

ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
M. E. ENVIRONMENTAL ENGINEERING
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
I TO IV SEMESTERS CURRICULA AND I SEMESTER SYLLABUS
SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA4159	Statistical Methods for Engineers	FC	4	0	0	4	4
2.	EV4101	Environmental Chemistry	PCC	3	0	0	3	3
3.	EV4102	Environmental Microbiology	PCC	3	0	0	3	3
4.	EV4103	Physical and Chemical Treatment Systems for Water and Wastewater	PCC	3	0	0	3	3
5.	EV4104	Water Transmission, Water Distribution and Sewerage Systems	PCC	3	0	0	3	3
6.	RM4151	Research Methodology and IPR	RMC	2	0	0	2	2
7.		Audit Course I*	AC	2	0	0	2	0
PRACTICALS								
8.	EV4111	Environmental Chemistry Laboratory	PCC	0	0	4	4	2
9.	EV4112	Environmental Microbiology Laboratory	PCC	0	0	4	4	2
TOTAL				20	0	8	28	22

* Audit Course is optional

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	EV4201	Biological Treatment Process for Wastewater	PCC	3	0	0	3	3
2.	EV4202	Air and Noise Pollution Control Engineering	PCC	3	0	0	3	3
3.	EV4203	Industrial Wastewater Pollution-Prevention and Control	PCC	3	0	0	3	3
4.		Professional Elective I	PEC	3	0	0	3	3
5.		Professional Elective II	PEC	3	0	0	3	3
6.		Professional Elective III	PEC	3	0	0	3	3
7.		Audit Course II*	AC	2	0	0	2	0
PRACTICALS								
8.	EV4211	Environmental and Processes Monitoring Laboratory	PCC	0	0	6	6	3
TOTAL				20	0	6	26	21

* Audit Course is optional

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE- GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Professional Elective IV	PEC	3	0	0	3	3
2.		Professional Elective V	PEC	3	0	0	3	3
3.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
4.	EV4311	Technical Seminar	EEC	0	0	2	2	1
5.	EV4312	Industrial Training (2 Weeks)	EEC	0	0	0	0	1
6.	EV4313	Project Work I	EEC	0	0	12	12	6
TOTAL				9	0	14	23	17

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE- GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	EV4411	Project Work II	EEC	0	0	24	24	12
TOTAL				0	0	24	24	12

TOTAL CREDITS: 72

FOUNDATION COURSES (FC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	MA4159	Statistical Methods for Engineers	4	0	0	4	1

PROFESSIONAL CORE COURSES (PCC)

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	EV4101	Environmental Chemistry	3	0	0	3	1
2.	EV4102	Environmental Microbiology	3	0	0	3	1
3.	EV4103	Physical and Chemical Treatment Systems for Water and Wastewater	3	0	0	3	1
4.	EV4104	Water Transmission, Water Distribution and Sewerage Systems	3	0	0	3	1
5.	EV4111	Environmental Chemistry	0	0	4	2	1
6.	EV4112	Environmental Microbiology Laboratory	0	0	4	2	1
7.	EV4201	Biological Treatment process for Wastewater	3	0	0	3	2
8.	EV4202	Air and Noise Pollution Control Engineering	3	0	3	3	2
9.	EV4203	Industrial Wastewater Pollution-Prevention and Control	3	0	0	3	2
10.	EV4211	Environmental and Processes Monitoring Laboratory	0	0	6	3	2
TOTAL CREDITS						28	

LIST OF PROFESSIONAL ELECTIVE COURSES [PEC]**SEMESTER II, ELECTIVE I**

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	EV4001	Solid and Hazardous Waste Management	3	0	0	3	3
2.	EV4002	Natural Systems for Wastewater Treatment	3	0	0	3	3
3.	EV4003	Environmental System Analysis	3	0	0	3	3

SEMESTER II, ELECTIVE II

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	EV4004	Environmental Impact Assessment	3	0	0	3	3
2.	EV4005	Septage and Onsite Wastewater Treatment	3	0	0	3	3
3.	EV4006	Sustainability Engineering	3	0	0	3	3
4.	EV4007	Project Formulation and Implementation	3	0	0	3	3

SEMESTER II, ELECTIVE III

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	EV4008	Advanced Oxidation Process	3	0	0	3	3
2.	EV4009	Computing Techniques in Environmental Engineering	3	0	0	3	3
3.	EV4010	Geo Environmental Engineering	3	0	0	3	3
4.	EV4011	Environmental Monitoring Instruments	3	0	0	3	3

SEMESTER III, ELECTIVE IV

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	EV4012	Water Quality Modeling	3	0	0	3	3
2.	EV4013	Marine Pollution and Control	3	0	0	3	3
3.	EV4014	Climate Change and Modeling	3	0	0	3	3
4.	EV4015	Operation and Maintenance of Water and Wastewater Treatment Systems	3	0	0	3	3

SEMESTER III, ELECTIVE V

S NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
			L	T	P		
1.	EV4016	Air Quality Modeling	3	0	0	3	3
2.	EV4017	Fate and Remediation of Emerging Contaminants	3	0	0	3	3
3.	EV4018	Environmental Reaction Engineering	3	0	0	3	3
4.	EV4019	Membrane Separation for Water and Wastewater Treatment	3	0	0	3	3

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	RM4151	Research Methodology and IPR	2	0	0	2	1
TOTAL CREDITS						2	

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S. NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	EV4311	Technical Seminar	0	0	2	1	3
2.	EV4312	Industrial Training (2 Weeks)	0	0	0	1	3
3.	EV4313	Project Work I	0	0	12	6	3
4.	EV4411	Project Work II	0	0	24	12	4
TOTAL CREDITS						20	

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

S. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	AX4091	English for Research Paper Writing	2	0	0	0	1/2
2.	AX4092	Disaster Management	2	0	0	0	
3.	AX4093	Constitution of India	2	0	0	0	
4.	AX4094	நற்றமிழ் இலக்கியம்	2	0	0	0	

SUMMARY

S. No.	Name of the Programme: M.E. ENVIRONMENTAL ENGINEERING					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	04	00	00	00	04
2.	PCC	16	12	0	00	28
3.	PEC	00	9	6	00	15
4.	RMC	02	00	00	00	02
5.	OEC	00	00	3	00	03
6.	EEC	00	00	08	12	20
7.	Non Credit/Audit Course	✓	✓	00	00	00
8.	TOTAL CREDIT	22	21	17	12	72

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OBJECTIVES :

- This course is designed to provide the solid foundation on topics in various statistical methods which form the basis for many other areas in the mathematical sciences including statistics, modern optimization methods and risk modeling. It is framed to address the issues and the principles of estimation theory, testing of hypothesis, correlation and regression, design of experiments and multivariate analysis.

UNIT I ESTIMATION THEORY**12**

Estimators : Unbiasedness, Consistency, Efficiency and sufficiency – Maximum likelihood estimation – Method of moments.

UNIT II TESTING OF HYPOTHESIS**12**

Sampling distributions - Small and large samples -Tests based on Normal, t, Chi square, and F distributions for testing of means, variance and proportions – Analysis of r x c tables – Goodness of fit.

UNIT III CORRELATION AND REGRESSION**12**

Multiple and partial correlation – Method of least squares – Plane of regression – Properties of residuals – Coefficient of multiple correlation – Coefficient of partial correlation – Multiple correlation with total and partial correlations – Regression and partial correlations in terms of lower order co-efficient.

UNIT IV DESIGN OF EXPERIMENTS**12**

Analysis of variance – One way and two way classifications – Completely randomized design – Randomized block design – Latin square design - 2^2 Factorial design.

UNIT V MULTIVARIATE ANALYSIS**12**

Random vectors and matrices – Mean vectors and covariance matrices – Multivariate normal density and its properties – Principal components : Population principal components – Principal components from standardized variables.

TOTAL: 60 PERIODS**OUTCOMES :**

After completing this course, students should demonstrate competency in the following topics:

- Consistency, efficiency and unbiasedness of estimators, method of maximum likelihood estimation and Central Limit Theorem.
- Use statistical tests in testing hypotheses on data.
- Concept of linear regression, correlation, and its applications.
- List the guidelines for designing experiments and recognize the key historical figures in Design of Experiments.
- Perform exploratory analysis of multivariate data, such as multivariate normal density, calculating descriptive statistics, testing for multivariate normality.

The students should have the ability to use the appropriate and relevant, fundamental and applied mathematical and statistical knowledge, methodologies and modern computational tools.

REFERENCES :

- Gupta.S.C., and Kapoor, V.K., "Fundamentals of Mathematical Statistics", 12th Edition, Sultan Chand and Sons, 2020.
- Jay L. Devore, "Probability and statistics for Engineering and the Sciences", 8th Edition, Cengage Learning, 2014.
- Johnson, R.A., Miller, I and Freund J., "Miller and Freund's Probability and Statistics for Engineers", 9th Edition, Pearson Education, Asia, 2016.

- Johnson, R.A. and Wichern, D. W. "Applied Multivariate Statistical Analysis", 6th Edition, Pearson Education, Asia, 2012.
- Rice, J.A. "Mathematical Statistics and Data Analysis", 3rd Edition, Cengage Learning, 2015.

EV4101

ENVIRONMENTAL CHEMISTRY

L T P C
3 0 0 3

OBJECTIVES:

- To educate the students in the area of water, air and soil chemistry
- To explain the theoretical basis and observational methods for study of contaminants and interactions in the environment

UNIT I FUNDAMENTALS

9

Stoichiometry and mass balance-Chemical equilibria, acid base, solubility product(K_{sp}) ,heavy metal precipitation, amphoteric hydroxides, CO_2 solubility in water and species distribution – Ocean acidification, Chemical kinetics , First order- 12 Principles of green chemistry.

UNIT II AQUATIC CHEMISTRY

11

Water and wastewater quality parameters- environmental significance and determination; Fate of chemicals in aquatic environment, volatilization, partitioning, hydrolysis, photochemical transformation– Degradation of synthetic chemicals - Metals, complex formation, oxidation and reduction , pE – pH diagrams, redox zones – sorption- Colloids, electrical properties, double layer theory, environmental significance of colloids, coagulation .

UNIT III ATMOSPHERIC CHEMISTRY

7

Atmospheric structure – chemical and photochemical reactions – photochemical smog. Ozone layer depletion – greenhouse gases and global warming, CO_2 capture and sequestration – acid rain- origin and composition of particulates. black carbon, air quality parameters determination.

UNIT IV SOIL CHEMISTRY

9

Nature and composition of soil - Clays- cation exchange capacity-acid base and ion-exchange reactions in soil – agricultural chemicals in soil-reclamation of contaminated land; salt by leaching- Heavy metals by electrokinetic remediation.

UNIT V EMERGING POLLUTANTS

9

Heavy metals-chemical speciation –Speciation of Hg & As- endocrine disturbing chemicals- Pesticides, Dioxins & Furan, PCBs , PAHs and Fluro compounds toxicity- Nano materials, CNT, titania, composites ,environmental applications.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Students will gain competency in solving environmental issues of chemicals based pollution
CO2: Ability to determine chemicals mobility in aquatic systems
CO3: Ability to identify contaminating chemicals in air and their fate
CO4: Understand the type of soil contaminants and provide remediation
CO5: Identify emerging environmental contaminants including speciation

REFERENCES:

- Sawyer, C.N., Mac Carty, P.L. and Parkin, G.F., "Chemistry for Environmental Engineering and Science", Tata McGraw – Hill, Fifth edition, New Delhi 2003.
- Colin Baird,, Environmental Chemistry, Freeman and company, New York, 5th Edition,2012.
- Manahan, S.E., "Environmental Chemistry", Ninth Edition, CRC press, 2009.
- Ronald A. Hites , "Elements of Environmental Chemistry", Wiley, 2nd Edition,2012.

OBJECTIVES:

- The course provides a basic understanding on microbiology relevant to environmental engineering for candidates with little prior knowledge of the subject.
- The morphology, behaviour and biochemistry of bacteria, fungi, protozoa, viruses, and algae are outlined.
- The microbiology of wastewater, sewage sludge and solid waste treatment processes is also provided. Aspects on nutrient removal and the transmission of disease causing organisms are also covered.
- An exposure to toxicology due to industrial products and byproducts are also covered.

UNIT I FUNDAMENTALS OF MICROBIOLOGY**10**

Classification of microorganisms – prokaryotic, eukaryotic, cell structure, characteristics, importance, introduction to water, soil and air borne pathogens and Parasites and their effects on human, animal and plant health, transmission of pathogens, transmissible diseases – bacterial, viral, protozoan, and helminths parasites, concentration and detection of virus. control of microorganisms preservation of microorganisms, DNA, RNA, replication, recombinant DNA technology, their potential applications and intellectual property rights.

UNIT II MICROBIAL DIVERSITY AND NUTRIENT TURNOVER**10**

Distribution of microorganisms in different environments – diversity of microorganisms – fresh and marine, terrestrial – microbes in surface soil, air – outdoor and Indoor, aerosols, bio safety in laboratory – extreme environment – archae bacteria – occurrence in water supplies – problems and control. biogeochemical cycles-nitrogen, carbon, phosphorus, sulphur – Role of Microorganism in nutrient cycle.

UNIT III METABOLISM OF MICROORGANISMS**9**

Nutrition and metabolism in microorganisms, growth phases, carbohydrate, protein, lipid metabolism – respiration, aerobic and anaerobic-fermentation, glycolysis, Kreb's cycle, hexose monophosphate pathway, electron transport system, oxidative phosphorylation, environmental factors, enzymes, bioenergetics, disruption in metabolism and disease. biodegradation of organic pollutants

UNIT IV MICROBIOLOGY OF WASTEWATER TREATMENT SYSTEMS**8**

Microbiology of biological treatment processes – aerobic and anaerobic, α -oxidation, β -oxidation, nitrification and denitrification, eutrophication. nutrients removal – BOD, nitrogen, phosphate. microbiology of sewage sludge - indicator organisms of water – coliforms - total coliforms, E-coli, streptococcus, clostridium, Bioleaching

UNIT V TOXICOLOGY**8**

Ecotoxicology – toxicants and toxicity, factors influencing toxicity. effects – acute, chronic, test organisms – toxicity testing-lab and field testing methods, bioconcentration – Bioaccumulation, biomagnification, bioassay, biomonitoring.

TOTAL: 45 PERIODS**OUTCOMES:**

- On completion of the course, the student is expected to be able to
 - CO1** Explain the basic importance and functional elements of environmental microbiology including the potential applications in the environment and intellectual property rights.
 - CO2** Understand and describe the type of microorganisms in the environment, their importance in water supplies and the role of microorganisms in the cycling of nutrients in an ecosystem.
 - CO3** Understand the metabolic processes on carbohydrates, protein and lipids, importance of enzymes, production of energy and the various additional metabolic processes.

- CO4** Select and apply appropriate methods for assessing the water, air and soil borne pathogens, their health implications, importance of microbes in aerobic and anaerobic cycles and deterioration of water bodies.
- CO5** Conduct testing and research on toxicology, understand the importance of test organisms, environmental applications such as biomagnifications, biomonitoring and in developing risk based standards.

REFERENCES:

1. Bhatia S.C. , "Hand Book of Environmental Microbiology", Part 1 and 2, Atlantic Publisher, 2008
2. Gabriel Bitton, Wastewater Microbiology, 2nd Edition, 3. Raina M. Maier, Ian L. Pepper, Charles P. Gerba, "Environmental Microbiology", Academic Press, 2000
4. Volodymyr Ivanov, Environmental Microbiology for Engineers 2nd Edition, CRC Press, 2015, ISBN 9781498702126
5. Nduka Okafor, Environmental Microbiology of Aquatic and Waste systems. Springer Publishers, 2011, ISBN 978-94-007-1459-5
6. Stanley E. Manahan, "Environmental Science and Technology", Lewis Publishers, 2008.
7. Hurst, C.J. Manual of "Environmental Microbiology". 2nd Ed. ASM PRESS, Washington, D.C. ISBN 1-55581 - 199 - X. 2002
8. Frank C. Lu and Sam Kacew, LU's Basic Toxicology, Taylor & Francis, London 4th Ed, 2002.

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EV4103

PHYSICAL AND CHEMICAL TREATMENT SYSTEMS FOR WATER AND WASTEWATER

L T P C
3 0 0 3

OBJECTIVE:

- To understand about the various pollutants present in water and wastewater and to choose the respective physico-chemical systems for effective treatment
- To apply the knowledge for municipal, industrial water and wastewater treatment plants and design suitable treatment schemes
- To advance knowledge on the emerging environmental issues on treatment systems and conduct research to identify most appropriate treatment schemes

UNIT I INTRODUCTION

5

Pollutants in water and wastewater—characteristics, standards for performance- significance of physico-chemical treatment—Selection criteria-types of reactor-reactor selection-batch-continuous type-kinetics

UNIT II TREATMENT PRINCIPLES

10

Physical treatment - screening – mixing, equalization –sedimentation – filtration – evaporation– incineration–gas transfer–mass transfer coefficient adsorption – isotherms – membrane separation, Reverse Osmosis, nanofiltration, ultrafiltration and electrodialysis, distillation– stripping and crystallization – recent advances.

Principles of Chemical treatment– Coagulation - flocculation–Precipitation – flotation - solidification and stabilization–Disinfection, Ion exchange, Electrolytic methods, Solvent extraction–advanced oxidation/reduction– recent trends

UNIT III DESIGN OF MUNICIPAL WATER TREATMENT PLANTS 10

Selection of treatment–design of municipal water treatment plant units–aerators–chemical feeding–flocculation–clarifier–tube settling–filters–rapid sand filters, slow sand filter, pressure filter, dual media filter – disinfection flow charts– layouts –hydraulic profile ,PID-construction and O&M aspects–case studies, residue management – upgradation of existing plants – recent trends.

UNIT IV DESIGN OF INDUSTRIAL WATER TREATMENT PLANTS 10

Design of industrial water treatment units-selection of process–design of softeners – demineralisers–Reverse osmosis plants–flow charts–layouts–hydraulic profile, PID-construction and O&M aspects–case studies, residue management–upgradation of existing plants –recent trends.

UNIT V DESIGN OF WASTEWATER TREATMENT PLANTS 10

Design of municipal wastewater treatment units-screens- grit chamber-settling tanks- sludge thickening - sludge dewatering systems - sludge drying beds - design of industrial wastewater treatment units - equalization - neutralization - chemical feeding devices – mixers - floatation units - oil skimmer - flowcharts – layouts – hydraulic profile, PID, construction and O&M aspects – case studies, retrofitting - residue management – upgradation of existing plants – recent trends.

TOTAL: 45 PERIODS

OUTCOME:

- On Completion of the course, the student is expected to be able to

- CO1** Explain the significance of various pollutants present in water, wastewater and develop the kinetics for reactor design
- CO2** Choose the relevant physico-chemical systems for effective water and wastewater treatment
- CO3** Design the treatment scheme for municipal and industrial water, wastewater to meet the specific needs on residue management and up gradation of existing plants
- CO4** Identify environmental issues in the society on wastewater treatment and formulate technical solutions that are economically feasible and socially acceptable
- CO5** Conduct research to identify and design most appropriate treatment schemes for the emerging environmental issues on treatment systems in collaboration with municipalities, corporation, pollution control boards and industries

REFERENCES:

1. Metcalf & Eddy, Inc., George Tchobanoglous, Franklin L. Burton and H. David Stensel, Wastewater engineering, treatment and reuse, Fourth Edition, McGraw-Hill, 2017
2. Lee, C.C. and Shun dar Lin, "Handbook of Environmental Engineering Calculations", McGraw Hill, New York, 1999.
3. Qasim.S.R., Guang Zhu., "Wastewater Treatment and Reuse" – Volume 1& 2 2018.
4. CPHEEO manual – "Manual for sewerage and sewage treatment systems" – Part A,B,C, Ministry of Urban development, New Delhi,2013.
5. CPHEEO manual – "Manual for water supply and treatment" –Ministry of Urban development, New Delhi, 1999.

OBJECTIVE:

- To educate the students on economic design of water mains, distribution system and sewer networks

UNIT I GENERAL HYDRAULICS**8**

Fluid properties; fluid flow – continuity principle, energy principle and momentum principle; frictional head loss in free and pressure flow, minor head losses, carrying capacity– flow measurement. need for transport of water and wastewater and types

UNIT II WATER TRANSMISSION MAINS**9**

Planning of water system – design of storage reservoirs - water transmission main design- compound gravity and pumping main; selection of pumps and characteristics curve - economics; specials, jointing, laying and maintenance, water hammer analysis;

UNIT III WATER DISTRIBUTION**9**

Service reservoirs-types and design. water distribution pipe networks design, analysis and optimization – appurtenances – corrosion prevention – minimization of water losses – leak detection. plumbing for water supply in high rise buildings. use of computer software in water transmission, water distribution design – EPANET 2.0, LOOP version 4.0, BRANCH,

UNIT IV WASTEWATER COLLECTION AND CONVEYANCE**10**

Planning factors – design of sanitary sewer; partial flow in sewers, economics of sewer design; wastewater pumps and pumping stations- sewer appurtenances; material, construction, inspection and maintenance of sewers; design of sewer outfalls-mixing conditions; conveyance of corrosive wastewaters. plumbing for drains in high rise buildings

UNIT V STORM WATER DRAINAGE**9**

Necessity- combined and separate system; estimation of storm water runoff - formulation of rainfall intensity duration and frequency relationships- rational methods. use of computer software in sewer design–sewer. SewerCAD, SewerGEMS

TOTAL: 45 PERIODS**OUTCOMES:**

- On Completion of the Course the student will be able to

- CO1** Understand general hydraulics and need for proper collection and conveyance of water and wastewater
- CO2** Design economic diameters of gravity and pumping mains and storage reservoirs
- CO3** Design and analysis of water distribution networks and apply computer softwares
- CO4** Design sewer networks for various flow conditions
- CO5** Design storm water drain and apply computer softwares for design of sewers.

REFERENCES:

- Pramod R. Bhawe, Rajesh Gupta. "Analysis of Water Distribution Networks", Alpha Science International, 2006
- Bajwa, G.S. "Practical Handbook on Public Health Engineering", Deep Publishers, Shimla, 2003
- "Manual on water supply and Treatment", CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.
- "Manual on Sewerage and Sewage Treatment Part-A Engineering", CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 2013

UNIT I RESEARCH DESIGN**6**

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES**6**

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING**6**

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS**6**

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

UNIT V PATENTS**6**

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filing, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.

TOTAL :30 PERIODS**REFERENCES**

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013.

OBJECTIVES:

- To train in the analysis of physico-chemical parameters with hands on experience

1.	Good Laboratory Practices, Quality control, calibration of Glassware	8
2.	Sampling and Analysis of water (pH, alkalinity, hardness, chloride, Sulphate, turbidity EC, TDS, TS, nitrate, fluoride and Iron)	20
3.	Sampling and Wastewater analysis (BOD, COD, Phosphate, Ammonia, TKN, Oil & Grease, Surfactant and heavy metals)	20
4.	Sampling and characterization of soil (Moisture, EC, pH ,Na and K)	12

TOTAL: 60 PERIODS**OUTCOME:**

CO1 : Ability to calibrate and standardize the equipments

CO2 : Ability to collect proper sample for analysis

CO3 : The candidate ability to perform field oriented testing of water, wastewater and soil

CO4 : Able to perform soil testing

CO5 : Able to perform analysis of water and wastewater

REFERENCES:

1. APHA, "Standard Methods for the Examination of Water and Wastewater", 22nd Ed. Washington, 2012.
2. "Laboratory Manual for the Examination of water, wastewater soil Rump", H.H. and Krist, H. – Second Edition, VCH, Germany, 3rd Edition, 1999.
3. "Methods of air sampling & analysis", James P.Lodge Jr(Editor) 3rd Edition, Lewis publishers,Inc,USA,1989.

EV4112**ENVIRONMENTAL MICROBIOLOGY LABORATORY****L T P C
0 0 4 2****OBJECTIVE:**

- To train the students in the analysis of various microbiological techniques, microbiological analysis, enzyme assay, pollutant analysis and operation of bioreactors.

EXPERIMENTS:

1. Preparation of culture media,
2. Isolation and culturing of microorganisms
3. Microscopical identification of Microorganisms (algae, bacteria and fungi)
4. Measurement of growth of microorganisms,
5. Analysis of air borne microorganisms,
6. Staining of bacteria.
7. Effect of pH, temperature on microbial growth
8. Bacteriological analysis of wastewater (Coliforms, *E.coli*, *Streptococcus*) – MPN
9. Bacteriological analysis of wastewater (Coliforms, *Streptococcus*) - MF techniques,
10. Effect of Heavy metals on microbial growth.
11. Detection of Anaerobic bacteria (*Clostridium* sp.)
12. Bioreactors (cultivation of microorganisms)

TOTAL: 60 PERIODS**OUTCOMES:**

- On completion of the course, the student is expected to be able to

- CO1** Explain the basic importance and functional elements of environmental microbiology including the types of microorganisms in air, water and soil.
- CO2** Understand and describe the type of microorganisms in the environment, their importance and the method of culturing of microorganisms in the laboratory.
- CO3** Understand the basic biochemical method of identification of microorganisms and to identify them using microscopical tool.
- CO4** Select and apply appropriate methods for detection in the water, air and soil borne pathogens, their health implications, importance of microbes in our daily life.
- CO5** Conduct testing and research on toxicology, the importance of test organisms, environmental applications of such microorganisms in toxicological studies and in developing risk based standards.

REFERENCES:

1. APHA, "Standard Methods for the Examination of Water and Wastewater", 22nd Ed. Washington, 2012.
2. Charles P. Gerba, "Environmental Microbiology: A laboratory manual", Elsevier Publications, 2012.
3. Christon J. Hurst, Ronald L. Crawford, Jay L. Garland, David A. Lipson, Aaron L. Mills, and Linda D. Stetzenbach, "Manual of Environmental Microbiology", 3rd Edition, ASM Press, 2007.

AUDIT COURSES

AX4091

ENGLISH FOR RESEARCH PAPER WRITING

L T P C
2 0 0 0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING

6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS

6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS

6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS

6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS

6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS

OUTCOMES

CO1 – Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION**6**

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS**6**

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA**6**

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT**6**

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT**6**

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS**OUTCOMES**

- CO1: Ability to summarize basics of disaster
- CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- CO5: Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi, 2009.
2. Nishitha Rai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "NewRoyal book Company, 2007.
3. Sahni, Pardeep Et. Al. , " Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi, 2001.

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION

History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Panchayati raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO Zila Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

- The Constitution of India, 1950 (Bare Act), Government Publication.
- Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
- M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
- D. D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

UNIT I	சங்க இலக்கியம்	6
	1. தமிழின் துவக்க நூல் தொல்காப்பியம் - எழுத்து, சொல், பொருள் 2. அகநானூறு (82) - இயற்கை இன்னிசை அரங்கம் 3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி 4. புறநானூறு (95,195) - போரை நிறுத்திய ஔவையார்	
UNIT II	அறநெறித் தமிழ்	6
	1. அறநெறி வகுத்த திருவள்ளுவர் - அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புறவு அறிதல், ஈகை, புகழ் 2. பிற அறநூல்கள் - இலக்கிய மருந்து - ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல்)	
UNIT III	இரட்டைக் காப்பியங்கள்	6
	1. கண்ணகியின் புரட்சி - சிலப்பதிகார வழக்குரை காதை சமூகசேவை இலக்கியம் மணிமேகலை - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை	
UNIT IV	அருள்நெறித் தமிழ்	6
	1. சிறுபாணாற்றுப்படை - பாரி முல்லைக்குத் தேர் கொடுத்தது, பேகன் மயிலுக்குத் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள் 2. நற்றிணை - அன்னைக்குரிய புன்னை சிறப்பு 3. திருமந்திரம் (617, 618) - இயமம் நியமம் விதிகள் 4. தர்மச்சாலையை நிறுவிய வள்ளலார் 5. புறநானூறு - சிறுவனே வள்ளலானான் 6. அகநானூறு (4) - வண்டு நற்றிணை (11) - நண்டு கலித்தொகை (11) - யானை, புறா ஐந்திணை 50 (27) - மான் ஆகியவை பற்றிய செய்திகள்	

1. உரைநடைத் தமிழ்,
 - தமிழின் முதல் புதினம்,
 - தமிழின் முதல் சிறுகதை,
 - கட்டுரை இலக்கியம்,
 - பயண இலக்கியம்,
 - நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

TOTAL: 30 PERIODS

தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University) - www.tamilvu.org
2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia) - <https://ta.wikipedia.org>
3. தர்மபுர ஆதின வெளியீடு
4. வாழ்வியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம் - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம் - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்

