing plagiarism if you copy the work of another person and turn it in as your own, even if you should have the permission of that person. Plagiarism is one of the worst academic sins, for the plagiarist destroys the trust among colleagues without which research cannot be safely communicated.

On all course work, assignments, and examinations at Texas A&M University, the following Honor Pledge shall be preprinted and signed by the student:
"On my honor, as an Aggie, I have neither given nor received unauthorized aid on this academic work."