Hybridization Proposal for Water Resource Engineering (CE 3211)

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Course Overview

Water Resources Engineering is the study of water within the surface and subsurface. Analysis and design of surface hydrology, groundwater (subsurface) hydrology and open channel flow hydraulics. The overall course objectives for the class are as follows:
Course Learning Objectives (CLOs):

- Delineate watershed using topographic maps and evaluate watershed characteristics.
- Solve precipitation and surface runoff using statistics.
- Calculate surface peak discharge, using mathematical models.
- Solve groundwater flow mechanics
- Interpret surface and subsurface water availability, regulations, monitoring and control practices.
- Analyze subcritical, supercritical, critical flow, uniform flow and non-uniform flow
- Design gravity flow pipelines and channels based on design criteria (including hydraulic structure).
- Use hydraulic and hydrologic software to perform hydrologic and hydraulic analysis (i.e HEC-Ras, Storm CAD, Sewer CAD).
- Demonstrate ability to develop hydraulic and hydrologic design report.

Clear lesson level learning outcomes have been developed for each week. This will ensure that students are receiving the necessary instruction to be successful on their quizzes, discussion boards, homework assignments, projects and tests. By breaking up the course into weekly outcomes, students will be able to successful complete the course level outcomes. Appendix A provides the weekly lesson level learning objectives.

Hybrid Proposal

Since 2014, I have been actively creating micro-lectures to include in my courses. The micro-lectures allowed me to create a flipped classroom environment for my students in fall 2016. Over the past several years, I continued to make additional micro-lectures. The flipped classroom intentionally shifts instruction to a learner-centered model in which time in the classroom is used to explore topics in greater depth and create meaningful learning opportunities while students are initially introduced to new topics outside of the classroom. Now that the course has all the micro-lectures developed, the course it is ready to be converted to a **synchronous hybrid class**.

This proposal is intended to teaching sections 2 and 3 of CE 3211 in fall 2020 as a **synchronous hybrid class**. The course is scheduled to meet from 150 mins weekly.

> During the **asynchronous 50 minutes** students will prepare for the coming week by watching micro-lectures, completing readings, take notes and completing a quiz. A discussion board will be used for students to upload their questions (i.e. muddiest points). This will help allow for a smooth synchronous zoom meeting. On even weeks (2,4,6,etc), there will be a open-ended blackboard discussion board on an issue associated with material we are learning in the course. These discussion boards will be graded using a holistic rubric.
>
> During the **synchronous 100 minutes** students will be provided resources and material to help clarify information from the micro-lectures and pre-Monday quizzes. They will also participate in problem solving and group work.

Table 1 provide a daily overview of the synchronous and asynchronous lessons. It is essential for students to complete the asynchronous material prior to attending the synchronous session of the course.

Table 1 - Weekly Overview

Week	Date		Mode of Instruction	Topic
0			Synchronous	Welcome
	Fri	8/21/2020	Asynchronous	Introduction to Water Resources - Micro-lectures, Readings, Notes, Discussion board & Quiz
1	Mon	8/24/2020	Synchronous	*Continue* Introduction to Water Resources - review muddies points, discussion to stimulate critical thinking and practice problems
	Wed	8/26/2020	Synchronous	Library Resources - Guest Speaker
	Fri	8/28/2020	Asynchronous	Watershed Delination and Measurements - Micro-lectures, Readings, Notes, Discussion board & Quiz
2	Mon	8/31/2020	Synchronous	*Continue* Watershed - review muddiest points, provide more depth on topic and group based practice problems
	Wed	9/2/2020	Synchronous	
	Fri	9/4/2020	Asynchronous	Watershed Characteristics and Precipitation - Micro-lectures, Readings, Notes, Discussion board & Quiz
3	Mon	9/7/2020	Synchronous	*Continue* Watershed Characteristics and Precipitation - review muddies points, discussion to stimulate critical thinking and practice problems
	Wed	9/9/2020	Synchronous	
	Fri	9/11/2020	Asynchronous	Probability and Statistics - Micro-lectures, Readings, Notes, Discussion board & Quiz
4	Mon	9/14/2020	Synchronous	*Continue* - Probability and Statistics- review muddies points, discussion to stimulate critical thinking and practice problems
	Wed	9/16/2020	Synchronous	
	Fri	9/18/2020	Asynchronous	Applied Statistics for Water Resources - Micro-lectures, Readings, Notes, Discussion board & Quiz
5	Mon	9/21/2020	Synchronous	*Continue* - Applied Statistics for Water Resources - review muddies points, discussion to stimulate critical thinking and practice problems
	Wed	9/23/2020	Synchronous	
	Fri	9/25/2020	Asynchronous	Peak Discharge - Micro-lectures, Readings & Quiz
6	Mon	9/28/2020	Synchronous	*Continue* - Peak Discharge - review muddies points, discussion to stimulate critical thinking and practice problems
	Wed	9/30/2020	Synchronous	
	Fri	10/2/2020	Asynchronous	Surface Water Qualility - Micro-lectures, Readings, Notes, Discussion board & Quiz
7	Mon	10/5/2020	Synchronous	*Continue* - Surface Water Quality and Review for Midterm - review muddies points, discussion to stimulate critical thinking and practice problems.
	Wed	10/7/2020	Synchronous	
	Fri	10/9/2020	Asynchronous	**MIDTERM** Open Channel - Micro-lectures, Readings & Quiz
8	Mon	10/12/2020	Synchronous	*Continue* - Introduction to Open Channel - review muddies points, discussion to stimulate critical thinking and practice problems
	Wed	10/14/2020	Synchronous	
	Fri	10/16/2020	Asynchronous	Hydraulic Strutures - Micro-lectures, Readings, Notes, Discussion board & Quiz
9	Mon	10/19/2020	Synchronous	*Continue* - Hydraulic Structures - review muddies points, discussion to stimulate critical thinking and practice problems
	Wed	10/21/2020	Synchronous	
	Fri	10/23/2020	Asynchronous	Rapidly Varied Flow - Micro-lectures, Readings & Quiz
10	Mon	10/26/2020	Synchronous	*Continue* - Rapidly Varied Flow - review muddies points, discussion to stimulate critical thinking and practice problems
	Wed	10/28/2020	Synchronous	
	Fri	10/30/2020	Asynchronous	Gradually Varied Flow - Micro-lectures, Readings, Notes, Discussion board & Quiz
11	Mon	11/2/2020	Synchronous	*Continue* - Gradually Varied Flow- review muddies points, discussion to stimulate critical thinking and practice problems
	Wed	11/4/2020	Synchronous	
	Fri	11/6/2020	Asynchronous	Combineing GVF and RVF (Excel Tutorials) - Micro-lectures, Readings & Quiz
12	Mon	11/9/2020	Synchronous	*Continue* - Combining GVF and RVF - review muddies points, discussion to stimulate critical thinking and practice problems
	Wed	11/11/2020	Veterans Day Holiday	
	Fri	11/13/2020	Asynchronous	Groundwater - Micro-lectures, Readings, Notes, Discussion board & Quiz
13	Mon	11/16/2020	Synchronous	*Continue* - Introduction to Groundwater, Seepage and Flow nets - review muddies points, discussion to stimulate critical thinking and practice problems
	Wed	11/18/2020	Synchronous	
	Fri	11/20/2020	Asynchronous	1D Steady Flow and 1D Well Hydraulics - Micro-lectures, Readings & Quiz
14	Mon	11/23/2020	Synchronous	*Continue* - 1D Steady Flow and 1D Well Hydraulics - review muddies points, and practice problem + Upload review question
	Wed	11/25/2020	Synchronous	
	Fri	11/27/2020	Thanksgiving Holiday	
15	Mon	11/30/2020	Synchronous	Catch up and Review
	Wed	12/2/2020	Synchronous	Review
	Fri	12/4/2020	Synchronous	Special Office Hours for Questions

Assessment Plan

Over the course of the semester students will be engaged in various assessments that show that they are achieving the course learning outcomes. The assessments will consist of: Discussion Board (Participation), Quizzes, Homework Assignments, Projects and Exams. Table 2 provides a breakdown of the point distribution.

Table 2 – Grading Distribution

Discussion Board	10%
Micro Video Quizzes	10%
Project (3 Total)	20%
Homework Assignment (~10 total)	15%
Midterm Exam	15%
Final Exam	20%

All of the assessments will be evaluated to determine student's ability to achieve the student learning outcomes for the course. Table 3 provides a matrix outlining the course level outcomes to the various assessments.

Table 3 - Assessment Matrix

Course Learning Objectives	Discussion	Quizzes	Homework	Exams	Project
Delineate watershed using topographic maps and evaluate watershed characteristics.	X	X	X	X	X
Solve precipitation and surface runoff using statistics.	X	X	X	X	
Calculate surface peak discharge, using mathematical models.	X	X	X	X	X
Solve groundwater flow mechanics		X	X	X	
Interpret surface and subsurface water availability, regulations, monitoring and control practices.	X	X	X	X	X
Analyze subcritical, supercritical, critical flow, uniform flow and non-uniform flow	X	X	X	X	X
Design gravity flow pipelines and channels based on design criteria (including hydraulic structure).	X	X	X	X	X
Use hydraulic and hydrologic software to perform hydrologic and hydraulic analysis (i.e HEC-Ras, Storm CAD, Sewer CAD).			X		X
Demonstrate ability to develop hydraulic and hydrologic design report.	X				X

Ideally, I would like to continue teaching in this model when campus returns face to face. One benefit to the hybrid model is regarding campus resources. The hybrid model will open up classroom space so two class can be taught in the same room with clear instruction on which days the student and faculty need to be present at a synchronous meeting.

Appendix A – Lesson Objectives

Week/Topic	Lesson Learning Objectives
Week 0/Welcome	• Locate course content within blackboard • Recognize the weekly schedule and due dates for various assignments for the course
Week 1/ Introduction to Water Resources & Library Resources	• Describe engineering hydrology. • Evaluation of contemporary issues associated with hydrologic analysis and design. • Perform hydrologic budgets of hydrologic systems
Week 2/ Watershed	• Demonstrate an ability to read topographic maps. • Produce a watershed delination based on topographic maps
Week 3/ Watershed Characteristics and Precipitation	• Determine the effects soil composition has on flow calculations • Calculate the runoff curve number for a watershed which is a function of soil type, quantity of vegetative cover, soil moisture and land use. • Define travel time, time of concentration and storm duration. • Determine how travel time calculations vary and effect watershed response. • Differentiate and identify rainfall data for various sources
Week 4/ Probability and Statistics	• Define various statistical terms • Calculate and use sample moments to analyze data • Differentiate between mass and continuous functions
Week 5/ Applied Statistics for Water Resources	• Identify where to obtain hydrologic data for analysis • Describe probability paper and plotting position • Define binomial, normal and log normal distributions
Week 6/ Peak Discharge	• Calculate the peak discharge using calibrated and un-calibrated model. • Identify the most appropriate model for calculating discharge.
Week 7/ Surface Water Quality and Review for Midterm	• Identify types of contaminates found in storm water and how to permit a project. • Locate a list of contaminates that are potentially on a project site. • Identify Best Management Practices for use on a project site.
Week 8/ Introduction to Open Channel	• Differentiate pressurized vs open channel flow hydraulics • Define open channel geometry • Identify different flow types and regime types. • Define and calculate critical depth based on the Froude Number. • Define and calculate Specific Energy • Define and calculate normal depth.
Week 9/ Hydraulic Structures	• Calculating flowrates through various hydraulic structures. • Determine the depth of flow within the hydraulic structure. • Designing hydraulic structures to meet design conditions.
Week 10/ Rapidly Varied Flow	• Apply the specific energy equation to evaluate the water surface depth for channels that experience abrupt changes. • Identify flow profiles under supercritical and subcritical flow regimes. • Evaluate when flow within the channel undergoes choking. • Calculate depth and length of a hydraulic jumps.
Week 11/ Gradually Varied Flow	• Identify channel types based on normal and critical depth. • Define water surface control within in an open channel. • Qualitative and quantitatively draw water surface profiles
Week 12/ GVF and RVF	• Evaluate multiple channel systems which include GVF and RVF. • Use excel and HEC-RAS to program channel.
Week 13/ Introduction to Groundwater, Seepage and Flow nets	• Define groundwater, groundwater hydrology, confined and unconfined aquifers. • Calculate Groundwater flow based on the Darcy's Law. • Identify when seepage occurs. • Perform flow net calculations.
Week 14/ 1D Steady Flow and 1D Well Hydraulics	• Calculate steady-state groundwater flow in a confined aquifer. • Calculate steady-state groundwater flow in an unconfined aquifer. • Calculate flowrate of a well in a confined and unconfined aquifer • Calculate the hydraulic conductivity and transmissivity • Determine the drawdown within a well.
Week 15/ Review	This week will allow for catch-up and review of the semester.

Water Resource Engineering

Course Overview

Water Resources Engineering is the study of water within the surface and subsurface. Analysis and design of surface hydrology, groundwater (subsurface) hydrology and open channel flow hydraulics. A deeper knowledge and appreciation of the following topics will be covered: statistics, watersheds, precipitation, evaporation, infiltration, discharge calculations, subsurface flow calculations, critical flow, uniform flow, non-uniform flow, culverts and open drainage design.

Course Learning Objectives:

- Delineate watershed using topographic maps and evaluate watershed characteristics.
- Solve precipitation and surface runoff using statistics.
- Calculate surface peak discharge, using mathematical models.
- Solve groundwater flow mechanics
- Interpret surface and subsurface water availability, regulations, monitoring and control practices.
- Analyze subcritical, supercritical, critical flow, uniform flow and non-uniform flow
- Design gravity flow pipelines and channels based on design criteria (including hydraulic structure).
- Use hydraulic and hydrologic software to perform hydrologic and hydraulic analysis (i.e HEC-Ras, Storm CAD, Sewer CAD).
- Demonstrate ability to develop hydraulic and hydrologic design report.

Course Layout

This course is a virtual synchronous hybrid class. The course is scheduled to meet from 150 mins weekly. Each week we will meet for 100 mins synchronously. During these meetings, students will be provided resources and material to help clarify information from the micro-lectures and pre-Monday quizzes. We will also participate in problem solving and group work. During the other 50 minutes students will prepare for the coming week by watching micro-lectures, completing readings and take notes. Prior to the start of each week students will complete a quiz on the material presented in the asynchronous section. A discussion board will be used for students to upload their questions (i.e. muddiest points). This will help allow for a smooth zoom meeting. On even weeks, there will be a open-ended blackboard discussion board on a issue associated with material we are learning in the course. These discussion boards will be graded.

The following table provides you with a general overview of a regular week.

	Friday - Sunday	**Monday**	**Tuesday**	**Wednesday**	**Thursday**	**Friday**

Student Tasks	Watch micro lectures on blackboard **Complete quiz** **Summit comment on the discussion board** regarding an area that you need clarification on.	**Attend synchronous class**	**Submit HW** from prior week lesson	**Attend synchronous class.** The class will consist of group work, guest speaker, or additional topics for clarification.	Even weeks (2, 4, 6, etc.) **submit a tread on the open-ended discussion board** question. (Note this will be graded). You can add a unique comment or provide additional feedback to another students comment.	Asynchronous class…no official synchronous meeting Start material for the coming week to prepare.
Instructor Task	Review discussion board to develop Monday lesson.	Provide clarification and additional resources on topic. Provide preview on group work and problem-solving session Assign homework for the Week	Address all questions in discussion board. If they were not addressed in class provide responses	Even weeks (2, 4, 6, etc.) create the open-ended discussion board question. This will be regarding contemporary issue or impact that water resources has on engineering analysis and design.	Upload all content for coming week.	Grade homework

Week 1. Introduction to Hydrology

Evaluate how precipitation leads to runoff is key analysis necessary for civil engineering design. As an engineering student, engineering hydrology is a key concept that you will utilize in variety of civil engineering projects (i.e. Roadway Design, Land Development, etc.). A key reasons that hydrology can be a challenging subject is because it is constantly changing and as an engineering you need to understand the effects of dam removal, climate change, CO2 emission, Stormwater quality control, and many other topics in hydrologic analysis and design.

Lesson Learning Objectives:

- Describe engineering hydrology.
- Evaluation of contemporary issues associated with hydrologic analysis and design.
- Perform hydrologic budgets of hydrologic systems.

Asynchronous

Online Lecture Material

- What is Hydrology? - https://youtu.be/VlJMdua-3E0
- Hydrologic Cycle: https://youtu.be/al-do-HGuIk
- Too Much or Just Not Enough: https://youtu.be/f63_ZBrykCI ; https://youtu.be/_eAg_F7kpnM ; https://youtu.be/yIn5f7YANBU
- Hydrologic Budget: https://youtu.be/hk1x58cv3fc

Reading Material

- USGS Water Cycle
- Hydrologic Budget

Prior to Synchronous Class

- Upload muddiest point to blackboard discussion forum for the week
- Take notes from video and readings
- Complete quiz

Synchronous Class

- Discussion and Practice Problems on Hydrology
- Introduce Project #1
- Library Instruction

Homework/Project/Assessment

- Introductory Discussion Board
- Quiz #1 – Micro Lectures
- Homework #1
- Project #1 – Part 1 Assigned (Annotated Bibliography)

Week 2. Watershed

Prior to calculating the quantity of water, which leaves a watershed, it is essential to identify the actual watershed. This is done by performing a watershed delineation. The boundary represents the contributing area to a specified point.

Lesson Learning Objectives:

- Demonstrate an ability to read topographic maps.
- Produce a watershed delination based on topographic maps

Asynchronous

Online Lecture Material

- Watch the video on Watershed Delineation: https://youtu.be/cXqA5nhxqX0
- Watch the video on Watershed Measurements: https://youtu.be/UgMrucegIvk

Optional Lecture Material

- a single point along a stream - http://youtu.be/f7aVNyVMO5g
- a new roadway - http://youtu.be/5I_iMbzl6Tg
- a new land development project - http://youtu.be/gKT41Yc48PQ

Reading Material

- NRCS – Hoe to Read a Topographic Map and Delineate a Watershed

Prior to Synchronous Class:

- Upload muddiest point to blackboard discussion forum for the week
- Take notes from video and readings
- Complete quiz
- Complete the Delineation of Burbank Canyon and Volfe Canyon

Synchronous Class

- Discussion of Watershed Delineation
- Review concepts of confusion
- Provide additional examples

Homework/Project/Assessment

- Quiz #2 – Micro Lectures
- Homework #2
- Discussion Question

Week 3. Watershed Characteristics and Precipitation

Various factors influence the overall runoff leaving a watershed. Factors such as location, size, slope, vegetative cover, etc. all impact the potential design project. By identifying the watershed characteristics your overall analysis will have a higher degree of accuracy for your final design.

> The runoff curve number (also called a curve number or simply CN) is an empirical parameter used in hydrology for predicting direct runoff or infiltration from rainfall excess. The curve number is a function of: soil type, quantity of vegetative cover, soil moisture and land use.
>
> Travel time is used to explain the time it take water to travel from the basin divide to the outlet or point of interest. The travel time is an important concept in hydrologic analysis because the longest travel time will we used to make all calculations for a given watershed. Travel time is used interchangeably with time of concentration and storm duration.

Precipitation can take many forms. This includes rain, snow, sleet, hail and mist. In this course we will focus on rainfall for hydrologic design. As rainfall hits the ground surface it generates runoff that can cause flooding. Rainfall characteristics can impact the overall design for a project. Precipitation/rainfall data is provided in various output forms for a user. It is important that you can read and synthesize the data to be applied to a hydrologic model which will provide overall flow runoff.

Lesson Learning Objectives:

- Determine the effects soil composition has on flow calculations
- Calculate the runoff curve number for a watershed which is a function of soil type, quantity of vegetative cover, soil moisture and land use.
- Define travel time, time of concentration and storm duration.
- Determine how travel time calculations vary and effect watershed response.
- Differentiate and identify rainfall data for various sources.

Asynchronous

Online Lecture Material

- Watershed Characteristics: https://youtu.be/5sK7dxZSGag
- Curve Number: https://youtu.be/7U885bT-L-E
- Travel Time: https://youtu.be/NYF3Cm8x9R8
- Precipitation Characteristics - https://youtu.be/FX8vD-lUsBA

Optional Lecture Material

- Watershed Soils - http://youtu.be/eC_tJsrCVB0
- Weighted Curve Number / Runoff Coefficient - http://youtu.be/NV3Rul0AM9s
- Travel Time: http://youtu.be/37xG7rtjwSQ and http://youtu.be/b6uxyvDmYCk

Reading Material

Definition of a watershed: https://water.usgs.gov/edu/watershed.html

Prior to Synchronous Class

- Upload muddiest point to blackboard discussion forum for the week
- Take notes from video and readings.
- Attempt the practice problems.
- Complete quiz

Synchronous Class

- Discussion of Watershed Characteristics and Precipitation
- Review concepts of confusion
- Provide additional examples

Homework/Project/Assessment

- Quiz #3 – Micro Lectures
- Homework #3
- Project 1 – Assigned additional parts

Week 4. Probability and Statistics

Probability and statistics are essential components to Hydrological Engineering. The idea of weather it will rain or their will be a flood is uncertain. Therefore it is key to understand probability and statistics.

Lesson Learning Objectives

- Define various statistical terms
- Calculate and use sample moments to analyze data
- Differentiate between mass and continuous functions

Asynchronous

Online Lecture Material

- Statistics and Probability Terminology - https://youtu.be/wAmBf_Un3bI
- Sample Moments - https://youtu.be/L7ZohSr0HMg
- Linear Regression - https://youtu.be/JGTi9O5Svko
- Variable Type https://youtu.be/wQuOT-n_kSQ

Prior to Synchronous Class

- Upload muddiest point to blackboard discussion forum for the week
- Take notes from video.
- Attempt the practice problems.
- Complete quiz

Synchronous Class

- Discussion of Statistics and Probability
- Review concepts of confusion
- Provide additional examples

Homework/Project/Assessment

- Quiz #4 – Micro Lectures
- Homework # 4
- Discussion Question
- Project #2 – Assigned

Week 5. Applied Statistical Hydrology

Applying statistics to hydrology can be beneficial. This unit will cover how to use binomial, normal and log normal distributions. A Binomial Function is a mass function. It is used to determine the probability of a specific event occurring based on a past or known probability. A normal and lognormal distributions are density functions. They are used to analyze frequency days. Frequency analysis is an essential analysis for hydrological understanding. To perform these analyses, we need to obtain data, plot data and perform statistical analysis.

Lesson Learning Objectives:

- Identify where to obtain hydrologic data for analysis
- Describe probability paper and plotting position
- Define binomial, normal and log normal distributions

Asynchronous

Online Lecture Material

- Binomial Function https://youtu.be/L7a0IZM0THE
- Flood Frequency Analysis https://youtu.be/6AcFV6QGK9A

Reading Material

- Estimating Flood Frequency

Prior to Synchronous Class

- Upload muddiest point to blackboard discussion forum for the week
- Take notes from video.
- Attempt the practice problems.
- Complete quiz

Synchronous Class

- Discussion of Applied Statistics for Water Resources
- Review concepts of confusion
- Provide additional examples

Homework/Project/Assessment

- Quiz #5 – Micro Lectures
- Homework # 5

Week 6. Peak Discharge

Peak discharge is used to determine a flowrate within a watershed based on a specific design return period. Models used to generate peak discharge can be based on calibrated and uncalibrated models. Calibrated models are based on actual runoff measurements used to develop regression equations, while uncalibrated models are not based on actual watershed measurements but based on watershed characteristics and design rainfall/precipitation.

Lesson Learning Objectives:

- Calculate the peak discharge using calibrated and un-calibrated model.
- Identify the most appropriate model for calculating discharge.

Asynchronous

Online Lecture Material

- Peak Discharge: https://youtu.be/o4dGElYCDPM

Optional Lecture Material

- Peak Runoff - http://youtu.be/Pa9ECbyn280
- Peak Runoff From Multiple Sub basins - http://youtu.be/nrUSXRrd8BE

Reading Material

- Orange County Hydrology Manual (Section D)

Prior to Synchronous Class

- Upload muddiest point to blackboard discussion forum for the week
- Take notes from video and reading.
- Attempt the practice problems.
- Complete quiz

Synchronous Class

- Discussion of Peak Discharge
- Review concepts of confusion
- Provide additional examples

Homework/Project/Assessment

- Quiz #6 – Micro Lectures
- Homework # 6
- Discussion Question (Upload question for midterm)

Week 7. Water Quality

Stormwater quality is essential in engineering project. When it rains, flows drain into our waterways (rivers, lakes and oceans) and can impact habitat and water use.

Lesson Learning Objectives:

- Identify types of contaminates found in storm water and how to permit a project.
- Locate a list of contaminates that are potentially on a project site.
- Identify Best Management Practices for use on a project site.

Asynchronous

Online Lecture Material

- Underdevelopment

Reading Material

- Riverside County LID BMP
- Long Beach, LID BMP
- Los Angeles County, LID BMP
- NPDES Permit

Prior to Synchronous Class

- Upload muddiest point to blackboard discussion forum for the week
- Take notes from video and reading.
- Complete quiz

Synchronous Class

- Discussion of Peak Discharge
- Review concepts of confusion

Homework/Project/Assessment

- Quiz #7 – Micro Lecture
- Midterm Exam

Week 8. Introduction to Open Channel Hydraulics

The basic principles of open channel flow are that it is gravity flow. There is no work being done on the system by a pump or a pressurized tank - it is just gravity. The first challenge of open channel flow is that there are a large number of open channel solutions for every diversion or conveyance problem.

This unit provides an overview of open channels and the vocabulary we use to describe them, such as friction slope, roughness, flow area, wetted perimeter, hydraulic radius, normal depth, critical depth and specific energy.

Specific Energy is an important topic to be covered in open channel. Energy in an open channel is the same as it is in a pressurized pipe, but there are minor differences between the two scenarios that need to be clarified. Firstly, we look at energy - at least initially - as relative to the channel bed, and not to an absolute datum. You also need to understand how to define the energy profile in an open channel given the flowrate and shape. This provides the engineer a new design rule of thumb: Stay away from Critical Depth. We also use a new dimensionless number to classify the type of flow in an open channel: The Froude Number.

Manning's equation is used to determine the flowrate within a channel. When the slope of the channel is parallel to the friction slope the Manning's equation can be used to determine the normal depth (d_n). In this section, we apply the Manning's equation to design and analyze triangular, trapezoidal, irregular and circular (i.e. pipes) cross sections.

Lesson Learning Objectives:

- Differentiate pressurized vs open channel flow hydraulics
- Define open channel geometry
- Identify different flow types and regime types.
- Define and calculate critical depth based on the Froude Number.
- Define and calculate Specific Energy
- Define and calculate normal depth.

Asynchronous

Online Lecture Material

- Open Channel Introduction: https://youtu.be/TbNv3Z3V6No
- Open Channel Design - http://youtu.be/9VXbanB84Ec
- Open Channel Analysis - http://youtu.be/2cn0uncCwc4
- Theory Critical Depth, Flow Regime and Specific Energy - https://youtu.be/GPQYjxmruxM
- Example Problems - https://youtu.be/eKfK6Ftf_kU
- Normal Depth and Uniform Flow - https://www.youtube.com/watch?v=r5_NxefTn90
- Circular Pipes - https://youtu.be/KRcnGgjnNvw

Optional Lecture Material

- Open Channel Intro - http://youtu.be/7vqj2z5PYqA

Reading Material

- Kings Tables

Prior to Synchronous Class

- Upload muddiest point to blackboard discussion forum for the week
- Take notes from video and reading.
- Do practice problems
- Complete quiz

Synchronous Class

- Discussion of Open Channel
- Review concepts of confusion
- Do practice problems

Homework/Project/Assessment

- Quiz #8 – Micro Lectures
- Homework # 7
- Discussion Question

Week 9. Hydraulic Structures

Hydraulic structure refers to any object that water flows under, over, or through. Though, in general, when we discuss hydraulic structures we do not typically talk about the flow in conduits. The week we will discuss orifices, weirs, roadways, shallow channels and culverts.

Learning Objectives

- Calculating flowrates through various hydraulic structures.
- Determine the depth of flow within the hydraulic structure.
- Designing hydraulic structures to meet design conditions.

Asynchronous

Online Lecture Material

- Theory: https://youtu.be/yg-_xdchtvk
- Hydrologic Design: https://youtu.be/_O0dzwkgplI
- Culvert Overview 1 - http://youtu.be/1VtWm9t50WY
- Culvert Overview 2 - http://youtu.be/ajDGTU1qJ7g
- Culvert Analysis 1 - http://youtu.be/NUvvrvLGP8w

Prior to Synchronous Class

- Upload muddiest point to blackboard discussion forum for the week
- Take notes from video and reading.
- Do practice problems
- Complete quiz

Synchronous Class

- Discussion on Hydraulic Structure
- Review concepts of confusion
- Do practice problems

Homework/Project/Assessment

- Quiz #9 – Micro Lectures
- Homework # 8

Week 10. Rapidly Varied Flow

Breaking up non-uniform flow into its two major components, we start by analyzing Rapidly Varied Flow (RVF). RVF occurs where there is an abrupt change in water surface elevation even if the flowrate is steady.

> In open channel flow humps and depressions can be found in channels. When the flow is supercritical the water surface profiles are in phase while when the flow regime is supercritical the water surface profiles are out of phase. The following lesson explains how to uses the specific energy equation to determine the flow depth within the channel.
>
> In an open channel flow will pass through contractions. The specific energy is constant through the contraction. The following lesson explains how to uses the specific energy equation to determine the flow depth within the channel.
>
> Hydraulic Jumps occurs when you transition between supercritical flow and subcritical flow as you transition upward through the minimum energy region on the specific energy graph. The analysis tools we use here are empirical. The simplification presented can only be applied to rectangular channels. They provide us a way to estimate the sequent depths of a hydraulic jump as well as determine the length of a hydraulic jump. Complete Handout 15 along with this task.

Learning Objectives:

- Apply the specific energy equation to evaluate the water surface depth for channels that experience abrupt changes.
- Identify flow profiles under supercritical and subcritical flow regimes.
- Evaluate when flow within the channel undergoes choking.
- Calculate depth and length of a hydraulic jumps.

Asynchronous

Online Lecture Material

- Humps and Depressions: https://youtu.be/VMGh4T6iAG8
- Expansions and Contractions: https://youtu.be/04Yq0ot6__8
- Hydraulic Jumps: http://youtu.be/vsWgkqsNyuE

Prior to Synchronous Class

- Upload muddiest point to blackboard discussion forum for the week
- Take notes from video and reading.
- Do practice problems
- Complete quiz

Synchronous Class

- Discussion on Rapidly Varied Flow

- Review concepts of confusion
- Do practice problems and use excel

Homework/Project/Assessment

- Quiz #10 – Micro Lectures
- Homework # 9
- Discussion Board
- Project #3 assigned

Week 11. Gradually Varied Flow Analysis

Flows are usually not completely steady and uniform. This is because channels change direction, slope, material, and shape. Each of these can have an impact on the hydraulics of the channel by creating backwater effects (water backing up into the channel) or tailwater effects (water tailing off downstream as it accelerates). The first step to understanding these effects is to sketch the possible changes in the flow level that are a result of the non-uniform transitions. The next step is to calculate the gradually varied profiles.

Learning Objectives:

- Identify channel types based on normal and critical depth.
- Define water surface control within in an open channel.
- Qualitative and quantitatively draw water surface profiles

Asynchronous

Online Lecture Material

- Channel Type: https://youtu.be/5GgPOVE17L4
- Gradually Varied Flow Profiles: https://youtu.be/pFUSdfbbtVY
- Calculate GVF: TO COME

Optional Lecture Material

- NonUniform Flow - http://youtu.be/kf5i4IIxzRs
- NonUniform Flow 2 - http://youtu.be/72KWUGFAVlE
- Gradually Varied Flow Analysis - http://youtu.be/fXShOZZ3JYo

Prior to Synchronous Class

- Upload muddiest point to blackboard discussion forum for the week
- Take notes from video and reading.
- Do practice problems
- Complete quiz

Synchronous Class

- Discussion on GVF
- Review concepts of confusion
- Do practice problems and use excel

Homework/Project/Assessment

- Quiz #11 – Micro Lectures
- Homework # 10

Week 12. Combining GVF and RVF

When performing open channel hydraulic analysis GVF and RVF need to be combined. This lesson covers combining GVF and RVF using both Excel and HEC-RAS

Learning Objectives

- Evaluate multiple channel systems which include GVF and RVF.
- Use excel and HEC-RAS to program channel.

Asynchronous

Online Lecture Material

- Working on creating a new video
- Part 1 - https://youtu.be/0-CaYRGpCDg
- Part 2 - https://youtu.be/RRiV20Rd5W0
- Part 3 - https://youtu.be/SgvgGiOZNEI
- Part 4 - https://youtu.be/84noC3anN28
- Part 5 - https://youtu.be/1X6U_CjvHx0
- Part 6 - https://youtu.be/8V1NTidSM8s
- Part 7 - https://youtu.be/lwXyS1YGY_o

Prior to Synchronous Class

- Upload muddiest point to blackboard discussion forum for the week
- Take notes from video and reading.
- Do practice problems
- Complete quiz

Synchronous Class

- Discussion on GVF
- Review concepts of confusion
- Do practice problems and use excel

Homework/Project/Assessment

- Quiz #12 – Micro Lectures
- Homework # 11
- Discussion Board

Week 13. Introduction to Groundwater, Seepage and Flow nets

Groundwater is the flow of water under the surface. This unit will explain the various aspects of subsurface flow and explain important vocabulary. It will also introduce you to concepts of seepage, where flows can damage hydraulic structures. And finally, perform calculations using flownets around dams.

Learning Objectives

- Define groundwater, groundwater hydrology, confined and unconfined aquifers.
- Calculate Groundwater flow based on the Darcy's Law.
- Identify when seepage occurs.
- Perform flow net calculations.

Asynchronous

Online Lecture Material

- Introduction to Groundwater: NEED TO DEVELOP
- Seepage: NEED TO DEVELOP
- Flow nets: NEED TO DEVELOP

Prior to Synchronous Class

- Upload muddiest point to blackboard discussion forum for the week
- Take notes from video and reading.
- Do practice problems
- Complete quiz

Synchronous Class

- Discussion on Groundwater, seepage and flow nets
- Review concepts of confusion
- Do practice problems and use excel

Homework/Project/Assessment

- Quiz #13 – Micro Lectures
- Homework # 12 (two-week assignment)

Week 14. Groundwater Flow

Groundwater moves differently in confined and unconfined aquifers. This unit will allow you to determine the flow of water within the aquifer and also calculate the hydraulics associated with wells.

Learning Objectives

- Calculate steady-state groundwater flow in a confined aquifer.
- Calculate steady-state groundwater flow in an unconfined aquifer.
- Calculate flowrate of a well in a confined and unconfined aquifer
- Calculate the hydraulic conductivity and transmissivity
- Determine the drawdown within a well.

Asynchronous

Online Lecture Material

- Steady State Subsurface Flow - https://youtu.be/qjENECdGCS0
- Well Hydraulics - https://youtu.be/KKwZqUcgKqw

Prior to Synchronous Class

- Upload muddiest point to blackboard discussion forum for the week
- Take notes from video and reading.
- Do practice problems
- Complete quiz

Synchronous Class

- Discussion on
- Review concepts of confusion
- Do practice problems and use excel

Homework/Project/Assessment

- Quiz #14 – Micro Lectures
- Homework # 12 (two-week assignment)
- Discussion Board (final exam questions)

Week 15. Review