

Course Information

Lectures: Tuesday / Thursday 11:30 – 12:20 (CHB 9)

Lab: Monday 2:30 – 5:30 (BGS 0184) (note: some elements of the lab assignments may be conducted in BGS 1058)

Pre-requisites: Earth Sciences 3372A/B

Statement on Requisites: Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.

Aims of the course:

At the end of the course, the student should be able to create play and prospect maps that integrate **seismic, stratigraphic, petrophysical, pressure, and fluid** data. The student should be able to determine the **volume** and **characteristics** of the **mapped petroleum prospect**, and be able to estimate the **uncertainty** and **risk** associated with the prospect. Finally, the student should be able to estimate the **economic value** of the prospect in terms of **risked discounted cash flow valuation**. The course uses a highly enriched experiential learning design based on the American Association of Petroleum Geologists (AAPG) Imperial Barrel Award contest model (project area to be selected by the class). Lectures, group discussions, assigned readings and project reports will form the basis for achieving these learning objectives.

In order to attain these goals, students will receive feedback on their techniques through evaluations of oral presentations of project updates and written assignments. Project work will be conducted during labs that will incorporate the use of several oil and gas industry software packages, as well as frequent use of Microsoft PowerPoint and Excel[®], and Surfer 11[©]. The lab projects will sequentially build up a foundation of basic skills that will be used to conduct a real-world oil or gas prospect assessment. Much of this work will be conducted using a team approach, and the entire class will contribute to the project database. The lab component is evaluated by an oral and written project report. In addition, students will be evaluated on a combination of lecture and lab material via weekly short quizzes, a mid-term reflection essay and a final exam based on lecture material.

This course requires a high level of engagement and participation by all students. Although traditional lecture slides from the previous offering of ES 4472 are used as a basis for learning, the dynamic nature of play and prospect assessment requires active discussion by all class members. Participation in class discussion, as well as team project work, will be evaluated and will contribute to the final course grade. From time to time, class members will be called upon to lead the discussion to help all students understand how their project work has applied fundamental concepts in petroleum assessment.

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Instructor Information

Instructor: Dr. Burns A. Cheadle, Associate Professor, Department of Earth Sciences

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Tel: (519) 661-2111 x89009

Office Hours: by appointment

Course Website: <https://owl.uwo.ca/portal> (log in with UWO username and password)

Note: PowerPoint presentations for each lecture will be posted the evening before the lecture (at the latest), and will remain on the website for the rest of the term. In addition, lecture slides from ES 3372B will be provided as background material. PowerPoint presentations posted on OWL are not to be used as a substitute for coming to class (***you have been warned***), and should be considered as supplementary to the required textbook. It is up to you to download the presentations when they are available and to obtain information from your classmates if you miss a class.

Course Syllabus

(Note: This is an outline of lecture and lab topics that will be covered, but we will adjust the emphasis on certain topics depending on the specific application to the selected assessment project. For some topics, formal lectures will be replaced with a “flipped classroom” discussion of provided lecture slides or reading assignments.)

Lecture Topics

Introduction and Course Objectives

- course outline & objectives | summary of petroleum systems | introduction to play and prospect assessment

Basin Analysis

Basin Analysis for Petroleum Assessment

- fundamentals of basin analysis | subsidence mechanisms

Extensional Basin Petroleum Systems

- heat flow history | rift phase systems | passive margin systems

Foreland Basin Petroleum Systems

- tectonics and stratigraphy | maturation and migration | reservoir development

Translational Basin Petroleum Systems

- transtension and transpression | source considerations | reservoir development

Burial History and Timing

- fundamentals of basin analysis | burial history plots | timing and prospectivity

Source

Source Rock Characterization

- transformation of kerogen | Rock-Eval pyrolysis data | modeling petroleum generation

Maturation and Migration

- maturity indicators | expulsion mechanics | capillarity and multiphase flow

Reservoir

Reservoir Characterization

- characterization as a discipline | scales of characterization | workflow considerations

Reservoir Architecture

- clastic architectural elements | outcrop analogs | quantitative facies modeling

Seismic Reservoir Characterization

- seismic attributes | porosity inversion | rock mechanics considerations

Petrophysical Reservoir Characterization

- quantitative petrophysical methods | scaling properties for models

Trap & Seal

Evaluation of Extensional Traps

- seismic method | fault geometries | fault seal analysis

Evaluation of Compressional Traps

- seismic imaging of thrusts | palinspastic restoration | compressional trap geometries

Evaluation of Stratigraphic Traps

- modeling unconformities | diagenetic modeling | stratigraphic vs. structural closure

Evaluation of Seal

- capillary seal | hydrocarbon column height

Engineering & Economics

Reservoir Engineering

- primary production characteristics | decline analysis | gas material balance analysis
- enhanced oil recovery | production operations

Resources and Reserves

- resources vs. reserves | reserves categories
- volumetric oil reserves calculation | volumetric gas reserves calculation

Petroleum Economics

- uncertainty and risk | time value of money | discounted cash flow analysis | economic indicators

Unconventional Resources

"Shale Gas" Assessment

- typical workflow | geomechanical considerations

Lab / Project Topics

Orientation and Organization Session

- developing a "predation image" | general assessment workflow
- project candidate overviews
- project data mining | public data sources | assembling a project library
- project team assignments

Basin History: Tectonic Setting and Paleogeography

- plate tectonic context | basin evolution
- tectonostratigraphic units | age constraints
- paleogeographic evolution | paleoclimate

Source Interpretation: Quality and Generation Potential

- source rock analysis | source quality evaluation
- burial history analysis | thermal history | petroleum system charts

Seismic Interpretation

- building a seismic project | importing .sgy data files
- seismic well ties | velocity model | time-depth conversion
- horizon picking | fault interpretation | time structure mapping
- seismic reservoir attributes

Stratigraphic Interpretation

- avoiding the pitfall of lithostratigraphy | chronostratigraphic principles in correlation
- designing a cross-section grid | datum selection | strategies for effective correlation

Petrophysical Interpretation: Quantitative Well Log Analysis

- "quick look" techniques | lithology prediction | porosity and saturation calculation
- clay volume estimation | effective porosity calculation | bound water volume

- hydrocarbon pore volume determination

Seal and Trap Interpretation

- seal presence and quality evaluation
- trap closure classification | spillpoint interpretation
- traps and migration pathways

Integration of Fluid and Pressure Analyses

- reading a water analysis report | quality control of water analyses | formation water resistivity (Rw)
- reading a DST report | reading a flow and buildup test report | spotting problem tests
- prediction of fluid contacts | prediction of hydrocarbon column height
- production performance indicators | mapping production data

Play and Prospect Map Construction

- data integration | play map construction
- dry hole analysis
- prospect mapping
- volumetric reserves calculation | decline analysis | gas material balance

Basic Risked Economic Evaluation

- economic inputs | fiscal regimes
- discounted cash flow table | calculating Net Present Value
- calculating chance of success | risk mitigation
- risked economics | prospect seriatim

Course Materials

Required Text: Bjørlykke, K., 2015. ***Petroleum Geoscience: From Sedimentary Environments to Rock Physics, 2nd edition***. Springer. 662p. (note that this textbook is available through the Western Library system as a Springer e-book)

Optional Text: Allen, P.A. and Allen, J.R., 2013. ***Basin Analysis: Principles and Applications***. 3rd edition. Blackwell. 619 p. (*Part 4 is particularly relevant to petroleum geology*)

(Any citations for required readings or other reference materials will be made available by the instructor throughout the course via OWL)

Required Materials: The workstations in BGS0184 will be used for the labs. When required, workstations in the Petroleum Geoscience Lab (BGS 1058) will be used on a limited basis. At the time of writing, software options are under evaluation for seismic interpretation and petrophysical analysis project components and these may determine where the work is completed.

Methods of Evaluation

Your assessment will be based on in-class and team participation, weekly short quizzes, oral and written project reports, a mid-term reflection essay, and a comprehensive final examination.

Participation (10% of total):

- initiation and response to in-class discussions
- contribution to team project work (assessment by team members)
- rubrics will be provided

Short Quizzes (10% of total):

- ten quizzes administered throughout the course (1 % each); multiple choice and True/False format delivered through course OWL site

Lab / Project Report (40% of total):

- The lab portion of the course uses a project-based approach. Students will be assigned to a team that is responsible for a specific aspect of the overall project assessment (provision will be made for team re-assignment within the first three weeks of the course). Project teams will be responsible for providing short weekly progress reports (**5%**) to the class during the lab session, as well as a final team oral presentation (**20%**) of results during the final lab session. Team project work will be shared with other teams via a common project folder maintained on the class OWL site. Each student will individually submit a short written report (**15%**) on their project work (due* November 21, two weeks prior to the final lab session)

Mid-Term Assignment (10% of total):

- Assigned essay in which students reflect on learnings to date and identify learning gaps, propose a plan to address those gaps, and set out measurable learning goals (complete instructions and a rubric will be provided); due October 25*

Final Examination (30% of total):

- *during the scheduled exam period*
- evaluation of fundamental concepts from lecture portion of the course

** due dates for assignments are firm - 10% per day will be deducted for late assignments. See note (4) under "University Policies" for exceptions due to illness or special circumstances. The Instructor will grant accommodation, without requirement for documentation (medical or otherwise), for work 10% or less of the total course grade. Accommodations for work in excess of 10% of the total course grade, and all accommodations requiring documentation (medical or otherwise) must be referred to the student's Academic Counselling Unit.*

Sessional Dates (ES 4472A specific dates in bold)

September 8	Fall term classes begin
September 8	ES4472A lectures begin (11:30 – 12:30 CHB 9)
September 12	ES4472A labs begin (2:30 – 5:30 BGS 0184)
September 16	Last date for late registration
October 10	Thanksgiving Holiday
October 11-13	Instructor away for conference / guest lecturers
October 25	Mid-term reflection essay due
October 27-28	Fall Study Break
November 5	Last day to drop a first-term half course or a first-term full course (2016-17 Fall/Winter Term) without academic penalty.
November 21	ES4472A written project reports due
December 5	ES4472A final lab session / team project presentations
December 6	ES4472A final lecture session
December 7	Fall/Winter term classes end
December 8-9	Study Days
December 10-21	Mid-year examination period

The Exceptional Contributor: “The Class Was Better Because You Were Here.”

As part of the learning process I expect all students to participate actively in class. Here are some guidelines to keep in mind when in class:

- You provide clear, concise, and correct explanations that help others gain a better understanding of concepts.
- You make outstanding, original, and informative comments.
- You make highly attentive and constructive comments on other people's statements.
- You ask questions that are penetrating or help clarify.
- You raise your hand strategically (understanding that there are other students in the class).
- You actively encourage others to express their ideas.
- You display body language that communicates interest in what others are saying.
- You arrive to class on time and are not absent without reason.

University Policies:

1) *Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site:*

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_undergrad.pdf

2) *Unless you have either the requisites for this course or written special permission from your Dean to enroll in it, you may be removed from this course and it will be deleted from your record. This decision may not be appealed. You will receive no adjustment to your fees in the event that you are dropped from a course for failing to have the necessary prerequisites.*

3) *All required papers may be subject to submission for textual similarity review to the commercial plagiarism detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between The University of Western Ontario and Turnitin.com (<http://www.turnitin.com>).*

4) *If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or other supporting documentation to the Academic Counselling Unit as soon as possible and contact your instructor immediately. It is the student's responsibility to make alternative arrangements with their instructor once the accommodation has been approved and the instructor has been informed. In the event of a missed final exam, a "Recommendation of Special Examination" form must be obtained from the Academic Counselling Unit immediately. For further information please see:*

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_illness.pdf

A student requiring academic accommodation due to illness should use the Student Medical Certificate when visiting an off-campus medical facility or request a Records Release Form (located in the Academic Counselling Unit) for visits to Student Health Services. The form can be found here:

https://studentservices.uwo.ca/secure/medical_document.pdf

5) *Students who are in emotional/mental distress should refer to Mental Health@Western http://uwo.ca/health/mental_wellbeing/ for a complete list of options about how to obtain help.*

6) *For the policy on Accommodation for Students with Disabilities, refer to: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_disabilities.pdf.*

7) *For the policy on Accommodation for Religious Holidays, refer to:*

http://www.uwo.ca/univsec/pdf/academic_policies/appeals/accommodation_religious.pdf

Accessibility Statement:

Please contact the course instructor if you require material in an alternate format or if you require any other arrangements to make this course more accessible to you. You may also wish to contact Services for Students with Disabilities (SSD) at 661-2111 x.82147 for any specific question regarding an accommodation.