ES476/576 Hydrology Final Exam Study Guide Winter 2020

Exam Format: *Similar to Mid-Term.*

Part 1 - Lecture Exam: closed book exam, short answer, essay, terms, definitions, will be administered online via Moodle on Thursday March 19, 12 Noon – 2 PM

Part 2 - Lab Practicum Problem-Solving Exam: open book, Equation lists, class notes, conversion charts, and calculators accessible. 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. Part 2 exam will be distributed Monday March 16, 2020 via email; due on Thursday March 19 5 PM; scanned answer sheets due as PDF upload via Moodle.

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

KEY TERMS AND CONCEPTS

Willamette Valley Hydrogeology Student Presentations

Geologic Framework
https://people.wou.edu/~taylors/es476_hydro/urich_wentz_1999_Env_Setting_Willamette_Valley.pdf

Cacadia subduction zone
Cascadia volcanic arc
Coast range
Willamette Valley
Siletz river volcanics
Tyee Formation
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
Willamette Silt
Portland Basin Gravels
Central-Southern Valley silts
Gravel aquifer

Water Budget / Groundwater Flow
https://people.wou.edu/~taylors/es476_hydro/Conlon_etal_2005_Groundwater_Hydro_Willamette.pdf
Recharge
Rain-on-Snow Transition
Runoff-Infiltration Model
Winter vs. Summer flow
Streamflow vs. Gwater levels
Evapotranspiration cycles
River discharge
Groundwater flow
Hydraulic Gradient
Willamette Silt Confining Unit
Rainall input
Pumping – Head Fluctuation
Aquifer Storage Recovery

Groundwater Flow Model
https://people.wou.edu/~taylors/es476_hydro/Herrara_et_al_2014_groundwater_flow_willamette.pdf
Steady State vs. Transient
Boundary Conditions
ModFlow
Vertical vs. Horiz. K
Storativity
Recharge
Transmissivity
Simulation Model
Model Calibration
Regional vs. Local Model

Surface Water Hydrology Part2
http://www.wou.edu/las/physci/taylor/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
rational runoff model

Groundwater Key Word Search
http://www.wou.edu/las/physci/taylor/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
http://www.wou.edu/las/physci/taylor/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. lithology / 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
http://www.wou.edu/las/physci/taylor/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

GIS / Geospatial Technology Guest Speakers

Goslin – GIS and River Restoration
https://people.wou.edu/~taylors/es476_hydro/GoslinM_Ch3_20200217_Channel_Morphology_Planform_Change.pdf
Carex Nudata (torrent sedge)
Upper John Day River
Restoration
Ecoengineering
Salmon Habitat Recovery
Watershed conservation
Geomorphic change detection
Air imagery analysis
Landscape change
Active restoration vs.
Passive restoration
Large wood placement
Channel change
Erosion / aggradation
RealTime Kinetic GPS
Resolution and accuracy
TIN vs. DEM
Grid resolution
Map algebra
Sedge islands
Photo rectification

Szpakowski – Remote Sensing and Fire Hazard
https://people.wou.edu/~taylors/es476_hydro/Szpakowski_Jensen_Review_of_RS_Applications_Fire_Ecology.pdf
wildfire analysis
fire controls
fuel – topo – climate
ignition sources
natural vs. manmade fires
wild fire geography
ground fire – surface fire – canopy fire
fuel load modeling
risk and hazard analysis
change detection
remote sensing
muticriteria modelling
thermal IR band
burn area mapping
risk-cost mapping
image processing
vegetation index NDVI
Grand Teton National Park
Image classification
Burn-recovery analysis

Makido – GIS and Urban Climate Change
https://people.wou.edu/~taylors/es476_hydro/Makido_Climate_2016.pdf

Land cover analysis
Land change analysis

Remote sensing
Image classification
Patch fragmentation
Urban heat island
Urban land cover
Doha, Qatar
Landsat 7
Land change model
Urban growth boundary
GPS monitoring
GIS workflow model
Heat index model

Liang – GIS and Karst Topography
https://people.wou.edu/~taylors/es476_hydro/Liang_Topo_Veg.pdf
GIS analysis of social media use
Karst landscape research
Remote sensing
Cockpit Karst topography
Puerto Rico – China
Limestone, dolostone
Tower karst
DEM analysis
Grid resolution
Vegetative cover
Topographic analysis
Slope gradient
Slope curvature
Aspect
Vegetative index
NDVI index
Topographic curvature
DEM flow analysis
Forest canopy
Image processing

Lab Skills to Focus on for Final

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 from the second lab:

- 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 (set 1)?

- 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 Transmissivity

Force
Weight
Pressure
Density
Porosity
Permeability
Specific Yield
Specific Retention
Darcy's Law / Permeameter Equations
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?