Environmental Engineering Technology | 2017-2018

Assessment Report

1. Please give a brief overview of the assessment data you collected this year.

The following ABET Student Learning Outcomes were assessed for required courses in the Environmental Engineering Technology BS program. Assessment was performed in courses required by the major that are taught at UW-Green Bay by UW-Green Bay faculty. Each outcome was assessed once at the lower level and once at the higher level. The chart below shows which outcomes were assessed in specific courses. Results and discussion of continuous improvement follow. Samples of student work are available.

ABET Criterion 3 Student Learning Outcomes (time of graduation) with ours under the applicable one

a. An ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly defined engineering technology activities
b. An ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies
c. An ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes
d. An ability to design systems , components, or processes for broadly defined engineering technology problems appropriate to program educational outcomes
e. An ability to function effectively as a member or leader on a technical team
f. An ability to identify, analyze, and solve broadly defined engineering technology problems
g. An ability to apply written, oral, and graphical communication in both technical and non-technical environments; and an ability to identify and use appropriate technical literature
h. An understanding of the need for and an ability to engage in self-directed continuing professional development
i. An understanding of and a commitment to address professional and ethical responsibilities including a respect for diversity
j. A knowledge of the impact of engineering technology solutions in a societal and global context
k. Commitment to quality, timeliness, and continuous improvement

Environmental Engineering Technology Assessment

Outcomes Courses	A	B (1)	C (3)	D (2)	E (6)	F	G (4)	H	I (5)	J	K
ET 101 Intro. to ET UM, JT fall								x	x	x	x
ET 103 Surveying RH fall		x			x						
ET 105 Drawing RH fall	x										
ET 118 Fluids 1 RH spr			x			x					
ET 201 Intro. to Air NWTC spr											
ET 202 Intro. to Solid Waste NWTC spr											
ET 203 Intro. to Water and Waste Water RH fall				x			x				
ET 330 Hydrology PT fall		x			x					x	
ET 360 Project Management RH spr									x		
ET 391 GIS ??											
ET 464 Atm. Poll. PT ET 334 Solid Waste ? ET 331 W & WW RH spr	x			x		x					
ET 400 Capstone ET 410 Internship PT			x				x	x			x

ABET Outcome Assessment Fall 2017

Course: ET 103 Surveying

Outcomes assessed: b and e

ET 105, Surveying was the course in which ABET learning outcomes b and e were assessed.

Outcome b states that a student will demonstrate: An ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedure or methodologies;

Outcome e states that a student will demonstrate: An ability to function effectively as a member or leader on a technical team;

These outcomes were met with the following laboratory assignment:

ET 103 - Surveying
Lab #12: Closed Loop Traverse

Objectives:

The overall objective is to use a total station instrument to measure horizontal angles direct and reverse and to measure distances on a closed loop traverse. In order to complete the overall objective each of you will need to:

1. Correctly set up and center a TSI over a point
2. Demonstrate correct procedure for measuring a horizontal angle
3. Demonstrate correct procedure for measuring a horizontal distance
4. Demonstrate correct way to record field notes
5. Demonstrate ability to function as a member and leader on a surveying crew

Equipment:

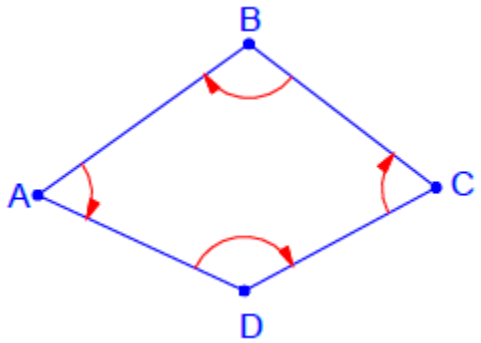
- Trimble M3 TSI
- Prism
- Prism pole
- Tribrach
- Tripod
- Plumb bob
- Two stakes
- Tape measure
- Marker

Before you begin, decide who in your group will be leading each component of the lab. At a minimum, you should have one leader for 1) documentation leader → preparing and making sure notes are taken for the entire lab and making sure everyone in the group has all of the information to complete the lab assignment, 2) technical leader → making sure the instrument is set correctly and the measurements are taken correctly, 3) crew leader → making sure all information is collected, meeting all requirements. **If at any point during the lab, I determine that you are not on task, I will deduct points from your grade for this assignment**.

In addition, it is still expected that each crew member must operate the TSI on at least one point.

Part A - Traversing Procedure

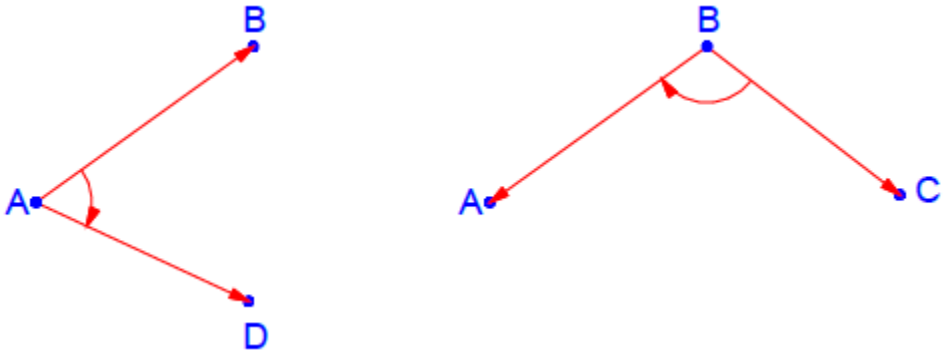
A. There are two different triangles for this lab. Locate the triangle to be measured as directed by your instructor.
B. Prepare your field book for recording horizontal angles and horizontal distances. An example of the minimum field notes is provided at the end of this handout.
C. Begin your measurements by setting up the TSI over the first point on the traverse. The procedure is attached to this document.
D. Enter the correct EDM settings (i.e., pressure and temperature) in the instrument. Record the EDM settings in the right plate of your field book and indicate that you entered them into the TSI.
    a. Determine the pressure and temperature before going outside.
E. Set up the TSI to measure distance using a prism.
F. Measure the instrument and target heights and enter them in the instrument. **The instrument height will change each time you set up over a new traverse station.**
G. Measure the angle right D & R between the backsight and the foresight.
    b. The interior angles of the figure are to be measured as "angles to the right."
        i. Always rotate the instrument in the direction of the angle measurement even if it means a longer way to go.
        ii.



    c. Each angle will be read twice direct and reverse (2 D/R).
        i. Direct and reverse angles should match within 25 seconds.
        ii. Add additional direct and reverse sets until two sets meet the criteria.

d. Use distinct sighting marks such as a plumb line, prism/range pole, or pencil tip. The narrower your sighting mark, the less pointing error potential. Sight low on rigid marks (e.g., pole, pencil, etc.) and high on plumb lines.
e. **Do not use a prism on a prism pole as a sight mark for angle measurement.**
f. Record these in your field book.

H. Now measure the distances from the point you're set up over to the backsight and foresight using the prism and prism pole.
   g. Each distance will be measured in both directions



      i. When at point A, measure A to B.
      ii. When at point B, measure B to A.
   h. Each horizontal distance should be measured a minimum of three times at each point. Wind or otherwise unstable prism set up may require additional measurements in order for them to "stabilize". The final distance will be the average of the accepted measurements.
   i. Record the distances in your field book. Because you are using the prism, the measurements should be within a few hundredths. Also, be sure you are recording the horizontal distance.

I. Move the total station to each point in the figure and repeat the steps described above.

Part B - Submittal

The total grade for this lab is 100 points. **Each student** will submit a technical memorandum summarizing the results of this lab, including a copy of their field notes and all computations completed, and a description of each crew member's contribution. Details regarding how each component of the lab will be graded is provided below. The purpose of this lab is to meet the ABET Outcomes: (b) An ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedure or methodologies and (e) An ability to function effectively as a member or leader on a technical team.

Technical Memorandum (50 points)

The technical memorandum should be less than 2 pages and include the following information.

A. An introductory paragraph briefly describing the lab, the purpose of the lab, and the methods used. Also include a brief description of the equipment, including the brand and model number, used. (10 points).
B. A figure showing the overall traverse that was measured and where the traverse was located. Be sure to label each traverse station and make sure the labels match the field notes and computations. A north arrow should also be included. (5 points).
C. Describe the quality control used for this lab in order to reduce or take into account errors. Describe the allowable difference between your direct and reverse angle measurements of 0°00'25" and if your angle measurements met this criteria. Also describe the allowable angular misclosure for the entire traverse and discuss if your traverse met the criteria. (5 points).
D. Provide a table with the final adjusted azimuths, latitudes and departures, and north and east coordinates for each Line of the traverse. State any assumptions that you made. (15 points).
E. Provide a short paragraph describing the duties and responsibilities of each crew member. In a table, assign each crew member, including yourself, a grade between 0 and 10 with 0 being the lowest grade and 10 being the highest. In the text, be sure to justify your grade assignments. At a minimum, the grade should reflect the portion of work each crew member contributed, how well the crew member understood how to complete the lab, and how well each crew member performed as a leader when he/she ran the total station. If you do not put thought into this, you will receive a grade of 0 for this part.
F. Appendix (5 points)
    a. A copy of your complete field notes for this lab. A description on how the field notes will be graded is provided below.
    b. All computations, including a printout of the Loop Traverse spreadsheet. A description of the computations that need to be completed and how they will be graded is provided below.

Field Notes (20 points total)

A. Angle criteria (12 points)
    a. Each crew member should complete the angle and distance measurements on at least one traverse point.
    b. Each angle will be worth 3 points. The full 3 points will be given based on meeting the 0°00'25" for 2 D/R sets. Any angle that does not have at least 2 D/R sets meeting this criteria will lose all 3 points.
B. Notes will also be graded based on the following (8 points):
    a. Neatness
    b. A sketch is included showing the angle turned (side and direction) on the right plate of your field notes.
    c. Not crowded. A minimum of one page per traverse station was used. More pages were used if D/R criteria were not met and the angle measurement was repeated.
    d. The support data is complete, especially concerning crew members and responsibilities. Each crew member's name appears as the instrument operator on at least one point.

Computations (30 points total)

A. Individual angles (4 points)

a. For each traverse point, list the accepted D/R measurement and difference.
b. From these, compute an average angle for each traverse point. Compute to 01”

B. Angular misclosure (6 points)
   a. Sum the angles from Part A and see if they meet the closure specification of

$$c = \pm 0°00'25'' \times \sqrt{n}$$

Where n is the number of points on your traverse

Misclosure	Grade
≤ c	6
≤ 2c	4
≤ 3c	2
> 3c	0

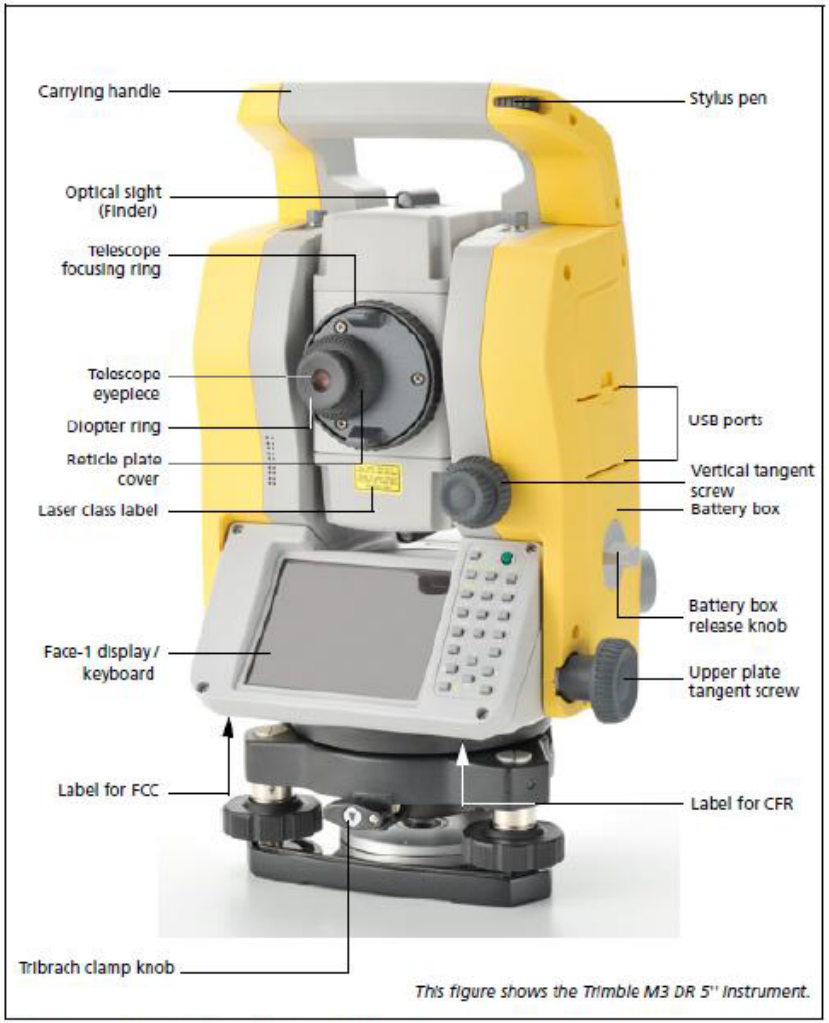
C. Distribute angular misclosure (4 points)
   a. Use a judgment-based approach: apply larger corrections to those angles which have greater D/R spreads.
   b. Be sure to document your decisions so I can tell why you applied different corrections to different angles.

D. Compute Azimuths (8 points)
   a. Assume the azimuth of one line and using the angles from Part C, compute the remaining azimuths. Be sure to perform a math check.

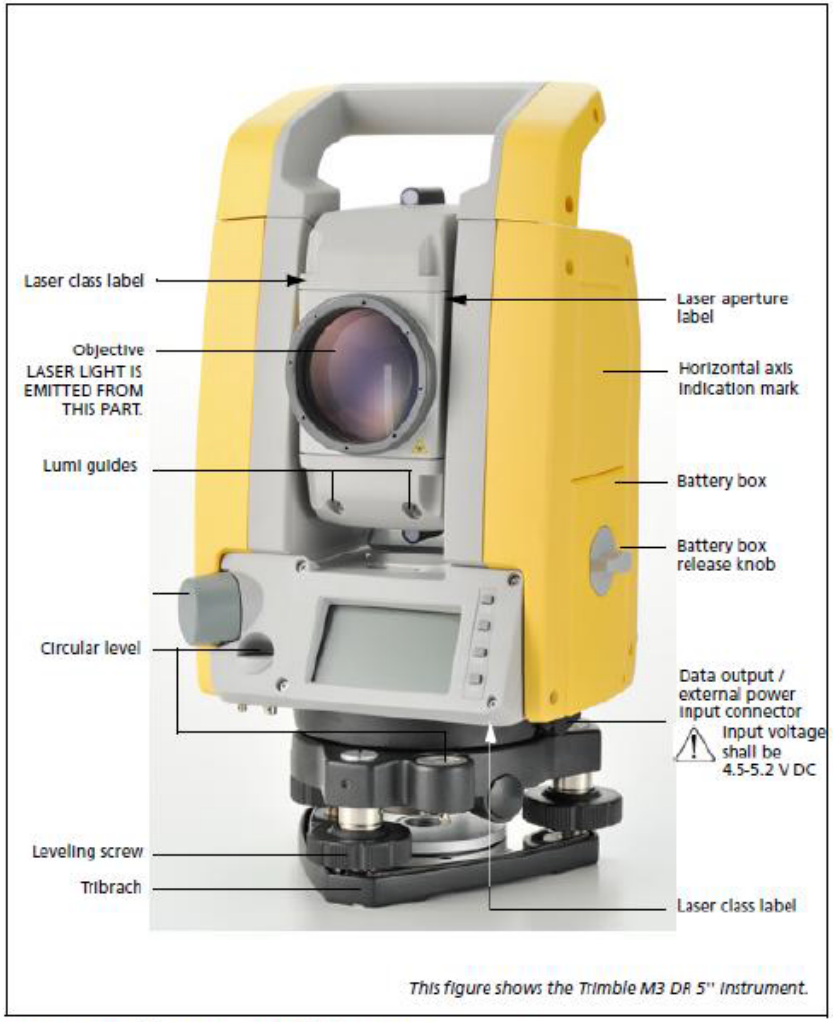
E. Summarize Distances (4 points)
   a. Compute and list in a table the average distance for each traverse line. Show to 0.001 ft to minimize rounding error.

F. Use the data from Parts D and E, compute and adjust your traverse with the Loop Traverse spreadsheet. (4 points)
   a. Assume coordinates for your beginning point.

Appendix - Trimble M3 Total Station Instrument Operation Handout



This figure shows the Trimble M3 DR 5'' instrument.



This figure shows the Trimble M3 DR 5'' instrument.

Turning on/off Trimble M3

1. Press the Green Power Button to turn on TS
2. The Trimble Access Screen should appear
3. If the Desktop appears, double-click (tap) Trimble Access icon to open the Application
4. To turn off the TSI, press Power Button. The screen below should appear

5. Tap Standby button to turn off the instrument
6. Tap OK to close the screen or Press Power Button to return to previous screen.
7. Please check the battery life before putting away TSI and make sure the Instructor is notified that the battery needs charging.

Setting up the Trimble M3

1. Centering and rough leveling
2. Precise leveling

Centering and rough leveling

1. Set tripod over point
   a) Tripod top should be relatively level and legs spread to provide a stable platform.
   b) Beginners may find it handy to drop something, like a pebble or set of keys, from directly below the tripod head.
   c) Common error: setting the tripod too high.
   d) Legs should be firmly planted.
   e) Once in place, the tripod should not be moved.
2. Attach TSI to tripod
   a) Tribrach should be oriented parallel with and centered on tripod head.
   b) Do not over-tighten mounting screw.
   c) Make sure leveling screws are mid-run.
   d) TSI will be neither level nor centered at this point.
3. Center TSI over ground mark
   a) Center the optical plummet cross-hairs on the ground mark.
   b) Retighten mounting screw
4. Center circular bubble by adjusting tripod leg lengths
   a) Extending or shortening one tripod legs at a time to center the bubble.
   b) Doesn't have to be perfectly centered but should be entirely within scribe mark.
   c) Be careful unlocking a leg – TSI weight may cause leg to collapse.
   d) Be sure to fully lock the leg.
   e) When the bubble is centered the optical plummet should still be on the ground mark.

5. Check the optical plummet
   a) If the TSI must be re-centered, loosen the mounting screw and slide TSI back/forth or left/right on top of the tripod.
   b) Re-tighten the mounting screw.

Precise Leveling

1. Turn on digital level.
   a) Turn on the TSI (green power button)
   b) Select General Survey.
   c) Tap on the TSI icon on the right side of the screen 

   d) Tap on the Level option 

2. Rotate TSI so one digital bubble is aligned with two leveling screws. The second bubble will be perpendicular to those two screws.

3. Center the first digital bubble using those two screws
4. Center second digital bubble using only the third screw
5. Re-check first digital bubble and re-center using its two screws.
6. Re-check second digital bubble and re-center using the third screw. If it runs, bring it back halfway using the third leveling screw.
7. Check optical plummet on ground point. Re-center the TSI over ground point if necessary and check level.

Measuring a Distance

1. Tap on the TSI icon on the right side of the screen 

2. Tap on the Survey Basic Option 

3. Check digital level and [Accept] if the TSI is precisely leveled
4. Type in the Temperature and Pressure (check the National Weather Service, http://www.weather.gov/ → search for 54311) and [Accept].

5. Tap on the prism icon on the right of the screen 

.
   a) Select [Target 2, 30 mm] as the prism constant if you are using a prism 

.
   b) Select [Target DR, 0 mm] as the prism constant if you are not using a prism 

.
   c) [Accept]
6. Tap on [Set] and insert the target height and instrument height measured with ruler (note: the ruler is in units of decimal feet) and tap [Accept].
7. Sight the prism center or object (when not using a prism)
   a) Use the horizontal and vertical slow motions to accurately sight
   b) Tap [Measure]
8. Record results (Repeat measurement at least three times).
   a) Use the right arrow next to the measurements to cycle between HA (horizontal angle), VA (vertical angle), SD (slope distance), HD (horizontal distance), and VD (vertical distance).

Measuring a Horizontal Angle

1. Sight the BS target and set the horizontal angle to 0° with [Zero].
   a) Use fine targets to minimize error.
   b) Read and record angle.
2. Rotate to the right sight FS target.
   a) Read and record angle.
3. Reverse telescope about HA (i.e., flip telescope vertically 180°).
4. Rotate to the right (horizontally)to sight BS target
5. Set the horizontal angle to 180° with [Zero].
   a) Read and record angle.
6. Rotate to the right to sight FS target
   a) Read and record angle.

This completes one Direct and Reverse angle set. Repeat Steps 3-6 for additional D/R sets.

The difference between the FS and BS angle reading is the horizontal angle. Use the average of a direct and reverse set as the angle. If you are repeating the direct and reverse angles, average all horizontal angles.

TRAVERSING

INST	Sight	Dir <	Rev <	diff
B	C	0°00'00"	180°00'00"	
	A	38°17'30"	218°17'35"	
	<	38°17'30"	38°17'35"	0°00'05"
B	C	0°00'00"	180°00'00"	
	A	38°17'35"	218°17'45"	
	<	38°17'35"	38°17'45"	0°00'10"
AVERAGE ANGLE				
Distances				
B-A	279.42	279.43	279.42	
B-C	~~384.61~~	384.65	384.66	384.64
AVERAGE DISTANCES				

NOTE: ALL ANGLES ARE MEASURED CLOCKWISE.
ALL DISTANCES ARE HORIZONTAL.

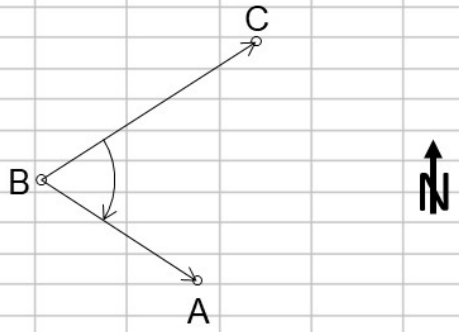
TRAVERSING

22 NOV 2017
OUTSIDE CONDITOINS: Cloudy
2:15 PM TO 3:45 PM
CREW & STATION MEASURED:

TRIMBLE M3 DR3"

T = 31 °F, P=30.0" Hg -> 5 ppm (dialed in)

STATION DESCRIPTIONS AND TRAVERSE SKETCH.



Ryan Holzem 11/22/17

Note: Use multiple pages!

Assessment was performed using the rubric below, along with the Average grade for each category of the 6 students that completed the project.

Rubric		Total Points	Average Grade (n=8)
Technical Memorandum		***50***	
	An introductory paragraph briefly describing the lab, the purpose of the lab, and the methods used. Also include a brief description of the equipment, including the brand and model number, used.	10	9.83
	A figure showing the overall traverse that was measured and where the traverse was located. Be sure to label each traverse station and make sure the labels match the field notes and computations. A north arrow should also be included.	5	4.33
	Describe the quality control used for this lab in order to reduce or take into account errors. Describe the allowable difference between your direct and reverse angle measurements of 0°00'25" and if your angle measurements met this criteria. Also describe the allowable angular misclosure for the entire traverse and discuss if your traverse met the criteria.	5	4.83
	Provide a table with the final adjusted azimuths, latitudes and departures, and north and east coordinates for each Line of the traverse. State any assumptions that you made.	15	14.00
	Provide a short paragraph describing the duties and responsibilities of each crew member. In a table, assign each crew member, including yourself, a grade between 0 and 10 with 0 being the lowest grade and 10 being the highest. In the text, be sure to justify your grade assignments. At a minimum, the grade should reflect the portion of work each crew member contributed, how well the crew member understood how to complete the lab, and how well each crew member performed as a leader when he/she ran the total station.	10	10.00
	Appendix	***5***	
	A copy of your complete field notes for this lab. A description on how the field notes will be graded is provided below.	2.5	2.50
	All computations, including a printout of the Loop Traverse spreadsheet. A description of the computations that need to be completed and how they will be graded is provided below.	2.5	2.50
Field Notes		***20***	
	Angle Criteria	***12***	
	Each crew member should complete the angle and distance measurements on at least one traverse point.		
	Each angle will be worth 3 points. The full 3 points will be given based on meeting the 0°00'25" for 2 D/R sets. Any angle that does not have at least 2 D/R sets meeting this criteria will lose all 3 points.	12	12.00
	Notes	***8***	
	Neatness	2	2.00
	A sketch is included showing the angle turned (side and direction) on the right plate of your field notes.	2	2.00
	Not crowded. A minimum of one page per traverse station was used. More pages were used if D/R criteria were not met and the angle measurement was repeated.	2	2.00
	The support data is complete, especially concerning crew members and responsibilities. Each crew member's name appears as the instrument operator on at least one point.	2	2.00
Computations		***30***	
	Individual Angles	***4***	
	For each traverse point, list the accepted D/R measurement and difference.	2	2.00
	From these, compute an average angle for each traverse point. Compute to 01"	2	2.00
	Angular misclosure	***6***	
	Sum the angles from Part A and see if they meet the closure specification	6	6.00
	Distribute Angular Misclosure	***4***	
	Use a judgment-based approach: apply larger corrections to those angles which have greater D/R spreads.	2	2.00
	Be sure to document your decisions so I can tell why you applied different corrections to different angles.	2	2.00
	Compute Azimuths	***8***	
	Assume the azimuth of one line and using the angles from Part C, compute the remaining azimuths. Be sure to perform a math check.	8	8.00
	Summarize Distances	***4***	
	Compute and list in a table the average distance for each traverse line. Show to 0.001 ft to minimize rounding error.	4	4.00
	Traverse Spreadsheet	***4***	
	Assume coordinates for your beginning point.	4	4.00
	Total Score	**100**	**98.00**

Continuous improvement:

ET103: Outcome e and

In response to the Fall 2015 and 2016 assessment, I provided further guidance in the handout describing the different roles that each student must play, especially regarding leadership roles. I also had the students evaluate each other regarding how well each group member served as a leader. I required that students put thought into their answer or receive a grade of 0. I think it would be helpful for future classes to make this lab more practical to meet Outcome b. I recommended in 2016 that I should have the students complete a loop traverse and calculate the area of a plot of land on campus and use the area calculation to determine quantities of engineering materials, etc. However, I was unable to make these changes. Thus, to improve the class for next year, I think the assignment should be made into more of a real world engineering project.

ABET Outcome Assessment Fall 2017

Course: ET 203 Introduction to Water and Wastewater

Outcomes assessed: d and g

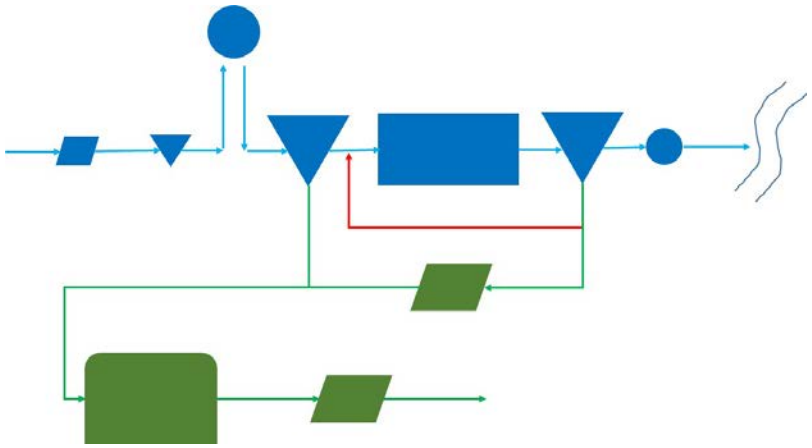
Outcome d states that a student demonstrate: An ability to design systems, components, or processes for broadly defined engineering technology problems appropriate to program educational objectives;

This was met with the Problems on the final exam: **Final Exam Problems 5, 6, 7, and 8**

Problem 5 (15 points)

The figure below is a schematic of a typical wastewater treatment plant. Circle three of the shapes and answer the following questions. You cannot do disinfection.

a. Name each (3 points).
b. Explain the purpose of each (6 points).
c. State what each removes/treats (6 points).



Problem 6 (10 points)

Draw a schematic of a drinking water treatment plant by placing the following processes in the order through which water will flow (source = surface water). Currently the processes are in alphabetical order:

chlorination, coagulation, distribution, filtration, flocculation, grit removal, screening, sedimentation, solids handling, source

Problem 7 (7 points)

A 6 MGD (6,000,000 gallons per day) wastewater treatment plant operates at an overflow rate of 1,000 $\frac{gal}{ft^2 \cdot day}$. What is the diameter if three circular clarifiers are used?

Problem 8 (15 points)

A 20 MGD wastewater treatment plant has an influent BOD_5 concentration of 240 mg/L and an influent TSS concentration of 220 mg/L. Assume 65% TSS and 30% of BOD_5 are removed by primary clarification. Assume Extended aeration activated sludge will be used and that the primary effluent will be split equally into three aeration basins of the same size.

Common values from the 10 State Standards for F/M ratio and MLSS are shown in the table provided. Yes, you will have to pick values. Assume the volatile fraction (i.e., MLVSS) of MLSS is 75%. Be careful with units.

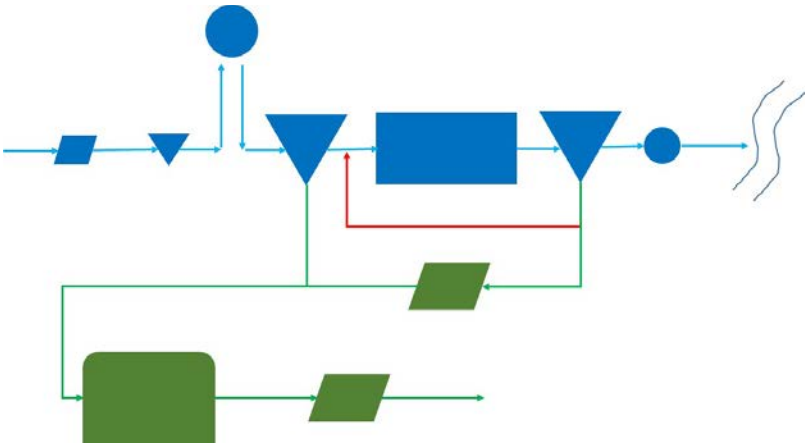
PERMISSIBLE AERATION TANK CAPACITIES AND LOADINGS

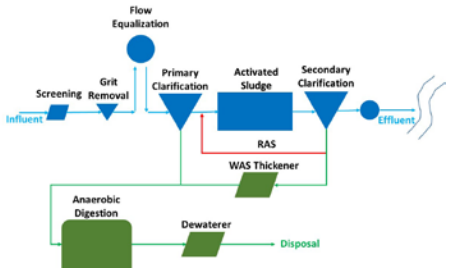
Process	*Aeration Tank Organic Loading lb BOD_5/d/1000 ft^3 [kg BOD_5/ (m^3·d)]**	F/M Ratio lb BOD_5/d/lb MLVSS [kg BOD_5/(kg MLVSS·d)]**	MLSS*** mg/L
Conventional Step Aeration Complete Mix	40 (0.64)	0.2-0.5	1,000-3,000
Contact Stabilization	50****(0.80)	0.2-0.6	1,000-3,000
Extended Aeration Single Stage Nitrification	15 (0.24)	0.05-0.1	3,000-5,000

a. Determine the primary effluent BOD_5 (3 points).
b. Select an appropriate F/M and convert to units of lb BOD_5/lb MLSS·d from lb BOD_5/lb MLVSS·d (3 points).
c. Use the equation we derived in class for F/M and solve for total volume. You will need to select an appropriate MLSS from the table provided (6 points).
d. Calculate the volume in ft^3 for <u>each of the three</u> aeration basin rounded to the nearest 10,000 cubic ft (3 points).

Assessment was performed using the key below. The average score for each problem the 3 students that completed the exam is also provided.

5. (15 points) The figure below is a schematic of a typical wastewater treatment plant. Circle three of the shapes and answer the following questions. You cannot do disinfection.
    a. Name each (3 points).
    b. Explain the purpose of each (6 points).
    c. State what each removes/treats (6 points).



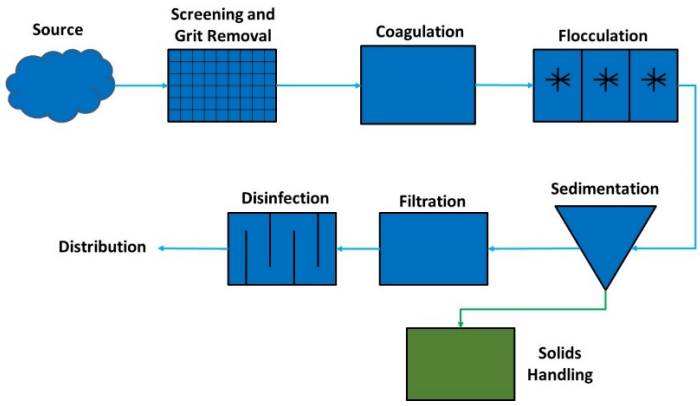


Screening – remove large debris, such as rags, rocks, sticks, etc. and to protect downstream equipment.
Grit removal – remove sand, gravel, and other dense material to reduce mechanical equipment repairs, reduce grit buildup in tanks, channels, and digesters.
Flow Equalization – Dampen variation in flow and organic loading, so that wastewater downstream can be treated at a nearly constant flowrate.
Primary clarification – Remove readily setteable (mostly organic) solids and floating materials. Reduce TSS 50-70%, reduce BOD 25-40% and reduce P 20%.
Activated sludge – use microorganisms to remove dissolved organic matter (BOD). Modifications can be made to remove nutrients, such as N and P.
Secondary clarifier – removes remaining particles (mostly microorganisms) and either recycles the material to the activated sludge basin or wastes it to control SRT and maintain BOD removal efficiency.
WAS thickener – remove water from mainly secondary sludge to reduce required digester size. The water is recycled back to the front of the plant.
Anaerobic digester – stabilize the solids removed from primary and secondary clarification by reducing organics (i.e., VSS).
Dewaterer – remove water from anaerobic digester effluent to reduce disposal costs.

Average Score: 15/15 (100%)

6. (10 points) Draw a schematic of a drinking water treatment plant by placing the following processes in the order through which water will flow (source = surface water). Currently the processes are in alphabetical order:

chlorination, coagulation, distribution, filtration, flocculation, grit removal, screening, sedimentation, solids handling, source



Average Score: 9.9/10 (98.8%)

7. (7 points) A 6 MGD (6,000,000 gallons per day) wastewater treatment plant operates at an overflow rate of 1,000 $\frac{gal}{ft^2 \cdot day}$. What is the diameter if three circular clarifiers are used?

OR $= \frac{Q}{A} = 1000 \frac{gal}{ft^2 d} = \frac{6{,}000{,}000\ gal}{A}$ → A=6000 ft^2 for all three clarifiers, so 2000 ft^2 for each.

$\frac{D\pi^2}{4}$ = 2000 ft^2 Solve for D = 50.5 ft

Average Score: 7/7 (100%)

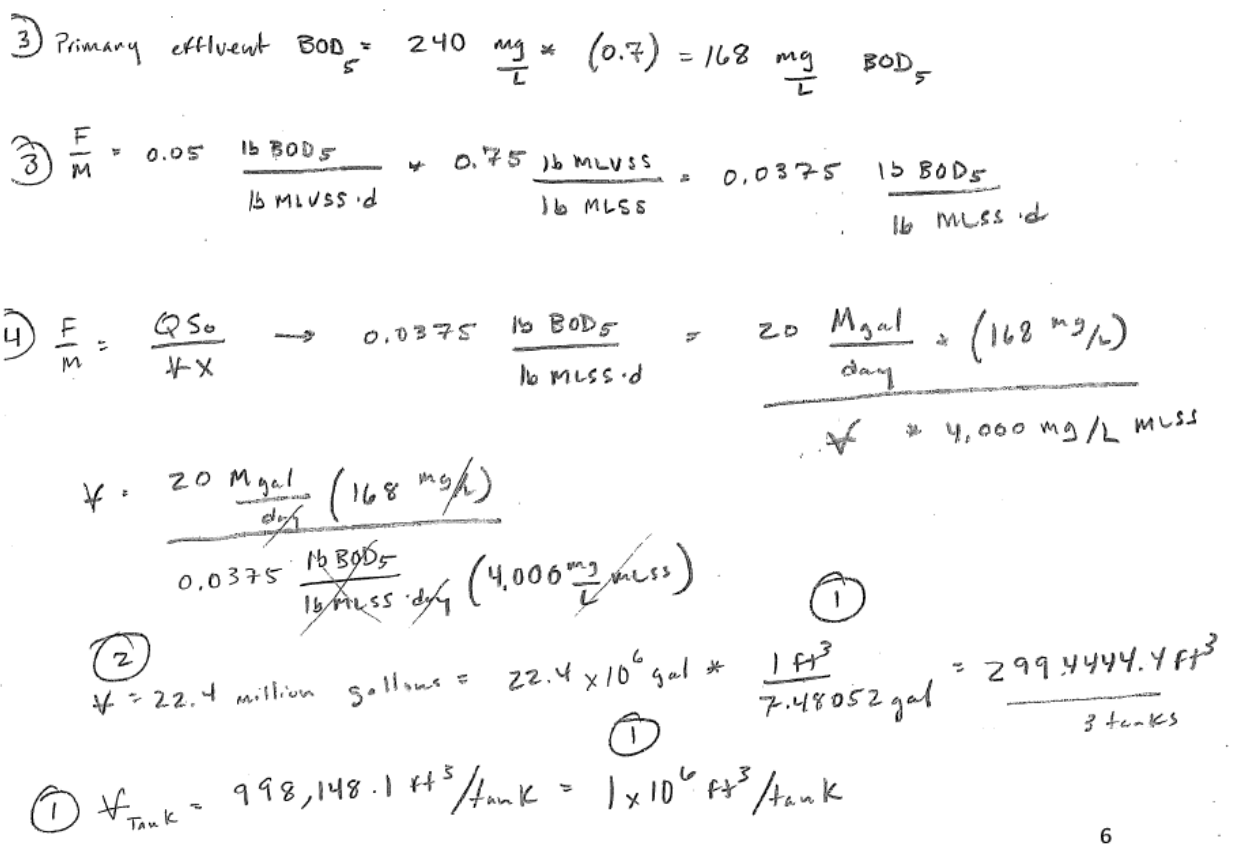
8. A 20 MGD wastewater treatment plant has an influent BOD_5 concentration of 240 mg/L and an influent TSS concentration of 220 mg/L. Assume 65% TSS and 30% of BOD_5 are removed by primary clarification. Assume Extended aeration activated sludge will be used and that the primary effluent will be split equally into three aeration basins of the same size.

Common values from the 10 State Standards for F/M ratio and MLSS are shown in the table provided. Yes, you will have to pick values. Assume the volatile fraction (i.e., MLVSS) of MLSS is 75%. Be careful with units.

PERMISSIBLE AERATION TANK CAPACITIES AND LOADINGS

Process	*Aeration Tank Organic Loading lb BOD_5/d/1000 ft^3 [kg BOD_5/ (m^3·d)]**	F/M Ratio lb BOD_5/d/lb MLVSS [kg BOD_5/(kg MLVSS·d)]**	MLSS*** mg/L
Conventional Step Aeration Complete Mix	40 (0.64)	0.2-0.5	1,000-3,000
Contact Stabilization	50****(0.80)	0.2-0.6	1,000-3,000
Extended Aeration Single Stage Nitrification	15 (0.24)	0.05-0.1	3,000-5,000

e. Determine the primary effluent BOD_5 (3 points).
f. Select an appropriate F/M and convert to units of lb BOD_5/lb MLSS·d from lb BOD_5/lb MLVSS·d (3 points).
g. Use the equation we derived in class for F/M and solve for total volume. You will need to select an appropriate MLSS from the table provided (6 points).
h. Calculate the volume in ft^3 for <u>each of the three</u> aeration basin rounded to the nearest 10,000 cubic ft (3 points).



Average Score: 13.1/15 (87.5%)

Continuous improvement:

ET203: Outcome d

In response to last year's comments, I changed a couple of the problems that were evaluated for ABET on the exam. These questions focused more on meeting the outcomes. To improve the assignment for next year, I should state in the individual problem heading that the problem will be assessed for ABET. In addition, I should convert one of the labs, probably the wastewater treatment lab, to an ABET assignment. This assignment requires the students to complete basic wastewater measurements and then relate the results to actual treatment application.

ABET Outcome Assessment Fall 2017

Course: ET 203 Introduction to Water and Wastewater

Outcomes assessed: d and g

Outcome g states that a student demonstrate: An ability to apply written, oral, and graphical communication in both technical and non-technical environments; and an ability to identify and use appropriate technical literature;

This was met with the following assignment.

ET 203 – Introduction to Water and Wastewater Final Project

Objective

As an environmental engineer, you will work on projects assessing, mitigating, or remediating many different anthropogenic compounds that have been introduced into the environment, especially those that have the potential to harm animals, humans, or processes that are beneficial to humans (e.g., crop growth). While we will continue to discuss various examples of chemicals and how they relate to environmental engineering in class, we cannot cover them all in the allotted time. Thus, to improve your familiarity with common chemicals environmental engineers deal with, each of you will complete a technical research paper and video regarding the chemical characteristics, toxicity, and treatment options of one of these chemicals. Everyone's research report and video will be posted on D2L for reference. Furthermore, this assignment will address the ABET program Outcomes (g): An ability to apply written, oral, and graphical communication in both technical and non-technical environments; and an ability to identify and use appropriate technical literature.

Project Components

There are two components to this research project: a paper and a video. You will be asked to complete tasks similar to this project when you are an engineer working for a company. As an engineer your supervisor may ask you to put together a short report regarding a chemical, technology, or process in a short period of time. Typically, the purpose of this type of report is to aid the supervisor in deciding whether to pursue a particular project or to obtain information to present to the public, client, or another organization. Most of the time, basic research is not covered by the budget of the project and you would be doing work similar to this on your own. If you are provided time for basic research tasks, it will likely be minimal. In addition, social skills and the ability to communicate effectively with others is needed in the engineering field. The inability to write and communicate orally is the number one problem I hear from engineers in industry. In fact, I have heard complaints about student's abilities for the past 10-15 years, as I progressed through academia and industry. Thus, the more opportunities you have to practice written and oral communication, the better chance you will have to improve. As you progress with the next generation of engineers, you will be required to not only communicate well, but communicate using new forms of technology, including video.

Part I – Paper – Chemical name due 9/19/17, Paper due 10/24/17

The first component is to write a 3 page (maximum) technical research paper covering the chemical of your choice. Example chemicals are provided below. *You are required to provide me the name of the chemical you will research by September 19, 2017*. Only one student per chemical, so you are encouraged to provide me the chemical name as soon as you can. If you would like to request a chemical that is not on the list, please contact me in advance of the deadline. *The main audience of the paper will be environmental engineers working in the industry.*

Example Chemicals

1. Polychlorinated Biphenyls
2. Chlorofluorocarbons
3. Dioxins
4. Trichloroethylene and Perchloroethylene
5. Polybrominated Diethyl Ethers
6. Pharmaceutically Active Compounds
7. Mycotoxins
8. Mercury
9. Pesticides and Herbicides – DDT, lindane and heptachlor
10. Carbon Tetrachloride
11. Pentachlorophenol
12. Chromium
13. Benzene
14. Perchlorate
15. Ozone
16. Green House Gases
17. *Giardia lamblia*
18. *Cryptosporidium parvum*
19. *Stachybotrys chartarum*

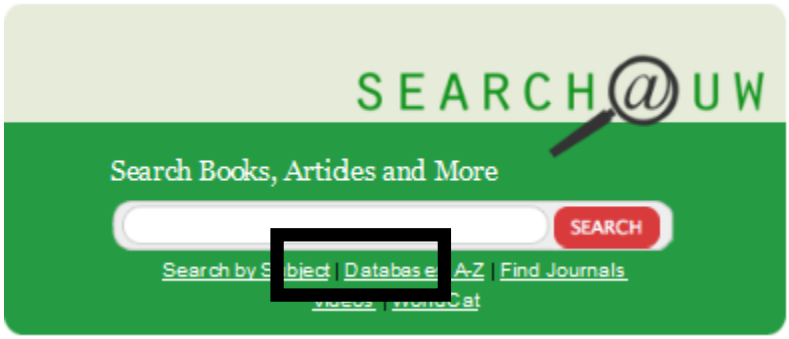
Your paper should have a brief introduction to state what chemical you researched and what will be presented in the paper. You should also include a brief conclusion, which highlights the major concepts of your paper. Within the body of the paper you should, at a minimum, succinctly address the following. NOTE: The list provides the MINIMAL requirements and is not in any particular order. Your paper should provide this information in an organized, fluid manner.

- Chemical properties (physical/chemical/biological) with a focus on the parameters discussed in class (e.g., equilibrium constants and partition coefficients) and what they mean as far as where the chemical will end up (i.e., its fate), how the chemical will move around (i.e., its transport), and how the chemical can be treated. *Lesson 04.*
- Health concerns. Be sure to comment on cancerous and non-cancerous risk. *Lesson 08.*
- Sources of contamination.
- Fate of the contaminant in the environment (connect this to the properties and sources of the chemical).
- Routes of exposure. *Lesson 08.*
- Major incidents of exposure (i.e., provide examples when your chemical ended up in the environment and resulted in negative impacts, such as spills)
- Treatment processes or remediation techniques (i.e, tie this into the chemical properties). Also comment on the efficacy of these treatment techniques, as well as, their advantages and disadvantages, including costs.
- Regulations and legislation
- Economic, social, and ethical implications of use; replacement or banning of the contaminant

You do not have a lot space to present a lot of information. Thus, you will have to be clear and concise. You may also find it helpful to provide a figure or table that condenses some of the information you are presenting. You must include at least one figure or table in the paper. However, all figures or tables included need to be either created by you (and are original) or are reproductions of figures or tables from other sources (i.e., you cannot just copy one from one of your sources). *** THUS, I do not want to see any low quality figures. If the figure is low quality, reproduce it (cite your source) in a program like PowerPoint, Illustrator, etc. Be sure to cite any figures or tables you reproduce.

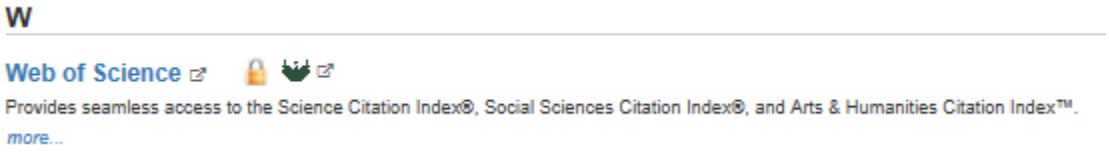
To complete the research, you can use online sources. However, use your engineering judgement to verify that the source is legitimate. Wikipedia can get you on the right track, but you should find a more legitimate source for your information. In addition, you must include three peer-reviewed journal articles as sources and have at least 10 primary sources. Use Web of Science to search for peer-reviewed journal articles regarding your chemical:

1. Go to the Cofrin Library website: http://www.uwgb.edu/library/
2. Click on 'Databases A-Z' under the search bar



3. Click on 'W'.

4. Click on 'Web of Science'



5. Search for papers regarding your chemical in the search bar. Note that you may have to try a few key words to narrow and locate the appropriate papers.

Make sure you provide all of your references.

Your paper will be graded using the following rubric. Scores provided to the nearest 0.5 point.

Paper	Weight	Excellent (5.0)	(4.0)	Good (3.0)	(2.0)	Needs Improvement (1.0)	Points (Weight x Score)
Content	3	The paper includes all of the required information. It is clear that the author has in depth knowledge of the topic.		The paper includes most of the required information, but information is noticeably missing. It is clear that the author has limited knowledge of the topic.		The paper misses most of the required information and is incomplete. It is clear that the author has little or no knowledge of the topic.	15
Organization /Structure	2	All information is presented in a logical sequence and is clear and easy to follow. Paragraphs have one topic sentence and contain only one main idea. Paragraphs are also clearly linked to each other. Language is clear and precise; Sentences are consistently strong, varied structure.		Most information is presented in logical order, which the audience can follow. However, structure of paragraphs is not easy to follow and paragraph transitions are needed. Language lacks clarity and includes non-technical terms.		The organization and structure of the paper detract from the message of the author. Paragraphs are disjointed and lack transition of thought. Language uses mostly non-technical terms.	10
Grammar, Punctuation, & Spelling	2	The paper follows the rules of grammar and the conventions of engineering writing are followed. Correct word usage, punctuation, and spelling are used.		The paper contains few grammatical, punctuation, and spelling errors and mostly follows the conventions of engineering writing. The errors, however, are not too distracting and do not obscure the meaning of the sentence.		The paper contains numerous grammatical, punctuation, and spelling errors and does not follow the conventions of engineering writing. The errors are distracting and it is apparent that little to no editing occurred.	10
Appropriateness to Audience	3	The paper assists in teaching the information to environmental engineers or provides a succinct review of the information.		The paper is too informal in its explanations and does not use technical detail or terms common to environmental engineers in the industry.		The paper was not appropriate for the audience and.	15
Length	1	The paper is 2-3 pages.		The paper is 1-2 or 3-4 pages.		The paper is less than 1 or greater than 4 pages.	5
Graphic	2	At least one figure or table present. All figures and tables are either created by the author or are reproductions created by the author.		At least one figure or table included in the paper. However, figures and tables are copied directly from another source and not created or reproduced by the author.		No figures or tables provided.	10
References	3	At least 3 peer-reviewed sources and 10 primary sources included in correct format, including the sources for figures and tables. The reader can be confident that information and ideas can be trusted.		Some peer-reviewed and primary sources, but less than the number required. Accuracy of some sources may not be verifiable, but are generally regarded as legitimate.		No peer-reviewed or primary sources provided. Virtually no professionally reliable sources.	15
						Total =	80

Conventions of Engineering Writing

1. Use past tense.
2. Check out a writing guide for the proper use of semi-colons, colons, and commas. : = list, ; = for a separate, but related sentence.
3. i.e., = in other words; e.g., = for example.
4. Use third person and avoid pronouns (e.g., they, this that, those them, he, she, it, I, our, me, we, etc.). Replace pronouns with specific noun. If the sentences sound redundant, restructure the sentences and paragraphs, including combining multiple sentences, to remove as much redundancy as possible.
5. Avoid using contractions (e.g., can't, don't, won't, couldn't, etc.).
6. Do not use possessive (e.g., do not write 'the presentation's main point was…' write 'the main point of the presentation was…').
7. Avoid clichés.
8. Always define acronyms and terms that might be unfamiliar to the audience. Also define the acronym before using it (e.g., The University of Wisconsin – Green Bay (UWGB) has over 6,000 students.).
9. Be consistent in your capitalization.
10. Be consistent in using the same term to refer to the same topic.
11. Use the word 'stated' in place of 'said', 'talked', 'questioned', 'emphasized', etc. or rewrite the sentence so 'stated' can be used.
12. Replace 'in order to' with just 'to.'
13. Avoid ending a sentence with a preposition (e.g., on, is, for, etc.).
14. Do not start a sentence with But, Or, or And.
15. Place a comma before the word 'and' ONLY if the words following 'and' can form a separate, complete sentence. A comma should always precede the word 'but.'
16. 11 or 12 pt font; Times New Roman, Arial, or Calibri.
17. Avoid spelling errors by using spell-check.
18. Write in complete sentences and avoid run-on sentences.

Part II – Video – Due 11/30/17

The second component of the research project is to put together a five-minute video summarizing your research paper to the *general adult public that has little background regarding the topic*. Your video should include, at a minimum, the following five components.

1. Introduce your chemical and show why it is important.
2. Provide a summary of its chemical characteristics.
3. Based on the chemical characteristics show where this chemical usually ends up (i.e., its fate) in the environment and where the chemical goes (i.e., its transport).
4. Provide at least one example for how this chemical can be mitigated or remediated. Be sure to briefly describe how the technique works.
5. Provide one major example where this chemical entered the environment and how it was dealt with to minimize/avoid negative impacts.

You should also provide the sources for the information used in the video, as well as the sources, for images, videos, and other graphics at the end of the video. To help the flow of the video, appropriate titles and transitions will be helpful.

Making the Video:

You are encouraged to be as creative as you want for the video. However, your main goal will be to effectively communicate the information to your audience. Thus, I should be able to show this video to any random adult and they should understand what you are talking about. Thus, you will need to define your terms and avoid talking only in technical jargon. You will also want to keep your audience engaged for the five minutes.

The Cofrin Library has equipment that students can check out, including camcorders, tripods, microphones, projectors, GoPro Cameras, etc. (http://libguides.uwgb.edu/equipment). There are limited numbers of some of the equipment and there are many students that use the equipment, so plan when your needs in advance. There are also a lot of tools available to you, including a recording space and green screens at Academic Technology Services. As far as video editing, Windows MovieMaker is installed in the General Access Computer (GAC) lab. If you would like to work from home, you can remote into the GAC lab computers (https://uknowit.uwgb.edu/page.php?id=24065). For those of you that are Mac people, iMovie is installed on all campus Macs. Adobe Premiere is also available on campus computers, but without training, can be difficult to learn. If you have experience with Premiere or would like to use this assignment as an opportunity to learn it, there are free courses available on Lynda.com (https://www.uwgb.edu/human-resources/learning-development/lynda/). There are also Lynda.com courses for the other software as well.

A few example videos from Conservation Biology taught by Amy Wolf are provided at the links below. Note the topics and requirements of the videos are very different from the requirements in this class. However, the videos provide good examples regarding quality. Also, note that these are only examples. Your video can be completely different as far as how you present the information.

https://youtu.be/dDH7md5Cg-A
https://www.youtube.com/watch?v=Mvytfc60XYM
https://www.youtube.com/watch?v=R-25JrPJh4Q&t=11s
https://www.youtube.com/watch?v=h5guSJm0-9s
https://www.youtube.com/watch?v=1u51Iu2uGCE&feature=youtu.be

Notes on Video Production

Basics of editing

- "The best editing is barely noticed."
- Decide whether you will edit live or in post production.
- Post-Production editing is usually done from an outline (get at least 4x as much footage as you think you need)

Pitfalls to avoid

- "Firehozing" - Using the viewfinder as your eye
- "Jogging" - obbly camera ("shakiness")
- Backlighting / Washing Out - Subject is silhouetted against overly bright background. The opposite happens too: too much light can create a washed out subject and overly dark background area OR wash out your entire shot.
- Lack of "Nose Room" - Subject looks off the side of the shot or doesn't turn through the shot to get from starting position to looking at camera.
- Too much "Head Room" - Too much area in the shot above the subject—attention of viewer drawn away.

Techniques to use

- Rule of thirds
- Smooth camera movements
- Film under good environmental conditions (overcast, sun with usable shade; especially avoid wind and rain)
- Keep notes of your interview's topics to later film B-Roll
- If possible, shoot interviews in two or more parts from different angles or with two different cameras to use for visual interest in editing.

Other considerations

- Limitations and abilities of your device (avoid using cell phones if at all possible—motion is compounded and audio is often poor) → If you use a device to capture video, other than a GoPro or camcorder, use a microphone or be diligent about the sound quality.
- What is the environment like for: your camera, subject, you, video/audio quality?
- Is your subject stationary?
- Do you need additional lighting? A tripod? → If you use a device to capture video, other than a GoPro, use a tripod.
- What B-Roll will you need?
- How will time affect footage gathering? (Sun movement, continuity, subject availability, access to locations) Rule of thumb: Get it while you can.

Sound

- Most important element of sound is leveling (not having loud and quiet clips put together)
- Next most important: quality (It's easier to forgive OK quality when it's well leveled. It's hard to forgive poorly leveled audio no matter how good the quality.)
- Consider collecting sound and video at the same time but from different devices. Use waveforms of good quality audio and lesser camera mic audio to sync separately recorded audio and video (ability to do this will depend on the editor you use).
- Mics should be as near to the speaker's mouth as possible but out of frame (red indicators should blink from time to time but should not stay on; audio clipping).
- Lavalier microphones are best if available

- Camera mic quality – mic adapters coming soon
- Regardless of microphone quality: avoid wind

Photo, Video, and Audio Sources

There's a lot of fine print out there. Be sure to double-check all content for copyrights, licensing information, or attribution requirements. Written permission is always best and sometimes required. Copyright applies to audio, video, images, written text, and even fonts.

- https://search.creativecommons.org/ is a good launching point when searching for music, images, and other content. Many of the results are free to use with attribution (must put the title and artist in your credits).
- It is possible to track down the owner of content from YouTube and email them. If doing so, be sure that they are willing to provide you with the original content (video or audio file) as you cannot capture/download content direct from YouTube.
- Photos of places: http://www.panoramio.com/ (Some photographers list their images as free. Site makes it easy to contact them otherwise to obtain permission)
- https://pixabay.com CC image search and download site (links to other sites like Shutterstock as well)
- https://www.flickr.com/ has many free-to use images. It's still best to verify rights of use and get written permission
- https://commons.wikimedia.org/ hosts generally free-to-use open content
- https://archive.org/ is a valuable tool but requires some digging to verify rights to use content
- https://images.google.com/ allows you to search for images "labeled for reuse"

Sharing the Video:

To share the video, you will upload your video to Kaltura using the steps at the following link (https://uknowit.uwgb.edu/page.php?id=63804). You will then embed your video into the Embed Final Project Video discussion in the Final Project Folder on D2L using the steps at the following link (https://uknowit.uwgb.edu/page.php?id=70855).

Your video will be graded using the following rubric. Scores provided to the nearest 0.5 point.

Video	Weight	Excellent (5.0)	(4.0)	Good (3.0)	(2.0)	Needs Improvement (1.0)	Points (Weight x Score)
Content	3	The video touches upon all of the required components. It is clear that the maker of the video has an in depth knowledge of the topic.		The video touches on most of the required components, but information is noticeably missing. It is clear that the maker of the video has limited knowledge of the topic.		The video misses most of the required material and is incomplete. It is clear that the maker of the video has little or no knowledge of the topic.	15
Organization	2	All information is presented in a logical, interesting, and novel sequence, which is easily followed.		Most information is presented in logical order, which the audience can follow.		Difficult to follow presentation due to erratic topical shifts and jumps.	10
Audio Content /Clarity/Style	2	The audience is able to easily understand the text/audio of the video.		The audience is able to understand most of the text/audio of the video easily.		The audience has difficulty hearing and/or understanding the text/audio of the video.	10
Graphics (photos/videos/figures), mechanics, and Transitions	3	Video is exceptionally well put together, props and/or effects are used appropriately, music and/or sound effects are applied.		Video is well put together, props and/or effects are used appropriately, music and/or sound effects are applied		The video appears haphazard and low quality.	15
Appropriateness to Audience	3	The video either assists in teaching a concept to beginners or helps a person that just learned the content to remember it.		The video is either vague in its explanations or provides too much technical detail or jargon that the audience has difficulty understanding.		The video was not appropriate for the audience and was either way below or way over the heads of the audience.	15
Creativity	1	The video is interesting and there is thorough evidence of imagination, creativity, or thoughtfulness. It is clear that significant time and effort were dedicated to making the video unique.		The video is interesting and there is some evidence of imagination, creativity, or thoughtfulness, but may not support the subject matter. It is clear that some time and effort were dedicated to making the video unique.		The video is uninteresting, lacking in imagination, creativity, or thoughtfulness, and it appears that little time was taken in its production.	5
Duration is 5 minutes or less	1	The video is 3-5 minutes in length (and there is no obvious "filler")		The video is between 2-3 minutes and 5-6 minutes in length.		The video is less than 2 or greater than 6 minutes in length.	5
References	3	At least 3 peer-reviewed and 10 primary sources included in correct format. Acknowledges images, video, and experts.		Some peer-reviewed and primary sources, but less than the number required. Acknowledges some sources of information.		No peer-reviewed or primary sources provided. Acknowledges some, but not all sources of information.	15
						Total =	90

Assessment was performed using the rubrics below. The average score for 3 students for the paper and the video are provided for each category							
Paper	**Weight**	**Excellent (5.0)**	**(4.0)**	**Good (3.0)**	**(2.0)**	**Needs Improvement (1.0)**	**Points (Weight x Score)**
Content	3	The paper includes all of the required information. It is clear that the author has in depth knowledge of the topic.		The paper includes most of the required information, but information is noticeably missing. It is clear that the author has limited knowledge of the topic.		The paper misses most of the required information and is incomplete. It is clear that the author has little or no knowledge of the topic.	15
Organization /Structure	2	All information is presented in a logical sequence and is clear and easy to follow. Paragraphs have one topic sentence and contain only one main idea. Paragraphs are also clearly linked to each other. Language is clear and precise; Sentences are consistently strong, varied structure.		Most information is presented in logical order, which the audience can follow. However, structure of paragraphs is not easy to follow and paragraph transitions are needed. Language lacks clarity and includes non-technical terms.		The organization and structure of the paper detract from the message of the author. Paragraphs are disjointed and lack transition of thought. Language uses mostly non-technical terms.	6
Grammar, Punctuation, & Spelling	2	The paper follows the rules of grammar and the conventions of engineering writing are followed. Correct word usage, punctuation, and spelling are used.		The paper contains few grammatical, punctuation, and spelling errors and mostly follows the conventions of engineering writing. The errors, however, are not too distracting and do not obscure the meaning of the sentence.		The paper contains numerous grammatical, punctuation, and spelling errors and does not follow the conventions of engineering writing. The errors are distracting and it is apparent that little to no editing occurred.	4
Appropriateness to Audience	3	The paper assists in teaching the information to environmental engineers or provides a succinct review of the information.		The paper is too informal in its explanations and does not use technical detail or terms common to environmental engineers in the industry.		The paper was not appropriate for the audience and.	15
Length	1	The paper is 2-3 pages.		The paper is 1-2 or 3-4 pages.		The paper is less than 1 or greater than 4 pages.	5

Graphic	2	At least one figure or table present. All figures and tables are either created by the author or are reproductions created by the author.		At least one figure or table included in the paper. However, figures and tables are copied directly from another source and not created or reproduced by the author.		No figures or tables provided.	9.3
References	3	At least 3 peer-reviewed sources and 10 primary sources included in correct format, including the sources for figures and tables. The reader can be confident that information and ideas can be trusted.		Some peer-reviewed and primary sources, but less than the number required. Accuracy of some sources may not be verifiable, but are generally regarded as legitimate.		No peer-reviewed or primary sources provided. Virtually no professionally reliable sources.	15
						Total =	69.3

Video	**Weight**	**Excellent (5.0)**	**(4.0)**	**Good (3.0)**	**(2.0)**	**Needs Improvement (1.0)**	**Points (Weight x Score)**
Content	3	The video touches upon all of the required components. It is clear that the maker of the video has an in depth knowledge of the topic.		The video touches on most of the required components, but information is noticeably missing. It is clear that the maker of the video has limited knowledge of the topic.		The video misses most of the required material and is incomplete. It is clear that the maker of the video has little or no knowledge of the topic.	15
Organization	2	All information is presented in a logical, interesting, and novel sequence, which is easily followed.		Most information is presented in logical order, which the audience can follow.		Difficult to follow presentation due to erratic topical shifts and jumps.	10
Audio Content /Clarity/Style	2	The audience is able to easily understand the text/audio of the video.		The audience is able to understand most of the text/audio of the video easily.		The audience has difficulty hearing and/or understanding the text/audio of the video.	6
Graphics (photos/videos/figures), mechanics, and Transitions	3	Video is exceptionally well put together, props and/or effects are used appropriately, music and/or sound effects are applied.		Video is well put together, props and/or effects are used appropriately, music and/or sound effects are applied		The video appears haphazard and low quality.	15
Appropriateness to Audience	3	The video either assists in teaching a concept to beginners or helps a person that just learned		The video is either vague in its explanations or provides too much technical detail or jargon that the audience		The video was not appropriate for the audience and was either way below or	15

		the content to remember it.		has difficulty understanding.		way over the heads of the audience.	
Creativity	1	The video is interesting and there is thorough evidence of imagination, creativity, or thoughtfulness. It is clear that significant time and effort were dedicated to making the video unique.		The video is interesting and there is some evidence of imagination, creativity, or thoughtfulness, but may not support the subject matter. It is clear that some time and effort were dedicated to making the video unique.		The video is uninteresting, lacking in imagination, creativity, or thoughtfulness, and it appears that little time was taken in its production.	5
Duration is 5 minutes or less	1	The video is 3-5 minutes in length (and there is no obvious "filler")		The video is between 2-3 minutes and 5-6 minutes in length.		The video is less than 2 or greater than 6 minutes in length.	5
References	3	At least 3 peer-reviewed and 10 primary sources included in correct format. Acknowledges images, video, and experts.		Some peer-reviewed and primary sources, but less than the number required. Acknowledges some sources of information.		No peer-reviewed or primary sources provided. Acknowledges some, but not all sources of information.	15
						Total =	86.7

Continuous improvement: ET203: Outcome g

The assignment was greatly improved over last year. First, I handed it out earlier in the semester, so the students had more time to pull it together. I also had the students turn in their paper after the midterm. This year, I also had the students complete a 5 minute video instead of a short presentation. This allowed the students to become familiar with a new technology and still work on their communication skills. The video also made it so no additional time was required to be set aside for presentations. The videos turned out remarkably. To improve the papers, I recommend making them due earlier and provide time to get feedback that must be incorporated into a final draft. However, this might be beyond the scope of the class. I think it is also still a good idea to demonstrate how we search for papers using the UWGB Library's website right during class. Again, although I spelled it out in the handout, I still had a lot of confusion.

Course: ET 330 Hydrology- Fall 2017

Outcomes assessed: b, e, j, WE

ET 330, Hydrology, was the course in which ABET learning outcomes b, e, and j were assessed.

> Outcome b states that a student will demonstrate: An ability to select and apply a knowledge of mathematics, science, engineering, and technology to engineering technology problems that require the application of principles and applied procedures or methodologies).

This was met with the following end of term project:

Hydrology Final Project

A municipality has hired you to perform a hydrologic analysis on a site that is slated for development. Because the site is prone to flash flooding, your analysis will be for the 100 year storm of duration 3 hours. However, the developer also wishes to know how much rainfall excess will be produced in a 9 hour storm with precipitation depth of 16 inches.

The following information is available to you:

Watershed size = 1500 acres
Soil type = C
Land slope = 0.5% (0.005 ft/ft)
Travel length = 6313.5 feet
Past precipitation depth data on 2 hour storms: (12 data points)

5.5 inches	7. 5 inches
6.3 inches	8. 6.8 inches
6.4 inches	9. 5.8 inches
5.6 inches	10. 4.2 inches
7 inches	11. 6.5 inches
6.3 inches	12. 8.1 inches

Land use:
20% ¼ acre residential in good condition
20% ½ acre residential in good condition
40% commercial and townhouses
10% woods with good cover
10% meadow

Your firm must provide the following calculations for the client:

Determine via statistics the depth of precipitation associated with the 100 year flood of duration 2 hours.

Use the NRCS-CN method to estimate rainfall excess (in inches).

Use P and R from the above calculations to estimate the rational coefficient, C.

Use the NRCS-CN method/equations for both peak flow (cfs) and time of concentration (hours) to estimate the hydrograph for the 100 year storm of 2 hour duration. (Assuming your calculations are correct, your time of concentration should be an integer value. If you get something close to an integer, round it to the nearest integer, ie; 1.97 = 2.04 = 2)

Use this hydrograph to estimate the hydrograph for a 9 hour storm that produced 16 inches of precipitation. (Remember that you can only lag a unit hydrograph!)
Help: The hydrograph from part 4 is a triangle. Hence, you can find the flow rate (cfs) at each hour increment from just the peak flow because both the rising (time = 1 to peak) and recession (time = peak to end of hydrograph) limbs are linear.

In addition to showing all calculations, you must provide a 1 page, double spaced summary of your results that includes a recommendation of whether or not development should occur at this site.
Each individual is allowed 3 free questions to the overall project coordinator (me). Afterwards, questions may be asked, but will cost 3 points each. You may consult with NO one, except your partner or the project coordinator.

Assessment was performed using the rubric below. In each category the percentage and (number) of students achieving each criteria is reported.

n= 30 students	Unsatisfactory	Developing	Satisfactory	Exemplary
Write correct water mass balance from written problem description	Fails to write water mass balance	Identifies at least 70% of mass balance terms from written problem statement	Identifies all but one mass balance term from written problem description 33.3%, (10)	Identifies all mass balance terms relevant to written problem description 66.7%, (20)
Apply appropriate mathematical models to estimate each term in mass balance	Fails to identify appropriate models for mass balance terms	Applies correct models for at least 70% of mass balance terms 6.7% (2)	Makes only one error in determining values of mass balance terms 33.3%, (10)	Applies appropriate math models for each term to correctly determine its numerical value 60%, (18)
Apply statistics to determine design storm	Fails to apply statistics	Applies some statistics, but fails to consider all factors	Applies statistics correctly, but makes math error 33.3%, (10)	Applies correct statistical models to determine design storm depth 66.7%, (20)

Convert each term in mass balance to volume of water	Fails to convert mass balance terms to volumes	Correctly converts at least 65% of mass balance terms to volumes	Makes only one error in converting mass balance terms to volumes 33.3%, (10)	Applies correct methodology to convert mass balance term to volumes 66.7%, (20)
Determine correct storm storage volume/depth	Fails to use mass balance or design storm to determine correct volume/depth	Makes more than one error in determining storage volume/depth 3.3%, (1)	Makes only one error in determining storage volume/depth 30%, (9)	Correctly determines storage volume/depth 66.7%, (20)
Convert given hydrograph into design storm hydrograph	Fails to model design storm hydrograph 3.3% (1)	Makes more than one error in modeling design storm hydrograph 20%, (6)	Makes only one error in modeling design storm hydrograph 30%, (9)	Correctly models design storm hydrograph 46.7%, (14)

Continuous improvement:

ET 330: Outcome b

No significant changes will need to be made. Next fall (2017) This semester the students completed the project individually. Students struggled the most with producing the design storm hydrograph. While there is an in-class example and homework problem associated with this skill, it is not included on the second exam as it takes too long to completely convert one storm hydrograph into another one for a different storm duration and precipitation depth. Additional practice may be required.

Outcome e states that a student will demonstrate An ability to function effectively as a member or leader on a technical team.

This was met with the following assignment:

1. Stream flow measurement (group of 3-4 people)

Using criteria discussed in class, form a group of 3-4 students and measure stream flow in the arboretum. The following materials will be needed. Each group will turn in one estimate of stream flow with calculations and each group member will evaluate all other group members' participation according to the rubric below.

Materials needed:
Measuring tape
Ruler
Orange or other similar sized floating object
Stop watch
Two group member with wading boots or shoes that can get wet
Pencil and paper

Assessment was performed using the rubric below. In each category the percentage and (number) of students achieving each criteria is reported.

n = 21 students	Unsatisfactory	Developing	Satisfactory	Exemplary
Brings assigned tools and shares in team work	Brings no tools and does not perform assigned duties	Brings some tools and/or reluctantly performs some duties 15.4%, (4)	Brings necessary tools and performs assigned duties 61.5%, (16)	Brings necessary tools, performs assigned duties, and assists others willingly 21.3%, (6)
Listens to other team members	Never allows anyone else to speak	Usually does most of the talking	Listens most of the time and responds professionally 73.1%, (19)	Listens and appropriately and professionally responds 26.9%, (7)
Contributes to final calculation using collected data	Does not contribute to final calculation	Contributes minimally to calculation 30.8%, (8)	Contributes to entire calculation 42.3%, (11)	Contributes and explains concepts to group members as needed 26.9%, (7)
Has a positive attitude toward team members	Demonstrates a poor attitude toward the work and does not respect group members	Is a reluctant team member 11.5%, (3)	Is a willing participant and is respectful of group members 38.5%, (10)	Demonstrates a positive attitude and is respectful towards group members 50%, (13)

Continuous improvement:

ET 330: Outcome e

In Fall 2015. The students evaluated each other. In fall (2016), I observed and evaluated each group, which gave scores that were far more realistic. It is still a challenge to get a real assessment, however, because the students knew I was observing them and some, therefore, were probably more engaged than they would have been otherwise. This fall, I observed the groups again and they performed well, but this was a class with an overall positive attitude. Additionally, I had them work on the calculations in the classroom in their small groups because spectators in the calculation phase has been a weak point.

Outcome j states that the student will have A knowledge of the impact of engineering technology solutions in a societal and global context

This was met with the following assignment:
The attached article describes a dam on the Nile River that Ethiopia is building. You are to write a 8-10 page (double spaced with font size 11 or 12) paper that

- Describes the project and its purpose
- Investigates and discusses thoroughly what entities (peoples, the environment, etc) will benefit from the dam and how (socially, economically, politically, environmentally) they will benefit
- Investigates and discusses thoroughly what entities (peoples, the environment) will suffer negatively from the dam and how (socially, economically, politically, environmentally) they will suffer
- Describes realistic potential outcomes between affected parties
- Makes a realistic assessment and discuss any potential global precedents.

Consider not just the immediate affected parties, but the impact on a global scale. Does this dam project set any precedents for future development?

The paper will be graded on two criteria:

- How well is the above assessment criteria is met?
- How well is the paper written in terms of grammar and organization?

Assessment for the first criteria, j, was performed using the rubric below. In each category the percentage and (number) of students achieving each criteria is reported.

n = 29 students	Unsatisfactory	Developing	Satisfactory	Exemplary
Describes the project and its purpose	Fails to define problem or describe its purpose 3.4% (1)	Gives little information about project and purpose	Adequately describes project and purpose from one perspective 27.6%, (8)	Thoroughly describes project and purpose from more than one perspective 69%, (20)
Investigates and discusses what entities will benefit and how	Fails to describe what entities will benefit or how they will benefit 3.4% (1)	Identifies one benefit and which entity benefits 10.4% (3)	Identifies/discusses two to three benefits; local recipient entities; and the nature of the benefits 51.7%, (15)	Thoroughly assesses multiple benefits and recipients and the nature of the benefit both locally and globally 34.5%, (10)

Investigates and discusses what entities will suffer and how	Fails to describe what entities will suffer or how they will suffer 3.4% (1)	Identifies one negative outcome and the recipient entity 10.4% (3)	Identifies/discusses two to three negative outcomes, local recipient entities; and the nature of the negative outcome 55.2%, (16)	Thoroughly assess multiple negative outcomes and recipients and the nature of the outcome locally and globally 31%, (9)
Describes realistic potential outcomes between affected parties	Fails to describe relationships or outcomes between affected groups 3.4%, (1)	Hypothesizes some outcomes, but fails to consider if they are realistic 17.2%, (5)	Identifies at least one potential realistic outcome in the context of relationships between entities 41.4%, (12)	Thoroughly discusses from more than one perspective realistic outcomes in the context of relationships between affected groups 34.5%, (10)
Assess and discuss global precedents	Makes no assessment 34.5%, (10)	Makes some assessment but fails to consider global precedents 20.7%, (6)	Assesses based on one perspective and considers global precedents from this perspective 17.2%, (5)	Gives thorough assessment based on multiple perspectives and discusses global precedents from multiple perspectives 27.6%, (8)

Assessment for the second criteria, writing emphasis, was performed using the rubric below. In each category the percentage and (number) of students achieving each criteria is reported.

n = 29 students	Unsatisfactory	Developing	Satisfactory	Exemplary
Topic is thoroughly researched and properly cited	Topic is not researched much beyond given information	One or two appropriate references are used and cited	Three or four appropriate references are used and cited 24.1%, (7)	Topic is thoroughly researched from multiple (5 or more) sources and is well cited 75.9%, (22)
Paper is well organized	Paper is not organized at all	Paper has some organization, but inconsistent 24.1%, (7)	Paper is organized according to the questions asked, but not well organized overall 20.7%, (6)	Paper is organized according to topics and overall into an easy to follow flow of information 55.2%, (16)

Correct grammar and spelling are used throughout	Grammar and spelling are poor – many errors per page 17.3%, (5)	Grammar and spelling are marginally acceptable – 2 to 3 errors per page 34.5%, (10)	Grammar and spelling are good – no more than one error per page 44.8%, (13)	Grammar and spelling are near perfect – no more than 3 errors in entire paper 3.4%, (1)
Tables and figures illustrate concepts	No tables or figures are provided 34.5%, (10)	One figure or table is given – a map of area 3.4%, (1)	Tables and figures illustrate some concepts 34.5%, (10)	Tables and figures completely support the text 27.6%, (8)

Continuous improvement:

ET 330: outcome j

Students did not perform as well as they did in Fall 2016. Very few (2) took advantage of the opportunity to turn in their papers early for me to proof read them. It was obvious that many papers were written at the last minute, so I will really need to encourage students to start on their papers early in the semester. Next fall, I will require a rough outline several weeks into the semester.

ET 330: Writing emphasis

While papers were well researched and organized, grammar and spelling remain an issue for some students. I allowed students to turn in their papers early for me to provide feedback before the final version was submitted, but next fall I will make this mandatory or I will require an outline of the paper several weeks before the due date. If I have them turn in a first draft, I will grade based on the average of the draft and revised copy so as not to encourage submitting a poor quality first draft.

Fall 17 and Spring 18 ET 400 Combined Assessment

ABET learning outcomes assessed: c, g, h, k

UWGB general education outcome assessed: Writing Emphasis (WE)

Rather than separate out environmental from electrical or mechanical engineering technology students, assessment was performed on all students with a single set of results.

ET 400 is the course assigned to the Engineering Technology internship. In addition to completing a minimum of a summer or semester long internship with a company in the appropriate field (electrical, environmental, mechanical engineering technology), each student will write a term paper documenting their experience and give an oral presentation at the end of the term. The course grade is based on evaluation by the internship supervisor, the written paper, and the presentation. ABET learning outcomes, specific assignments used to assess each one, and assessment rubrics are discussed below.

Criteria for the term paper are as follows:

Internship Experience Report:

At the end of the internship semester, each student will write a 12 to 20 page paper (double spaced) detailing their experience. The paper should follow the outline below and include all of the information in the outline.

1. Describe the company, what products it makes, what the markets are for the products.
2. Describe the manufacturing process. Include applicable graphics to explain.
3. Describe your position with the company including responsibilities.
4. Describe projects that you worked on including the goals of the projects, any experiments or design work applied to the project; methods for measurements and analysis of measurements taken; results of any experiments or design work; and how processes were improved as a result
5. Discuss skills attained relevant to both engineering technology and a future professional career
6. Describe any opportunities for additional training/professional development and what skills were learned

This paper will also be used to assess the Writing Emphasis requirement of the course

ABET outcome c states that the student will demonstrate: An ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes
This outcome was assessed by both Prof. Patricia Terry and each student's internship supervisor. Prof. Terry obtained the internship supervisor's assessment via a phone conversation if an electronic copy of the evaluation was not completed. The assessment rubric and a summary of the results are given below.

Assessment Rubric for ABET c: Assessment by Prof. Terry (Assessed primarily from the paper)

N = 22	Unsatisfactory	Developing	Satisfactory	Exemplary
Describe the purpose of measurements/ experimentation in context of process	Description not adequate to explain what is being performed or why	Gives some information about the tests/ measurements (2) 9.1%	Adequately describes tests/Measurements and why they are performed 72.7% (16)	Comprehensive description of tests/measurements in the context of the overall process 18.2% (4)
Properly conducts tests and collects data	Fails to apply correct scientific method such that data is meaningless	Conducts tests with only minor errors and records inputs and outputs	Conducts tests using scientific methods and records inputs and outputs 77.7% (17)	Conducts tests using scientific methods and records data on all process parameters that might be affected 22.7% (5)
Analyze data and interpret results	Fails to apply appropriate models for analysis	Applies at least one model with no significant errors and interprets results based on this	Applies correct models to analyze data and interprets results specific to the tests 68.2% (15)	Applies all correct models to data analysis and interprets results in the context of the entire process 31.8% (7)
Apply analysis for process improvement	Makes incorrect changes to process	Makes process changes based on single model	Correctly applies analysis to process changes 45.5% (10)	Correctly applies analysis to process changes and documents improvement 54.5% (12)
Document process improvement	Fails to document results	Provides minimal documentation of process improvement (2) 9.1%	Document results of process improvement in a manner that allows replication 45.5% (10)	Documents results of process improvement in a manner that allows replication and suggests further tests/experiments 45.4% (10)

Assessment Rubric for ABET c: Summary of internship supervisor reports

N = 22	Unsatisfactory	Developing	Satisfactory	Exemplary
Describe the purpose of measurements/ experimentation in context of process	Description not adequate to explain what is being performed or why	Gives some information about the tests/ measurements	Adequately describes tests/ Measurements and why they are performed 45.5% (10)	Comprehensive description of tests/ measurements in the context of the overall process 54.5% (12)
Properly conducts tests and collects data	Fails to apply correct scientific method such that data is meaningless	Conducts tests with only minor errors and records inputs and outputs (1)4.5%	Conducts tests using scientific methods and records inputs and outputs (11) 50%	Conducts tests using scientific methods and records data on all process parameters that might be affected 45.5% (10)
Analyze data and interpret results	Fails to apply appropriate models for analysis	Applies at least one model with no significant errors and interprets results based on this	Applies correct models to analyze data and interprets results specific to the tests 36.4% (8)	Applies all correct models to data analysis and interprets results in the context of the entire process 63.6% (14)
Apply analysis for process improvement	Makes incorrect changes to process	Makes process changes based on single model (1)4.5%	Correctly applies analysis to process changes (10) 45.5%	Correctly applies analysis to process changes and documents improvement 50% (11)
Document process improvement	Fails to document results	Provides minimal documentation of process improvement	Document results of process improvement in a manner that allows replication 59.1% (13)	Documents results of process improvement in a manner that allows replication and suggests further tests/experiments 40.9% (9)

ABET outcome g states that the student will demonstrate: An ability to apply written, oral, and graphical communication in both technical and non-technical environments; and an ability to identify and use appropriate technical literature

The term paper was used to assess the written and graphical communication components of g: with rubric and summary of results below. Assessment performed by Prof. Terry.

N = 22	Unsatisfactory	Developing	Satisfactory	Exemplary
Written articulation of experience	Fails to articulate experience at all	Text rambles, repeated reading needed to understand, key points not organized (1) 4.5%	Articulates experience, but writing is somewhat difficult to follow (11) 50%	Articulates experience clearly and concisely 45.5% (10)
Written organization	Little to no structure or organization is used	Some structure and organization is used	Generally well organized, but some sections not clearly identified 40.9% (9)	Organized in a logical sequence to enhance readers' comprehension 59.1% (13)
Professionally written to audience (professor and supervisors)	Writing style is inappropriate for the audience and the assignment	Style is informal or inappropriate to audience (3) 13.7%	Usually uses professional, scientific writing style appropriate to audience 54.5% (12)	Uses excellent professional, scientific writing style to appropriate audience 31.8% (7)
Quality of written work	Work is not presented neatly; many spelling/ grammar errors (4) 18.2%	Work has more than 3 spelling or grammar errors per page; is somewhat messy 27.3% (6)	Work is presented neatly with few grammar or spelling errors 54.5% (12)	Work is presented neatly; grammar and spelling are correct 33% (1)
Use of graphics: tables/graphs/ figures	No graphics are used (1)4.5%	Graphics are presented, but flawed	Use of graphics is appropriate and usually in the correct format (6) 27.3%	Use of graphics is appropriate and all are in proper format 68.2% (15)

Assessment Rubric for ABET g (oral): Each student gave a 12-15 minute presentation of their work and answered audience questions. The ET 101 class was the audience.

N = 22	Unsatisfactory	Developing	Satisfactory	Exemplary
Oral articulation of experience	Fails to articulate experience at all	Speaker rambles, key points not organized	Articulates experience but somewhat difficult to follow (3) 13.6%	Articulates experience clearly and concisely 86.4% (19)
Presentation organization	Little to no structure or organization is used	Some structure and organization is used	Generally well organized 27.3% (6)	Organized in a logical sequence to enhance comprehension 72.7% (16)
Presentation quality	Student not prepared, presentation not appropriate	Style is informal or inappropriate to audience	Student mostly prepared; presentation is appropriate to audience 40.9% (9)	Student very well prepared, knowledgeable; presentation is appropriate to audience 59.1% (13)
Use of graphics: tables/graphs/ figures	No graphics are used	Graphics are presented, but flawed	Use of graphics is appropriate and usually in the correct format 18.2% (4)	Use of graphics is appropriate and all are in proper format 81.8% (18)
Stays within time limits	Student goes significantly over time limit (more than 6 minutes) (2) 9.1%	Student goes a little over time limit (about 3-5 minutes) or significantly under 18.2% (4)	Student is within 2 minutes of time limit 54.5% (12)	Presentation exactly meets time requirement 18.2% (4)
Answers questions	Student unable or unwilling to answer questions	Student attempts to answer questions, but in a rambling, insufficient manner	Student answers questions in an acceptable manner 54.5% (12)	Student willingly and concisely answers all relevant questions 45.5% (10)

ABET outcome h states that the student will demonstrate: An understanding of the need for and an ability to engage in self-directed continuing professional development

This outcome will be assessed both by the internship supervisor through interaction with the student and by Professor Terry through the internship report.

Assessment Rubric for ABET h: Prof. Terry

N = 22	Unsatisfactory	Developing	Satisfactory	Exemplary
Student seeks professional development opportunities through internship	Shows no interest in opportunities offered	Participates in opportunities only when required	Takes advantage of opportunities offered during internship 50% (11)	Actively seeks opportunities through internship supervisor 50% (11)
Student seeks professional development opportunities outside of internship	Participates in no professional or extra-curricular organizations	Participates in activities when required by a class (5) 22.7%	Takes advantage of activities offered by faculty 68.2% (15)	Actively seeks opportunities within professional societies or campus activities 9.1% (2)
Has knowledge of professional societies	Fails to identify or join professional societies	Identifies professional societies (9) 40.9%	Joins professional society 59.1% (13)	Joins professional society and actively engages on local chapter

ABET outcome k states that the student will demonstrate a: Commitment to quality, timeliness, and continuous improvement.

This outcome will be assessed by the internship field supervisor and sent to Professor Terry.

Assessment Rubric for ABET k:

N = 22	Unsatisfactory	Developing	Satisfactory	Exemplary
Demonstrates reliability	Does not reliably come to work on agreed upon schedule and misses meetings	Misses more than once a month without an acceptable reason; occasionally misses meeting	Rarely misses work and gives appropriate notification; never misses meetings (5) 22.7%	Only misses work for acceptable reasons and notifies supervisor in a timely manner; never misses meetings 77.3% (17)
Demonstrates commitment to timeliness	Often fails to arrive on time to work or meetings	Is late to work more than once a week or is late to or meetings	Rarely arrives late for work or meetings 18.2% (4)	Always arrives to work or meetings on time 81.8% (18)
Demonstrates commitment to quality	Quality of work is unacceptable	Quality of work needs significant improvement	Quality meets expectations for a student intern 45.5%% (10)	Quality significantly exceeds expectations for a student intern 54.5% (12)
Demonstrates commitment to improvement	Does not take direction well; ignores feedback	Sometimes takes direction well; sometimes open to feedback	Usually takes direction well; usually incorporates feedback into work 27.3% (6)	Always takes direction well; open to feedback and incorporates into work 72.7% (16)
Would you hire this student?	no	Possibly after graduation if significant growth occurs	Would consider for an open position. 13.6% (3)	Absolutely, with no reservations. 86.4% (19)

This course also meets the UW-Green Bay general education learning outcome for Writing Emphasis

Assessment Rubric for Writing Emphasis: Term paper is assessed by Prof. Terry

N = 22	Unsatisfactory	Developing	Satisfactory	Exemplary
Paper includes all required components	Only two or three components are covered and not all at adequate level	Most components are included and most are at adequate level (3) 13.6%	Paper includes all required components 45.5% (10)	Paper gives thorough description of all components 40.9% 92)
Paper is well organized	Paper is not organized at all	Paper has some organization, but inconsistent	Paper is organized according to the questions asked, but not well organized overall (8) 36.4%	Paper is organized according to topics and overall into an easy to follow flow of information 63.6% (14)
Correct grammar and spelling are used throughout	Grammar and spelling are poor – many errors per page (4) 18.2%	Grammar and spelling are marginally acceptable – 2 to 3 errors per page 27.3% (6)	Grammar and spelling are good – no more than one error per page 36.3% (8)	Grammar and spelling are near perfect – no more than 3 errors in entire paper 18.2% (4)
Tables and figures illustrate concepts	No tables or figures are provided (2) 9.1%	One figure or table is given – a map of area	Tables and figures illustrate some concepts 59.1% (13)	Tables and figures completely support the text 31.8% (7)

Continuous improvement:

ABET c: Students generally did fine with ABET learning outcome c. Again, lab classes help students develop these skills, especially ET specific labs. More emphasis on quality lab reports may shift some students from the satisfactory to the exemplary mark. Two students scored "developing," but this was a much more representative pool than the first semester ET 400 ran. We need to make sure students have completed sufficient ET credits before doing an internship to make sure they know what is expected.

ABET g Written and graphical communication: As before, w students articulated their experiences in an organized paper, emphasis needs to be placed on correct grammar and punctuation. Faculty need to better emphasize the need for correct grammar and spelling and they should inform students of the Writing Center on campus to help students with these skills.

ABET g oral communication: Student presentations were for the most part very good. Almost one-third of students did need help staying within a set time limit. Perhaps a tutorial on presentation preparation would help with this. Presentations were well organized and students demonstrated knowledge of their companies and projects.

ABET h: UW-Green Bay students struggle a bit with continuing professional development. Most students carry a full academic load and work part time to pay tuition. This leaves little time for other activities. While students did take advantage of opportunities offered through employment and by faculty, many were not yet able to join professional societies. Time and expense were the biggest factors and these are difficult to overcome. Faculty will continue to encourage such activities and offer on campus activities.

ABET k: Internship supervisors gave high marks to all students, both through phone interview and written feedback. Many of the students (roughly 20) were hired by the companies that sponsored their internships. UW-Green bay students have the strong work ethic that this region is known for and tend, overall, to be reliable and hard working.

Writing Emphasis: As expected, students overall wrote well organized papers with required content, but grammar and spelling continue to be a challenge. We may need to consider a course specific to technical writing skills or, at least, spend some time in lower level courses emphasizing writing grammatically correct English. We also need to direct students to the campus Writing Center for help.

Spring 2018 Assessment:

ET 118: Fluids 1

Instructor: Professor Patricia Terry, terryp@uwgb.edu

ABET Outcomes (c and f were assessed in this course.)

The Engineering Technology Program must also satisfy the ABET Program Outcomes, which require a student to possess the following knowledge, skills, and attitudes (lower case letters are used to be consistent with ABET terminology). Not every Engineering Technology course is expected to meet every ABET Outcome.

(c) An ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes;

(f) An ability to identify, analyze, and solve broadly defined engineering technology problems;

ABET C was assessed via the following laboratory experiment on buoyancy.

Students worked in groups of 3-4 and rotated until each of the 4 sections was complete. They then completed a lab report that included:

Lab Introduction
Procedures for each section
Data and results from each section
Sources of error
Conclusions

Fluids Lab 4: Bouyancy

The buoyant force upward on a submerged object (Fb) due to the fluid in which the object is submerged is equal to the weight of the fluid displaced by the submerged object.

Theoretically, this means:

$$F_b = m_{fluid}\, g,$$

$$m_{fluid} = \rho_{fluid}\, V_{displaced}$$

$$\Rightarrow F_b = \rho_{fluid}\, V_{displaced}\, g$$

ρ is the density of the fluid, V is the volume of the object that is submerged (if the object is completely submerged, the volume displaced is the volume of the entire object), *g* is acceleration due to gravity. This model for the buoyant forces is called **Archimedes' Principle**.

If you weigh an object while it is under water, you will find it weighs less than if it were in air. That is because when you weigh a submerged object, you are actually measuring the weight minus the buoyant force. If you do this with a mass scale, then the apparent mass, $m_{apparent}$ (mass in the water), will be less than the actual mass, m_{actual} (mass in the air). The difference between the apparent mass and the actual mass will be due to the buoyant force on the object.

Experimentally, this means:

$F_b = m_{\text{actual}}\, g - m_{\text{apparent}}\, g = (m_{\text{actual}} - m_{\text{apparent}})g$

If you use a spring scale that measures force directly, the buoyant force is the force on the object in air – force on the object when it is submerged in a fluid.

The buoyant force for objects like bottles or beakers that float can be determined in the same way using the apparatus shown below.

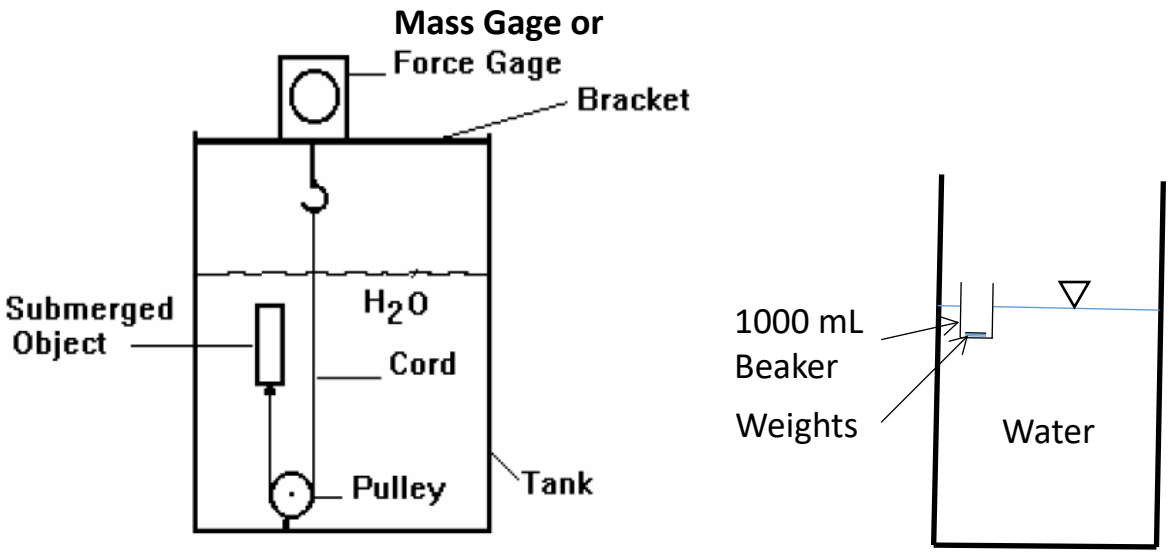


Figure 1. Measuring buoyancy of floating objects.

The buoyant force for objects that do not float (e.g., steel and aluminum) can be determined with the apparatus shown below. Note the only difference between the apparatus for floating objects and the apparatus for non-floating objects is the addition of the pulley.

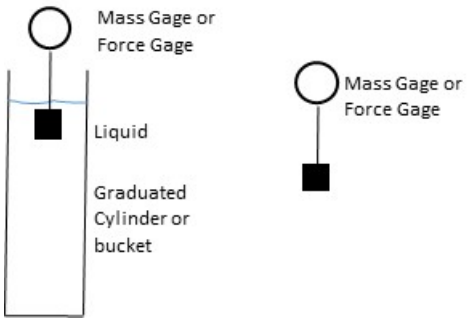


Figure 2. Measuring buoyancy of non-floating objects.

Lab Tasks

Station 1 – Floating objects

1. Determine the buoyancy of objects that float in water by measuring the force of gravity on the objects in the air and submerged in water. Note that the volume of the milk jug is 3.84 L. The volume of the wood block should be determined by measuring the dimensions of the block. The volume of the Toilet Float should be determined by submerging the float in a beaker of water filled to the top, capturing the displaced water in a bucket, and measuring the volume of displaced water with a graduated cylinder.
    a. Milk jug
    b. Wood Block

Object	Volume	Mass or Force in Air	Mass or Force Submerged	Buoyant force

Station 2-

2. Determine the buoyant force required to displace a beaker to the 800 mL and 900 ml marks using the 10 g weights. Note you will have to add about 120g of weight in order for the beaker to stay upright as you add the rest of the weights. A mass balance is provided to determine the weight of the beaker.
    a. One measurement each for all four groups.

Object	Volume	Mass of Beaker in Air	Mass Added to Displace Beaker to 900 mL Mark	Buoyant fprce
Beaker	800 mL			
	900 ml			

Station 3 – Large, Non-Floating Objects

1. Determine the buoyant force on objects that <u>do not</u> float in water by measuring the force of gravity on the objects in the air and submerged in water. The volume of the 2 kg and 5 kg weight can be determined by submerging the weights in a beaker of water filled to the top, capturing the displaced water in a bucket, and measuring the volume of displaced water with a graduated cylinder. **Note: hold on to the weights when submerging in the beaker, so you don't drop the weight and break the beaker.**

    a. 2 kg weight.
    b. 5 kg weight

Object	Volume	Mass or Force in Air	Mass or Force Submerged	Buoyant Force

Station 4 – Small, Non-Floating Objects

1. Determine the buoyant force on objects that do not float in water by measuring the force of gravity on the objects in the air and submerged in water.
    a. All three groups – aluminum, copper, and lead blocks

Object	Volume	Mass or Force in Air	Mass or Force Submerged	Buoyant Force
Aluminum Block				
Copper Block				
Lead Block				
Steel				

ABET outcome C was assessed with the following rubric. Student results are shown.

ABET c: An ability to conduct standard tests and measurements; to conduct, analyze, and interpret experiments; and to apply experimental results to improve processes;

N = 16	Unsatisfactory	Developing	Satisfactory	Exemplary
Correctly perform buoyancy experiment on floating objects	Fails to perform adequately	Performs experiment, but is unable to convert collected data to buoyant force (3) 18.8%	Correctly sets up experiment, but makes an error in determining mass, volume, or buoyant force or forgets units (3) 18.8%	Correctly sets up experiment, collects data (mass and volume), and calculates buoyant force all with correct units (10) 62.5%
Correctly perform buoyancy experiment on the floating beaker	Fails to perform test adequately	Performs experiment, but is unable to convert collected data to buoyant force (2) 12.5%	Correctly sets up experiment, but makes an error in determining mass, volume, or buoyant force or forgets units (5) 31.3%	Correctly sets up experiment, collects data (mass and volume), and calculates buoyant force all with correct units (9) 56.2%
Correctly perform buoyancy experiment on large, non-floating objects	Fails to perform test adequately	Performs experiment, but is unable to convert collected data to buoyant force (1) 6.3%	Correctly sets up experiment, but makes an error in determining mass, volume, or buoyant force or forgets units (5) 31.3%	Correctly sets up experiment, collects data (mass and volume), and calculates buoyant force all with correct units (10) 62.5%
Correctly perform buoyancy experiment on small non-floating objects	Fails to perform test adequately	Performs experiment, but is unable to convert collected data to buoyant force (1) 6.3%	Correctly sets up experiment, but makes an error in determining mass, volume, or buoyant force or forgets units (4) 25%	Correctly sets up experiment, collects data (mass and volume), and calculates buoyant force all with correct units (11) 68.7%
Interpret experiments to understand and demonstrate buoyancy	Offers no interpretation (1) 6.3%	Performs experiments and calculates buoyancy (with no or minor error) (2) 18.8%	Performs experiments, but offers no overall interpretation of buoyancy (5) 31.3%	Interprets all 4 experiments fully to the concept of buoyancy (7) 43.8%
Analyzes error sources for process improvements	Identifies no error sources (1) 6.3%	Identifies only one error source (2) 12.5%	Identifies several error sources (12) 75%	Identifies several error sources for the labs and offers suggestions for improving (1) 6.3%

Continuous improvement:

Students, for the most part, performed at an acceptable level on this learning outcome. While they performed calculations correctly, many forget to include units. In the future, I must remind them of the need for proper units assigned to any number and include this requirement in grading homework. Given that this is a freshman level course, I am not surprised that students did not interpret results at a higher level or offer suggestions for improving the experimental design. In subsequent courses, I can discuss with them how to assess error sources and recommend improvements in design.

ABET (f): An ability to identify, analyze, and solve broadly defined engineering technology problems

This outcome was assessed with the following question from the last (3) exam:

1. A power plant uses pumped storage to maximize its energy efficiency. During low energy demand hours, water is pumped to an elevation of 20 m. The piping system is 200 meters long and includes one sharp edged tank inlet, one sharp edge tank exit, and 10 90° threaded smooth bends. The pipe diameter is 20 cm and $\varepsilon/D = 0.01$. The water's volumetric flow rate is 0.08 m^3/ sec, which gives a velocity of 2.55 m/sec. Using the Moody table to estimate the friction factor, f, estimate total ΔP for the system and the pump power requirement if the efficiency is 60%.

Assessment was performed with the following rubric with results shown:

N=19	Unsatisfactory	Developing	Satisfactory	Exemplary
Correctly identifies total correct equation for ΔP	Fails to identify correct pressure loss equation (1) 5.3%	Sets up equation, but with major errors (4)21.1%	Correctly sets up equation with one error in pressure loss terms (2) 10.5%	Correctly sets up experiment, collects data equation with all pressure loss terms (12) 63.1%
Correctly estimates Reynolds number and determines Moody friction factor	Fails to estimate Reynold's number or friction factor (2)10.5%	Estimates Reynolds number and friction factor with major error or multiple minor ones (3) 15.8%	Estimates Reynolds number and friction factor with minor error (10) 52.6%	Correctly estimates Reynolds number and determines Moody friction factor (4) 21.1%
Estimates ΔP from friction loss	Does not apply correct equation (1) 5.3%	Major error in determining ΔP (2) 10.5%	Applies Moody eqn with minor error or with wrong friction factor to estimate ΔP (8) 42.1%	Applies correct Moody friction factor to Bernoilli eqn for ΔP (8) 42.1%

Correctly estimates ΔP for fittings	Fails to get K_l values and/or does not estimate loss from fittings (2)10.5%	Leaves out more than one K_l for fittings and/or does not correctly apply ΔP equation (2)10.5%	Gets all but one K_l values for fittings and/or makes minor error in estimating ΔP (8) 42.1%	Correctly gets the K_l fric loss values for all fittings and estimates ΔP (7) 36.9%
Correctly calculates pump requirement	Fails to calculate pump power (1)5.3%	Applies either incorrect, but close, equation or has major errors (3) 21.1%	Applies correct equation with minor error (10) 52.6%	Applies total ΔP to correct equation for pump power (4) 21.1%

Continuous improvement:

Students performed acceptably at identifying the correct equation, but were not consistently successful with calculating all the terms in the equation for pressure loss. Most students made minor errors in estimating the friction factor or determining the total pressure loss coefficient from pipe fittings and turns, etc…More students than I would consider to be acceptable had difficulty separating out the three terms in the equation (pressure loss from friction, minor losses from fittings and pipe configuration, and elevation change). The best way to learn is by practice, so next semester there will be more example problems and homework problems addressing multi-part equations. Since this is a first year course, students may not have encountered a three-term equation and may need more practice.

ENV SCI 335/ET331/ENV SCI 535 Water and Wastewater Treatment

Instructor: Dr. Patricia Terry, LS 463, terryp@uwgb.edu

ABET Outcomes a and d were assessed.

(a) An ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly defined engineering technology activities;

(d) An ability to design systems, components, or processes for broadly defined engineering technology problems appropriate to program educational objectives;

ABET a was assessed with the following assignment: Project 2

Your consulting firm has been hired to design a chemical treatment plant for 14,000 liters per min of water with a severe hardness problem. The incoming and required exit water specifications are given below.

166 µg/1 carcinogenic volatile organic compounds are in the entering water. The effluent should have no more than 6µg/l VOCs.

With your vast experience and knowledge, you know that the standard procedure for treating this effluent stream should include an air stripping tower to remove VOCs. For the air stripping tower, assume that 2 towers in parallel are needed to handle the high water flow rates and that the volumetric air flow is 1.8 that of the water (Q_{air}/Q_w = 1.8). Henry's constant is 1.1 at the design temperature, the mass transfer coefficient is 0.018/sec and the loading is 5.32 lb/ft^{2}sec. The column diameter should be designed for a maximum air stream velocity of 1.5 ft/sec. You should specify the height and diameter of each column.

The water possesses hardness in the form of calcium bicarbonate, magnesium sulfate, and calcium sulfate that must be treated with lime and soda ash. The required exit limit of magnesium sulfate should not exceed 24 mg/liter. The kinetics of the reactions are given.

	Inlet (mg/l)	exit (mg/l)	k	rxn ord
Calcium bicarbonate	180	20	0.081/min	first
Magnesium sulfate	72	12	0.0026 1/mgmin	second
Calcium sulfate	156	6	3.26 mg/lmin	zero

For both lime and soda ash treatment specify the feed rates in g/min given 10 mg/l excess lime and 10 mg/1 excess soda ash. For each step (lime and soda ash) a rapid mix tank with a residence time of 1.6 minutes should be used to mix the chemicals and a combined reactor/sedimentation basin is needed for each.

Recarbonation must follow the soda ash tank. Size the tank for a gas/liquid contact time of 6 minutes.
Control for taste and odor is needed with activated carbon. Specify the feed location.

Disinfection with chlorine is required. Specify location and safety requirements.
For the above treatments specify: Aeration design

Equipment volumes (cubic meters) and chemical flow rates (g/min) at each point
Additional items or equipment for an operational plant
Final exit concentrations of all hardness chemicals

Also provide:
Flow diagram with points of addition of all chemicals (Filters do not have to be designed, but show location)
One page typed double spaced description
All pertinent chemical reactions

The following rubric was used to assess ABET a with student results shown:

ABET a: An ability to select and apply the knowledge, techniques, skills, and modern tools of the discipline to broadly defined engineering technology activities;

N=21	Unsatisfactory	Developing	Satisfactory	Exemplary
Lay out water treatment process steps in the correct order (knowledge)	Fails to provide flow diagram	Process diagram not in correct order and/or additional equipment missing (2) 9.5%	Provides flow diagram, but neglects some additional equipment (16) 76.2%	Detailed flow diagram in correct order is given with all equipment needed (3) 14.3%
Correctly applies stoichiometry to determine chemical additions (chemistry tech)	Fails to use stoichiometry	Errors in applying stoichiometry and incorrect lime/soda ash rates (2) 9.5%	Makes only one error in applying stoichiometry and determining rates (4) 19.%	Correctly applies stoichiometry to all hardness chemicals for lime and soda ash addition and determines rates of addition (15) 71.4%
Apply mass balances to determine concentrations when streams merge (skill)	Fails to apply mass balances	Two or three errors applying mass balances/determining CaSO4 made (1) 4.8%	One error in determining CaSO4 made and applying mass balances (7) 33.3%	Determines CaSO4 made and correctly applies mass balances throughout (13) 61.9%
Apply kinetics to determine reactor volumes: lime and soda ash	Fails to apply kinetics to size reactors	Two or more errors in applying kinetics to size reactors (2) 9.5%	One error in applying kinetics (mass balance error) (4) 19%	Correctly sizes both lime and soda ash reactor with kinetics (15) 71.4%
Specify all equipment needed for process to operate (knowledge)	Fails specify equipment needed (2)9.5%	Leaves out extra equipment for two or three process steps (6)28.6%	Only forgets one or two small pieces of equipment (11) 52.4%	Thoroughly identifies all equipment needed for process (2)9.5%

Correctly designs air stripping tower (modeling)	Fails to determine tower height or diameter and omits packing (1) 4.8%	Makes major error in determining tower dimensions (2) 9.5%	Correctly determines tower height and diameter, but forgets packing and/or dist. Plates/makes minor error (12) 57.1%	Correctly determines tower height and diameter and includes packing and dist. Plates (4) 28.6%

Continuous improvement: While students did fine with selecting and using the application of equations from chemistry, engineering, etc to complete the project, they often forgot about additional equipment. In class, when I describe process steps, I make sure they understand qualitatively how each process works before I dive into equations. I don't always require them to provide this information in homework assignments where I tend to focus on correct selection and application of design and fundamental mass balance equations. However, when students get to the project, they forget to add and describe additional equipment once they have completed the mathematics. In the future, I will include the qualitative understanding in homework assignments to emphasize the importance of a complete design.

The following assignment was used to assess ABET d: Project 3

A very large brewery needs to clean its water prior to release or face significant fines. They have hired you to design a system for them that will handle a mixed contaminant stream. The water will exit the brewery into your treatment process at 300 m^3/min with some suspended solids (grains, hops, etc..), BOD waste from cleaning and processing, and calcium hardness. An analysis of the incoming stream shows

24 mg/1 Nitrogen
BOD_5 of 180 mg/1 with a first order rate constant of 0.13/day
320 ppm mixed calcium hardness that must be under 36 ppm

Hardness can be removed with ion exchange resin. Lab studies have shown the resin exhibits a favorable isotherm for $Ca+^2$ with a capacity determined by

$q_o = 0.27\ C_o^{1.14}$ where C_o is in ppm and q_o is in mg Ca^{2+}/g resin

Design 10 resin beds in parallel. These should operate for 6 hours before regeneration is needed. Assume a k_1 value of 0.53 1/gmin. The resin has. a density of 7.8 kg/1 and to maintain a high rate of mass transfer, the maximum water velocity through the bed should not exceed 0.8 m/sec. Specify the mass of resin required and the bed diameter and depth.
The primary clarifier should have an overflow rate of 0.0088 m/sec and a detention time of 20 minutes is adequate to remove 30% of incoming BOD.

Standard procedure for BOD removal should be step aeration activated sludge with secondary clarification. Start with a residence time of 6 hours with an average sludge age of 9 days. MLSS in the aeration tank should be 3000 mg/1 and that in the secondary clarifier return is 14,300 mg/1. Effluent SS should not exceed 20 mg/1. Specify the volume of the aeration tank and the return solids flow and waste flow from the secondary clarifiers.

Secondary ·clarification following the activated sludge tanks will be performed in 2 parallel tanks, each with a residence time of 40 minutes and an overflow rate of 0.0084 m/sec.

Given that SS in the influent is 42 mg/1, f = 0.48, and k = 0.60, estimate the mass of dry solids produced per day.

To complete your design,

Specify the volumes and dimensions of all tanks, reactors, and towers
Specify the types of biological species needed to treat the water
The type of sludge exiting each clarifier
A qualitative description of sludge treatment with necessary diagrams of equipment Specify additional equipment needed to make your plant operational
Include a one to two page qualitative description and a flow diagram

The following rubric with overall results was used to assess.

ABET d: An ability to design systems, components, or processes for broadly defined engineering technology problems appropriate to program educational outcomes

N=21	Unsatisfactory	Developing	Satisfactory	Exemplary
Lay out waste water treatment process steps in the correct order	Fails to provide flow diagram	Process diagram not in correct flow order and/or additional equipment missing (4)19%	Provides detailed flow diagram, but neglects some additional equipment (12)57.2%	Detailed flow diagram in correct order is given with all equipment/ biological conditions (5)23.8%
Determines total BOD and all microorganisms needed	Either NBOD nor organic BOD not correct and/or microorgs not adequately listed (1) 4.8%	Error in estimating NBOD or organic BOD and/or not all microrogs listed (6)28.6%	Both NBOD and organic BOD estimated and almost all microorgs listed (8)38%	Both NBOD and organic BOD estimated and all microorgs identified (5) 28.6%

Apply equations to size aerobic treatment activated sludge tank (volume, Qr, Qw)	Fails to correctly determine tank volume, BOD load, Qr, and Qw	Two or three errors in sizing system: volume, BOD load, Qw, Qr (3)14.3%	One minor error in one of tank volume, BOD load, Qr, Qw (6)28.6%	Correctly determines tank volume, BOD load, Qr, and Qw 12(57.2)
Size ion exchange beds	Fails to size or has major error	Minor error in sizing beds, fails to list all additional equipment (7)33.4%	Correctly sizes beds, but does not list all additional equipment (6)28.6%	Correctly sizes ion exchange beds and lists all additional equipment (8)38%
Specify all equipment needed for process to operate	Fails to specify any extra equip	Makes more than one error in specifying equip (7)33.3%	Makes only one error in specifying equip (12)57.2%	Thoroughly describes all equip needed (2)9.5%
Specify process for solids treatment	Fails to describe solids or solids treatment in any detail (6)28.6%	Identifies solids, but does not adequately describe solids treatment (7)33.4%	Adequately describes solids, identifies treatment and includes most equipment (4)19%	Gives thorough description of solids produced, solids treatment and disposal including equipment drawings (4)19%

Continuous improvement: Students did okay with the design of components with most making minor errors in calculations. Additional homework practice may help students apply equations correctly and minimize errors. In this project, I asked them to specify a treatment system for the solids collected at the bottom of clarifiers. It is apparent that I did not make my expectations clear because many student had solids treatment confused with the activated sludge process for treating the water and gave duplicate explanations. They also struggled with the design of ion exchange beds because that was not included in their textbook. I did lecture on it and reminded them not to miss class because the information was not in their text, but I also need to provide them some notes written by me to take with them. Also, while students performed okay with applying equations to design equipment, they forget to describe additional equipment to make a process functional (A resin bed needs an underdrain system and inlet weir, etc..). This needs to be emphasized more in homework assignments.

ET 424 Hazardous and Toxic Materials
Spring 2018 (Terry) Assessment ABET f

ABET f: An ability to identify, analyze, and solve broadly defined engineering technology problems

The following assignment was used to assess ABET f.

Project

Select an industry in which you are interested (paper mill, dry cleaning, metal plating) that uses or creates hazardous wastes and perform a complete hazardous materials assessment following the chapters in the text. This should include a list of hazardous chemicals and their sources, toxicology and health effects, risk assessment, environmental effects (air, water and soil), mitigation of these effects, transportation assessment, management of the material and emergency plan, and treatment and disposal of the wastes. Below are due dates for segments of the final report. For the first three, feedback will be given and changes may be made prior to the final report completion.

The following rubric was used to assess the project with overall results included.

ABET f: An ability to identify, analyze, and solve broadly defined engineering technology problems

N= 4	Unsatisfactory	Developing	Satisfactory	Exemplary
Describe industry and identify waste streams	Fails to adequately describe industry or waste streams	Either does not adequately describe industry or does not list several hazardous wastes (2)50%	Describes process/industry and identifies almost all hazardous wastes (1)25%	Thoroughly describes industry/process and identifies all hazardous wastes (1)25%
Analyze each hazardous waste for health and environmental impacts	Fails to analyze	Provides limited information on health, etc impacts	Provides most health, evvironmental, toxicological impacts, some EPA information (3)75%	Thoroughly analyzes all health, environmental, toicological impacts of each waste with EPA data sheets (1)25%
Describe mitigation methods for each hazardous waste	Fails to describe	List, but does not adequately describe	Describes one mitigation method for each (2)50%	Thoroughly describes all mitigation methods for each waste (2) 50%
Describe proper transport procedures for each hazardous waste	Fails to describe	Lists, but does not adequately describe (2)50%	Describe transport procedure via most common transport path (2)50%	Thoroughly describes transport procedures via rail, road, etc

Describe the appropriate management and emergency plans for each waste	Fails to describe	Does not adequately describe management or provides partial emergency plan	Adequately describes, both but not a lot of detail (3)75%	Thoroughly describes management and emergency plans for all haz wastes (1)25%
Analyze appropriate treatment and disposal methods for each waste	Fails to provide information on treatment or disposal methods	Lists, but does not describe or analyze treatment and/or disposal methods (1)25%	Provides information on treatment and disposal methods (2)50%	Thoroughly analyzes all treatment and disposal methods (1)25%

Continuous Improvement:

While the 4 students' performance on this assignment was certainly acceptable, it was below my level of expectation for them. There are, I believe, two factors here. The first is that they were all graduating seniors and had a bit of senioritis. The second is that I probably did not lay out my expectations as explicitly as i should have. Usually, i give the students the assessment rubric with the assignment and I did not do that this time. I will in the future as this helps students understand exactly what information is desired.

2. How will you use what you've learned from the data that was collected?

For each assessed outcome in the above report, Continuous Improvement was included to describe how the assessment will be used to improve student learning in subsequent semesters.