ES476 Hydrology Mid-Term Study Guide – Winter 2020
Mid-term Exam Tuesday Feb.11

Study Tips

- complete all labs and worksheets before 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, some of the material we briefly discussed, but did not spend much time on in class... but the notes will give you the detail.

Exam Procedures: (1) Midterm exam will be 100 points; (2) Part 1 – Closed book, short answer/essay questions. See key-word/review recommendations below; (3) Part 2 Open Book- lab-style quantitative questions.

Key Terms and Concepts

Introductory Notes
http://www.wou.edu/las/physci/taylor/es476_hydro/intro.pdf

hydrology
spatial scale
temporal scale
mass
energy
flux
mass transfer functions
evaporation
condensation
precipitation
runoff
infiltration
transpiration
~~deterministic vs. stochastic~~
processes
hydrologic cycle (sketch it)
convection
advection
groundwater
surface water
global water storage
residence time
compartments
oceans
groundwater
lakes
glaciers
ice caps
transpiration
evapotranspiration
runoff
infiltration
vegetative interception
ice sheets
oceans
springs
soil moisture
atmospheric moisture
fresh water storage

Global Water Budget
http://www.wou.edu/las/physci/taylor/es476_hydro/budgfigs.pdf
-Sketch hydro cycle in detail
-understand global precip. distribution
-know the basic distribution of water resources
-why is there high runoff in PNW?

Water Budget Equations:
Input-Output = change in Storage

$I - O = \Delta S$
$P = R + E + \Delta S$

I = input, O = output, ΔS = change in storage, P = precipitation, R = stream runoff, E = evapotranspiration (all expressed as water volume equivalents over unit time)

Water Chemistry
http://www.wou.edu/las/physci/taylor/es476_hydro/watr_chem.pdf

atoms
isotopes
oxygen isotopes
carbon isotopes
ion
cation
anion
complex ion
dissolved ions in water
molecules
compounds
mixtures
atomic forces
bonding forces
octet rule
stable-8 configuration
valence shell
electron shells
lewis dot model
atomic no.
atomic mass
no. protons
no. neutrons
no. electrons
ionic bonding
metallic bonding
covalent bonding
dot-model reactions
aqueous solutions
solute
solvent
saline solution
salinity
sheath of hydration
dissolution
concentration
~~mass percent~~
~~parts per thousand~~

~~parts-per-million~~
~~parts-per-billion~~
density
hydrogen bonds
polar covalent bonds
viscosity
weight density

Hydro - Physics Overview
http://www.wou.edu/las/physci/taylor/es476_hydro/physrevw.pdf

Know how to define and quantify the following...
mass
length
time
temperature
force
angle (degrees)
area
volume
velocity
acceleration
discharge
pressure
force
energy/work
~~power~~
~~momentum~~
mass density
weight density
viscosity

other physics concepts to consider:

heat
heat flow
heat capacity
volume expansion/contraction
density-driven rise / fall
"hot air balloon model"
heat transfer
conduction
convection
radiation
material phases
solid
liquid
gas
Heat
Molecular kinetic energy
states / phase changes
condensation
evaporation
melting
freezing
(consider these in terms of heat loss and heat gain)
physical properties of water
liquid / fluid
heat capacity
polar molecule
solvent
covalent bonds
density-visosity-temp relations

Hydrometeorology
http://www.wou.edu/las/physci/taylor/es476_hydro/meteor.pdf

meteorology
weather
climate
temperature
humidity
precipitation
rain-snow-sleet
clouds
air pressure
water vapor
heat capacity
latent heat
particulate matter
dust
Troposphere Structure
condensating nucleii
altitude vs. temp variation
altitude vs. press. variation
Earth-Sun Relation
rotational axis
north pole
south pole
equator
axial tilt (23.5 deg.)
global solar radiation budget
water vapor
precipitation
solid, liquid, gas
heat energy
evaporation
condensation
freezing
~~sublimation~~
humidity
specific humidity
relative humidity
vapor saturation
saturation capacity
temperature vs. humidity
temperature vs. air volume
hot air balloon model
dew point / vapor saturation
dew
fog
clouds
rain
condensating nucleii
cloud droplets
adiabatic heating
stable vs. unstable air
rising air mass
sinking air mass
forceful lifting
covergent lifting
orographic lifting
frontal wedging
air pressure
force / unit area = pressure
altitude vs. air pressure
millibar – psi- pascal
pounds per sq. inch
barometer

Trenberth et al Reading 2007 Global Water Budget
http://www.wou.edu/las/physci/taylor/es476_hydro/trenberth_etal_2007_global_water_budget.pdf

P = precipitation
E = evapotranspiration
E – P
Hydrologic cycle
Reservoirs
Storage
Exchanges
Flux
Surface flow
Groundwater flow
Ocean-ice
Vapor transport

Permafrost
Soil moisture
Solar radiation
Latent heating
Soil moisture storage
Sea surface temperatures
Atmospheric moisture
Climate change
$P = R + E + \Delta S$
E-P = runoff
PRISM models
Climate models
Ice volumes
Cryosphere
Energy supply
Precipitation network

Flood Climatology
Hirschboeck Readings
http://www.wou.edu/las/physci/taylor/es476_hydro/hirschboeck_etal_2001_flood_hydroclimatology.pdf

Flood causing weather
-convective thunderstorms
-tropical storms/hurricanes
-extratropical cyclones
-frontal systems
rapid snowmelt
runoff
antecedent soil moisture
snow cover

Air Uplift Mechanisms
-Thermal convection
-large-scale frontal convergence
-orographic lifting

Convectional Processes
-Thunderstorm Activity
-flashy, intense pppt
-Fla/ Gulf, highest occurrence

Mesoscale Convective Complex
-"MCC's" and MCS's
-huge, multiple celled, highly organized thunderstorm complexes

Tropical Cyclones
-largest atmospheric features
-convective processes
-tropical low press. systems
-sources: western N.Atlantic, Gulf, Caribbean
critical temps of sea-surface: >79 F

Large-Scale Atmospheric
-Convergence
-Extratropical Cyclones
-cyclone tracks as westerlies across U.S./Midwest
Orographic Lifting
Antecedent soil moisture
soil mosture content
-summer > ET, < flood potential, < soil moisture
-Snow Cover, Frozen Ground and Snowmelt
-Frozen ground = impervious surface; > flood potential
-spring rain on snow, + snow melt = flood

Surface Water Hydrology
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
Mannings Equation
Roughness
Slope /gradient
stream lengths
drainage density
shreve magnitude
stream ordering
1st order, 2nd order, etc.
peak discharge
peak annual flow
peak monthly flow
rational runoff equation
rational runoff coefficient
rainfall intensity
flood recurrence interval
flood magnitude
flood frequency
flood frequency curve
flood hydrograph – what is it?
Seasonal flood climatology

GO BACK OVER THE SLIDE SHOWS ON THE CLASS WEB SITE; MAKE SURE YOU UNDERSTAND THE PRINCIPLES ILLUSTRATED IN THE SLIDE IMAGES

Big Concept Ideas / Essay Question Possibilities / Lab Skills

Can you sketch and discuss the hydrologic cycle? Including all the reservoirs, exchanges, fluxes and storage values?
What are the primary atmospheric processes that trigger precipitation events? Can you list, describe, and sketch the mechanisms?
What types of meteorological conditions lead to flooding in the Pacific Northwest? What about largest flood events in the U.S. as a whole?
Can you list the equations and discuss the difference between energy, force, pressure, and work?
Can you summarize the physical and chemical properties of water?
Why is water a good solvent? Sketch the water molecule.
How are density and buoyancy related to heat in the system?
Can you discuss the global distribution of water in reference to ocean, rivers, lakes, atmosphere, glaciers, etc.
Summarize the physical and chemical properties of water.
Summarize the units and equations for the following: work, pressure, force, acceleration, acceleration due to gravity, newtons, pascals, millibars, continuity equation, storage equation, newton's second law, density vs. weight density
What are the four primary lifting mechanisms related to precipitation events.
What is the general circulation model of the Earth's atmosphere? What is the influence of the Coriolis effect on the general circulation model.
Compare and contrast cyclones to anticyclones.
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: 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; calculate the equation for a line from a graph
write an equation if given a description of a quantitative problem; Draw Sketches from word problems
convert between mass and volume using density
Can you perform the following quantitative skills from the applied problems labs:
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)
determine the discharge of runoff using weir techniques
calculate the volume of lake water using the frustrum of a cone
solve the input-output conservation equation
Can you perform the following quantitative skills from the contouring exercises
draw contour lines on rainfall data (isohyets)?

- identify contour intervals and interpolate between data points
- Can you use the planimeter and cross-section paper to determine areas?
- Determine average precipitation using the arithmetic, thiessen, and isohyetal methods?
- Can you work with map scales?

Work the continuity equation for channel discharge-velocity-cross-sectional area
Work Manning's equation for streamflow velocity; calculate areas-volumes of watershed inputs and outputs
Determine evaporation loss volumes and precipitation volume gains
Lab and Class Exercises Covered by the Open Book Part of the Exam

Applied problems in hydrology
Introduction to quantitative methods in hydrology
Water budget calculations
Pressure calculations and conversions
Isohyet contouring / precipitation problems; Water in – water out book keeping problem

OTHER STUDY RESOURCES

Hydrologic Cycle Animation (NASA *.mpeg 45 Mb)

Youtube Global Water Budget Overview (~4 min)
https://www.youtube.com/watch?v=f6Tp13duE5A

Youtube-Principles of Water Balance (Univ. Reno ~9 minutes)
https://www.youtube.com/watch?v=e9fFcjUqNyA

Youtube-Reservoirs and Residence Times (Univ. Reno ~13 minutes)
https://www.youtube.com/watch?v=pW7b8RaiPkg

MOODLE TEXTBOOK CHAPTERS