ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS AFFILIATED COLLEGES
REGULATIONS 2021

B. E. ENVIRONMENTAL ENGINEERING

CHOICE BASED CREDIT SYSTEM

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs) :

I. To prepare students for successful careers in Environmental Engineering field that meets the needs of National and International organisations.
II. To develop the confidence and ability among students to synthesize data and technical concepts and thereby apply it in real world problems.
III. To develop students to use modern techniques, skill and mathematical engineering tools for solving problems in Environmental Engineering.
IV. To provide students with a sound foundation in mathematical, scientific and engineering fundamentals necessary to formulate, solve and analyse environmental problems and to prepare them for graduate studies.
V. To promote students to work collaboratively on multi-disciplinary projects and make them engage in life-long learning process throughout their professional life.

PROGRAM OUTCOMES (POs)

PO#	Graduate Attribute
1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2	**Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of Mathematics, natural sciences, and engineering sciences.
3	**Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10 **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11 **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12 **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

Graduates of the programme B.E Environmental Engineering will be able to

PSO1 Knowledge of Environmental Engineering discipline
Demonstrate in-depth knowledge Environmental Engineering discipline, with an ability to evaluate, analyze and synthesize existing and new knowledge.

PSO2 Critical analysis of Environmental Engineering problems and innovation
Critically analyze complex Environmental Engineering problems, apply independent judgment for synthesizing information and make innovative advances in a theoretical, practical and policy context.

PSO3 Conceptualization and evaluation of engineering solutions to Environmental Engineering Issues Conceptualize and solve Environmental Engineering problems, evaluate potential solutions and arrive at technically feasible, economically viable and environmentally sound solutions with due consideration of health, safety, and socio-cultural factors

PROGRESS THROUGH KNOWLEDGE

ANNA UNIVERSITY, CHENNAI
NON-AUTONOMOUS AFFILIATED COLLEGES
REGULATIONS 2021
CHOICE BASED CREDIT SYSTEM
B. E. ENVIRONMENTAL ENGINEERING
CURRICULUM FOR SEMESTERS I TO VIII AND SYLLABI FOR SEMESTERS III AND IV

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	IP3151	Induction Programme	-	-	-	-	-	0
THEORY								
2.	HS3151	Professional English - I	HSMC	3	0	0	3	3
3.	MA3151	Matrices and Calculus	BSC	3	1	0	4	4
4.	PH3151	Engineering Physics	BSC	3	0	0	3	3
5.	CY3151	Engineering Chemistry	BSC	3	0	0	3	3
6.	GE3151	Problem Solving and Python Programming	ESC	3	0	0	3	3
7.	GE3152	அறிவியல் தமிழ் /Scientific Thoughts in Tamil	HSMC	1	0	0	1	1
PRACTICALS								
8.	GE3171	Problem Solving and Python Programming Laboratory	ESC	0	0	4	4	2
9.	BS3171	Physics and Chemistry Laboratory	BSC	0	0	4	4	2
10.	GE3172	English Laboratory[$]	EEC	0	0	2	2	1
			TOTAL	**16**	**1**	**10**	**27**	**22**

[$] Skill Based Course

SEMESTER II

S. NO.	COURSE CODE	COURSE TITLE	CATE-GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	HS3251	Professional English - II	HSMC	2	0	0	2	2
2.	MA3251	Statistics and Numerical Methods	BSC	3	1	0	4	4
3.	BE3252	Basic Electrical, Electronics and Instrumentation Engineering	ESC	3	0	0	3	3
4.	GE3251	Engineering Graphics	ESC	2	0	4	6	4
5.	BE3255	Basic Civil and Mechanical Engineering	ESC	3	0	0	3	3
6.		NCC Credit Course Level 1[#]	-	2	0	0	2	2[#]
7.	GE3252	தமிழர் மரபு /Heritage of Tamils	HSMC	1	0	0	1	1
PRACTICALS								
8.	GE3271	Engineering Practices Laboratory	ESC	0	0	4	4	2
9.	BE3272	Basic Electrical, Electronics and Instrumentation Engineering Laboratory	ESC	0	0	4	4	2
10.	GE3272	Communication Laboratory / Foreign Language [$]	EEC	0	0	4	4	2
			TOTAL	**14**	**1**	**16**	**31**	**23**

[#] NCC Credit Course level 1 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA.
[$] Skill Based Course

SEMESTER III

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	MA3391	Probability and Statistics	BSC	3	1	0	4	4
2.	EN3301	Environmental Chemistry	PCC	3	0	0	3	3
3.	EN3302	Environmental Microbiology	PCC	3	0	0	3	3
4.	EN3303	Sustainable Development	PCC	3	0	0	3	3
5.	EN3304	Fluid Mechanics and Hydraulics	PCC	3	0	0	3	3
6.	CE3351	Surveying and Levelling	PCC	3	0	0	3	3
PRACTICALS								
7.	EN3311	Environmental Fluid Mechanics Laboratory	PCC	0	0	3	3	1.5
8.	CE3361	Surveying and Levelling Laboratory	PCC	0	0	3	3	1.5
9.	GE3361	Professional Development $	EEC	0	0	2	2	1
			TOTAL	**18**	**1**	**8**	**27**	**23**

$ Skill Based Course

SEMESTER IV

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	EN3401	Environmental Legislations	PCC	3	0	0	3	3
2.	EN3402	Water Supply Engineering	PCC	3	0	0	3	3
3.	EN3403	Environmental Management Systems	PCC	3	0	0	3	3
4.	EN3404	Municipal Solid Waste Management	PCC	3	0	0	3	3
5.	EN3405	Fate and Transport of Contaminants in the Environment	PCC	3	0	0	3	3
6.	CCE331	Air and Noise Pollution Control Engineering	PCC	3	0	0	3	3
7.		NCC Credit Course Level 2#		3	0	0	3	3 #
PRACTICALS								
8.	EN3411	Environmental Chemistry and Microbiology Laboratory	PCC	0	0	4	4	2
			TOTAL	**18**	**0**	**4**	**22**	**20**

 # NCC Credit Course level 2 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA

SEMESTER V

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	EN3501	Soil Mechanics and Foundation Engineering	PCC	3	0	0	3	3
2.	EN3502	Life Cycle Assessment	PCC	3	0	0	3	3
3.	EN3503	Wastewater Engineering	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.		Mandatory Course-I[&]	MC	3	0	0	3	0
PRACTICALS								
8.	EN3511	Environmental Engineering Laboratory	PCC	0	0	4	4	2
9.	EN3512	Environmental Engineering Design and Drawing	PCC	0	0	4	4	2
			TOTAL	**21**	**0**	**8**	**29**	**22**

[&] Mandatory Course-I is a Non-credit Course (Student shall select one course from the list given under MC-I)

SEMESTER VI

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	EN3601	Environmental Monitoring Instruments	PCC	3	0	0	3	3
2.	CCE334	Industrial Wastewater Management	PCC	3	0	0	3	3
3.		Professional Elective IV	PEC	3	0	0	3	3
4.		Professional Elective V	PEC	3	0	0	3	3
5.		Professional Elective VI	PEC	3	0	0	3	3
6.		Professional Elective VII	PEC	3	0	0	3	3
7.		Open Elective – I*	OEC	3	0	0	3	3
8.		Mandatory Course-II[&]	MC	3	0	0	3	0
9.		NCC Credit Course Level 3[#]		3	0	0	3	3[#]
PRACTICALS								
10.	EN3611	Environmental Instrumentation Laboratory	PCC	0	0	4	4	2
			TOTAL	**24**	**0**	**4**	**28**	**23**

***Open Elective – I shall be chosen from the emerging technologies**

[&] Mandatory Course-II is a Non-credit Course (Student shall select one course from the list given under MC-II)

[#] NCC Credit Course level 3 is offered for NCC students only. The grades earned by the students will be recorded in the Mark Sheet, however the same shall not be considered for the computation of CGPA

SEMESTER VII/VIII*

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	CCE333	Environmental Impact Assessment	PCC	3	0	0	3	3
2.	CCE332	Environmental Health and Safety	PCC	3	0	0	3	3
3.	GE3791	Human Values and Ethics	HSMC	2	0	0	2	2
4.	GE3753	Engineering Economics and Financial Accounting	HSMC	3	0	0	3	3
5.		Open Elective – II**	OEC	3	0	0	3	3
6.		Open Elective – III***	OEC	3	0	0	3	3
7.		Open Elective – IV***	OEC	3	0	0	3	3
			TOTAL	**20**	**0**	**0**	**20**	**20**

***If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII.**

****Open Elective – II shall be chosen from the emerging technologies**

*****Open Elective III and IV (Shall be chosen from the list of open electives offered by other Programmes**

SEMESTER VIII/VII*

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	EN3811	Project Work/Internship	EEC	0	0	20	20	10
			TOTAL	**0**	**0**	**20**	**20**	**10**

***If students undergo internship in Semester VII, then the courses offered during semester VII will be offered during semester VIII**

TOTAL CREDITS: 163

MANDATORY COURSES I

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3081	Introduction to Women and Gender Studies	MC	3	0	0	3	0
2.	MX3082	Elements of Literature	MC	3	0	0	3	0
3.	MX3083	Film Appreciation	MC	3	0	0	3	0
4.	MX3084	Disaster Management	MC	3	0	0	3	0

MANDATORY COURSES II

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	MX3085	Well Being with Traditional Practices (Yoga, Ayurveda and Siddha)	MC	3	0	0	3	0
2.	MX3086	History of Science and Technology in India	MC	3	0	0	3	0
3.	MX3087	Political and Economic Thought for a Humane Society	MC	3	0	0	3	0
4.	MX3088	State, Nation Building and Politics in India	MC	3	0	0	3	0
5.	MX3089	Industrial Safety	MC	3	0	0	3	0

ANNA UNIVERSITY
PROGRESS THROUGH KNOWLEDGE

PROFESSIONAL ELECTIVE COURSES : VERTICALS

VERTICAL I Water and Wastewater Engineering	VERTICAL II Air Pollution Engineering	VERTICAL III Solid Waste Management	VERTICAL IV Environmental Management	VERTICAL V Diversified Courses
Groundwater and Well Engineering	Indoor Air Quality Management	Biochemical and Thermochemical Conversion of Biomass	Surface and Groundwater Quality Modelling	Coastal Zone Management
Functional design of Rainwater Harvesting Systems	Noise Pollution Control in Industries	Biomedical Waste Management	Remote Sensing and GIS Applications in Environmental Management	Irrigation Water Quality and Wastewater Management
Operation and Maintenance of Water and Wastewater Treatment Plants	Climate Change and Adaptation	Landfill Engineering and Remediation Technology	Occupational Health, Safety and Risk Assessment	Solar and Wind Energy System
Septage Management	Low Carbon Economy	Plastic and E waste Management	Planning, Design and Management of Large Housing Complexes	Epidemiology and Control of Communicable Diseases
Marine Pollution and Control	Climatology and Meteorology	Industrial Hazardous waste Management	Energy Management in Industries	Cleaner Production
Natural Wastewater Treatment Systems	Air Quality Modelling and mapping	Resource recovery from waste	Public Health Engineering Services in Buildings	Sustainable Agriculture and Environmental Management
Design of Water and Wastewater Treatment Plants	Climate Change Modelling	Green buildings	Environmental system Engineering	Project Formulation and Implementation

Registration of Professional Elective Courses from Verticals:

Professional Elective Courses will be registered in Semesters V and VI. These courses are listed in groups called verticals that represent a particular area of specialisation / diversified group. Students are permitted to choose all the Professional Electives from a particular vertical or from different verticals. Further, only one Professional Elective course shall be chosen in a semester horizontally (row-wise). However, two courses are permitted from the same row, provided one course is enrolled in Semester V and another in semester VI.

The registration of courses for B.E./B.Tech (Honours) or Minor degree shall be done from Semester V to VIII. The procedure for registration of courses explained above shall be followed for the courses of B.E/B.Tech (Honours) or Minor degree also. For more details on B.E./B.Tech (Honours) or Minor degree refer to the Regulations 2021, Clause 4.10.

PROFESSIONAL ELECTIVE COURSES: VERTICALS

VERTICAL I: WATER AND WASTEWATER ENGINEERING

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CAI333	Groundwater and Well Engineering	PEC	3	0	0	3	3
2.	EN3001	Functional Design of Rainwater Harvesting Systems	PEC	3	0	0	3	3
3.	EN3002	Operation and maintenance of Water and Wastewater Treatment Plants	PEC	3	0	0	3	3
4.	EN3003	Septage Management	PEC	3	0	0	3	3
5.	EN3004	Marine Pollution and Control	PEC	3	0	0	3	3
6.	EN3005	Natural Wastewater Treatment Systems	PEC	3	0	0	3	3
7.	EN3006	Design of Water and Wastewater Treatment Plants	PEC	3	0	0	3	3

VERTICAL II : AIR POLLUTION ENGINEERING

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EN3007	Indoor Air Quality Management	PEC	3	0	0	3	3
2.	EN3008	Noise Pollution Control in Industries	PEC	3	0	0	3	3
3.	CAI332	Climate Change and Adaptation	PEC	3	0	0	3	3
4.	EN3009	Low Carbon Economy	PEC	3	0	0	3	3
5.	EN3010	Climatology and Meteorology	PEC	3	0	0	3	3
6.	EN3011	Air Quality Modelling and Mapping	PEC	3	0	0	3	3
7.	EN3012	Climate Change Modelling	PEC	3	0	0	3	3

VERTICAL III: SOLID WASTE MANAGEMENT

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CAI331	Biochemical and Thermochemical Conversion of Biomass	PEC	3	0	0	3	3
2.	EN3013	Biomedical Waste Management	PEC	3	0	0	3	3
3.	EN3014	Landfill engineering and Remediation Technology	PEC	3	0	0	3	3
4.	EN3015	Plastic and E waste Management	PEC	3	0	0	3	3
5.	EN3016	Industrial Hazardous Waste Management	PEC	3	0	0	3	3
6.	EN3017	Resource recovery from Waste	PEC	3	0	0	3	3
7.	EN3018	Green Buildings	PEC	3	0	0	3	3

VERTICAL IV: ENVIRONMENTAL MANAGEMENT

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EN3019	Surface and Groundwater Quality Modelling	PEC	3	0	0	3	3
2.	EN3020	Remote sensing and GIS Applications in Environmental Management	PEC	3	0	0	3	3
3.	EN3021	Occupational Health, Safety and Risk Assessment	PEC	3	0	0	3	3
4.	EN3022	Planning, Design and Management of Large Housing complexes	PEC	3	0	0	3	3
5.	EN3023	Energy Management in Industries	PEC	3	0	0	3	3
6.	EN3024	Public Health Engineering Services in Buildings	PEC	3	0	0	3	3
7.	EN3025	Environmental System Engineering	PEC	3	0	0	3	3

VERTICAL V: DIVERSIFIED COURSES

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	EN3026	Coastal Zone Management	PEC	3	0	0	3	3
2.	CAI334	Irrigation Water Quality and Waste Water Management	PEC	3	0	0	3	3
3.	CAI335	Solar and Wind Energy System	PEC	3	0	0	3	3
4.	EN3027	Epidemiology and Control of Communicable Diseases	PEC	3	0	0	3	3
5.	EN3028	Cleaner Production	PEC	3	0	0	3	3
6.	EN3029	Sustainable Agriculture and Environmental Management	PEC	3	0	0	3	3
7.	EN3030	Project Formulation and Implementation	PEC	3	0	0	3	3

ANNA UNIVERSITY
PROGRESS THROUGH KNOWLEDGE

OPEN ELECTIVES

(Students shall choose the open elective courses, such that the course contents are not similar to any other course contents/title under other course categories)

OPEN ELECTIVE I AND II
(EMERGING TECHNOLOGIES)

To be offered other than Faculty of Information and Communication Engineering

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OCS351	Artificial Intelligence and Machine Learning Fundamentals	OEC	2	0	2	4	3
2.	OCS352	IoT Concepts and Applications	OEC	2	0	2	4	3
3.	OCS353	Data Science Fundamentals	OEC	2	0	2	4	3
4.	OCS354	Augmented and Virtual Reality	OEC	2	0	2	4	3

OPEN ELECTIVES – III

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS351	English for Competitive Examinations	OEC	3	0	0	3	3
2.	OMG352	NGOs and Sustainable Development	OEC	3	0	0	3	3
3.	OMG353	Democracy and Good Governance	OEC	3	0	0	3	3
4.	OME353	Renewable Energy Technologies	OEC	3	0	0	3	3
5.	OME354	Applied Design Thinking	OEC	2	0	2	4	3
6.	OMF351	Reverse Engineering	OEC	3	0	0	3	3
7.	OMF353	Sustainable Manufacturing	OEC	3	0	0	3	3
8.	OAU351	Electric and Hybrid Vehicle	OEC	3	0	0	3	3
9.	OAS352	Space Engineering	OEC	3	0	0	3	3
10.	OIM351	Industrial Management	OEC	3	0	0	3	3
11.	OIE354	Quality Engineering	OEC	3	0	0	3	3
12.	OSF351	Fire Safety Engineering	OEC	3	0	0	3	3
13.	OML351	Introduction to non-destructive testing	OEC	3	0	0	3	3
14.	OMR351	Mechatronics	OEC	3	0	0	3	3
15.	ORA351	Foundation of Robotics	OEC	3	0	0	3	3
16.	OAE352	Fundamentals of Aeronautical engineering	OEC	3	0	0	3	3
17.	OGI351	Remote Sensing Concepts	OEC	3	0	0	3	3
18.	OAI351	Urban Agriculture	OEC	3	0	0	3	3
19.	OCE353	Lean Concepts, Tools And Practices	OEC	3	0	0	3	3
20.	OEE352	Electric Vehicle technology	OEC	3	0	0	3	3

21.	OEI353	Introduction to PLC Programming	OEC	3	0	0	3	3
22.	OCH351	Nano Technology	OEC	3	0	0	3	3
23.	OCH352	Functional Materials	OEC	3	0	0	3	3
24.	OBT352	Biomedical Instrumentation	OEC	3	0	0	3	3
25.	OFD352	Traditional Indian Foods	OEC	3	0	0	3	3
26.	OFD353	Introduction to food processing	OEC	3	0	0	3	3
27.	OPY352	IPR for Pharma Industry	OEC	3	0	0	3	3
28.	OTT351	Basics of Textile Finishing	OEC	3	0	0	3	3
29.	OTT352	Industrial Engineering for Garment Industry	OEC	3	0	0	3	3
30.	OTT353	Basics of Textile Manufacture	OEC	3	0	0	3	3
31.	OPE351	Introduction to Petroleum Refining and Petrochemicals	OEC	3	0	0	3	3
32.	OPE352	Energy Conservation and Management	OEC	3	0	0	3	3
33.	OPT351	Basics of Plastics Processing	OEC	3	0	0	3	3
34.	OEC351	Signals and Systems	OEC	3	0	0	3	3
35.	OEC352	Fundamentals of Electronic Devices and Circuits	OEC	3	0	0	3	3
36.	OBM351	Foundation Skills in integrated product Development	OEC	3	0	0	3	3
37.	OBM352	Assistive Technology	OEC	3	0	0	3	3
38.	OMA352	Operations Research	OEC	3	0	0	3	3
39.	OMA353	Algebra and Number Theory	OEC	3	0	0	3	3
40.	OMA354	Linear Algebra	OEC	3	0	0	3	3

OPEN ELECTIVES – IV

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	OHS352	Project Report Writing	OEC	3	0	0	3	3
2.	OMA355	Advanced Numerical Methods	OEC	3	0	0	3	3
3.	OMA356	Random Processes	OEC	3	0	0	3	3
4.	OMA357	Queuing and Reliability Modelling	OEC	3	0	0	3	3
5.	OMG354	Production and Operations Management for Entrepreneurs	OEC	3	0	0	3	3
6.	OMG355	Multivariate Data Analysis	OEC	3	0	0	3	3
7.	OME352	Additive Manufacturing	OEC	3	0	0	3	3

8.	OME353	New Product Development	OEC	3	0	0	3	3
9.	OME355	Industrial Design & Rapid Prototyping Techniques	OEC	2	0	2	4	3
10.	OMF352	Micro and Precision Engineering	OEC	3	0	0	3	3
11.	OMF354	Cost Management of Engineering Projects	OEC	3	0	0	3	3
12.	OAU352	Batteries and Management system	OEC	3	0	0	3	3
13.	OAU353	Sensors and Actuators	OEC	3	0	0	3	3
14.	OAS353	Space Vehicles	OEC	3	0	0	3	3
15.	OIM352	Management Science	OEC	3	0	0	3	3
16.	OIM353	Production Planning and Control	OEC	3	0	0	3	3
17.	OIE353	Operations Management	OEC	3	0	0	3	3
18.	OSF352	Industrial Hygiene	OEC	3	0	0	3	3
19.	OSF353	Chemical Process Safety	OEC	3	0	0	3	3
20.	OML352	Electrical, Electronic and Magnetic materials	OEC	3	0	0	3	3
21.	OML353	Nanomaterials and applications	OEC	3	0	0	3	3
22.	OMR352	Hydraulics and Pneumatics	OEC	3	0	0	3	3
23.	OMR353	Sensors	OEC	3	0	0	3	3
24.	ORA352	Foundation of Automation	OEC	3	0	0	3	3
25.	ORA353	Concepts in Mobile Robotics	OEC	3	0	0	3	3
26.	OMV351	Marine Propulsion	OEC	3	0	0	3	3
27.	OMV352	Marine Merchant Vehicles	OEC	3	0	0	3	3
28.	OMV353	Elements of Marine Engineering	OEC	3	0	0	3	3
29.	OAE353	Drone Technologies	OEC	3	0	0	3	3
30.	OGI352	Geographical Information System	OEC	3	0	0	3	3
31.	OAI352	Agriculture Entrepreneurship Development	OEC	3	0	0	3	3
32.	OCE354	Basics of Integrated Water Resources Management	OEC	3	0	0	3	3
33.	OEE353	Introduction to control systems	OEC	3	0	0	3	3
34.	OEI354	Introduction to Industrial Automation Systems	OEC	3	0	0	3	3
35.	OCH353	Energy Technology	OEC	3	0	0	3	3
36.	OCH354	Surface Science	OEC	3	0	0	3	3

37.	OBT353	Environment and Agriculture	OEC	3	0	0	3	3
38.	OFD354	Fundamentals of Food Engineering	OEC	3	0	0	3	3
39.	OFD355	Food safety and Quality Regulations	OEC	3	0	0	3	3
40.	OPY353	Nutraceuticals	OEC	3	0	0	3	3
41.	OTT354	Basics of Dyeing and Printing	OEC	3	0	0	3	3
42.	OTT355	Fibre Science	OEC	3	0	0	3	3
43.	OTT356	Garment Manufacturing Technology	OEC	3	0	0	3	3
44.	OPE353	Industrial safety	OEC	3	0	0	3	3
45.	OPE354	Unit Operations in Petro Chemical Industries	OEC	3	0	0	3	3
46.	OPT352	Plastic Materials for Engineers	OEC	3	0	0	3	3
47.	OPT353	Properties and Testing of Plastics	OEC	3	0	0	3	3
48.	OEC353	VLSI Design	OEC	3	0	0	3	3
49.	OEC354	Industrial IoT and Industry 4.0	OEC	2	0	2	4	3
50.	OBM353	Wearable devices	OEC	3	0	0	3	3
51.	OBM354	Medical Informatics	OEC	3	0	0	3	3

PROGRESS THROUGH KNOWLEDGE

SUMMARY

NAME OF THE PROGRAMME										
	Subject Area	**Credits per Semester**								**Credits Total**
		I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	
1.	HSMC	4	3					5		12
2.	BSC	12	4	4						20
3.	ESC	5	14							19
4.	PCC			18	20	13	8	6		65
5.	PEC					9	12			21
6.	OEC						3	9		12
7.	EEC	1	2	1	0				10	14
	Total	**22**	**23**	**23**	**20**	**22**	**23**	**20**	**10**	**163**
8.	Mandatory Course (Non credit)					✓	✓			

ANNA UNIVERSITY
PROGRESS THROUGH KNOWLEDGE

ENROLLMENT FOR B.E. / B. TECH. (HONOURS) / MINOR DEGREE (OPTIONAL)

A student can also optionally register for additional courses (18 credits) and become eligible for the award of B.E. / B. Tech. (Honours) or Minor degree.

For B.E. / B. Tech. (Honours), a student shall register for the additional courses (18 credits) from semester V onwards. These courses shall be from the same vertical or a combination of different verticals of the same programme of study only.

For minor degree, a student shall register for the additional courses (18 credits) from semester V onwards. All these courses have to be in a particular vertical from any one of the other programmes, Moreover, for minor degree the student can register for courses from any one of the following verticals also.

Complete details are available in clause 4.10 of Regulations 2021.

VERTICALS FOR MINOR DEGREE (In addition to all the verticals of other programmes)

VERTICAL I	VERTICAL II	VERTICAL III	VERTICAL IV	VERTICAL V
Fintech and Block Chain	**Entrepreneurship**	**Public Administration**	**Business Data Analytics**	**Environment and Sustainability**
Financial Management	Foundations of Entrepreneurship	Principles of Public Administration	Statistics for Management	Sustainable infrastructure Development
Fundamentals of Investment	Team Building and Leadership Management for Business	Constitution of India	Datamining for Business Intelligence	Sustainable Agriculture and Environmental Management
Banking, Financial Services and Insurance	Creativity and Innovation in Entrepreneurship	Public Personnel Administration	Human Resource Analytics	Sustainable Bio Materials
Introduction to Blockchain and its Applications	Principles of Marketing Management for Business	Administrative Theories	Marketing and Social Media Web Analytics	Materials for Energy Sustainability
Fintech Personal Finance and Payments	Human Resource Management for Entrepreneurship	Indian Administrative System	Operation and Supply Chain Analytics	Green Technology
Introduction to Fintech	Financing New Business Ventures	Public Policy Administration	Financial Analytics	Environmental Quality Monitoring and Analysis
-	-	-	-	Integrated Energy Planning for Sustainable Development
-	-	-	-	Energy Efficiency for Sustainable Development

(Choice of courses for Minor degree is to be made from any one vertical of other programmes or from anyone of the following verticals)

VERTICAL 1: FINTECH AND BLOCK CHAIN

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG331	Financial Management	PEC	3	0	0	3	3
2.	CMG332	Fundamentals of Investment	PEC	3	0	0	3	3
3.	CMG333	Banking, Financial Services and Insurance	PEC	3	0	0	3	3
4.	CMG334	Introduction to Blockchain and its Applications	PEC	3	0	0	3	3
5.	CMG335	Fintech Personal Finance and Payments	PEC	3	0	0	3	3
6.	CMG336	Introduction to Fintech	PEC	3	0	0	3	3

VERTICAL 2: ENTREPRENEURSHIP

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG337	Foundations of Entrepreneurship	PEC	3	0	0	3	3
2.	CMG338	Team Building and Leadership Management for Business	PEC	3	0	0	3	3
3.	CMG339	Creativity and Innovation in Entrepreneurship	PEC	3	0	0	3	3
4.	CMG340	Principles of Marketing Management for Business	PEC	3	0	0	3	3
5.	CMG341	Human Resource Management for Entrepreneurship	PEC	3	0	0	3	3
6.	CMG342	Financing New Business Ventures	PEC	3	0	0	3	3

VERTICAL 3: PUBLIC ADMINISTRATION

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG343	Principles of Public Administration	PEC	3	0	0	3	3
2.	CMG344	Constitution of India	PEC	3	0	0	3	3
3.	CMG345	Public Personnel Administration	PEC	3	0	0	3	3
4.	CMG346	Administrative Theories	PEC	3	0	0	3	3
5.	CMG347	Indian Administrative System	PEC	3	0	0	3	3
6.	CMG348	Public Policy Administration	PEC	3	0	0	3	3

VERTICAL 4: BUSINESS DATA ANALYTICS

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CMG349	Statistics for Management	PEC	3	0	0	3	3
2.	CMG350	Datamining for Business Intelligence	PEC	3	0	0	3	3
3.	CMG351	Human Resource Analytics	PEC	3	0	0	3	3
4.	CMG352	Marketing and Social Media Web Analytics	PEC	3	0	0	3	3
5.	CMG353	Operation and Supply Chain Analytics	PEC	3	0	0	3	3
6.	CMG354	Financial Analytics	PEC	3	0	0	3	3

VERTICAL 5: ENVIRONMENT AND SUSTAINABILITY

SL. NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
1.	CES331	Sustainable infrastructure Development	PEC	3	0	0	3	3
2.	CES332	Sustainable Agriculture and Environmental Management	PEC	3	0	0	3	3
3.	CES333	Sustainable Bio Materials	PEC	3	0	0	3	3
4.	CES334	Materials for Energy Sustainability	PEC	3	0	0	3	3
5.	CES335	Green Technology	PEC	3	0	0	3	3
6.	CES336	Environmental Quality Monitoring and Analysis	PEC	3	0	0	3	3
7.	CES337	Integrated Energy Planning for Sustainable Development	PEC	3	0	0	3	3
8.	CES338	Energy Efficiency for Sustainable Development	PEC	3	0	0	3	3

MA3391 PROBABILITY AND STATISTICS L T P C
3 1 0 4

OBJECTIVES

- This course aims at providing the required skill to apply the statistical tools in engineering problems.
- To introduce the basic concepts of probability and random variables.
- To introduce the basic concepts of two dimensional random variables.
- To acquaint the knowledge of testing of hypothesis for small and large samples which plays an important role in real life problems.
- To introduce the basic concepts of classifications of design of experiments which plays very important roles in the field of agriculture and statistical quality control.

UNIT I PROBABILITY AND RANDOM VARIABLES 9 + 3

Axioms of probability – Conditional probability – Baye's theorem - Discrete and continuous random variables – Moments – Moment generating functions – Binomial, Poisson, Geometric, Uniform, Exponential and Normal distributions – Functions of a random variable.

UNIT II TWO- DIMENSIONAL RANDOM VARIABLES 9 + 3

Joint distributions – Marginal and conditional distributions – Covariance – Correlation and linear regression – Transformation of random variables – Central limit theorem (for independent and identically distributed random variables).

UNIT III ESTIMATION THEORY 9 + 3

Unbiased estimators - Efficiency - Consistency - Sufficiency - Robustness - Method of moments - Method of maximum Likelihood - Interval estimation of Means - Differences between means, variations and ratio of two variances

UNIT IV NON- PARAMETRIC TESTS 9 + 3

Introduction - The Sign test - The Signed - Rank test - Rank - sum tests - The U test - The H test - Tests based on Runs - Test of randomness - The Kolmogorov Tests .

UNIT V STATISTICAL QUALITY CONTROL 9 + 3

Control charts for measurements ($\bar{X}$ and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling.

TOTAL: 60 PERIODS

OUTCOMES:

Upon successful completion of the course, students will be able to:

- Understand the fundamental knowledge of the concepts of probability and have knowledge of standard distributions which can describe real life phenomenon.
- Understand the basic concepts of one and two dimensional random variables and apply in engineering applications.
- Apply the concept of testing of hypothesis for small and large samples in real life problems.
- Apply the basic concepts of classifications of design of experiments in the field of agriculture and statistical quality control.
- Have the notion of sampling distributions and statistical techniques used in engineering and management problems

TEXT BOOKS

1. Johnson. R.A., Miller. I.R and Freund . J.E, " Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 9th Edition, 2017.
2. Milton. J. S. and Arnold. J.C., "Introduction to Probability and Statistics", Tata Mc Graw Hill, 4th Edition, 2017.
3. John E. Freund, "Mathematical Statistics", Prentice Hall, 6th Edition, 1998

REFERENCES:

1. Gupta. S.C. and Kapoor. V. K., "Fundamentals of Mathematical Statistics", Sultan Chand & Sons, New Delhi, 12th Edition, 2020.
2. Devore. J.L., "Probability and Statistics for Engineering and the Sciences", Cengage Learning, New Delhi, 9th Edition, 2020.
3. Ross. S.M., "Introduction to Probability and Statistics for Engineers and Scientists", 5thEdition, Elsevier, 2014.
4. Spiegel. M.R., Schiller. J. and Srinivasan. R.A., "Schaum's Outline of Theory and Problems of Probability and Statistics", Tata McGraw Hill Edition, 4th Edition, 2012.
5. Walpole. R.E., Myers. R.H., Myers. S.L. and Ye. K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 9th Edition, 2010.

EN3301 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(Ksp) ,heavy metal precipitation, amphoteric hydroxides, CO_2 solubility in water and species distribution – Ocean acidification, Chemical kinetics , First order- 12 Principles of green chemistry.

UNITII AQUATIC CHEMISTRY 9

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 9

Atmospheric structure – chemical and photochemical reactions – photochemical smog. Ozone layer depletion – greenhouse gases and global warming, CO2 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:

On completion of the course, the student is expected to

CO1: Gain competency in solving environmental issues of chemicals based pollution

CO2: Determine chemicals mobility in aquatic systems

CO3: 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:

1. Sawyer, C.N., Mac Carty, P.L. and Parkin, G.F., "Chemistry for Environmental Engineering and Science", Tata McGraw – Hill, Fifth edition, New Delhi 2017.
2. Colin Baird„ Environmental Chemistry, Freeman and company, New York, 5th Edition,2012.
3. Manahan, S.E., "Environmental Chemistry", Eleventh Edition, CRC press, 2022.
4. Ronald A. Hites ,"Elements of Environmental Chemistry", Wiley, 2nd Edition,2020.

EN3302 ENVIRONMENTAL MICROBIOLOGY

L	T	P	C
3	0	0	3

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 by-products are also covered.

UNIT I FUNDAMENTALS OF MICROBIOLOGY 9

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 9

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 9

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 9

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

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, 3rd Edition, 2005
3. Raina M. Maier, Ian L. Pepper, Charles P. Gerba, "Environmental Microbiology", Academic Press,3rd Edition 2014
4. Volodymyr Ivanov,Environmental Microbiology for Engineers 2nd Edition, CRC Press, 2021, ISBN 9781498702126
5. N duka 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. 2007
8. Frank C. Lu and Sam Kacew, LU"s Basic Toxicology, Taylor & Francis, London 5th Ed, 2009.

PROGRESS THROUGH KNOWLEDGE

EN3303 SUSTAINABLE DEVELOPMENT L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mind-set for Sustainable development.

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLEGES 9

Definition of sustainability – environmental, economic and social dimensions of sustainability - sustainable development models – strong and weak sustainability – defining development millennium development goals – mindsets for sustainability: earthly, analytical, precautionary, action

and collaborative– syndromes of global change: utilisation syndromes, development syndromes, and sink syndromes – core problems and cross cutting Issues of the 21 century - global, regional and local environmental issues – social insecurity - resource degradation –climate change – desertification.

UNIT II PRINCIPLES AND FRAME WORK 9

History and emergence of the concept of sustainable development - our common future - Stockholm to Rio plus 20 – Rio Principles of sustainable development – Agenda 21 natural step peoples earth charter – business charter for sustainable development – UN Global Compact – Role of civil society, business and government – United Nations' 2030 Agenda for sustainable development – 17 sustainable development goals and targets, indicators and intervention areas

UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING 9

The Unjust World and inequities - Quality of Life - Poverty, Population and Pollution – Combating Poverty - - Demographic dynamics of sustainability - Strategies to end Rural and Urban Poverty and Hunger – Sustainable Livelihood Framework- Health, Education and Empowerment of Women, Children, Youth, Indigenous People, Non-Governmental Organizations, Local Authorities and Industry for Prevention, Precaution , Preservation and Public participation.

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS 10

Sustainable Development Goals and Linkage to Sustainable Consumption and Production Investing in Natural Capital- Agriculture, Forests, Fisheries - Food security and nutrition and sustainable agriculture- Water and sanitation - Biodiversity conservation and Ecosystem integrity – Ecotourism - Sustainable Cities – Sustainable Habitats- Green Buildings – Sustainable Transportation –– Sustainable Mining - Sustainable Energy– Climate Change –Mitigation and Adaptation - Safeguarding Marine Resources - Financial Resources and Mechanisms

UNIT V ASSESSING PROGRESS AND WAY FORWARD 8

Nature of sustainable development strategies and current practice**-** Sustainability in global, regional and national context –Approaches to measuring and analysing sustainability– limitations of GDP- Ecological Footprint- Human Development Index- Human Development Report – National initiatives for Sustainable Development - Hurdles to Sustainability - Science and Technology for sustainable development –Performance indicators of sustainability and Assessment mechanism – Inclusive Green Growth and Green Economy – National Sustainable Development Strategy Planning and National Status of Sustainable Development Goals

TOTAL: 45 PERIODS

OUTCOMES

On completion of the course, the student is expected to

CO1 Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises.

CO2 Identify and critically analyze the social environmental and economic dimensions of sustainability in terms of UN Sustainable development goals.

CO3 Develop a fair understanding of the social, economic and ecological linkage o Human wellbeing, production and consumption.

CO4 Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems.

CO5 Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability.

REFERENCES:

1. Tom Theis and Jonathan Tomkin, Sustainability: A Comprehensive Foundation, Rice University, Houston, Texas, 2018
2. A guide to SDG interactions:from science to implementation, International Council for Science, Paris, 2017

3. Karel Mulder, Sustainable Development for Engineers - A Handbook and Resource Guide, Rouledge Taylor and Francis, 2017.
4. The New Global Frontier - Urbanization, Poverty and Environmentin the 21st Century *George* Martine,Gordon McGranahan,Mark Montgomery and Rogelio Fernández-Castilla, IIED and UNFPA, Earthscan, UK, 2008

EN3304 FLUID MECHANICS AND HYDRAULICS L T P C
3 0 0 3

OBJECTIVES:

- To introduce the students about the properties of the fluids, behaviour of fluids under static, kinematic and dynamic conditions through the control volume approach and expose them to the applications of the conservation laws and to impart basic knowledge of the dimensional analysis and model studies along with flow through pipes.
- The students will be exposed to the basic concepts of open channel flows with significance to steady uniform flows along with flow measurements in open channels.
- To expose the students to the classification of pumps the basic principles of working and to design centrifugal pump.

UNIT I FLUID PROPERTIES AND FLUID STATICS 9

Definition and properties of fluid - Fluid statics – Fluid pressure and measurement – Mechanical gauges - Forces on plane and curved surfaces - Buoyancy - Stability of floating bodies.

UNIT II FLUID KINEMATICS AND FLUID DYNAMICS 9

Classification of fluid flows - Continuum hypothesis - System and Control volume approach - Streamline, streak-line and path-lines - Application of continuity, energy and momentum - Euler's equation of motion along a stream line - Bernoulli's equation - Linear momentum equation

UNIT III FLOW THROUGH PIPES AND MODEL STUDIES 9

Reynolds experiment - Laminar flow through circular pipe - Darcy-Weisbach equation - Moody diagram - Major and minor losses in pipe flow – Total energy line – Hydraulic grade line – Siphon - Pipes in series and parallel- Equivalent pipes- Fundamental dimensions - Dimensional homogeneity - Buckingham Pi theorem - Dimensionless parameters - Similitude and model studies - Distorted and undistorted models.

UNIT IV OPEN CHANNEL FLOWS 9

Types of flow – Characteristics of open channel - Chezy's equation - Manning equation – Hydraulically efficient channel sections - Critical depth – Specific energy application to channel transitions – Flow measurement in channels and natural streams – Current meter – Classification of hydraulic jumps- momentum equation- Energy loss.

UNIT V PUMPS 9

Types of pumps – Efficiencies -Selection of pump capacity - Centrifugal pump – Characteristics and working principle – Types of impellers - Priming – NPSH - Cavitation – Minimum speed to start the pump - Specific speed – Submersible pump - Jet pump – Air lift pump - Sludge pump - Reciprocating pump and its working priciples.

TOTAL: 45 PERIODS

TEXT BOOKS:

1. Chandramouli P N, Applied Hydraulic Engineering, Yes Dee Publisher, 2017
2. Jain A. K. Fluid Mechanics including Hydraulic Machines, Khanna Publishers, New Delhi, 2014.
3. Subramanya K., Flow in Open Channels, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2019.

4. Modi P.N and Seth Hydraulics and Fluid Mechanics including Hydraulic Machines, Standard Book House, New Delhi, 2019.

REFERENCES:

1. S K Som; Gautam Biswas and S Chakraborty, Introduction to Fluid Mechanics and Fluid Machines, McGraw Hill Education (India) Pvt. Ltd., 2017.
2. Ven Te Chow, Open Channel Hydraulics, McGraw Hill, New York, 2009.
3. Subramanya K, Fluid Mechanics and Hydraulic Machines: Problems and Solutions, McGraw Hill Education (India) Pvt. Ltd., New Delhi, 2018.

COURSE OUTCOMES:

On completion of the course, the student is expected to

CO1 Demonstrate the properties of fluid and its behaviour in static conditions along with pressure measurements.

CO2 Apply the conservation laws applicable to fluid flows and its application through fluid kinematics and dynamics.

CO3 Estimate losses in pipelines for both laminar and turbulent conditions and analysis of pipes connected in series and parallel and to understand the concept of application of dimensional analysis in model studies.

CO4 Describe the basics characteristics of open channel flows and analysis of steady uniform flow with hydraulically efficient channel sections and to measure the flows in artificial/natural channels.

CO5 Explain the classification, design and working principles of various pumps.

CE3351 SURVEYING AND LEVELLING L T P C
3 0 0 3

OBJECTIVES:

- To introduce the rudiments of plane surveying and geodetic principles to Environmental Engineers and to learn the various methods of plane and geodetic surveying to solve the real world problems. To introduce the concepts of Control Surveying. To introduce the basics of Astronomical Surveying

UNIT I FUNDAMENTALS OF CONVENTIONAL SURVEYING 9

Definition – Classifications – Basic principles – Equipment and accessories for ranging and chaining – Methods of ranging – Well conditioned triangles – Chain traversing – Compass – Basic principles – Types – Bearing – System and conversions – Sources of errors and Local attraction – Magnetic declination – Dip – compass traversing – Plane table and its accessories – Merits and demerits – Radiation – Intersection – Resection – Plane table traversing.

UNIT II LEVELLING 9

Level line – Horizontal line – Datum – Benchmarks – Levels and staves – Temporary and permanent adjustments – Methods of leveling – Fly leveling – Check leveling – Procedure in leveling – Booking – Reduction – Curvature and refraction – Reciprocal leveling – Precise leveling - Contouring.

UNIT III THEODOLITE SURVEYING 9

Horizontal and vertical angle measurements – Temporary and permanent adjustments – Heights and distances – Tacheometric surveying – Stadia Tacheometry – Tangential Tacheometry – Trigonometric leveling – Single Plane method – Double Plane method.

UNIT IV CONTROL SURVEYING AND ADJUSTMENT 9

Horizontal and vertical control – Methods – Triangulation – Traversing – Gale‘s table – Trilateration – Concepts of measurements and errors – Error propagation and Linearization – Adjustment methods - Least square methods – Angles, lengths and levelling network.

UNIT V MODERN SURVEYING 9

Total Station: Digital Theodolite, EDM, Electronic field book – Advantages – Parts and accessories – Working principle – Observables – Errors - COGO functions – Field procedure and applications.GPS: Advantages – System components – Signal structure – Selective availability and antispoofing receiver components and antenna – Planning and data acquisition – Data processing – Errors inGPS – Field procedure and applications.

TOTAL 45 PERIODS

OUTCOMES:

On completion of the course, the student is expected to

CO1 Introduce the rudiments of various surveying and its principles.
CO2 Imparts knowledge in computation of levels of terrain and ground features
CO3 Imparts concepts of Theodolite Surveying for complex surveying operations
CO4 Understand the procedure for establishing horizontal and vertical control
CO5 Imparts the knowledge on modern surveying instruments

TEXTBOOKS:

1. Dr. B. C. Punmia, Ashok K. Jain and Arun K Jain, Surveying Vol. I & II, Lakshmi Publications Pvt Ltd, New Delhi, Sixteenth Edition, 2016.
2. T. P. Kanetkarand S. V. Kulkarni, Surveying and Levelling, Parts 1 & 2, Pune Vidyarthi Griha Prakashan, Pune, 2008.

REFERENCES:

1. R. Subramanian, Surveying and Levelling, Oxford University Press, Second Edition, 2012.
2. James M. Anderson and Edward M. Mikhail, Surveying, Theory and Practice, Seventh Edition, Mc Graw Hill 2001.
3. Bannister and S. Raymond, Surveying, Seventh Edition, Longman 2004.
4. S. K. Roy, Fundamentals of Surveying, Second Edition, Prentice^ Hall of India2010.
5. K. R. Arora, Surveying Vol I & II, Standard Book house, Twelfth Edition 2013.
6. C. Venkatramaiah, Textbook of Surveying, Universities Press, Second Edition, 2011.

EN3311 ENVIRONMENTAL FLUID MECHANICS LABORATORY

L	T	P	C
0	0	3	1.5

OBJECTIVE:

- To provide hands on experience in calibration of flow meters, performance characteristics of pumps and turbines.

LIST OF EXPERIMENTS

A. FLOW MEASUREMENT

1. Bernoulli's Experiment
2. Calibration of Rotameter
3. Flow through Orificemeter/Mouthpiece,
4. Flow through Venturimeter and Notches

B. LOSSES IN PIPES

5. Determination of friction factor in pipes.
6. Determination of minor losses

C. PUMPS

7. Characteristics of Centrifugal pumps
8. Characteristics of Gear pump

9. Characteristics of Submersible pump
10. Characteristics of Reciprocating pump

TOTAL : 45 PERIODS

OUTCOMES:

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

CO1 Understand and Apply the concept of Bernoulli equation in fluid flow
CO2 Calibrate the flow measuring devices in a pipe line/channel
CO3 Measure friction factor in pipes and compare with Moody diagram
CO4 Determine the performance characteristics of rotodynamic pumps.
CO5 Determine the performance characteristics of positive displacement pumps.

REFERENCES:

1. Hydraulic Laboratory Manual
2. Modi P.N. and Seth S.M., Hydraulics and Fluid Mechanics. Standard Book House. New Delhi, 2017.
3. Subramanya K, Fluid Mechanics and Hydraulic Machines, Tata McGraw Hill Edu. Pvt. Ltd. 2011

CE3361 SURVEYING AND LEVELLING LABORATORY

L	T	P	C
0	0	3	1.5

OBJECTIVES:

- At the end of the course the student will possess knowledge about survey field techniques

LIST OF EXPERIMENTS:

Chain Survey

1. Study of chains and its accessories, Aligning, Ranging, Chaining and Marking Perpendicular offset
2. Setting out works – Foundation marking using tapes single Room and Double Room

Compass Survey

3. Compass Traversing – Measuring Bearings & arriving included angles

Levelling - Study of levels and levelling staff

4. Fly levelling using Dumpy level &Tilting level
5. Check levelling

Theodolite - Study of Theodolite

6. Measurements of horizontal angles by reiteration and repetition and vertical angles
7. Determination of elevation of an object using single plane method when base is Accessible/inaccessible.

Tacheometry – Tangential system – Stadia system

8. Determination of Tacheometric Constants
9. Heights and distances by stadia Tacheometry
10. Heights and distances by Tangential Tacheometry

Total Station - Study of Total Station, Measuring Horizontal and vertical angles

11. Traverse using Total station and Area of Traverse
12. Determination of distance and difference in elevation between two inaccessible points using Total station

TOTAL: 45 PERIODS

COURSE OUTCOMES

On completion of the course, the student is expected to

CO1 Impart knowledge on the usage of basic surveying instruments like chain/tape, compass and levelling instruments

CO2 Able to use levelling instrument for surveying operations

CO3 Able to use theodolite for various surveying operations

CO4 Able to carry out necessary surveys for social infrastructures

CO5 Able to prepare planimetric maps

REFERENCES:

1. T. P. Kanetkarand S. V. Kulkarni, Surveying and Levelling, Parts 1 & 2, Pune Vidyarthi Griha Prakashan, Pune, 24th Reprint, 2015.
2. Dr. B. C. Punmia, Ashok K. Jainand Arun K Jain, Surveying Vol. I & II, Lakshmi Publications Pvt Ltd, New Delhi, 17th Edition, 2016.
3. James M. Anderson and Edward M. Mikhail, Surveying, Theory and Practice, Seventh Edition, McGraw Hill 2001
4. Bannisterand S. Raymond, Surveying, Seventh Edition, Longman 2004 a. David Clark, Plane and Geodetic Surveying for Engineers, Volume I, Constable and Company Ltd, London, CBS, 6th Edition, 2004.
5. David Clark and James Clendinning, Plane and Geodetic Surveying for Engineers, VolumeII, Constable and Company Ltd, London, CBS, 6th Edition, 2004.
6. S. K. Roy, Fundamentals of Surveying, Second Edition, Prentice 'Hall of India 2004
7. K. R. Arora, Surveying Vol. I & II, Standard Book house, Eleventh Edition, 2013.

EN3401 ENVIRONMENTAL LEGISLATIONS L T P C

3 0 0 3

OBJECTIVES:

- To explain the role of law, policy and institutions in the conservation and management of natural resources as well as pollution control
- To introduce the laws and policies both at the national and international level relating to environment
- To equip the students with the skills needed for interpreting laws, policies and judicial decisions

UNIT I INTRODUCTION TO ENVIRONMENTAL LEGISLATIONS AND INTERNATIONAL SCENARIO 9

Significance of Environmental Law **-**International Environmental Law **-**Development of International Environmental Law **-**Source and General principals of International Environmental Law **–**General rights and obligations of States **-**General Issues of the international law related to environmental protection **-**Stockholm Declaration**-**Rio Declaration on Environment and Development**-**Basel Convention on the Control of Trans boundary Movement of Hazardous Wastes and their disposal**-** Convention of Biological Diversity**-**U.N Frame Work Convention on Climate Change**-**Montreal Protocol on Substances that deplete Ozone Layer**-**Kyoto Protocol**.**

UNIT II INDIAN CONSTITUTIONS AND ENVIRONMENTAL PROTECTION 9

Indian Constitution and Environmental Protection -Constitutional provisions concerning Environment Articles 14,15,(2) (b) 19 (e),21,31,32,38,39,42,47, 48-A,49,51,51-A: Indian Environmental Policy 2006 Administrative machinery for pollution control Common Law & Criminal Law Nuisance, Negligence, Strict liability and Absolute liability, Provisions of IPC relating to environmental problems (public nuisance u/s 268 and others (Sections 269,270,277,284,285,286,425 to 440) Section 133 of Cr.P.C.

UNIT III REMEDIES FOR ENVIRONMENTAL POLLUTION 9

Common Law Remedies/Remedies under Law of Tort – Penal Remedies – Indian Penal Code and Code of Criminal Procedure – Remedies under Constitutional Law – Writs – Public Interest Litigation - Public Liability Insurance Act, 1991 – The National Green Tribunal Act 2010

UNIT IV MAJOR INDIAN LEGISLATIONS 9

Water Act (1974) Air Act (1981) Environmental Protection Act (1986) Major Notifications, The Municipal solid Wastes (Management and Handling) Rules 2016-Bio Medical Wastes (Management and Handling) Rules 2016- Hazardous Wastes (Management and Handling Rules 2016- Environment Impact Assessment Notifications- Coastal Regulation Zone Notification- Public Hearing Notifications

UNIT V ENVIRONMENT AND DEVELOPMENT CASE LAWS 9

Meaning and concept of development - Its impact on environment; conflict between environment and development, Concept of Sustainable Development., Polluter Pay Principle, Precautionary Principle, Public Trust Doctrine. Landmark Judgments **-** Oleum gas leakage case, Rural Litigation and Entitlement Kendra, Dehradun, (1985) Supp SCC 487) Vellore Citizen Welfare Forum vs. Union of India, (1996) 5SCC 647) Ganga Pollution case (1988) I SCC) S. Jagannath vs. UOI (1997) SCC867) Vellore Citizens welfare forum case M.C. Mehta Vs. Kamalnath (1997) I SCC 388)

TOTAL: 45 PERIODS

OUTCOMES:

·On completion of the course, the student is expected to

CO 1. Understand origins and sources of environmental laws, and understand how and by whom environmental laws are made and interpreted

CO 2. Understand the key principles of, and actors within, environmental laws

CO 3. Understand the National Environmental Policy and Various Legislations enacted in line with Policy

CO 4. Critically analyze environmental laws within various contexts and to evaluate laws against procedural and substantive criteria.

CO 5. Understand and the Legal system operating in India and will be in a position to prepare compliance reports for getting environmental clearance.

REFERENCES:

1. Leelakrishnan P., Environmental Law in India, Butterworths Wadhwa, 3rd Edition 2010
2. Leelakrishnan P., Environmental Case Book, Lexis Nexis,2010
3. Shanthakumar S. , Environmental Law – An Introduction, Butterworths,2008
4. Shyam Diwan and Armin Rosencranz, Enviromental Law and Policy in India, Oxford, 2002

PROGRESS THROUGH KNOWLEDGE

EN3402 WATER SUPPLY ENGINEERING

L	T	P	C
3	0	0	3

OBJECTIVES:

- The course objective is to identify the sources and quantity of surface and ground water bodies and their demand for the public and also to study the quality of water and their treatment techniques.

UNIT I PUBLIC WATER SUPPLY SCHEMES AND QUANTITY OF WATER 8

Necessary and objectives of public water supply schemes – planning and financing – Quantity of water – water requirements – continuous and intermittent supply – water demand – variations in rate of demand- its effect on design – design period – population growth and forecast – estimating the quantity of water required.

UNIT II HYDROLOGICAL CONCEPTS AND SOURCES OF WATER 9

Hydrological concepts – hydrological cycle – Sources of water – Intakes – types of intakes – infiltration galleries – infiltration well – storage reservoirs – storage capacity by analytical method and mass curve method – types of wells – sanitary protection of wells – tests for yield of a well.

UNIT III QUALITY OF WATER AND TRANSPORTATION OFWATER 8

Quality of water – portable water and mineral water – contamination of water – sampling techniques– analysis of water – Bacteriological analysis- water borne diseases – water quality standards. Transportation of water – Hydraulics of pipe flow – pipes & its types – design of pipes – Joints – pipe appurtenances – pumps – types of pumps – selection of pumps.

UNIT IV PURIFICATION OF WATER 12

Treatment of water- working principles of all the unit process of water treatment, Purpose and its design – screening – plain sedimentation – coagulation sedimentation – filtration – disinfection – water softening and Desalination– Operation & Maintenance aspects of all the unit process.

UNIT V OTHER TREATMENTS AND DISTRIBUTION OF WATER 9

Removal of Iron and Manganese – Fluoridation and Defluoridation– distribution of water – Planning – Methods of distribution – Service Reservoirs – purpose – types – locations and height – Design aspects – requirements of good distribution system – layout of distribution system- Net work analysis – preventive methods to reduce wastage of water – pipe appurtenances – house service connection.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student is expected to

CO1 Understand the various components of water supply scheme

CO2 Design of intake structure and conveyance system for water transmission

CO3 Understand the process of conventional treatment of water and design of water treatment system.

CO4 Understand and design the various advanced treatment system and knowledge about the recent advances in water treatment process

CO5 Design and evaluate water distribution system and water supply in buildings

TEXTBOOKS :

1. Garg. S.K., "Water Supply Engineering", Khanna Publishers, Delhi, September 2008
2. Punmia B.C, Arun K.Jain, Ashok K.Jain, " Water supply Engineering" Lakshmi publication private limited, New Delhi, 2016.
3. Birdie.G.S., "Water Supply and Sanitary Engineering", Dhanpat Rai and sons, 2018.

REFERENCES :

1. Fair. G.M., Geyer.J.C., "Water Supply and Wastewater Disposal", John Wiley and Sons, 1954.
2. Babbit.H.E, and Donald.J.J, "Water Supply Engineering" , McGraw Hill book Co, 1984.
3. Steel. E.W.et al., "Water Supply Engineering" Mc Graw Hill International book Co, 1984.
4. Duggal. K.N., "Elememts of public Health Engineering", S.Chand and Company Ltd, New Delhi, 1998.
5. Mark J. Hammer & Mark J. Hammer Jr., "Water and Waste Water Technology", Prentice Hall of India Pvt. Ltd., New Delhi, 2008.

EN3403 ENVIRONMENTAL MANAGEMENT SYSTEMS L T P C
3 0 0 3

OBJECTIVES:

- To impart an understanding of systems approach to Environmental Management as per ISO 14001 and skills for environmental performance assessment in terms of legal compliance, pollution prevention and continual improvement.

UNIT I ENVIRONMENTAL MANAGEMENTSTANDARDS 9

Unique Characteristics of Environmental Problems - Classification of Environmental Impact Reduction Efforts - Systems approach to Corporate environmental management - Business Charter for Sustainable Production and Consumption – Tools and Barriers - Evolution of Environmental Stewardship –National policies on abatement of pollution and conservation of resources - Charter on Corporate responsibility for Environmental protection - Environmental quality objectives – Rationale of Environmental standards: Concentration and Mass standards, Effluent and stream standards, Emission and ambient standards, Minimum national standards, environmental performance evaluation: Indicators, benchmarking

UNIT II PREVENTIVE ENVIRONMENTAL MANAGEMENT 9

Pollution control Vs Pollution Prevention - Opportunities and Barriers – Cleaner production and Clean technology, closing the loops, zero discharge technologies – Four Stages and nine approaches of Pollution Prevention - Getting management commitment – Analysis of Process Steps- source reduction, raw material substitution, toxic use reduction and elimination, process modification –Material balance – Technical, economical and environmental feasibility evaluation of Pollution Prevention options in selected industries –Preventive Environmental Management over Product cycle.

UNIT III ENVIRONMENTAL MANAGEMENT SYSTEM 10

ISO 14000 family- EMS as per ISO 14001– benefits and barriers of EMS – Understanding the organisation and its context- Understanding the needs and expectations of interested parties- Determining the scope of the environmental management system- Leadership and commitment- Environmental policy- Organizationalroles, responsibilities and authorities- Actions to address risks and opportunities- Environmental objectives and planning – Resources- Competence-Awareness- Communication-Documented Information –Operational Planning and Control- Emergency preparedness and response- Monitoring, measurement, analysis and evaluation - Management review

UNIT IV ENVIRONMENTAL AUDIT 8

Environmental management system audits as per ISO 19011-Internal Audits and Certification Audits – Principles of auditing- Roles and qualifications of auditors - Determining auditor competence- Managing an audit programme – Establishing and Implementing audit programme- Selecting audit team members and Assigning responsibility - Conducting an audit- opening meeting, Audit evidence gathering - Collecting and verifying information - Managing and maintaining audit programme records- closing meeting and reporting - Non conformance – Corrective and preventive actions - Continual improvement - compliance audits – waste audits and waste minimization planning – Environmental statement (form V) - Due diligence audit

UNIT V CASE STUDIES 9

Case studies on applications of EMS, Waste Audits and Pollution Prevention in Textile industry , Tanning industry, Electroplating, Pulp & Paper, Dairy, Chemical industries and service organizations.

TOTAL: 45 PERIODS

OUTCOMES:

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

CO1 Explain the various elements of Corporate Environmental Management systems and audits complying to international environmental management system standards

CO2 Apply the knowledge of science and engineering fundamentals to pollution prevention assessment and environmental performance evaluation

CO3 Develop environmental management systems for organisations

CO4 Conduct environmental management system audits taking into account the sustainability context

CO5 Conduct research pertinent to pollution prevention and communicate effectively to different stakeholders as well as engage in independent life-long learning

REFERENCES:

1. ISO 14001/14004:2016 Environmental management systems – Requirements and Guidelines – International Organisation for Standardisation, 2015
2. ISO 19011: 2018, "Guidelines for auditing Management Systems, International Organisation for Standardisation, 2018
3. ISO 14031:2021, Environmental management -- Environmental performance evaluation Guidelines, International Organisation for Standardisation, 2015
4. Marek Bugdol and Piotr Jedynak, Integrated Management Systems, Springer International, 2015.
5. Ryan Dupont, Kumar Ganesan, Louis Theodore, Pollution Prevention: Sustainability, Industrial Ecology, and Green Engineering, Second Edition, CRC Press, 2016
6. Paul L Bishop †Pollution Prevention: Fundamentals and Practice€, McGraw- Hill International, Boston,2004.
7. Lennart Nilsson, Per Olof Persson, Lars Rydén, Siarhei Darozhka and Audrone Zaliauskiene,Cleaner Production Technologies and Tools for Resource Efficient Production, The Baltic University Environmental Management book series, Uppsala 2007

EN3404 MUNICIPAL SOLID WASTE MANAGEMENT **L T P C**
3 0 0 3

OBJECTIVES:

- To make the students conversant with different aspects of the types, sources, generation, storage, collection, transport, processing and disposal of municipal solid waste.

UNIT I SOURCES AND TYPES 8

Sources and types of municipal solid wastes-waste generation rates-factors affecting generation, characteristics-methods of sampling and characterization; Effects of improper disposal of solid wastes-Public health and environmental effects. Elements of solid waste management –Social and Financial aspects – Municipal solid waste (M&H) rules – integrated management-Public awareness; Role of NGO"s.

UNIT II ON-SITE STORAGE AND PROCESSING 8

On-site storage methods – Effect of storage, materials used for containers – segregation of solid wastes – Public health and economic aspects of open storage – waste segregation and storage – case studies under Indian conditions – source reduction of waste – Reduction, Reuse and Recycling.

UNIT III COLLECTION AND TRANSFER 8

Methods of Residential and commercial waste collection – Collection vehicles – Manpower– Collection routes – Analysis of collection systems; Transfer stations – Selection of location, operation & maintenance; options under Indian conditions – Field problems- solving.

UNIT IV OFF-SITE PROCESSING 12

Objectives of waste processing – Physical Processing techniques and Equipments; Resource recovery from solid waste composting and biomethanation; Thermal processing options – case studies under Indian conditions.

UNIT V DISPOSAL 9

Land disposal of solid waste; Sanitary landfills – site selection, design and operation of sanitary landfills – Landfill liners – Management of leachate and landfill gas- Landfill bioreactor– Dumpsite Rehabilitation

TOTAL: 45 PERIODS

OUTCOMES:

The students completing the course will have

CO1 understand the nature and characteristics of municipal solid wastes and the regulatory requirements regarding municipal solid waste management

CO2 explains the segregation of solid waste and the onsite storage methods

CO3 explains the various transfer methods and to know the site condition for the transfer station

CO4 select appropriate methods for processing and disposal of solid and hazardous wastes, taking into account the impact of the solutions in a sustainability context

CO5 knowledge about selection of appropriate disposal methods and its handling in an efficient manner

TEXTBOOKS:

1. Tchobanoglous.G., Theisen, H. M., and Eliassen, R. Solid. Wastes: Engineering Principles and Management Issues. New York: McGraw Hill, 1977.
2. Vesilind, P.A. and Rimer, A.E., “Unit Operations in Resource Recovery Engineering”, Prentice Hall, Inc., 1981
3. Paul T Willams, “Waste Treatment and Disposal”, John Wiley and Sons, 2005

REFERENCES:

1. Manual on Municipal Solid Waste Management, CPHEEO, Ministry of Urban Development,Government of India, New Delhi, 2016.
2. Bhide A.D. and Sundaresan, B.B. Solid Waste Management Collection, Processingand Disposal, 2001
3. Manser A.G.R. and Keeling A.A, “Practical Handbook of Processing and Recycling of Municipal solid Wastes”, Lewis Publishers, CRC Press, 1996
4. George Tchobanoglous and FrankKreith, Handbook of "Solid waste Management", McGraw Hill, New York, 2002

PROGRESS THROUGH KNOWLEDGE

EN3405 FATE AND TRANSPORT OF CONTAMINANTS IN THE ENVIRONMENT L T P C

3 0 0 3

OBJECTIVE:

- To educate the students on the mechanism of transport and fate of contaminants in the geosphere of the environment.

UNIT I EQUILIBRIUM AND TRANSPORT MECHANISMS 10

Concentration and Phase density – air-water equilibrium, Soil-water equilibrium, Earthen solid- air equilibrium. Liquid-chemical equilibrium – thermal equilibrium at environmental interfaces. Diffusion and mass transfer – molecular diffusion- Fick,s Law – eddy diffusion – mass transfer theories -fundamentals of heat transfer –heat and mass transfer.

UNIT II EXCHANGE RATES BETWEEN AIR AND WATER 8

Desorption of gases and liquids from aerated basins and rivers – completely mixed basin – plug flow basin – gas exchange rates between the atmosphere and the surface of rivers – exchange of chemical across the air – water interface of lakes and oceans.

UNIT III EXCHANGE RATES BETWEEN WATER AND THE EARTHERN MATERIAL 9

Dissolution of chemicals -natural convection dissolution – water interface – mass transfer coefficients at the sediment – water interface. Flux of chemicals between sediment and the overlying seawater – movement of chemicals through the benthic boundary layer.

UNIT IV EXCHANGE RATES BETWEEN AIR AND SOIL 9

Turbulence above the air – soil interface – the Richardson number – chemical flux rates through the lower layer of the atmosphere –evaporation of liquid chemicals spilled on land – chemical flux rates through the upper layer of earthen material.

UNIT V CONTAMINANT TRANSPORT ANALYSIS 9

Potential theory- Potential Functions- Stream Function – Travel time along with Stream Functions- Residential Time Distribution Theory- Analysis of Chemical Spills and Contaminant plumes – Fourier analysis of Initial value – point spill analysis- vertically mix spill analysis- Horizontal Plane Source analysis

TOTAL: 45 PERIODS

OUTCOME

On completion of the course, the student is expected to

CO 1. Understand the equilibrium and transport mechanisms
CO 2. Have a knowledge of gas exchange rates between air and water
CO 3. Have a knowledge of gas exchange rates between water and soil
CO 4. Have a knowledge of gas exchange rates between air and soil.
CO 5. Understand contaminant transport analysis

TEXT BOOKS:

1. Thibodeaux, L.J, “Environmental Chemo dynamics: Movement Of Chemicals In Air, Water and Soil”, 2nd edition ., Wiley - Intercedence, New York, 1996.
2. Schnoor, J.L., Environmental Modelling Fate and Transport of Pollutants in Water, Air and Soil, John Wiley & Sons Inc., New York, 1996.
3. Walton, J.C., Fate and Transport of Contaminants in the Environment, College Publishing 2008.
4. Charbeneau, R.J., Groundwater Hydraulics and Pollutant Transport, Waveland Press, 2006

REFERENCES:

1. Zheng, C., and Bennett, G.D., Applied Contaminants Transport Modelling, Wiley-Blackwell, 2002.
2. Samiullah, Y., Prediction of the Environmental Fate of Contaminants, Springer 2011.
3. David Chin., Water Quality Engineering in Natural Systems: Fate and Transport Process in the Environment, Wiley-Blackwell, 2013.
4. Hemond, H.F., and Fechner, E.J., Chemicals Fate and Transport in the Environment, Academic Press, 2014.
5. Cussler, E.L, Diffusion: Mass Transfer In Fluid Systems, Cambridge University press, 1994

CCE331 AIR AND NOISE POLLUTION CONTROL ENGINEERING L T P C
3 0 0 3

OBJECTIVES:

- To impart knowledge on the sources, effects and control techniques of air pollutants and noise pollution.

UNIT I GENERAL 9

Atmosphere as a place of disposal of pollutants – Air Pollution – Definition - Air Pollution and Global Climate - Units of measurements of pollutants - Air quality criteria - emission standards - National ambient air quality standards - Air pollution indices - Air quality management in India.

UNIT II SOURCES, CLASSIFICATION AND EFFECTS 9

Sources and classification of air pollutants - Man made - Natural sources - Type of air pollutants - Pollution due to automobiles - Analysis of air pollutants - Chemical, Instrumental and biological methods.Air pollution and its effects on human beings, plants and animals - Economic effects of air pollution - Effect of air pollution on meteorological conditions - Changes on the Meso scale, Micro scale and Macro scale.

UNIT III SAMPLING, METEOROLOGY AND AIR QUALITY MODELLING 9

Sampling and measurement of particulate and gaseous pollutants - Ambient air sampling - Stack sampling. Environmental factors - Meteorology - temperature lapse rate and stability – Adiabatic lapse rate - Wind Rose - Inversion – Wind velocity and turbulence - Plume behavior - Dispersion of air pollutants- Air Quality Modeling.

UNIT IV AIR POLLUTION CONTROL MEASURES 9

Control - Source correction methods - Control equipments - Particulate control methods – Bag house filter - Settling chamber - cyclone separators - inertial devices - Electrostatic precipitator - scrubbers - Control of gaseous emissions - Absorption - Absorption equipments - adsorption and combustion devices (Theory and working of equipments only).

UNIT V NOISE POLLUTION AND ITS CONTROL 9

Sources of noise – Units and Measurements of Noise - Characterization of Noise from Construction, Mining, Transportation and Industrial Activities, Airport Noise – General Control Measures – Effects of noise pollution – auditory effects, non-auditory effects. Noise Menace– Prevention and Control of Noise Pollution – Control of noise at source, control of transmission, protection of exposed person - Control of other types of Noise Sound Absorbent

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student is expected to

CO1 Understand various types and sources of air pollution and its effects
CO2 Know the dispersion of air pollutants and their modeling
CO3 Know about the principles and design of control of particulate pollutants
CO4 Understand the principles and design of control of gaseous pollutant
CO5 Know the sources, effects and control of vehicular, indoor air and noise pollution

TEXTBOOKS:

1. C. S. Rao, “Environmental Pollution Control Engineering”, Wiley Eastern Limited, 2006.
2. M. N. Rao, H. V. N. Rao, Air pollution, Tata McGraw Hill Pvt Ltd, New Delhi, 2017
3. Dr. Y. Anjaneyulu, “Air Pollution and Control Technologies”, Allied publishers Pvt. Ltd., 2019.

REFERENCES:

1. Noel De Nevers, "Air pollution control Engineering", McGraw Hill International Edition, McGraw Hill Inc, New Delhi, 2000.
2. Air Pollution act, India, 1987
3. Peterson and E.Gross Jr., “Hand Book of Noise Measurement”, 7th Edition, 1974
4. Mukherjee, "Environmental Pollution and Health Hazards", causes and effects, 1986
5. Antony Milne, “Noise Pollution: Impact and Counter Measures”, David & Charles PLC, 1979.
6. Kenneth wark, Cecil F.Warner, “Air Pollution its Origin and Control”, Harper and Row Publishers, New York, 1998.

EN3411 ENVIRONMENTAL CHEMISTRY AND MICROBIOLOGY LABORATORY L T P C
0 0 4 2

OBJECTIVES:

- To train in the analysis of physico-chemical parameters with hands on experience
- To train the students in the analysis of various microbiological techniques, microbiological analysis, enzyme assay, pollutant analysis and operation of bioreactors.

A: Environmental Chemistry

1. Estimation of hardness in Water sample by volumetric titration
2. Estimation of Chloride in Water sample by volumetric titration
3. Determination of sulphate
4. Determination of phosphate
5. Determination of Total Solids, Total suspended solids, Total dissolved solids
6. Determination of COD in the wastewater sample
7. Determination of BOD in the wastewater sample

B: Environmental Microbiology

1. Preparation of culture media
2. Isolation and Culturing of Microorganisms
3. Gram Staining of bacteria
4. Bacteriological analysis of wastewater (Coliforms & Streptococcus) – MPN Technique
5. Bacteriological analysis of wastewater (Coliforms & Streptococcus MF technique

OUTCOMES

CO1 Analyze the water quality parameters such as hardness chloride and sulphate
CO2 Characterize the wastewater parameters like phosphate, solids COD and BOD
CO3 Prepare culture media necessary for microbial growth
CO4 Isolate and culture the bacteria - identify the bacteria -able to handle microscope
CO5 Analyze the coliform count in the wastewater.

REFERENCES

1. APHA, "Standard Methods for the Examination of Water and Wastewater", 23rd Ed. Washington, 2017
2. "Laboratory Manual for the Examination of water, wastewater soil, Rump, H.H. and Krist, H. – Second Edition, VCH, Germany, 3rd Edition, 1999.
3. Charles P. Gerba, "Environmental Microbiology: A laboratory manual", Elsevier Publications, 3rd, 2014

PROGRESS THROUGH KNOWLEDGE