ES476/576 Hydrology Final Exam Study Guide Winter 2022

Exam Format (125 pts): *Similar to Mid-Term.*

Part 1 – Closed Book Lecture Exam: closed book exam, short answer, essay, terms, definitions (make sure you know how to sketch relationships).

Part 2 – Open Book Lab Exam: Equation lists, conversion charts, and calculators accessible (but not entire note books). Suggestion, organize diagrams and equation lists by topic, so that you can easily find and use your tools on the open-book portion of the exam.

Recommended Study Techniques:

Memorize / study key words and concepts from class notes (focus on yellow highlight words below)
Review/watch class video resources (Youtube resources on drilling, well installation, aquifer testing)
Complete all lab exercises / review answer keys before exam
Read over textbook chapters on Moodle Class Site

Study Tips

- complete all labs and worksheets before exam
-go over the text and video review questions, some will be on the exam
- use study guide in combination with notes and online powerpoint slide shows
- go back through the in class / lab exercises, make sure you can work the math / units; review map skills
- spend a couple days studying, the exam will be short answer / essay and there is much material.
- don't wait until the last minute!
- carefully go through the notes, the notes will give you the detail.

Reading Assignments for Review

Text: Drainage Basins and Watersheds
https://people.wou.edu/~taylors/es476_hydro/Chap7_Drainage_Basins.pdf
Journal: Flood Climatology
https://people.wou.edu/~taylors/es476_hydro/hirschboeck_etal_2000_flood_hydroclimatology.pdf
Text: Groundwater Overview
https://people.wou.edu/~taylors/es476_hydro/cech_chap4_ground_water.pdf
Text: Aquifer Types
https://people.wou.edu/~taylors/es476_hydro/Sterrett_2007_App02A_Aquifer_Types.pdf
Text: Wells and Aquifer Testing
https://people.wou.edu/~taylors/es476_hydro/Sterrett_2007_aquifer_testing.pdf
Report: Hydrogeologic Framework of Willamette Lowland Aquifer System
https://people.wou.edu/~taylors/es476_hydro/hydrogeo_willamette_valley.pdf

Video Resources for Review

Flood Types https://www.youtube.com/watch?v=aAF9BbLsfQ8
Flood Recurrence Interval http://www.youtube.com/watch?v=a1gXKyIKnHk
Aquifers Explained https://www.youtube.com/watch?v=g7R0yLX0V9E
Porosity and Permeability https://www.youtube.com/watch?v=8mfBomrw0rs&t=4s
Darcy's Law https://www.youtube.com/watch?v=mb8clQdvrvo
Groundwater Flow https://www.youtube.com/watch?v=a1BWyMz3XiE
Groundwater Maps https://www.youtube.com/watch?v=X9cdYP2XSoY
Water Well Systems https://www.youtube.com/watch?v=8K6V450StO4
Groundwater Monitory Well Installation https://www.youtube.com/watch?v=u9kn4FT4Suk

KEY TERMS AND CONCEPTS

Surface Water Hydrology
https://people.wou.edu/~taylors/es476_hydro/surfwatr.pdf

drainage basin
watershed
drainage divide
interfluve
groundwater-surface water
discharge
drainage area
cross-sectional area
flow velocity
channel width
channel depth
volume/time
continuity equation Q = VA
stream lengths
drainage density
~~shreve magnitude~~
stream ordering
1st order, 2nd order, etc.
peak discharge
peak annual flow
~~peak monthly flow~~

Flood Climatology
https://people.wou.edu/~taylors/es476_hydro/hirschboeck_1991_climate_floods.pdf

Climate vs. Weather
Flood Weather
- Convective thunderstorms
- Tropical hurricanes
- Cyclones / low pressure
- Frontal systems
- Rain-on-snow events

U.S. Air Masses
- Polar continental
- Polar oceanic
- Tropical oceanic

Air Lifting
- Orographic
- Frontal
- Convective
- Cyclonic

Tropical Cyclones
Meso-scale Convective Clusters
Antecedent soil moisture
Snow cover / frozen ground

Groundwater Key Word Search
https://people.wou.edu/~taylors/es476_hydro/groundwater_key_word_search_exercise.pdf

Aquifer
Aquiclude
Porosity
Permeability
~~Saturated vs. Partially saturated~~ Aquifers
~~Pore pressure~~
~~Capillary force~~
Darcy's Law
Permeameter
Hydraulic conductivity
~~Intrinsic Permeability~~
Darcy's velocity
Isotropic vs. anisotropic conductivity
~~Matric potential~~
Vadose zone
~~Infiltration capacity~~
~~Wetting front~~
~~Capillary fringe~~
~~Base flow~~
Confined aquifer
Unconfined aquifer
~~Unsteady vs. steady flow~~
~~Hyporheic zone~~
Effective porosity
Yield porosity
~~Macro porosity~~
~~Saturated front~~
Water table
Potentiometric surface

Intro to Groundwater Notes
https://people.wou.edu/~taylors/es476_hydro/gwater1.pdf

~~Physics Review (know units and be able to calculate / define the following):~~
- ~~potential energy~~
- ~~kinetic energy~~
- ~~force~~
- ~~work~~
- ~~weight~~
- ~~density~~
- ~~specific weight~~
- ~~pressure~~

Groundwater
- defined
- meteoric
- connate
- juvenile

porosity
- intergranular
- primary
- secondary
- fracture
- vesicular

effective porosity
- ~~hygroscope water~~
- pendular water

porosity vs. lithology / material
~~specific yield~~
~~specific retention~~
hydraulic conductivity
- permeability
- Darcy's Law

diagram darcy's law
hydraulic gradient
vertical conductivity
lateral conductivity
permeability vs. lith material
aquifers
recharge
vadose zone
phreatic zone
water table
groundwater flow
cone of depression
drawdown
unconfined aquifer
confined aquifer
aquitard
aquiclude
~~capillary zone~~
~~atmospheric pressure~~
potentiometric surface

hydraulic contours
groundwater flow directions
- upgradient
- downgradient

transmissivity
storativity
specific storage
~~isotropic vs. anisotropic~~
Groundwater issues
- water resource
- water budget
- contamination
- pumping / recharge

Wells
- pumping well
- ~~injection well~~
- static water level
- cone of depression

permeameter
Darcy's Experiment
water table
potentiometric surface
confined
unconfined
artesian
free-flowing artesian
groundwater map
hydraulic gradient
aquiclude
aquitard
~~leaky confined aquifer~~
static water level
depth to water
water table elevation
upgradient
downgradient
groundwater flow vectors
fractured aquifer
~~porous medium~~
~~aquifer skeleton~~

Groundwater Flow
https://people.wou.edu/~taylors/es476_hydro/gwflow.pdf

Groundwater Contour Maps
hydrostatic pressure
atmospheric pressure
~~kinetic energy~~
~~potential energy~~
fluid pressure
hydraulic head
piezometer
hydraulic gradient
groundwater flow vectors
Darcy's Law
Darcy's Flux
Seepage Velocity (linear velocity)
groundwater flow vectors
~~equipotential lines~~

Drilling Techniques KeyWords
http://www.wou.edu/las/physci/taylor/es476_hydro/driscoll_well_drilling.pdf

Hollow stem auger
Cable tool drilling
Air rotary drilling
"Casing"
"Well Screen"
Split spoon
~~Blow counts~~
~~Shelby tube~~
Grout
Slotted screen
Riser pipe
Sand pack
Tri-cone rotary bit
Well log
Drillers log

Well Installation / Hydraulics Notes
http://www.wou.edu/las/physci/taylor/es476_hydro/Sterrett_2007_well_construction.pdf

Total depth
Bore-hole diameter
Annular diameter
SWL
TD
Stick-up
Static water level
DTW
Depth to water
Datum
Hydraulic head

know what a well installation looks like (be able to sketch it)

hydraulic gradient
drill rig
hollow stem auger
well screen
well riser
well diameter
static water level
pumping water level
well recovery
drawdown
groundwater contours
cone of depression
groundwater flow lines
hydraulic conductivity
pumping rate
Pump Test
~~Pumping Well~~
~~Observation Well~~
Cone of Depression
Drawdown-recovery curve
K = Hydraulic Conductivity
T = Transmissivity
S = storativity / storage coefficient

Willamette Valley Hydrogeology
https://people.wou.edu/~taylors/es476_hydro/hydrogeo_willamette_valley.pdf

Cacadia subduction zone
Cascadia volcanic arc
Coast range
Willamette Valley
Arc volcanism
Accretionary uplift
Subducting slab
Juan de Fuca plate
N. American plate
Siletz river volcanics
Tyee Formation
Yamhill formation
Spencer Formation
Western Cascade Volcanism
High Cascade volcanism

Fault-fold
Willamette Aquifer System
- Basement confining unit
- Columbia river basalt
- Willamette confining
- Willamette Aquifer
- Willamette Silt

Unconsolidated valley fill
Valley-fill alluvium
Fractured basalt aquifer
Gravel aquifers
Missoula flood silt
Bedrock / Basement
Basin-fill sediment
Floodplain sediment
Terrace sediment
Active channels
Holocene
Quaternary
Missoula flood deposits
Terrace gravels
Willamette alluvium
Isopach maps
Willamette Silt
Portland Basin Gravels
Central-Southern Valley silts
Gravel aquifer

Lab Skills to Focus on for Final Exam

ES476 Links to Equation Lists
Surface Water Equations https://people.wou.edu/~taylors/es476_hydro/swatreq.pdf
Groundwater Equations I https://people.wou.edu/~taylors/es476_hydro/gwatreq1.pdf
Groundwater Equations II https://people.wou.edu/~taylors/es476_hydro/key_equations_groundwater.pdf
Groundwater Flow Equations https://people.wou.edu/~taylors/es476_hydro/gwatreq2.pdf
Well Hydraulic Equations https://people.wou.edu/~taylors/es476_hydro/gwatreq3.pdf

Can you perform simple and complex unit conversions?

Do you understand dimensional analysis and unit algebra?

Do you know how to manage positive and negative exponents with respect to unit algebra?

Can you perform the following quantitative skills from the first lab:
- plotting a graph
- re-arranging equations
- solving for unknown variables in an equation
- manipulating exponents and bases
- convert between metric and english systems of measurement

~~Ice Budget balance problems~~

Recurrence Interval / Flood Frequency Problems? Rational runoff hydrology problems?

Can you perform the following quantitative skills:
- determine volumes of water in a reservoir
- calculating rates of discharge, evaporation and input into a hydrologic system
- converting between various measures of area, length, volume, and discharge
- determine the total input and withdrawl from a simple hydrologic system (calcuating water budgets)

Can you perform the following quantitative skills from the contouring exercises
- draw contour lines on rainfall data? draw contour lines on groundwater elevation data?
- identify contour intervals and interpolate between data points

Can you perform the following quantitative skills from the intro groundwater problem set?
- calculate: weight, force, density, specific weight as applied to water
- solve for the variables in Darcy's law
- determine hydraulic conductivity from a set of given values
-calculate transmissivity of an aquifer
-draw a groundwater contour map and draw generalized groundwater flow lines
- Can you calculate hydraulic gradient from a groundwater contour map

How about the problems from Groundwater problem set two.
Check out the answer keys and make sure you can work the problems and tutorials for the following labs:

- Groundwater Problem Set 1 (Introduction to Groundwater)
- Groundwater Problem Set 2 (Groundwater Flow)

Groundwater contouring Exercises
Well Log Interpretation
Applications to Groundwater Hydraulics

Key Groundwater Equation Summary (problem focus for exam):

Work
Force
Weight
Pressure
Density
Porosity
Permeability
Specific Yield
Specific Retention
Darcy's Law / Permeameter Equations
Transmissivity
Storativity
Hydraulic Gradient
Darcy's Flux (Q)
Seepage Velocity
Well Drawdown
Well Yield
Well Specific Capacity

Stream discharge
Continuity equation
Probability/recurrence interval equations
Interpreting flood hydrographs
What is the difference between a stream rating curve and a flood frequency curve?