ES486 Petroleum Geology Final Exam Study Guide
Winter 2023

Exam Format: The final exam will occur on Thursday March 23, 2023, worth a total of 100 points. Exam questions will 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.

Exam Logistics: In-person exam, NS218, no time limit, but scheduled for a 2-hour block. 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_Stratigrahy.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 5-2. Video Review Exercise: Earth Revealed Geologic Time
- 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 Questions: Subsurface Methods and 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 6-5. Hydraulics Demonstration / Darcy's Law Permeameter Experiment
- 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

Hudec et al., 2013, Jurassic Salt Dome Systems, Gulf of Mexico [SEAN]
Petersen et al., 2018, Source Rocks and Petroleum in Danish North Sea [CATHERINE]
Gross et al., 2018, Petroleum Systems North Alpine Foreland Basin, Austria [JEN]
Kohl et al., 2014, Gas Reservoirs in the Marcellus Shale, Appalachian Basin [ELDEN]
Tozer et al., 2014, Athabasca Oil Sands [DAVIS]

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_Stratigrahy.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
Tertial 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.