**ES486 Petroleum Geology Mid-Term Exam Study Guide**
**Winter 2015**

## Exam Format

Two-Part Exam, Tuesday February 10, 2015:

Part 1 - Closed Book, 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.

## Study Tips

- go through the web site, look at the figures and slide shows, compare to notes
- 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 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.

## Midterm Digital Lab Portfolio Moodle Upload Due Wednesday February 11, 2015

**Recommendation:**
Review Selley "Essentials of Petroleum Geology" Text Chapters (posted on Moodle class site);

*Chapter 1 Introduction;*
"Creekology"
Anticline Theory
Five Conditions of Petroleum Accumulation
- Source
- Reservoir
- Trap and seal
- Timing
- Preservation

Geology and Petroleum
Biology and Petroleum
Exploration vs. Production
Drakes Well, Titusville PA

*Chapter 2 Properties;*
Hydrocarbon gases
Natural gases
Organic matter
Inert gas
Methane-ethane-propane
Helium
Carbon dioxide
Gas hydrates
Crude Oil
API Gravity
Paraffins-Napthenes-Aromatics-Asphaltines
"Cracking" Distillation
Sweet crude-sour crude

*Chapter 4 Subsurface Environment*
Subsurface water
Connate-meteoric-juvenile water
Eh – Ph
Concentration
ppt, ppm, ppb
Brine water
Salinity
Total dissolved solids
Subsurface temperatures
Geothermal gradient
Bottom hole temperature
Thermal conductivity
Porosity / compaction
Formation temperatures
Subsurface pressures
Hydrostatic pressure
Lithostatic pressure
Oil-water contact
Pressure gradient
Artesian pressure
Structural pressure

*Chapter 5 Generation & Migration*
Organic vs. Inorganic Source
Mantle hydrocarbon
Meteorite hydrocarbon
Igneous hydrocarbon
Sedimentary hydrocarbon
Carbon cycle
Photosynthesis
Bacterial decay
Protein-carbohydrate-lignin-lipids
Plant vs. animal carbon
Biomass production
Organic preservation
Organic productivity Marine
Productivity NonMarine
kerogen
Bitumen
Diagenesis
Type I-II-III Kerogen
Maturation
Catagenesis
Metagenesis
Paleothermetry
Vitrinite Reflectance
Biogenic gas production
Thermogenic gas production
Primary Migration
Secondary Migration
Overpressure/microfractures
Oil Expulsion

**Key Words from Notes**
(Web links provided below)

*Introduction*
http://www.wou.edu/las/physci/taylor/es486_petro/1_Introduction.pdf

hydrocarbons
phases: solid-liqud-gas
crude oil
natural gas
kerogen
gas hydrate
tars and resins
sedimentary basin
biogenic sediment
geologic time
thermal maturity
source rock/sediement
reservoir
seals, cap rock
trap
Conditions for Petroleum
    Biogenic sediments
    Source Rock
  Thermogenic Maturation
  Reservoir-Seal-Trap
Dry gas/ wet gas
Sweet vs. sour crude
Inert gases
Light Oil vs. Heavy Oil
Hydrocarbon composition Wt%
  Paraffin
  Napthene
  Aromatics
  Asphaltics
Crude Distillates
Petroleum Engineering
Chemical Engineering
"Cracking"
Exploration-Production-Refining-Marketing
Historical Perspectives on Oil
Drakes Well

*Basic Principles Intro to Earth System*
http://www.wou.edu/las/physci/taylor/es486_petro/physrevw.pdf

Earth System Science
Environmental Spheres
Atmosphere
Biosphere
Lithosphere
Hydrosphere
Lithosphere-Tectonic Plates
Geothermal-Gravity-Solar
Matter-Energy-Force
Kinetic Energy
Potential Energy
Open System-Closed System
Transfer of Mass
Transfer of Heat
Mass-Energy-Heat Flux
Hydrologic Cycle
Carbon Cycle
Rock Cycle
Tectonic Cycle

*Physical Principles*
*http://www.wou.edu/las/physci/taylor/es486_petro/4A_Physical_Principles_Fluids.pdf*

Mass-Length-Time-Temperature
Force-Energy-Work
Motion-Velocity-Acceleration
Acceleration due to Gravity
Pressure
Power
Density
Weight Density = Specific Weight
Viscosity
Heat-solid-liquid-gas
Density-Buoyancy
Temperature-Density Relations
Newtons-Joules-Pascals-Watts
Periodic Chart
Atomic Model
Neutrons-Protons-Electrons
Atomic Number
Atomic Mass
Isotope
Formula Weight
Mole

*Review of Sedimentary Rocks*
*http://www.wou.edu/las/physci/taylor/es486_petro/2_sedimentary_rock_review.pdf*

weathering
sediment
sediment transport
sediment burial
lithification
fossil
erosion
lithification
compaction
cementation
Sed. Rock types
    detrital
    biochemical
    chemical
sediment size fractions
    gravel
    sand
    silt
    clay
grain shape
grain sorting
rock types
    sandstone
    conglomerate
    shale
    limestone
    evaporites
crystalline vs. microcrystalline
    coal
clastic / nonclastic
marine
nonmarine
fluvial
lacustrine
glacial
Sedimentary Features
sedimentary structures
methods of transport
bedload
suspension
dissolved load
cross-stratification
graded bedding
reverse grading
normal grading
asymmetric ripples
symmetric ripples
flute casts
cast vs. mold
mudcracks
raindrop imprints
paleocurrents

*Overview of Stratigraphy and*

*Depositional Systems*
*http://www.wou.edu/las/physci/taylor/es486_petro/3_Overview_Stratigraphy_Depositional_Systems.pdf*

Geologic time / Earth History
Age of Earth
Stratigraphy
Stratigraphic Record
Geologic Column / Time
- PreCambrian Era
  - Archeozoic
  - Proterozoic
- Paleozoic Era
  - Cambrian
  - Ordovician
  - Silurian
  - Devonian
  - Mississippian
  - Pennsylvanian
  - Permian
- Mesozoic Era
  - Triassic
  - Jurassic
  - Cretaceous
- Cenozoic Era
  - Tertiary
  - Quaternary

Law of Original Horizontality
Law of Superposition
Law of Uniformitarianism
Law of Cross-Cutting Relations
Law of Faunal Succession
Walthers Law
Relative Geologic Dating
Absolute (numerical) Dating
Half Life
Parent-Daughter Isotopes
Radioactive decay
Horizontal/vertical bed relations
Dike-Sill-Fault
Lithostratigraphy
Biostratigraphy
Seismic Stratigraphy
Index Fossils
Unconformity
Angular Unconformity
Nonconformity
Conformable Strata
Interfingering Strata
Diastem
Lacuna
Paraconformity
Transgression-Regression
Onlap-Offlap
Eustacy
Sedimentary Basins
Rift Basin
Strike-Slip Basin
Normal Fault
Reverse Fault
Isostatic Subsidence
Forearc Basin
Foreland
Backarc Basin
Intracratonic Sag
Aulacogen
Facies
Formation
Member
Bed
Marine-NonMarine
Fluvial
Lacustrine
Deltaic
Littoral
Beach-Barrier
Lagoonal-Estuarine
Tidal Flat
Shelf
Slope
Abyssal Plain
Reef

*Subsurface Fluids and Conditions*
http://www.wou.edu/las/physci/taylor/es486_petro/4_Reservoir_Fluids.pdf
Water-Oil-Gas
Connate-Meteoric-Juvenile
Fluid Density-Buoyancy
Brines
Formation Water
Salinity-Concentration-Total Dissolved Solids
Mass Percent-PPT-PPM-PPB
Solute-solvent
Crude Oil
C-H ratios
Parrafin-Napthene-Aromatics
Asphaltine
Barrels- bbl
Example Parrafin compounds
Example Napthenes-Aromatics
Molecular models
Oil Composition
Density-API Gravity Index
Viscosity-Temperature
Temperature-Volume-Density
Heat Content (BTU, Calorie)
Natural Gas
Dissolved vs. Free
"inflated oil"
Ideal Gas Law

*Source Rocks: Generation and Migration*
*http://www.wou.edu/las/physci/taylor/es486_petro/5_source_rocks_generation_petroleum.pdf*

Source rock
Organic matter
Hydrocarbons
Carbon sequestration
Carbon cycle
Photosynthesis
Carbohydrates
Proteins
Lipids
Lignins
Plant-Animal Compositions
Marine vs. Non marine biomass
Biomass Productivity Zones
High vs. Low Ecosystems
Organic Preservation
Anoxia-bacterial decy
Scavengers
Sedimentation rate
Depositional setting
Kerogen
Bitumen
Phases of Petroleum Generation
Kerogen Types (algal-plankton-humic)
Diagenesis-Catagenesis-Metagenesis
C/H progression
Thermogenic vs. Biogenic Gas
Clay diagenesis\
Dewatering
"Migration Paradox"
Migration Models
Primary vs. Secondary Migration

**Quantitative / Lab Skills**

*Quantitative Methods*
Perform basic unit conversions-unit algebra-solve quantitative word problems
Process Rate Calculations
calculate potential energy, kinetic energy, force, weight, stress
pressure-depth calculations
application of idea gas law to subsurface gas accumulations
calculation of basic engineering properties of rocks
porosity-density-specific weight
*Sedimentary Rocks*
what about the three diff. types of sed. rocks?
Can you estimate: grainsize? sorting? grading? angularity?
What about basic paleocurrent directions? How can you tell which way the fluid was moving when the sediment was deposited?
What about recognizing some basic sedimentary structures?
Associating a specific rock type to a possible sedimentary environment?
How does transport energy relate to grain size of deposits? (e.g. would you find boulders in the deep ocean?)
What are the basic marine and nonmarine sedimentary environments?
What are sedimentary structures and how are they used to reconstruct sedimentary environments?
What type of environment do the various sed. rock types form? e.g. sandstone, conglomerate, evaporites, coal, mudcracks, limestone, etc. where would these rocks form at the earth's surface?
*Stratigraphic Correlation*
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

**Big Concepts for Long-Answer Essay Questions**
What are the primary types of hydrocarbons?
What are the criteria necessary for the generation and accumulation of hydrocarbons in subsurface?
What compounds are petroleum and natural gas composed of? What are the basic carbon families and their general molecular compositions? What is the process necessary to find and produce petroleum-related products for industry? What is the basic refining process? How does transport energy relate to grain size of deposits? (e.g. would you find boulders in the deep ocean?) What are the fundamental energy sources of the earth system How do force-energy-pressure relate to the subsurface environment? What are the temperature and pressure conditions like in the subsurface environment?
What are the fundamental components of the Earth System?
How do the study of sedimentology and stratigraphy relate to petroleum geology?
What are the basic laws and principles of stratigraphy used to analyze sedimentary rocks?
What are the basic marine and nonmarine sedimentary environments?
What are sedimentary structures and how are they used to reconstruct sedimentary environments?
What type of environment do the various sed. rock types form? e.g. sandstone, conglomerate, evaporites, coal, mudcracks, limestone, etc. where would these rocks form at the earth's surface?
How do sediments accumulate over time? How is time recorded in the rock record?
What are the primary fluids contained in the subsurface environment? Relative abundance and composition of each? What is the chemical composition of formation water? Crude oil? Natural gas?
What are the key properties used to characterize petroleum and natural gas?
How is petroleum generated? What are the geologic conditions necessary? Discuss the global carbon cycle in the context of petroleum geology. What are the sources of organic materials in petroleum? Chemical composition? What are the steps in petroleum generation? The thermal maturation process? What is the migration paradox? Discuss secondary vs. primary migration processes.