DEPARTMENT OF CIVIL ENGINEERING
NATIONAL INSTITUTE OF TECHNOLOGY
TIRUCHIRAPPALLI - 620 015, TAMIL NADU, INDIA
Phone : +91-431-2503150 (O) , +91-431-2503171 (Direct), Fax : +91-431-2500133 (O/o the Director), E-Mail : rgmathii@nitt.edu

Course Code	:	CE711
Title of the Course	:	**PROCESS CHEMISTRY FOR WATER AND WASTEWATER TREATMENT**
Designation as a required or elective	:	Elective
Prerequisites	:	Fundamental Knowledge in Process chemistry
Contact Hours, Type of Course	:	36
Course Assessment Methods	:	Continuous Assessment, Semester Examination

Course Learning Objectives

1. To study the basic concepts of environmental chemistry and acid base equilibria
2. To use the solubility equilibria approach for the removal of heavy metals from water and wastewater
3. To learn the application of redox potentials in wastewater treatment
4. To discuss the various water stabilization techniques to provide stable water

Course Content

Environmental Chemistry - Basic Concepts from General Chemistry - Chemical Equations - Types of Chemical Reactions - Solutions - Activity and Activity Coefficients - Chemical Equilibria - Chemical Thermodynamics - Factors Affecting Chemical Equilibrium - Gas Laws - Acid Base Equilibria - Fundamentals - Equilibrium Diagrams - Alkalinity and Acidity, Carbonic Acid System, Buffering in Water Systems, Measuring Alkalinity - Solubility Equilibria - Slightly Soluble Salts, Effect of Other Solutes on Salt Solubility - Removal of Heavy Metals from Complex Water and Wastewater Systems - Oxidation Reduction Equlilibria - Oxidation Reduction Processes - Galvanic Cell - Chemical Thermodynamics - Stability Diagrams -Measuring Redox Potentials - Water Stabilization - Electrochemical Aspects of Corrosion - Langelier Saturation Index - Caldwell Lawrence Diagrams - Water Softening and Neutralization - Chemical Precipitation - Ion Exchange - Application of Redox Chemistry.

References

1. Benfield, L.D.; Weand, B.L.; Judkins, J.F. (1982) *Process chemistry for water and wastewater.* Prentice Hall Inc, Englewood Cliffs, New Jersey.
2. Weber Jr., W.J. (1972) *Physico-chemical Process for Water Quality Control.* Wiley Inc. Newyork.

Course Outcomes

At the end of the course student will be able

1. to infer the chemical processes involved in the treatment of water and wastewater
2. to apply the concepts of solubility equilibria for treatment of industrial wastewater
3. to differentiate the various biological conditions by measuring redox potential
4. to quantify the dosage of chemicals requirement based on chemical reactions in water treatment

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COURSE OUTLINE TEMPLATE

Course Title	PROCESS CHEMISTRY FOR WATER AND WASTEWATER TREATMENT		
Course Code	CE711	**No. of Credits**	**3**
Department	Civil Engineering	**Faculty**	Dr. R. Gandhimathi
Pre-requisites Course Code	-		
Course Coordinator(s)(if, applicable)	Dr. S. T. Ramesh		
Other Course Teacher(s)/Tutor(s) E-mail	-	**E-Mail**	**rgmathii@nitt.edu**

Course Type		
		Core
	√	Elective
		Open Elective
		Laboratory

COURSE OVERVIEW

Chemical processes are commonly employed at both water and wastewater treatment plants, and the design or operation of a particular process is normally based on a stoichiometric model. Chemicals are used during water and wastewater treatment in an array of processes to expedite disinfection. The chemical processes, which induce chemical reactions, are called chemical unit processes. There are several distinct chemical unit processes, including chemical coagulation, chemical precipitation, chemical oxidation and advanced oxidation, ion exchange and chemical neutralization and stabilization, which can be applied to water and wastewater during cleaning. Chemical precipitation is the most common method for removing dissolved metals from wastewater solution containing toxic metals, and the kind of reagent used. The goal is to provide a theoretical understanding of various chemical reactions involved in chemical unit processes with direct application of these processes to the design and operation of water and wastewater treatment systems.

COURSE LEARING OBJECTIVES

The objective of the course is,

1. To study the basic concepts of environmental chemistry and acid base equilibria
2. To use the solubility equilibria approach for the removal of heavy metals from water and wastewater
3. To learn the application of redox potentials in wastewater treatment
4. To discuss the various water stabilization techniques to provide stable water

COURSE OUTCOMES (CO)

Course Outcomes

After successful completion of the course, the students should be capable:

CO1	to infer the chemical processes involved in the treatment of water and wastewater
CO2	to apply the concepts of solubility equilibria for treatment of industrial wastewater
CO3	to differentiate the various biological conditions by measuring redox potential
CO4	to quantify the dosage of chemicals requirement based on chemical reactions in water treatment

Aligned Programme Outcomes(PO)

	1	2	3	4	5	6	7	8	9	10	11
CO1	M	M	L	M	L	L		L	M	L	M
CO2	M	M	M	H	L	L			M		L
CO3	M	M	H	H	M	L			L		M
CO4	M	L	M	M	L	L			L		L

1. Scholarship of Knowledge	2. Critical Thinking
3. Problem Solving	4. Research Skill
5. Usage of modern tools	6. Collaborative and Multidisciplinary work
7. Project Management and Finance	8. Communication
9. Life-long Learning	10. Ethical Practices and Social Responsibility
11. Independent and Reflective Learning	

COURSE TEACHING AND LEARNING ACTIVITIES			
Sl. No.	**Week**	**Topic**	**Mode of Delivery**
1.	2nd week of January 2018 **(3 Contact Hours)**	Basic concepts of chemistry. Acid, Base, molecules, atoms, Molecular weight,Types of chemical reactions metathetical reaction and Redox reactions, Chemical equations, Balancing of Chemical Equations	Lecture / Chalk & Talk
2.	3rd week of January 2018 **(3 Contact Hours)**	Balancing of Chemical Equations, Molarity, Molality, Normality, Problems, Concentration, activity and activity coefficients, Ionic strength, problems, Chemical thermodynamics, equilibrium constant (k_c and k_a)	Lecture / Chalk & Talk
3.	4th week of January 2018 **(3 Contact Hours)**	Estimation of Gibb's free energy, enthalpy under standard conditions and other than standard conditions, Estimation of Gibb's free energy, enthalpy under ideal and non-ideal conditions, Effect of Temperature, Concentration etc on chemical equilibrium, Gas laws	Lecture / Chalk & Talk
4.	5th week of January 2018 **(3Contact Hours)**	Acid, base, pH, pOH fundamentals, Importance of pKa, Calculations of pH of the solution, Equilibrium diagrams fundamentals, Derivation of Equilibrium diagram of strong mono and di-protic acid	Lecture / Chalk & Talk
5.	2nd week of February2018 **(3 Contact Hours)**	Derivation of Equilibrium diagram for weak mono-protic acid, weak di-protic acid, Equilibrium diagram for HNO_2, $NaNO_2$, HCl, Equilibrium diagram for combination of acid and salt of weak acid, weak di-protic acid	Lecture / Chalk & Talk
6.	3rd week of February 2018 **(3Contact Hours)**	Acidity and alkalinity, Carbonic acid system, Buffering in water systems, Buffer intensity-derivation, Buffer intensity for carbonic acid system, Dosage requirement for CO_2, titration curves	Lecture / Chalk & Talk
7.	4th week of February 2018	**ASSESSMENT 1**	
8.	5th week of February 2018 **(3 Contact Hours)**	Solubility equlilibria for slightly soluble salts- Common ion effect, Indifferent electrolyte effect, Determination of solubility of salts, Effect of other ions on equilibria.	Lecture / Chalk & Talk
9.	2nd week of March 2018 **(3 Contact Hours)**	Complex ion formation, Solubility diagram for Aluminium system-inferences, Solubility diagram for Iron system- inferences	Lecture / Chalk & Talk
10.	3rd week of March 2018 **(3 Contact Hours)**	Determination of minimum salt solubility, estimation of total soluble salt concentration, Removal of heavy metals from water and wastewater, Competing solid phase equilibria, ion ratio method	Lecture / Chalk & Talk
11.	4th week of March 2018 **(3 Contact Hours)**	Redox process fundamentals, Different types of cells, Galvanic cell, Chemical thermodynamics, Nernst equation derivation, Applications of Nernst equations, Stability diagram for Aluminium and Iron system, oxidising and reducing boundary	Lecture / Chalk & Talk
12.	5th week of March 2018	**ASSESSMENT 2**	
13.	1st week of April 2018 **(3 Contact Hours)**	Measurement of redox potentials, ion selective electrodes, Water stabilization, Basic concepts, Electrochemical aspects of corrosion, Langelier saturation index- derivation, estimation of LI - Characteristics of stable water, Water softening by precipitation-Lime soda process- estimation of dosage requirement, Water softening by precipitation- Caustic soda process- estimation of dosage requirement	Lecture / Chalk & Talk
14.	2nd week of April 2018 **(3 Contact Hours)**	Caldwell Lawrence diagrams, Applications, Water softening, basic concepts, estimation of lime soda requirement using CL diagrams, Estimation of caustic soda requirement using CL diagrams - Neutralization – single stage recarbonation, two stage recarbonation, CO_2 dosage estimation using CL diagrams, Split	Lecture / Chalk & Talk

		Treatment- estimation of dosage requirement using CL diagrams, Applications of redox chemistry	

COURSE ASSESSMENT METHODS

Sl. No.	Mode of Assessment	Week / Date	Duration	% Weightage
1.	Assessment 1	4th week of February 2018	60 Minutes	20%
2.	Assessment 2	5th week of March 2018	60 Minutes	20%
3.	Assessment 3 (Assignments / Group / Team Task / Term paper / project / presentation)	2nd week of February 2018 & 3rd week of March 2018	-	10%
4.	End Assessment	4th week of April 2018	180 Minutes	50%
5.	Compensation Assessment	3rd week of April 2018	60 Minutes	Respective weightages of Assessment 1 and 2

Note:

1. Attending all the assessments (Assessment 1 to 4) is MANDATORY for every student.
2. If any student is not able to attend Assessment-1 / Assessment-2 due to genuine reason, student is permitted to attend the compensation assessment (CA) with 20% weightage (20 marks).
3. At any case, CA will not be considered as an improvement test.
4. Every student is expected to score minimum 40% (i.e., 40 marks) to pass the course. Otherwise the student would be declared fail and 'F' grade will be awarded.

ESSENTIAL READINGS : Textbooks, reference books, Website addresses, journals, etc

1. Benfield, L.D.,Weand, B.L., Judkins, J.F. (1982) *Process chemistry for water and wastewater.* Prentice Hall Inc, Englewood Cliffs, New Jersy.
2. Weber Jr., W.J. (1972) *Physico-chemical Process for Water Quality Control.* Wiley Inc. Newyork.
3. Ronald L. Droste (2004) *Theory and Practice of Water and Wastewater Treatment*, John Wiley & Sons, Newyork.

COURSE EXIT SURVEY (mention the ways in which the feedback about the course is assessed and indicate the attainment also)

The purpose of this survey is to find out from you about your learning experiences and your thoughts about the course. Your replies are very important to assist us in better serving our graduate students. Be assured that your comments will remain absolutely confidential and I will not be able to identify you from other participants.

- Direct feedback from the students by face-to-face meeting individually and as the class as a whole.
- Feedback from the students during class committee meetings
- Exit survey from the students at the end of the session through questionnaire

COURSE POLICY (including plagiarism, academic honesty, attendance, etc.)

DISHONEST / PLAGIARISM

Dishonest / Plagiarism means knowingly presenting another person's ideas, findings or work as one's own by copying or reproducing them without due acknowledgement of the source, with intent to deceive the examiner into believing that the content is original to the student.

Plagiarism is a specific form of cheating which consists of the misuse of the published and/or unpublished works of others by misrepresenting the material (i.e., their intellectual property) so used as one's own work.

All of the following are considered plagiarism:

- turning in someone else's work as your own
- copying words or ideas from someone else without giving credit
- failing to put a quotation in quotation marks
- giving incorrect information about the source of a quotation
- changing words but copying the sentence structure of a source without giving credit
- copying so many words or ideas from a source that it makes up the majority of your work, whether you give credit or not (see our section on "fair use" rules)
- Failing to give credit via footnotes for ideas and concepts, date and information, statements and phrases, and/or interpretations and conclusions derived by another.
- Including references in the Bibliography that were not examined by the student.

ATTENDANCE

The attendance will be taken in all the contact hours. Students are encouraged to attend all the classes without absence. Also, the students are encouraged to participate in various co-curricular and extracurricular activities to enrich the academic / campus life. The percentage of attendance is calculated up to 3 days before the last working day in the respective session. The minimum attendance for appearing for the end semester examination is 75%. In some circumstances with reasonable cause for non attendance, the students should inform the faculty within one week after their absence or feasibly in a week prior. In that case, the students will be given the opportunity to make up the missed classes or quiz or assignment. Those students, whose attendance falls below 75% but above 50% in a subject, shall attend mandatory classes after the closure of the attendance of the current session. Only those students who have completed the mandatory classes will be eligible and be permitted to appear for end semester examination.

The percentage of attendance in a subject shall be computed as:

(a) For calculation of attendance in normal cases:

$$\text{Percentage of Attendaance} = \frac{\text{Actual no. of classes attended}}{\text{Total no. of classes held till date of compilation of attendance}} \text{X } 100$$

This should be 75%for the student to appear for semester examinations.

(b) For calculation of attendance in case of prolonged illness and/or hospitalization with medical certificate:

$$\text{Percentage of Attendaance} = \frac{\text{Actual no. of classes attended}}{\text{Total no. of classes held till date of compilation of attendance} - \text{No. of classes held during the days of prolonged illness and or hospitilization}} \text{X } 100$$

Under any case, a student should have more than 50% attendance calculated as per (a) above to be eligible for appearing in end semester examination.

ADDITIONAL COURSE INFORMATION

1. All the students are advised to check their NIT-T webmail regularly to know the updates. All the correspondence (schedule of classes / schedule of assessment / course material / any other information regarding this course) will be communicated through webmail.
2. Queries / Clarifications / Discussions (if required) may be E-mailed to me / contact me during 4.00 PM to 5.00 PM on Monday and Friday with prior intimation.

FOR APPROVAL

R. Gandhimathi
Dr. R. Gandhimathi
Course Faculty

Dr. Deendayal
Chairman (Class Committee)

12/1/18
Dr. K. Baskar
HoD