Mt. San Jacinto College
Integrated Course Outline of Record

Form B

Submitted by: Melita Caldwell-Betties **Date:** 12/17/2020

Department	Subject	Course Number	Title
Water Technology	Water Technology WATR	795	Wastewater Technology Math

Units/Hours

Each lecture unit requires 1 hour per week of class time, and 2 hours per week of study outside of class.
Each laboratory unit requires 3 hours per week of class time.
Each activity unit requires 2 hours per week of class time and 1 hour per week of study outside of class.

Lecture Units	Total Units
2.00	2.00
Lecture Contact Hours	**Total Contact Hours**
32.00 - 36.00	32.00 - 36.00
Lecture Homework Hours	
64.00 - 72.00	

Stand Alone:

Program Applicable

AA/AS Degree General Ed Breadth Area(s):

-none-

General Education Justification:

Maximum Enrollment: 40

Maximum Enrollment Justification: Justification:

Grading Method: Letter Grade or P/NP

TOP code: 0958.00*

Can be Taken 1 **time(s) for credit** (max 4)

- Visual or Performing Arts course that is required to meet major requirements for UC/CSU
- Intercollegiate athletics course
- Academic/vocational competition course

Catalog Description:

(Please do not refer to transferability or degree, certificate, or employment concentration applicability. Please only describe the course).
(**75 words** or less in gray box below).

This course prepares students for the quantitative and algebraic questions typically encountered on wastewater collections and wastewater treatment operations licensing examinations. Topics include, but are not limited to, unit conversion, volume, velocity, flow rates, chemical dosages, process control, and solids handling.

Schedule Description:

(Please do not refer to transferability or degree, certificate, or employment concentration applicability. Please only describe the course).
(**25 words** or less in gray box below).

This course prepares students for the quantitative and algebraic questions typically encountered on wastewater collections and wastewater treatment operations licensing examinations.

Need for the course:

Wastewater collection and treatment operations is one of the many fields that utilizes applied mathematics. The results of the various measurements and calculations reflect the operating condition of the both the wastewater collection system and the physical plant where the waste loads will be either treated or removed. In other words, the computations indicate specifically the waste (pollutant) load delivered through a collection system to a wastewater plant, including the total organic load, its characteristics and treatability, and the rate at which the wastes arrive to the plant. These measurements and calculations also tell both collection system and wastewater operators, what these facilities have accomplished in transporting and treating pollutants, as well as furnish needed information about the effect of these waste-streams when discharged into receiving bodies of water. For this reason, demonstrated proficiency in wastewater technology mathematics has been identified by the California State Water Resource Control Board (SWRCB) as a preparatory skillset for a minimally competent wastewater collections or treatment plant operator. This course is required for an 18 unit certificate and/or AS degree. This course is also an elective in the Environmental Studies: Water and Soil Technologies/Environmental Engineering Emphasis degree.

Prerequisite(s):

Prerequisites go through a separate approval process. See Forms E1-E6 for details.
(For further clarification, contact the Prerequisite Subcommittee)

-none-

Corequisite(s):

Corequisites go through a separate approval process. See Forms E1-E6 for details.

-none-

Recommend Preparation:

Recommended Preparation goes through a separate approval process. See Forms E1-E6 for details.

-none-

Other Enrollment Criteria:

-none-

Learning Objectives:

(please number each objective and express in behavioral terms)

Upon the completion of the course the student will be able to do the following:

1. Practice conversion of one unit of measurement to another using dimensional analysis.
2. Assess and select rules for solving applied wastewater technology math equations.
3. Evaluate expressions using the order of mathematical operations.
4. Perform basic operations such as multiplication and combination of like terms to find unknown variables.
5. Distinguish wastewater collection/treatment design and operating parameters.
6. Identify the appropriate mathematical units based on the process schematic or description.
7. Demonstrate an ability to extract relevant data and solve word problems.
8. Identify and apply algebraic techniques to solve simple and multi-step word problems routinely encountered in wastewater systems and technology.
9. Analyze mathematical calculations required to effectively operate, evaluate, and maintain wastewater systems.
10. Select and apply mathematical plans for appropriate process control of wastewater treatment processes as well as collection systems based on data evaluation and mathematical modeling.

Course Content:

(please number the outline of main topics and subtopics)

1. Use of the dimensional analysis to convert
    1. Cubic feet to cubic yards
    2. Acre-feet to gallons, gallons to acre-feet
    3. Gallons per Minutes (GPM) to acre-feet/day, acre-ft/day to GPM
    4. Gallons per minute to million gallons per day (MGD), MGD to GPM
2. Volumes
    1. Rectangular Tanks
    2. Cylindrical Tanks
3. Pipes
    1. Wastewater Collection and Pumping Rate
    2. Wet-Well Capacity
    3. Pumping Rate
4. Preliminary Treatment Math
    1. Screenings Removed
    2. Screenings Pit Capacity
    3. Grit Removal
    4. Grit Channel Velocity
5. Primary Treatment Math
    1. Hydraulic Loading
    2. Surface Overflow Rate
    3. Weir Overflow Rate
    4. Detention Time
    5. Unit Removal Efficiency
6. Anaerobic Digestion Math
    1. Solids testing in the laboratory
    2. Percent Total Solids (%TS
    3. Percent Fixed Solids
    4. Sludge Calculations
        1. Gallons of sludge removed
        2. Pounds of volatile solids pumped
        3. Percent Volatile Solids Reduction
        4. Organic Loading Rate
        5. Gas Production
        6. Digester Start-up

7. Wastewater Pond Math
    1. Area (acres)
    2. Volume (acre-feet and gallons
    3. Flow (acre-feet/day)
    4. Detention Time (days
    5. Population Loading
8. Basic Secondary Process Math
    1. Trickling Filters
        1. Re-circulation Ratio
        2. Hydraulic Loading (Gallons per Day/ft^2)
        3. Organic Loading Rate (lbs. of BOD/1000-cu. ft.)
        4. Surface Overflow Rate
        5. Weir Overflow Rate
9. The Activated Sludge Process
    1. Sludge Volume Index (SVI)
        1. Definitions
        2. Calculations
        3. Wasting Rate
    2. Food to Micro-organism ratio (F/M)
        1. Definition
        2. Calculations
    3. Mean Cell Residence Time (MCRT)
        1. Definition
        2. Calculations
    4. Solids Concentration in Aeration Tank
        1. Return Activated Sludge
        2. Solids Balance Approach
        3. Sludge settle-ability Approach
    5. Activated Sludge Process Control Calculations
    6. BOD Calculations
10. Sludge Thickening and Dewatering Calculations
    1. Percent Total Solids (%TS)
    2. Percent Solids Recovery (%TS)
11. J. Disinfection Math
    1. Feed Rate (lbs/day) using pound formula
    2. Dosage, Demand, and Residual
    3. Density and Specific Gravity

Methods of Instruction:

Methods of instruction may include, but are not limited to the following:

- **Method:** Lecture
  Integration: Lecture presentation and discussion with supporting visual materials (overhead slides or multimedia), introducing concepts and terminology relevant to wastewater treatment and collection systems (e.g. conversions, order of operations, solving for unknown values, word problems, and operational parameters such as pollutant loadings).
- **Method:** Homework
  Integration: Integration: Take-home word problem worksheets with sample problems such as conversions, order of operations, solving for unknown values, word problems, and operational parameters such regulating velocities and process control. Student writings may occur through private journal entries. Homework will be graded and discussed in both the traditional and virtual class setting.
- **Method:** Directed Study
  Integration: Students will conduct research related to concepts and skills developed throughout the course. Students will analyze mathematical calculations (i.e., process design, schematics, and operational parameters)

to determine the level of optimization required increase wastewater system efficiency.
- **Method:** In-class Exercises
  Integration: Instructor-led or small group activities and discussion of applied math concepts or wastewater treatment/collection strategies will be based on data evaluation and modeling. These activities may be rewarded with points for participation, but not necessarily graded with variable points. Students will be assessed on their comprehension and knowledge of unit process and control calculations.
- **Method:** Film/video Viewing and Discussion
  Integration: Videos will illustrate various aspects of wastewater treatment and collection system operations including normal and abnormal operating conditions typically encountered in the workplace. Relevant data will be extracted from the visual data and algebraic techniques covered in the course will be employed to solve simple and multi-step problems.

Methods of Evaluation:

A student's grade shall be determined by the instructor using multiple measures of performance related to the course objectives. Methods of evaluation may include but are not limited to the following:

- **Method:** Quizzes
  Integration: Periodic short objective tests will be used to assess the students' comprehension and retention of applied math concepts and terminology (i.e. conversions, order of operations, solving for unknown values, word problems, and operational parameters) relevant to wastewater treatment and collection systems. The final written work product will be graded for accuracy and completeness.
- **Method:** Homework
  Integration: Take-home word problem worksheets with algebraic expressions accessing studentâ€™s understanding of the order of operations, solving multi-step or unknown values equations and word problems. The final written work product will be graded on accuracy, completeness, and demonstrated mastery of the subject matter.
- **Method:** Class Work
  Integration: Practice word problem worksheets dealing with mathematical modeling of equipment used in wastewater conveyance, pollution control, and waste disposal systems. Student writing may also occur through private journal entries. Classwork will be graded for accuracy, completeness, and demonstrated mastery of the subject matter.
- **Method:** Graded assignments/worksheets
  Integration: Integration: Students' worksheets will be assessed on the ability to extract relevant mathematical data as well as articulate process, operational, and design parameters. The final written work product will be graded for accuracy, completeness, and demonstrated mastery of the subject matter.
- **Method:** Exams/Tests
  Integration: A combination of objective questions of important concepts (previously quizzed or discussed in class) will be given to assess the students' knowledge and comprehension on applied math calculations in wastewater treatment and the maintenance of wastewater collection systems (i.e., demonstrating the ability to extract relevant data and select rules for solving math equations). The final written work product will be graded for accuracy, completeness and demonstrated mastery of the subject matter.

Examples of Assignments:

Students will be expected to understand and critique college level texts or the equivalent. Reading and writing, as well as out of class assignments are required. These assignments may include but are not limited to the following:

1. Review the assigned mathematical worksheet "Actual Dose vs. Desired Dose." Perform the basic mathematical calculations to determine the required dosage, feed rate, and concentration of alum to be used during the sedimentation process to treat a given flow rate.
2. In a small group setting of peer students review the article entitled “The Great Stink." Become familiar with water quality degradation issues that resulted in the overloading and design failures of the city of London's wastewater conveyance systems. Use pollutant per capita estimates to calculate the solids and hydraulic loading criteria. Be prepared to discuss in class the critical lesson learned from this historic failure of a sanitation system.

3. The equation for calculating the total biochemical chemical demand (TBOD) in a wastewater sample is sometimes simplified to Total BOD (TBOD) equals Carbonaceous BOD (CBOD) plus Nitrogenous BOD (NBOD). Explain in one page or less, why this approximation usually gives the correct result when calculating the concentration of waste pollutants in a representative wastewater sample.
4. An aeration tank with a volume of 0.42 MG receives a primary effluent flow rate of 2.35 MGD. The mixed liquor suspended solids concentration is 2480 mg/L. Laboratory results indicate the volatile solids concentration is 85%. If the primary effluent BOD concentration is 184 mg/L, what is the current F:M Ratio?
5. Students will participate in the lecture discussion on solving for unknown variables: There are three variables in Q=AV calculations for pipelines: flow rate (Q), diameter (D), and velocity (V). Referencing practice calculations on a math worksheet, in following example, studnets will be tasked with identifying the unknown factor and solving for "x" the "flow rate": An 8-inch diameter pipeline has water flowing at a velocity of 3.4 feet per second (fps). What is the gallons per miniute (gpm)flow rate through the pipeline?

Textbooks:

- Spellman, Frank R. (2014). *Mathematics Manual for Water and Wastewater. 2nd ed. Taylor* Taylor and Francis Group. ISBN: 9780429195372
- Price, Joann K. (1998). *Applied Math for Wastewater Plant Operators* Taylor and Francis Group. ISBN: 9781566769891
- Price, Joann K. (1991). *Basic Math Concepts for Water & Wastewater* Taylor and Francis Group. ISBN: 9780877628088
- Price, Joann K. (1991). *Applied Math for Wastewater Plant Operators-Workbook* Taylor & Francis Group. ISBN: 9780877628101

Other Resources:

Minimum Qualification

- Environmental Technologies