

ES486 Petroleum Geology Final Exam Study Guide Winter 2021

Exam Format: The final exam will occur on Thursday March 18, 2021, worth a total of 120 points. Exam questions may be comprised of multiple choice, true/false and short answer-fill in blank; along with short and long answer essay, and lab-style problem solving. Two-Part Exam; Part 1 - Closed Book, qualitative exam questions, short answer essay – terms and definitions, draw sketches, long answer essay – “compare and contrast”, “discuss”, “explain”. Part 2, Open Book, lab-style problem solving, you will be able to use all of your class resources to solve math-based, lab-style problems. The exam content will primarily cover materials since the midterm, but basic fundamentals from the beginning of class may be revisited.

Exam Logistics: The online exam will be available as a link at the top of the General Section of the ES486 Moodle course shell, between 8 AM and 11 PM on exam day. Once a student begins the exam, it will be timed for 2 hours. You may begin the exam at any time between 8 AM and 11 PM, but make sure that once you start it, you have enough time before the 11 PM cut-off availability to complete the exam. The exam questions will be submitted only once, with no opportunities for resubmissions. The Professor will be manually grading your exams and reviewing your answers, in addition to the automated Moodle grading tools; typos and misspelled words in short answer will be evaluated for correctness in content. Additional testing accommodations are possible by prior arrangement with the professor.

Study Tips

- go through the web site, look at the figures and slide shows, compare to notes
 - review the video resources and exercise review sheets; check the lab answer keys for review
 - review textbook summary questions / answers
 - use study guide in combination with notes
 - go back through the in class / lab exercises, make sure you can work the math / units
 - spend a couple days studying, the exam will be essay and there is much material.
 - don't wait until the last minute!
 - carefully go through the notes, some of the material we briefly discussed, but did not spend much time on in class... but the notes will give you the detail
 - finish all your lab exercises and assignments before taking the exam!!! Lab questions will appear.
 - Exam format: Part 1. Closed book short answer / essay. Part 2. Open-book lab-style problem solving.
- NOTE: I would spend a minimum of 5 hours studying for this exam if I wanted to do well.**

Exam Study Resources (Readings and Class Notes from Weeks 5 through 10)

- Text Reading: Ch. 6 – Reservoirs
https://people.wou.edu/~taylors/es486_petro/text/Ch6_reservoir.pdf
- Class Notes 9. Reservoir Properties
https://people.wou.edu/~taylors/es486_petro/6_Reservoir_Characterization.pdf
- Class Notes: Traps and Seals
https://people.wou.edu/~taylors/es486_petro/7_Traps_Seals.pdf
- Text Reading: Ch. 7 Traps and Seals
https://people.wou.edu/~taylors/es486_petro/text/Ch7_traps_seals.pdf
- Class Notes: Exploration
https://people.wou.edu/~taylors/es486_petro/9_Exploration_Methods.pdf
- Text Reading: Ch. 3 Exploration
https://people.wou.edu/~taylors/es486_petro/text/Ch3_exploration.pdf
- Class Notes: Introduction to Stratigraphic Analysis
https://people.wou.edu/~taylors/es486_petro/9A_Techniques_Intro_Stratigraphic_Analysis.pdf
- Class Notes: Introduction to Seismic Stratigraphy
https://people.wou.edu/~taylors/es486_petro/9B_Introduction_Seismic_Stratigraphy.pdf

- Text Reading: Overview of Wireline Geophysics Methods and Facies Analysis
https://people.wou.edu/~taylors/es486_petro/Walker_Subsurface_Facies_Methods.pdf
- Text Reading: Production and Recovery
https://people.wou.edu/~taylors/es486_petro/10_Production_Recovery.pdf
- Class Notes: Sedimentary Basins
https://people.wou.edu/~taylors/es486_petro/8_Sed_Basins_Petro_Systems.pdf
- Text Reading: Ch. 8 Sedimentary Basins and Petroleum Systems
https://people.wou.edu/~taylors/es486_petro/text/Ch8_petro_systems.pdf

Review Questions from Homework Assignments:

- Task 5-1. Reading Review Questions: Chapter 6 Reservoirs
- Task 5-3. Lecture Review Questions Univ. of Delft: Oil Migration from Source to Sink
- Task 5-5. Reading Review Questions: Key Terms in Stratigraphy and Lithologic Correlation
- Task 6-1. Reading Review Questions: Chapter 7 Traps and Seals
- Task 6-2. Video Review Exercise: Earth Revealed Earth's Structures
- Task 6-3. Lecture Review Questions Univ. of Delft: Reservoir Properties
- Task 7-1. Reading Review Questions: Introduction to Exploration Methods
- Task 7-2. Lecture Review Questions Univ. of Delft: Traps
- Task 8-1. Key Word Review: Production and Recovery
- Task 8-2. Video Review Questions: Wire Line Logging Methods
- Task 8-3. Lecture Review Questions: Univ. Delft Basins Types and Exploration
- Task 9-1. Reading Review Questions: Ch.8 Sedimentary Basins and Petroleum System
- Task 9-2. Video Review Questions: Sedimentary Basins
- Task 10-1. Walker Text Reading Review Question: Wireline Logging and Stratigraphic Facies Analysis
- Task 10-2. Case Study Review Questions: Gas Reservoir Exploration in the Anadarko Basin

Lab Exercises

- Task 5-4. Lab Exercise: Geologic Time
- Task 6-4. Lab Exercise: Subsurface Well Correlation (Complete "Part 8E, Activity 8.7")
- Task 7-3. Class Exercise: Introduction to Contouring
- Task 7-4. Class Exercise: Introduction to Isopach Maps
- Task 8-4. In Class Exercise: Introduction to Structure Contour Mapping
- Task 9-3. Lab Exercise: Structure Contour Mapping Part 2

Student Presentations: Petroleum Basin Case Study Summaries

Journal Reading Download Link: https://people.wou.edu/~taylors/es486_petro/ES486_Case_Studies.htm

[Gaswirth and Higley, 2013, Petroleum Analysis of West Edmond Field, OK](#) [FAITH]

[Petersen et al., 2018, Source Rocks and Petroleum in Danish North Sea](#) [HUNTER]

[Okere et al., 2013, Hydrocarbon Potential in Kazakstan](#) [ALEX]

[Kohl et al., 2014, Gas Reservoirs in the Marcellus Shale, Appalachian Basin](#) [JOE]

[Tozer et al., 2014, Athabasca Oil Sands](#) [JAKE]

[Sen, 2013, Petroleum occurrence in the Black Sea, Turkey](#) [IVY]

[Ghalayani et al., 2018, Petroleum Systems of Lebanon](#) [GRACE]

[Gross et al., 2018, Petroleum Systems North Alpine Foreland Basin, Austria](#) [HALEY]

[Al Saad, 2016, Paleozoic Petroleum Systems, Qatar](#) [TROY]

Recommendation:

Review Selley “Essentials of Petroleum Geology” Text Chapters (posted on Moodle class site); Review class notes on ES486 web site; review class slide shows and text review questions

KEY WORD SUMMARY

Reservoirs (Selley Chapter 6)

https://people.wou.edu/~taylors/es486_petro/6_Reservoir_Characterization.pdf

Porosity
Effective porosity
Total porosity
Primary porosity
Secondary porosity
Intergranular porosity
Fracture porosity
Solution porosity
“Vuggy Porosity”
Intercrystalline porosity
Cementation/compaction
Diagenesis
permeability
permeability vs. porosity vs. lithology
Darcy’s Law
Millidarcy
100 md reservoir threshold
Viscosity
Permeameter
Horizontal vs. vertical permeability
Homogenous vs. heterogeneous
Anisotropic vs. Isotropic
Artesian Reservoirs (gushers)
Texture vs. Permeability vs. Porosity
Grain Shape-Sorting-Grain Size
Clay/shale vs. Sand/Sandstone
Grain packing; grain fabric
Sandstone/Limestone
Reservoirs
Shale/Mudstone Seals
Diagenesis effects on Reservoir
Clay alteration
Authigenic Clay

Feldspar degradation
Porosity loss vs. compaction
Cementation vs. porosity
Depth-compaction curves
Clay diagenesis / dewatering
Carbonate diagenesis
Dolomitization
Calcite-Dolomite
Transformation
Reservoir shape / continuity
Sheet vs. ribbon vs. pod

Traps and Seals (Selley Chapter 7)

https://people.wou.edu/~taylors/es486_petro/7_Traps_Seals.pdf

Trap vs. Seal
Oil-Water Contact (OWC)
Bottom water
Edge water
Bottom oil / tar mats
Fluid contacts
Shale Seal
Trap Classification
Structural traps
 Fold traps
 Fault traps
Diapir Traps
 Salt Domes
Stratigraphic Traps
 Pinch out
 Interfingering
 Unconformable
 Channel / ribbons
 Barrier Island Bars
 Reefs
Combination Traps
Compressional Anticlines
Compactional Anticlines
“Drape Anticlines”
Drag Folds
Faults – normal-reverse-thrust
Block faulting
Strike-slip faults
Transcurrent faults
Tranpression/transtension
Pull-apart basins
Updip / downdip
Growth faults

Onlap-Offlap
Transgression-Regression

Sedimentary Basins and Petroleum Systems (Selley Chapter 8)

https://people.wou.edu/~taylors/es486_petro/8_Sed_Basins_Petro_Systems.pdf

Sedimentary Basin
Structural vs. Topographic Basin
Marine vs. nonmarine basins
Symmetrical vs. asymmetrical
Depocenter
Basin Mechanisms
 Thermal contraction
 Crustal extension
 Crustal compression
 Crustal loading
Cratonic Basins
Intracratonic Sag
Passive Margin Loading
Forearc Basins
Backarc Basins
Foreland (Thrust) Basins
Rift Basins
Aulacogen
Strike-Slip Basins
Pull-Apart Basins

Petroleum Exploration Methods (Selley Chapter 3)

https://people.wou.edu/~taylors/es486_petro/9_Exploration_Methods.pdf

https://people.wou.edu/~taylors/es486_petro/9A_Techniques_Intro_Stratigraphic_Analysis.pdf

https://people.wou.edu/~taylors/es486_petro/9B_Introduction_Seismic_Stratigraphy.pdf

https://people.wou.edu/~taylors/es486_petro/Walker_Subsurface_Facies_Methods.pdf

Drilling Techniques
Cable tool – mud rotary
Directional drilling
Drill rods
Kelley bushing
Tri-cone roller bit
Drill stem
Drilling derrick
Drilling mast
Offshore / onshore rigs

Mud logging
 Coring / sidewall coring
 Wireline logs
 Electrical logs
 Caliper logs
 Temperature logs
 Pressure logs
 SP
 Resistivity
 Gamma Ray
 Density Logs
 Porosity logs
 Neutron Logs
 Seismic surveys
 Seismic Lines
 Seismic Refraction
 Data processing
 Seismic Reflection
 Gravity Surveying
 Magnetic Surveying
 Remote Sensing
 Well correlation
 Isopach map
 Structure contour map
 Facies map
 Seismic facies analysis
 Stratigraphic analysis

Production and Recovery

https://people.wou.edu/~taylors/es486_petro/10_Production_Recovery.pdf

Residual Oil
 Reserve Oil
 Unrecoverable Oil
 Attic Oil
 Primary Recovery
 Secondary Recovery
 Tertiary Recovery
 Water Drive
 Gas Drive
 Waterflood Recovery
 Viscosity Factor vs. Recovery
 Enhanced Oil Recovery
 Oilfield Brine
 Thermal Recovery
 Steam Drive
 Polymer Recovery
 Explosive Fracturing
 Hydraulic Fracturing
 Brine Disposal

Well Production
 Well Testing
 Petroleum Recovery Curve

Case Studies / Student

Presentations

http://www.wou.edu/las/physci/taylor/es486_petro/ES486_Case_Studies.htm

rift basin
 forearc basin
 back arc basin
 foreland basin
 aulacogen
 half graben
 normal faults
 TOC
 Seismic lines
 Seismic reflection
 Basin analysis
 Vitrinite reflectance
 Thermal maturation
 Fracture reservoirs
 Fracture permeability
 Migration pathways
 Tar Sands
 Flexure loading
~~Canadian Shield~~
 Bitumen
 Breached anticline
 Heavy oil
 Asphaltic bitumen
 Delta systems
 Regression-transgression
 Source terrane
 Rift zone
 Catchment analysis
 Petrophysical analysis
 Shale gas reservoirs
 Free gas vs. dissolved gas
 “tight” reservoirs
 Heterogeneity
 Salt domes
 Diapir
 Louann Salt
 Triassic Rift Basin
 Flexure Zone
 Deep Gulf Basin
 Sequence stratigraphy
 Formation-member
 Lithic vs. gamma ray logs

Transgression/regression
 Isopach maps
 Jurassic-Cretaceous
 Giant Oil Field
 North sea
 Rift basin
 Seismic profile
 Reservoir architecture
 Synrift sediments
 Postrift sediments
 Fault blocks
 Thrust Fault-Foreland
 Fault Traps
 Petroleum System
 Sandstone wedges
 Carbonate Ramps
 Carbonate Reservoir
 Reef Reservoir
 Thrust-anticline trap
 Fault block / extension
 Turbidites
 Source rocks
 Trap rocks
 Secondary porosity
 Syncline-anticline
 Unconventional reservoirs
 Facies analysis
 Wireline log
 Shelf-offshore facies
 Well correlation
 Paleogeography
 Biostratigraphy
 Carbonate platform
 Oolitic Limestone
 Dolomite – vuggy porosity
 Solution porosity
 Diagenetic traps
 Source rock maturation
 Extension
 Rift tectonics
 Heat flow
 Burial
 Synrift sedimentation
 depocenter
 Subsidence history
 Thermal migration
 Tight-gas sandstone
 3-D Seismic
 Fault trends
 Fracture analysis

Quantitative / Lab Skills

Quantitative Skills

Perform basic unit conversions-unit algebra-solve quantitative word problems

Process Rate Calculations

porosity-density-specific weight-pressure-temperature-depth calculations

Subsurface Mapping

Contouring-contour interval-contour interpolation-drawing contour lines

Isopach mapping

Structure Contour Mapping

Strike / Dip

~~Constructing Paleofacies Maps~~

Identifying geologic structures (faults, folds) from structure contour and isopach maps

Identifying stratigraphic features (unconformities, transgression, regressions) from structure contour and isopach maps

Stratigraphic/Log Correlation

Identify rock types and stratigraphic assemblages from well cuttings.

Identify formations-members-beds from lithologic logs

Correlate lithologic logs-define geologic/stratigraphic contacts in cross-section

Create a stratigraphic column from log data, to scale, and correlate lithologic units

Identifying stratigraphic features (unconformities, transgression, regressions) from well correlation, cross-section and stratigraphic columns

Big Concepts for Essay Questions

~~Discuss Porosity and Permeability, how measured? What is darcy's law? Units and equation?~~

List and discuss the concepts of reservoir, trap, seal; provide geologic examples.

What types of rocks are typical in reservoir.

Discuss the classification of traps.

What is a sedimentary basin? Classify and describe sedimentary basins in relation to plate tectonics.

What is the difference between a structural and stratigraphic trap, provide examples with sketches.

How is geophysics used in petroleum exploration?

What are the main wireline geophysics methods we used in the lab exercises to correlate strata?

What are the steps required for the exploration and discovery of petroleum?

What are the primary drilling techniques used in exploration? Sketch and discuss.

How do salt domes form and why are they important with respect to petroleum exploration?

Summarize the key concepts of the three student presentations from the case study review.

What are the primary sedimentary environments and how do they relate to source-reservoir-trap-seal?

What geologic conditions lead to the accumulation of economically viable hydrocarbon deposits?

What types of diagenetic processes lead to reservoir degradation?

List the primary types of faults and sketch

Draw a sketch and label structure features associated with salt domes and related traps.

List the primary types of traps, draw sketches

~~Describe the stages of petroleum maturation from primary organic material to kerogen to oil/gas.~~

~~What is the difference between kerogen and bitumen?~~

~~What are the primary components of source material (carbohydrates, lipids, lignins, proteins)~~

~~What are temperature-related stages of thermal maturation?~~

How do compaction, cementation, fracturing effect petroleum forming processes?

What are the primary types of reservoir rock, describe their shapes in relation to depositional environments.

What is the difference between bottom water and edge water?

What are the primary types of sedimentary basins? Explain how they form in the context of tectonic setting.

Compare and contrast foreland basins to rift basins, include structural style and subsidence mechanisms.

What are the primary processes that cause basin subsidence and sediment accumulation.

Provide examples of real-world oil fields as related to the student presentations. Where to they form and what environments lead to commercial quantities of hydrocarbons.