

**DETAILED SCHEDULE
PRINCIPLES OF HYDROLOGY 2023
Geography 827.3**

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31 Oct POMEROY Fundamentals, Physical Principles, Hydrometeorology and Precipitation

Welcome and course introduction.

Fundamentals

- Hydrological cycle, hydrological processes
- Units and physical constants for hydrology
- Fick's law, Viscosity, Darcy's law, Ohm's Law, Ideal Gas Law,
- Continuity and control volumes
- Flow of water in a pipe and Bernoulli's Equation
- Mass and energy balances
- Phase change and coupled mass and energy balances.
- Basins, sub-basins and hydrological response units as control volumes

Physical Principles

- Net radiation, including estimation of shortwave direct and diffuse to complex terrain, albedo variations of various surfaces, longwave radiation from the atmosphere and from the surface, measurement
- Ground heat fluxes – heat conduction equation, thermal conductivity, measurement

Turbulent Transfer

- wind flow, turbulence and boundary layers,
- convective heat transfer,
- convective water vapour transfer,
- stability effects.

Precipitation

- Physics of the formation of precipitation in the atmosphere
- Characteristics of frontal, convective and orographic precipitation
- Depth, area and duration of precipitation over an area
- Introduction to the statistical features of precipitation (rainfall)
- Measurement principles
- Precipitation data products

Essay Assignment Assigned.

Readings

- provided papers on Canvas
- Textbook, Dingman, Physical Hydrology 2nd or 3rd Edition. Chapters 1-4, Appendix D
- Supplementary Textbook: The Surface Climates of Canada, W.G. Bailey, T.R. Oke and W.R. Rouse, 1998: Montreal: McGill-Queen's Univ Press. (Available on Amazon)

1 November POMEROY Snow accumulation and redistribution

- Snowcover Properties and Measurement
- Snow Redistribution Processes
 - Wind: saltation, suspension, sublimation, vegetation effects
 - Vegetation: interception, unloading, sublimation
- Snowcover Distribution
 - Open environments
 - Forested environments

Readings

- Snowcover Accumulation, Relocation and Management (Pomeroy & Gray)
 - provided papers in Canvas
 - Dingman, Chapter 5
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2 November CEY Groundwater Hydrology

1. Basic principles of groundwater flow and transport
 - Porosity and fluid potential
 - Darcy's law, hydraulic conductivity, and permeability
 - Groundwater flow and velocity
 - Groundwater storage
 - Basic transport processes
2. Regional groundwater flow
 - Groundwater flow systems
 - Topography-driven flow
 - Scale of flow and effects of heterogeneity
 - Computer lab using USGS TopoDrive
3. Groundwater - surface water interactions
 - Interactions with streams, wetlands and lakes
 - Modelling and measurement methods
 - Water resource management – water budgets and groundwater pumping

Reading:

- Dingman (Physical Hydrology, 3rd ed., Chapter 9).
- Fetter (2001. Applied Hydrogeology, 4th ed., pp.66-109, 190-197, 400-414)
- provided papers in Canvas

Assignment 1 assigned. Groundwater Hydrology

3 November PETRONE Interception and Evapotranspiration

Canopy Interactions

- Intro
- Hydraulic Lift
- Interception
- Gash Model

Methods of Determination

- Direct:
 - o Pan / Lysimeter Measurements
 - o Gradient / Energy Balance (Bowen Ratio)
 - o Eddy Covariance
- Indirect:
 - o Thornthwaite
 - o Priestley-Taylor
 - o Penman – based

Textbook: Campbell and Norman (1998. An Introduction to Environmental Biophysics, 2nd Ed., pp. 37 – 50, 223 – 277)

Assignment 2 Assigned. Hydrometeorology and Evapotranspiration.

Afternoon Instrumented Site Visit: POMEROY

1300h-1530h bus to field site: Instrumented field site visit in afternoon (Marmot Creek Research Basin - Hay Meadow tower, 1400 m elevation, 20 min walk in, level terrain – dress appropriately, it can be windy)

-Hydrometeorological and hydrological sensor demonstration and discussion of sensors, including UAVs.

4 November POMEROY Snowmelt and snowcover depletion

- Snowmelt and Energy balance
 - Estimation of radiation and turbulent transfer terms,
 - Effect of vegetation,
 - Snowmelt estimation methods
- Snow covered area, snowmelt contributing area and areal depletion

Readings

- Provided papers in Canvas
 - Dingham Chapter 5
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5 November POMEROY Glacier Hydrology

Glacier Hydrology

- Ice properties
- The glacier-climate system
- Glacier mass balance
- Global glacier changes
- Canada's glaciers
- Mass balance trends in Canada
- Competing demands for water
- Environment and natural resource considerations
- Glaciers as storage
- Water routing
- Discharge characteristics
- Linear reservoir model approach
- Long-term effect of negative glacier mass balance
- Characterization of basin-wide glacier contribution

Assignment 3 assigned: Snow accumulation, glaciers and melt.

Readings

-provided papers in Canvas

6 November Day Off

Evening at the Coldwater Laboratory, Canmore – Hydrology and Public Policy Talk from UNU Chair Bob Sandford. Chance to visit Canmore. Bus from Field Station 6 pm.

7 November

Morning: IRESON Soil Hydrology

1. Soils and the soil water balance

- Soil texture and mineralogy
- Soil-water; mass volume relations
- Hydrological processes: infiltration, runoff generation, drainage, evapotranspiration

2. Soil physics

- Soil water content and matric potential
- Pressure and hydraulic gradient
- Darcy's equation
- Non-ideal soils: macropores, heterogeneity and other realities

3. Cold regions soil hydrology
 - Soil thermal regime
 - Freeze-thaw processes and impacts on infiltration

Reading:

- Dingman, S.L. Physical Hydrology (3rd Edition). 2015.; Chapter 7 (Principles of subsurface flow) and 8 (Infiltration and water movement in soils).
Provided papers in Canvas

Afternoon Snow Survey (POMEROY)

1300h-1700h. Bus to Highwood Pass. Weather permitting. You will be instructed in how to measure snow depth and density using gravimetric snow tubes, snow rulers and snow pit kits. You will work in teams to measure snow water equivalent in a mixture of open and wooded areas and can compare measurement methodologies. Bring appropriate clothing for walking on and digging in snow, taking measurements and standing outside in cold and windy conditions.

(parka, toque, light gloves, heavy gloves, wind pants, snow boots, sun glasses, pencil small note pad)

8 November CAREY Hillslope and Catchment Hydrology

1. Hillslope Hydrology
 - a. Historical context
 - b. Runoff generation processes
 - i. Hydrometric methods and responses
 - ii. Hydrochemical methods and responses
 - c. Catchment form and function
 - i. Topography, topology and typology
 - d. The role of storage
 - i. Riparian & Hyporheic Zone
 - ii. Wetlands
 - iii. Depressions
 - iv. Lakes
2. Modelling runoff at the hillslope and catchment scale
 - a. Conceptual Models
 - b. Numerical Models
 - i. Empirical Methods
 - ii. Physically-Based Methods

Assignment 4 assigned. Soil and Hillslope Hydrology

Reading:

Dingman (2001. Physical Hydrology, 2nd ed. pp. 389-456) or equivalent in new edition

Readings provided in Canvas

9 November SHOOK: River Basin Hydrology

River basins

Canadian River Basins

Basin Connectivity

Prairie Streamflow Generation

Event hydrograph prediction

-Isochronal analysis

-Rational method

-Unit hydrographs

-Application

-Derivation

Reading:

Dingman Ch. 10

-provided readings in Canvas

FALCONE: Hydrometric Observations

-Hydrometry demonstration of instruments in lecture theatre,

1500h Stream Gauge Field Site Visit (on foot).

To Kananaskis River below Barrier Lake. (Falcone and Pomeroy)

10 November STADNYK, POMEROY Hydraulics, river ice, routing, synthesis

STADNYK: Hydraulics, River Ice

Fundamental Equations of Open Channel Flow

- Terminology and Idealizations

- Conservation of Water Volume

- Conservation of Energy

- Uniform Flow and Channel Resistance

River Ice Processes

- Issues and Fundamentals
- Freeze-Up Processes
- Break-Up Processes
- Ice Jams

STADNYK: Hydrological Routing

Hydrological Flow Routing

- Principles
- Kinematic wave routing
- Muskingum routing

POMEROY: Synthesis

Cold Regions Hydrological Cycling and Streamflow Generation - synthesis

Assignment 5 assigned. River basin hydrology, river ice and hydraulics

Reading:

Dingman (2001. Physical Hydrology, 2nd ed. pp. 432-456) or equivalent in new edition

Dingman (2001. Physical Hydrology, 2nd ed.. pp.424-428, 548-551) or equivalent in new edition

-provided readings in Canvas

11 November Departure

0900h Departure (no lunch provided)
