Walchand College of Engineering, Sangli

(Government Aided Autonomous Institute)

Course Contents (Syllabus) for

First Year M. Tech.
Civil
(Environmental Engineering)
Sem – I to II

AY 2020-21

Title of the Course: **Research Methodology (4IC501)**	L	T	P	Cr
	2	-	-	2

Pre-Requisite Courses: Nil

Textbooks:

1. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction" , 2nd Ed.-2004, Juta and Company Ltd.
2. Ranjit Kumar, "Research Methodology: A Step by Step Guide for beginners" , 4th Ed.-2014, SAGE Publications.
3. Stuart Melville and Wayne Goddard, "Research Methodology: An Introduction for Science & Engineering Students", 2000 , Juta and Company Ltd.

References:

1. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
2. Mayall, "Industrial Design", McGraw Hill, 1992.
3. Niebel, "Product Design", McGraw Hill, 1974.
4. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Course Objectives:

1. To prepare students for undergoing research, identify and formulate the research problems, state the hypothesis, design a research layout, set a research process and methodology.
2. To enable students to investigate the problem, interpret the results, propose theories, suggest possible/alternative solutions, solve and prove the solution adapted–logically and analytically, conclude the research findings.
3. To impart knowledge to review the literature and publish research in conference and journals.
4. To expose students to research ethics, IPR and patents.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	**Analyze** research and its significance in economic, social and legal aspects.	IV	Analyzing
CO2	**Evaluate** research problem and its design for solution logically and critically.	V	Evaluating
CO3	**Produce** research solution, publication, Dissertation, IPR and patent.	VI	Creating

CO-PO Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1	3				1	
CO2	3			2		
CO3	3	3		2		

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	**Marks**
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

Title of the Course: Physico-Chemical Methods for Water and Wastewater Treatment (4EV501)	L	T	P	Cr
	3	-	-	3

Pre-Requisite Courses: A course on Environmental Engineering at graduate level

Textbooks:

1. Peavy H, S, Rowe D, R, and Tchobanoglous G, *"Environmental Engineering",* McGraw-Hill Book Company, Indian edition 2017.
2. Metcalf and Eddy *"Wastewater Engineering Treatment and Reuse",* Tata McGraw Hill Publication, Indian Edition 2017.
3. Davis, M, L, and Cornwell, D, A, *"Introduction to Environmental Engineering",* Tata McGraw Hill Publishing Company, Special Indian Edition, 2010.
4. Unit Operations and Processes in Environmental Engineering, 2nd Edition, by Tom D. Reynolds and Paul A. Richards, PWS Publishing Company, 1995.

References:

1. Droste, Ronald L *"Theory and Practice of Water and Wastewater Treatment",* Wiley student Edition, 2009.
2. Weber W, J, "*Physico-Chemical Processes of Water quality control",* Wiley-Interscience, 1994.
3. Sincero A, P and Sincero G, A, *"Environmental Engineering A Design approach",* PHI learning private limited, 2004.
4. Quasim, S. R., Motley E, M and Zhu G, *"Water works engineering",* PHI learning private limited, 2000.

Course Objectives:

1. To provide in-depth knowledge of unit operations and processes for the treatment of water and wastewater.
2. To impart technical competency for analysis, evaluation and design of physical and chemical treatment systems for water and wastewater.
3. To inculcate aptitude for research, and consultancy.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	**Explain and Apply** the concepts of unit operations and processes for physical and chemical treatment of water and wastewater.	II III	Understanding Applying
CO2	**Analyze** and **evaluate** the physical and chemical treatment systems used in water and wastewater.	IV V	Analyzing Evaluating
CO3	**Design** physical and chemical treatment systems for water and wastewater.	VI	Creating

CO-PO Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1			3			
CO2				3		
CO3						3

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	**Marks**
ISE 1	10

Title of the Course: **Municipal Solid Waste Management (4EV502)**	L	T	P	Cr
	3	-	-	3

Pre-Requisite Courses: Environmental Engineering

Textbooks:

1. Bhide. A. D. and Sundaresan. B. B., "Solid Waste Management", Indian National Scientific Documentation Centre, 1st Edition, 1983.
2. CPHEEO, "Manual on Municipal Solid waste management", Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000
3. Tchobanoglous G., "Integrated Solid Waste Management", Tata McGraw-Hill Publishing Company Limited, 1st Edition, 1993.

References:

1. Vesilind, Worrell and Reinhart, "Solid Waste Engineering", Cengage Learning India Pvt. Ltd.,
2. Masters G., "Introduction to Environmental Engineering and Science", Pearson Education, 2004
3. Peavy, Rowe and Tchobanoglous, "Environmental Engineering", Tata McGraw-Hill Publishing Company Limited, 1st Edition, 1985.
4. "MSW Rules 2016", Swachh Bharat Mission and Smart Cities Program of India.

Course Objectives:

1. Provide knowledge on functional elements of MSWM.
2. Impart basic skills for design and operation of MSWM systems.
3. Have overview of MSW rules and Government initiatives.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	**Recognize** fundamental elements of MSW and **summarize** practices for effective MSW management.	I II	Remembering Understanding
CO2	**Apply** the fundamental elements of MSWM to **analyze** collection, transportation, and processing of MSW.	III IV	Applying Analyzing
CO3	**Evaluate** processing and disposal system; and to **devise** suitable plans for rehabilitation of existing MSWM	V	Evaluating

CO-PO Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1			3			
CO2				3		3
CO3				3		

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	**Marks**
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 60-70% weightage for course content

Title of the Course: Professional Elective 1 **Environmental Chemistry and Microbiology (4EV511)**	L	T	P	Cr
	3	-	-	3

Pre-Requisite Courses: A course on chemistry at graduate level

Textbooks:

1. Sawyer C.N. and McCarty P.L., "Chemistry for Environmental Engineers", Tata McGraw-Hill Publishing Company Limited, 5th Edition, 2003.
2. Holler F. J. and Crouch S. R., "Skoog and West's Fundamentals of analytical Chemistry", Cengage Learning, 9th Edition, 2012.
3. Mohapatra P. K., "Textbook of Environmental Microbiology", I. K. International Publishing House Pvt. Ltd., Reprint 2013.

References:

1. VanLoon G. W. and Duffy S. J., "Environmental Chemistry: A Global Perspective", Oxford University Press, Indian Edition, Reprint 2011.
2. Pelczar Jr., M. J. E. C. S. Krieg, R. Noel., and Pelczar M. F., "Microbiology", Tata McGraw Hill Publishing Company Limited, Reprint 2012.
3. Madigan, M., Bender K. S., Buckley D.H., Sattley W. M., and Stahl D.A., "Brock Biology of Microorganisms", 15th Edition New York: Pearson, 2017.

Course Objectives:

1. To provide in-depth knowledge of environmental chemistry and microbiology for the treatment of water, wastewater and solid waste.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	**Explain** the basic concepts of environmental chemistry and microbiology of water and wastewater.	II	Understanding
CO2	**Summarize** environmental significance of organic compounds and microorganisms.	II	Understanding
CO3	**Apply** instrumental and microbiological methods for water and wastewater analysis.	III	Applying

CO-PO Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1			2			
CO2			2			
CO3			3	1		1

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	**Marks**
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Title of the Course: Professional Elective 1 **Geo-Environmental Engineering (4EV512)**	L	T	P	Cr
	3	-	-	3

Pre-Requisite Courses: Soil Mechanics

Textbooks:

1. G L SivakumarBabu, "Soil Reinforcement and Geosynthetics", Universities Press (India) Pvt. Ltd. Hyderabad, 2006.
2. S. K. Gulhati, Manoj Datta, "Geotechnical Engineering", Tata McGraw Hill, New Delhi, 2005.
3. Braja Das, "Principles of Geotech. Engg", Thomson Asia Pvt. Ltd, 5th Edition, 2002.
4. Fang, H.Y, "Introduction to Environmental Geotechnology", CRC Press, 1997.

References:

1. Donald Coduto, "Geotechnical Engineering Principles and Practices Prentice Hall of India Pvt. Ltd, New Delhi, 2002.
2. Daniel, D. E, "Geotechnical Practice for Waste Disposal", Chapman and Hall, 1993.
3. Koerner, R.M., "Designing with Geosynthetics", Fifth Edition, Prentice Hall, New Jersey, 2005.

Course Objectives:

1. To provide students the necessary knowledge and concepts in the field of Subsurface Contamination, their effects, detection and remedial measures.
2. To familiarize the students with types and properties of geosynthetic materials, their use for various Civil engineering functions in general and for solid/slurry waste containment in particular.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	**Describe** and **Differentiate** various engineering properties of soils, available geosynthetic materials, their properties and suitability.	II IV	Understanding Analyzing
CO2	**Calculate** area requirement of landfill site, **Evaluate** compaction quality using field tests.	IV V	Analyzing Evaluating
CO3	**Describe** components of sanitary landfill sites, **Analyze** stability of landfill embankments, liners and covers.	II IV	Understanding Analyzing

CO-PO Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1			3			
CO2				2		3
CO3				2		3

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	**Marks**
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)

Title of the Course: Professional Elective 2 **Computational Methods and Optimization Techniques (4EV515)**	L	T	P	Cr
	3	-	-	3

Pre-Requisite Courses: All Courses in Mathematics for UG

Textbooks:

1. Chapra S.C. and Canale R.P., "Numerical Methods for Engineers", Tata McGraw Hill Publications, 4th Edition, 2002.
2. Babu Ram "Numerical Methods", Pearson, 1st Edition, 2010.
3. Hamdy A. Taha, "Introduction to O.R.", 6th edition, (PHI)

References:

1. Balguruswamy, E. "Numerical Methods", Tata McGraw-Hill Publishing Co. Ltd., 2nd Edition, 2009.
2. Jain M.K., Iyengar S. R., Jain R. K., "Numerical Methods", New Age International (P) limited, 5th Edition, 2007.
3. N.D. Vora, "Quantitative Techniques in Management", 2nd edition (TMH).

Course Objectives:

1. To provide knowledge of numerical approach and significance of error analysis.
2. To provide necessary knowledge of numerical tools required for analyzing and solving problems in the field of engineering.
3. To provide pre-requisite statistical knowledge to the students for analyzing the data/results.
4. To deliver know-how of typical optimization techniques applicable to engineering problems.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	**Solve** linear, nonlinear equations, ODE and PDE by numerical methods.	III	Applying
CO2	**Analyze** data using various methods of regression and interpolation.	IV	Analyzing
CO3	**Propose** optimal solution using appropriate techniques.	V	Evaluating

CO-PO Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1				1		
CO2				2		
CO3				1		

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	**Marks**
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Title of the Course: Professional Elective 2 **Water Quality Modeling (4EV516)**	L	T	P	Cr
	3	-	-	3

Pre-Requisite Courses: Basics of hydraulics and water quality

Textbooks:

1. Tchobanoglous G. and Schroeder E. D., "Water Quality: Characteristics, Modeling and Modifications", Addison-Wesley publishing company, Reprint 1987.
2. Chapra S., "Surface Water Quality Modeling", Tata Mc-Graw Hill, 1997.
3. Walski, Chase and Savic, "Water Distribution Modeling", Haestad Press, First edition, 2007.

References:

1. Lee C. C and Lin S. D., "Hand book of environmental engineering calculations", McGraw Hill Publication, 2nd Edition 2007.
2. Todd D. K., "Groundwater Hydrology", John Wiley & Sons, Second Edition, 2007.
3. Metcalf and Eddy, "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, 6th Reprint. 2003.

Course Objectives:

1. Impart in-depth knowledge of modeling/simulation of water quality in surface, and sub-surface sources.
2. Enhance technical competency to deal with water quality issues in real life cases through modeling.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	**Explain** and **apply** concepts of simulation/modeling for pollutant transport in surface and sub-surface sources of water.	II III	Understanding Applying
CO2	**Analyze** and **evaluate** the processes contributing to water quality variations.	IV V	Analyzing Evaluating
CO3	**Apply** the modern tools of engineering for the analysis and design of environmental systems.	III	Applying

CO-PO Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1			3			
CO2				3		
CO3						3

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	**Marks**
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Title of the Course:	L	T	P	Cr
Environmental Chemistry and Microbiology Laboratory (4EV551)	-	-	4	2

Pre-Requisite Courses: Engineering Chemistry

Textbooks:

1. Peavy H. S., Rowe D. R. and Tchobanoglous G, *"Environmental Engineering",* McGraw-Hill book company, 1st Edition, 2013.
2. Pelczar Jr., M.J.E.C.S. Krieg, R. Noel., and Pelczar M. F., "Microbiology", Tata McGraw Hill Publishing Company Limited, 5th Edition, 1996.
3. Sawyer C.N. and McCarty P. L., *"Chemistry for Environmental Engineers",* Tata McGraw-Hill Publishing Company Limited, 5th Edition, 2003.

References:

1. American Public Health Association (APHA), "*Standard Methods for the Examination of Water and Wastewater",* 23rd Edition, 2017.
2. Metcalf and Eddy "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, 6th Reprint. 2003.

Course Objectives :

1. To provide hands-on practice for analyzing the water and wastewater by physical, chemical and instrumental methods.
2. To provide fundamental knowledge of laboratory skills.
3. To impart knowledge of microbiology and bacterial identification.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	**Experiment** water/wastewater quality analysis through physical, chemical, biological and advanced instrumental methods.	III	Applying
CO2	**Analyze** and **interpret** data acquired from the experiments.	III IV	Applying Analyzing
CO3	**Identify** types of cells, bacteria by using proper staining methods.	IV	Analyzing

CO-PO Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1			2	3		
CO2			2	2		
CO3			2	1		

Assessments:

Teacher Assessment:

In Semester Evaluations (ISE 1 & ISE 2), Mid Semester Evaluation (MSE) and End Semester Examination (ESE) have 25% weights each.

Assessment	Marks
ISE 1	25
MSE	25
ISE 2	25
ESE	25

ISE 1, ISE 2 and MSE are based on experimental work/performance in laboratory/assignment/declared test/etc.

ESE assessment is based on performance and oral.

Title of the Course:	L	T	P	Cr
Water Treatability Studies Laboratory (4EV552)	-	-	4	2

Pre-Requisite Courses: Physico-Chemical Methods for Water and Wastewater Treatment

Textbooks:

1. Peavy H, S, Rowe D, R, and Tchobanoglous G, "Environmental Engineering", McGraw-Hill Book Company, International edition, 1985.
2. Metcalf and Eddy "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, 6th Reprint, 2003.
3. "Manual on water supply and Treatment", CPHEEO, Ministry of Urban Development, GoI, New Delhi, 1999.

References:

1. Sincero A, P and Sincero G, A, "Environmental Engineering A Design approach", PHI learning private limited, 2004.
2. Sawyer and McCarty, "Chemistry for Environmental Engineers", Tata McGraw Hill, Edition 5, 2003.
3. Clesceri, L. S., Greenberg, A. E. and Eaton, A. D. (Eds), Standard Methods for the Examination of Water and Wastewater, Washington, D.C., 21st Ed., 2001.
4. Quasim, S. R., "Water treatment plants planning, design and operation", CRC Press, 2nd Edition, 2010.

Course Objectives:

1. To provide exposure to the techniques and tools for the design and conduct of the experiments.
2. To provide an opportunity to contribute individually/ in groups to the development of experimental set ups by applying the acquired technological knowledge.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	Descriptor
CO1	**Design** experiments by applying the acquired knowledge on techniques and tools.	VI	Creating
CO2	**Carry out** experimental studies for characterization, parameter estimation, and performance evaluation independently and in teams.	III	Applying
CO3	**Analyze, critique, and interpret** experimental results through application of modern engineering tools and **conclude** based on the results.	IV V	Analyzing Evaluating

CO-PO Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1			3			
CO2			3			
CO3				3		

Assessments:

Teacher Assessment:

In Semester Evaluations (ISE 1 & ISE 2), Mid Semester Evaluation (MSE) and End Semester Examination (ESE) have 25% weights each.

Assessment	**Marks**
ISE 1	25

Title of the Course: **Biological Methods for Wastewater Treatment (4EV521)**	L	T	P	Cr
	3	-	-	3

Pre-Requisite Courses: A course on Wastewater Treatment at graduate level and Physico-Chemical Methods for Water and Wastewater Treatment

Textbooks:

1. Peavy H, S, Rowe D, R, and Tchobanoglous G, "Environmental Engineering", McGraw-Hill Book Company, Indian edition 2017.
2. Metcalf and Eddy "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, Indian Edition 2017.
3. Unit Operations and Processes in Environmental Engineering, 2nd Edition, by Tom D. Reynolds and Paul A. Richards, PWS Publishing Company, 1995.

References:

1. Droste, Ronald L "Theory and Practice of Water and Wastewater Treatment", Wiley student Edition, 2009.
2. Crites Ron and Tchobanoglous George, "*Small and Decentralized Wastewater Management Systems*", McGraw-Hill Book Company, International edition, 1998.
3. Sincero A, P and Sincero G, A, *"Environmental Engineering A Design approach",* PHI learning private limited, 2004.
4. Quasim, S. R., "Wastewater treatment plants planning, design and operation", CRC Press, 2nd Edition, 2010.

Course Objectives :

1. To provide conceptual and field knowledge for the analysis, design and evaluation of biological processes of wastewater treatment.
2. To enhance the technical competency to conduct research and address the problems of industry/society related to wastewater treatment.
3. To inculcate the qualities of critical thinking.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	**Explain and Apply** the acquired knowledge on biological wastewater treatment.	II III	Understanding Applying
CO2	**Analyze** and **evaluate** the suspended and attached growth, aerobic and anaerobic biological wastewater treatment systems at secondary and tertiary levels.	IV V	Analyzing Evaluating
CO3	**Design** wastewater treatment and sludge processing facilities.	VI	Creating

CO-PO Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1			3			
CO2				3		
CO3						3

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	**Marks**
ISE 1	10
MSE	30
ISE 2	10
ESE	50

Title of the Course: **Air Pollution and Control (4EV522)**	L	T	P	Cr
	3	-	-	3

Pre-Requisite Courses: Environmental Engineering

Textbooks:

1. Wark and Warner, "Air Pollution", C.F., H.R. Publication, 1st Edition, 1978.
2. Nevers N., "Air Pollution control Engineering" McGraw-Hill, New York, 2nd edition, 1995.
3. Martin Crawford, "Air Pollution and Control", Tata McGraw Hill Publication, 1st Edition, 1976.

References:

1. Richard W. Boubel and Bruce Turner, "Fundamentals of Air Pollution", Academic Press, New York, Third edition, 1994.
2. Stern A. C., "Air Pollution Vol. I and II", Allied Publishers Limited, 1st Edition, 1994.
3. Rao H.V.N. and Rao M. N., "Air Pollution", Tata McGraw Hill, 1st Edition, 1989.

Course Objectives :

1. To provide knowledge on physics of atmosphere, meteorology and its relation to air pollution, different types of air pollution control equipment.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	**Recognize, and summarize** scientific and engineering principles for air pollution studies.	I II	Remembering Understanding
CO2	**Apply** appropriate dispersion models **estimate** air pollutant concentrations	III V	Applying Evaluating
CO3	**Analyze** situations leading to air pollution and **design** air pollution control strategies with due consideration to technical, environmental, health, safety and social considerations	IV V	Analyzing Evaluating

CO-PO Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1			3			
CO2			3			3
CO3				3		3

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	**Marks**
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.
MSE: Assessment is based on 50% of course content (Normally first three modules)
ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Air pollution: A retrospective	**7 Hrs.**
Air pollution: sources and types and effects on biosphere, National and international air emission standards; air pollution emission inventory; emission factor; air quality index; Strategy for effective control of air pollution in India, Introduction to air pollution control	

Title of the Course: Professional Elective 3 **Environmental Management Systems (4EV531)**	L	T	P	Cr
	3	-	-	3

Pre-Requisite Courses: Environmental Engineering Course at Graduate Level

Textbooks:

1. Canter, L. W., Environmental Impact Assessment, McGraw-Hill, 2nd Edition, 1997.
2. Agarwal, N. P., Environmental Reporting and Auditing, Raj Pub., 1st Edition, 2002.
3. Judith, P. and Eduljee, G., Environmental Impact Assessment for Waste Treatment and Disposal Facilities, John Wiley & Sons, 1st Edition, 1994.

References:

1. "Environmental Auditing", Published by CPCB, Govt. of India Publication, New Delhi.
2. Mhaskar, A.K., Environmental Audit", Media Enviro Publications, 2002.
3. K. Whitelaw and Butterworth, ISO 14001: Environmental System Handbook, 1997.

Course Objectives :

1. To provide knowledge of ecological aspects.
2. To provide knowledge of Environmental Ethics.
3. To provide knowledge of environmental legislation.
4. To provide necessary knowledge of managerial tools required for assessing, analyzing and solving problems in the field of environmental management.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	Explain ecological imbalance due to various types of pollution and perceive environmental ethics and legislation.	II	Understanding
CO2	Choose appropriate methodology for EIA and auditing and assess the impacts.	III IV	Applying Analyzing
CO3	Justify EMS and Environmental Management Plan for infrastructural facilities.	V	Evaluating

CO-PO Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1			1		2	
CO2			2	2		
CO3		1	3	3		

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	**Marks**
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Ecological Aspects and Noise Pollution	**7 Hrs.**
Ecological aspects: Salient features of major Eco Systems, Energy Transfer, Population Dynamics, Ecological imbalance, Preservation of Biodiversity. Land Pollution, Water	

Title of the Course: Professional Elective 3 **Hazardous Waste Management (4EV532)**	L	T	P	Cr
	3	-	-	3

Pre-Requisite Courses: Wastewater and Industrial Waste treatment

Textbooks:

1. LaGrega, M. D., Buckingham, P. L. and Evans, J. C., Hazardous Waste Management, 2nd Edition, McGraw Hill, 2001.
2. Metcalf and Eddy "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, 6th Reprint, 2003.

References:

1. Sincero A, P and Sincero G, A, "Environmental Engineering A Design approach", PHI learning private limited, 2004.
2. Wentz, C. A., Hazardous Waste Management, 2nd Ed., McGraw Hill, 1995.
3. Lewandowski G.A. and DeFilippi L.J., Biological Treatment of Hazardous Wastes, John Wiley & Sons, 1998.

Course Objectives :

1. Provide in-depth knowledge of hazardous waste management.
2. To enhance the technical competency and apply the acquired knowledge for research and development, industry, and consultancy activities.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	**Explain** characterization, waste minimization, transportation, site remediation, and risk associated with hazardous waste.	II	Understanding
CO2	**Explain** and **Apply** the physical, chemical, and biological methods of treating hazardous waste.	II III	Understanding Applying
CO3	**Design** treatment and disposal facilities for hazardous waste.	VI	Creating

CO-PO Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1			2			
CO2				2		
CO3				2		2

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	**Marks**
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.

Course Contents:

Module 1: Introduction to hazardous Waste Management	**5 Hrs.**
Hazardous waste: Definition, Sources, Characterization, Classification, Magnitude of problem, Concept of toxicity, Assessment of sites.	

Title of the Course: Professional Elective 4 **Energy and Buildings (4EV536)**	L	T	P	Cr
	3	-	-	3

Pre-Requisite Courses: Building Materials and Construction, Building Planning and Design

Textbooks:

1. Renewable Energy: Power for Sustainable Future, Ed. By Godfrey Boyle, Oxford Univ. Press, Third Edition.
2. Manual of tropical Housing and Building- Climatic Design by Koenigsberger, Ingersoll, Mayhew, Szokolay.
3. Alternative Building materials and Technologies by K.S. Jagadish, B.V.Venkatarama Reddy, K. S. Nanjunda Rao.

References:

1. Passive and Low Energy Building Design for Tropical Island Climates- by N. V. Baker, Published by Commonwealth Science Council, May 1987.
2. Energy Policy in the Greenhouse, Florentin Krause, Earthscan Pub. Ltd. London.
3. World Energy Investment Outlook- Special Report, International Energy Agency, London, 2014.

Course Objectives :

1. To introduce the PG students, the scientific and engineering principles of energy
2. To impress upon the integration of new materials and traditional techniques to bring about cost effectiveness, energy efficiency and environmental friendly technologies in construction industry.
3. Imparting the objective of environmental friendly building concepts during the construction and operational phases.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	***Grasp*** the language of energy in context to energy policies and ***interpret*** the relevance of environment and energy efficiency in context to nonrenewable and renewable energy resources.	II	Understanding
CO2	***Estimate*** the energy contribution of various materials and components in buildings and develop an ability to ***justify*** appropriate/environmental friendly/energy efficient building systems.	IV	Analyzing
CO3	***Apply*** the concept of heat exchange in buildings and adopt passive and active design strategies to maximize human comfort in buildings for tropical regions.	III	Applying

CO-PO Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1	2		2			
CO2	2			3		
CO3	2			3		

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	**Marks**
ISE 1	10
MSE	30
ISE 2	10
ESE	50

Title of the Course: Professional Elective 4 **Industrial Wastewater Pollution and Control (4EV537)**	L	T	P	Cr
	3	-	-	3

Pre-Requisite Courses: A course on Wastewater Treatment at graduate level and Physico-Chemical Methods for Water and Wastewater Treatment

Textbooks:

1. Peavy H, S, Rowe D, R, and Tchobanoglous G, "Environmental Engineering", McGraw-Hill Book Company, Indian edition 2017.
2. Metcalf and Eddy "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, Indian Edition 2017.
3. Unit Operations and Processes in Environmental Engineering, 2nd Edition, by Tom D. Reynolds and Paul A. Richards, PWS Publishing Company, 1995.

References:

1. Droste, Ronald L "Theory and Practice of Water and Wastewater Treatment", Wiley student Edition, 2009.
2. Crites Ron and Tchobanoglous George, "*Small and Decentralized Wastewater Management Systems*", McGraw-Hill Book Company, International edition, 1998.
3. Sincero A, P and Sincero G, A, *"Environmental Engineering A Design approach",* PHI learning private limited, 2004.
4. Quasim, S. R., "Wastewater treatment plants planning, design and operation", CRC Press, 2nd Edition, 2010.

Course Objectives :

1. To provide conceptual and field knowledge for the analysis, design and evaluation of biological processes of wastewater treatment.
2. To enhance the technical competency to conduct research and address the problems of industry/society related to wastewater treatment.
3. To inculcate the qualities of critical thinking.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	**Explain** and **apply** concepts of industrial wastewater treatment.	II III	Understanding Applying
CO2	**Analyze** and **evaluate** the physical and chemical treatment systems used in water and wastewater.	IV V	Analyzing Evaluating
CO3	**Design** physical and chemical treatment systems for water and wastewater.	VI	Creating

CO-PO Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1			2			
CO2				3		
CO3				2		3

Assessments:

Teacher Assessment:

Two components of In Semester Evaluation (ISE), One Mid Semester Examination (MSE) and one End Semester Examination (ESE) having 20%, 30% and 50% weights respectively.

Assessment	**Marks**
ISE 1	10
MSE	30
ISE 2	10
ESE	50

ISE 1 and ISE 2 are based on assignment/declared test/quiz/seminar etc.

MSE: Assessment is based on 50% of course content (Normally first three modules)

Title of the Course: MSW Characterization and Air Quality Monitoring Laboratory (4EV571)	L	T	P	Cr
	-	-	4	2

Pre-Requisite Courses: Solid Waste Management & Air Pollution and Control

Textbooks:

1. Wayne T. D., Air Pollution Engineering Manual, John Wiley & Sons, 2000.
2. Rao C. S., Environmental Pollution Control Engineering, New Age Int. Pubs, 2005.
3. "Manual for wet and dry depositing", CPCB Methods, Central Lab test methods, 2001.

References:

1. Sincero A. P. and Sincero G, A, "Environmental Engineering A Design approach", PHI learning Private limited, 2004.
2. Nathanson J. A. "Basic Environmental technology for water supply, waste management and Pollution control", PHI Publishing Company, 5th Edition, 2009.
3. Wark K. and Warner C.F., "Air Pollution", C.F., H.R. Publication, 1st Edition, 1978.

Course Objectives:

1. To provide hands on practice to analyze quality of ambient air, noise levels, stack emissions and MSW.
2. To provide knowledge to analyze environmental condition.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	Bloom's Cognitive	
		Level	**Descriptor**
CO1	**Recognize** and **explain** use of instrumentation for air, and noise monitoring and MSW Characterization.	I II	Remembering Understanding
CO2	**Use** instrumentation for air, and noise monitoring and MSW Characterization.	III	Applying
CO3	**Assess** environmental condition by using results obtained through experimentation	V	Evaluating

CO-PO Mapping:

PO	1	2	3	4	5	6
CO1			2	3		
CO2				3		2
CO3				3		2

Assessments:

Teacher Assessment:

In Semester Evaluations (ISE 1 & ISE 2), Mid Semester Evaluation (MSE) and End Semester Examination (ESE) have 25% weights each.

Assessment	Marks
ISE 1	25
MSE	25
ISE 2	25
ESE	25

ISE 1, ISE 2 and MSE are based on experimental work/performance in laboratory/assignment/declared test/etc.

ESE assessment is based on performance and oral.

Course Contents:

List of Experiments:

Part A:

Title of the Course:	L	T	P	Cr
Wastewater Treatability Studies Laboratory (4EV572)	-	-	4	2

Pre-Requisite Courses: Physico-Chemical Methods for Water and Wastewater Treatment and Biological Methods for Wastewater Treatment

Textbooks:

1. Hammer M, J and Hammer M, J, "Water and Wastewater Technology", PHI learning private limited, 6th Edition, 2008.
2. Metcalf and Eddy "Wastewater Engineering Treatment and Reuse", Tata McGraw Hill Publication, 6th Reprint. 2003.
3. Lee C, C and Lin S, D, "Hand book of environmental engineering calculations", McGraw Hill Publication, 2nd Edition. 2007.

References:

1. Sawyer and McCarty, "Chemistry for Environmental Engineers", Tata McGraw Hill, Edition 5, 2003.
2. Clesceri, L. S., Greenberg, A. E. and Eaton, A. D. (Eds), Standard Methods for the Examination of Water and Wastewater, Washington, D.C., 21st Ed., 2001.
3. Quasim, S. R., "Wastewater treatment plants planning, design and operation", CRC Press, 2nd Edition, 2010.

Course Objectives :

1. To provide hands-on practice to plan, design and conduct experiments.

Course Learning Outcomes:

CO	After the completion of the course the student should be able to	**Bloom's Cognitive**	
		Level	**Descriptor**
CO1	**Design** and **conduct** experiments using appropriate techniques and tools to demonstrate research skill individually/groups.	VI	Creating
CO2	**Analyze, critique,** and **interpret** results of experimental studies on performance evaluation and characterization studies.	IV V	Analyzing Evaluating

CO-PO Mapping:

PO	**1**	**2**	**3**	**4**	**5**	**6**
CO1			3			
CO2				3		

Assessments:

Teacher Assessment:

In Semester Evaluations (ISE 1 & ISE 2), Mid Semester Evaluation (MSE) and End Semester Examination (ESE) have 25% weights each.

Assessment	Marks
ISE 1	25
MSE	25
ISE 2	25
ESE	25

ISE 1, ISE 2 and MSE are based on experimental work/performance in laboratory/assignment/declared test/etc.

ESE assessment is based on performance and oral.

Course Contents:

List of Experiments:

ESE: Assessment is based on 100% course content with 60-70% weightage for course content (normally last three modules) covered after MSE.	
Course Contents:	
Module 1: Engineering Research Process	**6 Hrs.**
Meaning of research problem, Sources of research problem, Criteria and Characteristics of a good research problem, Errors in selecting a research problem, Definition, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.	
Module 2: Research Methodology Tools	**7 Hrs.**
Problem statement formulation, resources identification for solution, Experimental and Analytical modelling, Numerical and Statistical methods in engineering research, Software tools like spread sheets.	
Module 3: Research Ethics and Report Writing	**6 Hrs.**
Effective literature studies approaches, critical analysis, Plagiarism, Research ethics, Effective technical writing, how to write report, Paper. Presentation of paper/report/seminar.	
Module 4: Introduction to IPR and Patents	**7 Hrs.**
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT. Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies	
Module wise Outcomes: At end of each module students will be able to: 1. Identify and formulate the research problems, state the hypothesis, design a research layout, set a research process and methodology. 2. Apply research tools to obtain solution to research problem. 3. Analyze critically existing literature and prepare seminar, write research article and report. 4. Create IPR in his domain of research and produce patent.	