Course Name: **Bachelor of Vocational**
Discipline: **Environmental Assessment and Remediation**
(FOR THOSE WHO JOIN IN JUNE 2022 AND AFTER)
Duration of the Course: Three Years

1. Course Objectives

The objective is to recognize that curriculum, course content and assessment of academic achievement play complementary roles in shaping education. The course has been designed to improve the understanding of the students about different pollution control strategies and the skills of application of remediation techniques to combat pollution in three environmental compartments i.e. water, air and soil. The course will also be dealing with the sources of pollution in water, air, soil, solid-waste, thermal and noise and the impacts these sources on the environment and health. In addition, the students will be given the training to develop the particular skills required in pollution related structured study and conservation methods.

- To study sources and classification of water pollutants.
- To study air pollution: sources and effects.
- To study sources of soil contamination and management of solid waste.
- To develop skill in practical work, experiments, equipments and laboratory use along with collection of sample and interpretation of data for environmental Assessment.
- Make aware of natural resources and environment and the importance of conservation.

2. Eligibility for admission:

A pass in the Higher Secondary with Biology background / other streams also and its equivalent as per Madurai Kamaraj University rules.

COURSE SCHEME:

Semester	Part	Title of the Paper	Hrs	Theory	Skill	Total	Int.+Ext.= Total	Local	Regional	National	Global	Professional Ethics	Gender	Human Values	Environment & Sustainability	Employability	Entrepreneurship	Skill Development	Subject Code	Revised / New / No Change / Interchanged & Percentage of revision
I	Allied-1	Communicative English - Paper I	6	2	2	4	25+75=100		✔			✔						✔	**EV22E11**/ EV15E1	No change
	Allied-2	Mathematics-I	6	2	2	4	25+75=100	✔				✔						✔	**EV22M11/** EV15M1	No change
	Part-IV SLC	Value education	-	3	0	3	25+75=100		✔					✔		✔			**U22VE11**	
	Core-1	Environmental Science	5	3	2	5	25+75=100			✔					✔			✔	**EV22C11**	Revised – 50%
	Core-2	Environmental Pollution- I	5	3	2	5	25+75=100				✔				✔			✔	**EV22C12**	Revised – 30%
	Core 1 Lab	LAB: Environmental Chemistry	6	0	4	4	40+60=100			✔					✔			✔	**EV22CP11**	Revised – 20%
		Internship		0	5	5	100 (Internal)	✔										✔	**EV22IS11**/ EV15TV1	No change
		Total	**30**	**13**	**17**	**30**														

Semester	Part	Title of the Paper	Hrs	Theory	Skill	Total	Int.+Ext.= Total	Local	Regional	National	Global	Professional Ethics	Gender	Human Values	Environment & Sustainability	Employability	Entrepreneurship	Skill Development	Subject Code	Revised / New / No Change / Interchanged & Percentage of revision
II	Allied-3	Communicative English – Paper II	6	2	2	4	25+75=100	✔				✔						✔	**EV22E21/** EV15E2	No change
	Allied-4	Mathematics-II	6	2	2	4	25+75=100		✔			✔						✔	**EV22M21/** EV15M2	No change
	Allied-5	Basics of Computers for Reports Maintenance	2	2	1	3	25+75=100		✔			✔						✔	**EV22CS21**	New
	Core-3	Water Quality Assessment	5	3	2	5	25+75=100		✔						✔			✔	**EV22C21/** EV15T21	No change
	Core-4	Water and wastewater remediation techniques	5	3	2	5	25+75=100			✔					✔			✔	**EV22C22**	Revised – 10%
	Core 2 Lab	LAB: Water analysis	6	0	5	5	40+60=100		✔						✔			✔	**EV22CP21**	Revised – 20%
		Industrial Visit		0	4	4	100 (Internal)		✔			✔						✔	**EV22IV11/** EV15TV2	No change
		Total	**30**	**12**	**18**	**30**														

SEMESTER – I

COMMUNICATIVE ENGLISH - PAPER I

Contact Hours per week : 6 **Subject Code: EV22E11**/ EV15E1
Contact Hours per semester: 90 (Theory 60 + Skill 30) **Credits:** 4 (2 Theory + 2 Skill)

Section- A: Theory (2 credits)

Course Outcomes (CO):

On successful completion of the course, the learners will be able to

- **CO1**: provide the vital information required to understand the concepts underlying various communication skills.
- **CO2**: cover the several aspects of communication in oral and written modes.
- **CO3**: facilitate acquisition of necessary language skills.
- **CO4**: learn the basic grammar of English language
- **CO5**: apply knowledge of word power and grammar rules in formal and informal letter writings

Unit I – Grammar **12 hours**

i. Parts of Speech
ii. Tenses – Present, Past, Future

Unit II – Reading Skill **12 hours**

i. Comprehension of a Passage / Story / News

Unit III – Writing Skill **12 hours**

i. Narration of story
ii. Translation of sentences, short passages
iii. Letter writing (Informal Letters)

Unit IV – Phonetics **12 hours**

i. Vowels, Consonants, Diphthongs
ii. Transcription of words

Unit V – Speaking Skill **12 hours**

i. Introducing oneself and others
ii. Situational Communication – Greeting, Complimenting, Requesting etc.

Note: 2, 4 units are considered as a Language laboratory
(Allocation: 12 hours Laboratory, 18 Hours theory)

TEXTBOOK:

1. V.JeyaSanthi and R. Selvam, 2015. *Advanced Skills for Communication in English*: Book I, New Century Book House

REFERENCE BOOKS:

1. G.Radhakrishna Pillai - *Emerald English Grammar & Composition*, Emerald Publishers
2. Board of Editors - *Synergy – Communication in English and Study Skills*, Orient Blackswan
3. Dr.S.Vincent - *Let's Speak English (A Course in Spoken*

*English)*Soundra Publications
4. K.R.Lakshminarayanan, T.Murugavel - *Communication Skills in English*, SciTech Publications, Chennai.
5. G.Radhakrishna Pillai, K.Rajeevan - *Spoken English for You: Level One* Emerald Publishers
6. Bikram K.Das - *Functional Grammar and Spoken and Written Communication in English*, Orient Longman Pvt., Ltd.
7. A.R.Thorat, B.S.Valke, S.B.Gokhale - *Enriching Your Competence in English* Orient Longman Pvt. Ltd.

Section –B Skill Component

Contact Hours per semester: 30 **Credits: 2**

1. To impart and enhance communicative competency for professional mobility
2. To equip the student with necessary skills for employment
3. To prepare students for career in media
4. To develop ability of all students to read, write, listen, speak and think critically
5. To produce students with advanced skills in writing, reading and reasoning.

MATHEMATICS – I

Contact Hours per week : 6 **Subject Code: EV22M11/** EV15M1
Contact Hours per semester: 90 (Theory 60 + Skill 30) **Credits:** 4 (2 Theory + 2 Skill)

Section- A: Theory (2 credits)

COURSE OUTCOMES (CO):

On successful completion of the course, the learners will be able to

CO1: understand basic mathematics, data interpretations.
CO2: learn about effective presentation of data.
CO3: acquire knowledge about applications of Differentiation
CO4: enrich the knowledge about methods of data collection
CO5: demonstrate the Computations

Unit-I: **12 hours**

Methods of collection of data - primary-secondary – sampling: classification and tabulation: tabulation of data – rules for tabulation - diagrammatic and graphic representation.

Unit-II: **12 hours**

Arithmetic mean – median – mode Range – quartile deviation – mean deviation – standard deviation – co-efficient of variation (combined standard deviation excluded)

Unit-III: **12 hours**

Correlation - Regression analysis – regression equations.

Unit-IV: **12 hours**

Forecasting Introduction - Finding missing data using Lagrange Interpolation Formulae and Lagrange's Inverse interpolation formula

Unit-V: **12 hours**

Computations using worksheet formula, Interpreting data using spread sheet – A Simple presentation of your data.

Note: (Allocation: 18 hours Laboratory, 72 Hours theory)
[All units are from text books only. Include the theory parts without proof and derivations. Problems only]

TEXTBOOKS:

1. R.S.N. Pillai and V. Bagavathi, 2016. *Statistics*, S Chand Publishing
2. S.Arumugam, A.Thangapandi Isaac, A. Somasundaram, 2010. *Numerical Method*, Second Edition, SCITECH Publications.

REFERENCE BOOKS:

1. S. Narayanan and T.K. Manicavachagom, 2009. *Differential Equations and Its Applications*, S. Viswanathan (Printers & Publishers), Pvt. Ltd.
2. S.P. Gupta, 2018. *Business statistics*, SBPD Publications
3. D. C. Sancheti, V. K. Kapoor, 2010. *Statistics: Theory, Methods & Application* 7th Edition, Sultan Chand And Sons
4. J. H. Mathews, 1987. *Numerical Methods for Mathematics, Science and Engineering*, Prentice Hall, New Delhi, 2001.

Section –B Skill Component

Contact Hours per semester: 30 **Credits: 2**

1. Properties of mean
2. Arithmetic mean
3. Median
4. Mode
5. Frequency table
6. Standard deviation
7. Rank correlation
8. Correlation
9. Regression equation
10. Lagrange's method

ENVIRONMENTAL SCIENCE

Contact Hours per week : 5 **Subject Code: EV22C11**
Contact Hours per semester: 75 (Theory 45 + Skill 30) **Credits:** 5 (3 Theory + 2 Skill)

Section- A: Theory (3 credits)

Course Outcomes (CO)

On successful completion of the course, the learners will be able to

CO1: recognize the importance of environment and role of Individuals in its protection.
CO2: explain the key concepts of Ecosystem, Food Web and Bio geochemical.
CO3: apply the right measures for the sustainable use of natural resources.
CO4: analyze the ethical, cross-cultural, and historical context of environmental issues and the links between Human and Natural Systems.

CO5: examine the impact of human action on the biological environment

Unit – I: Concept and scope **9 hours**

Environmental science: Concept, Scope and importance – Environmental segments: Atmosphere, Hydrosphere, Lithosphere and Biosphere – Renewable and non-renewable resources

Unit – II: Eco system and Energy flow **9 hours**

Ecosystem: Structure and Function – Classification of Ecosystem: Terrestrial (Forest & Grassland) and Aquatic (Fresh water & marine) – Energy flow in the Ecosystem: Food chain & Food web – Ecological pyramids. Biogeochemical cycle: water cycle – carbon cycle and nitrogen cycle.

Unit-III: Biodiversity and conservation **9 hours**

Biodiversity: Introduction and Definition – Types: Genetic, Species and Ecosystem diversity. Indian Biodiversity Hotspots – Endemic species – Threats to biodiversity – Conservation of Biodiversity – *In-situ* and *Ex-situ* conservation strategies. IUCN Red list Categories.

Unit – IV: Atmosphere **9 hours**

Atmosphere structure – composition of atmosphere – evolution of the atmosphere – particles, ions and radicals in the atmosphere – Chemical and photo chemical reactions in the atmosphere: oxygen and ozone chemistry – Biological components of atmosphere.

Unit – V: Environmental Policy and Law **9 hours**

Climate change – Global warming – Ozone layer depletion – Environment (Protection) Act, (1986) and Rules – Water Prevention and Control of Pollution act, 1974 – Air prevention and control of pollution Act, 1981 – Salient features of wildlife (Protection) Act 1972 – Kyoto protocols and Convention on Biological Diversity (CBD) – Industrial regulation act.

TEXTBOOKS:

1. Dharmaraj, J, 2008. *Text book of Environmental studies*, S. Chand and Co. New Delhi.
2. Singh, YK. 2006. *Environmental Science*. New Age International Pub. New Delhi
3. Bharucha, E, 2021. *Textbook of Environmental Studies*. Orient Blackswan Pvt Ltd
4. A.K.De, 2010. *Environmental chemistry*, 7th edition, New age International Publishers New Delhi.

REFERENCE BOOKS

1. Benny Joseph, 2006. *Environment science and engineering*, Tata McGraw-Hill publishing Company limited, New Delhi.
2. Stanley E.Manahan, *Environmental Chemistry*, Seventh Edition, Lewis Publishers, Newyork.
3. Trivedi, R.K. 2010. *Handbook of Environmental Laws, Acts, Guidelines, Compliance and Standards*, Vol I & II, B.S. Publications, Hyderabad.

Section –B Skill Component

Contact Hours per semester: 30 **Credits: 2**

1. Determination of soil texture
2. Effect of light intensity on the growth of plants
3. Survey of flora and fauna in an area
4. Domestic waste segregation
5. Estimation of dust pollution

ENVIRONMENTAL POLLUTION-I

Contact Hours per week : 5 **Subject Code: EV22C12**
Contact Hours per semester: 75 (Theory 45 + Skill 30) **Credits:** 5 (3 Theory + 2 Skill)
Course Outcomes (CO)

On successful completion of the course, the learners will be able to

CO1: focus the impact and monitoring of Air pollution
CO2: understand various types of water pollution and analysis of water quality.
CO3: know the effect of heavy metals and their interactions with soil components.
CO4: discuss the effect of noise pollutants on human beings.
CO5: simplify pollution control method

Unit-I **9 hours**

Environmental Pollution: Definition, Causes – population, resource consumption, deforestation, industrialization, agriculture, urbanization and transport. Air pollution: Sources of pollution (Natural and anthropogenic) – Classification of air pollutants: primary and secondary pollutants – carbon monoxide, oxides of sulphur and nitrogen, suspended particulate matter (SPM), transport, acid rain, global warming.

Unit-II **9 hours**

Water pollution – sources of surface and groundwater pollution, types and impacts; Eutrophication - causes and effects and control. Wastewater Treatment: Primary, Secondary and Advanced treatment methods. Effects of water pollutants on physicochemical and biological parameters of water bodies.

Unit-III **9 hours**

Marine Pollution – sources (point and non point sources), effects, - pollution caused by Oil exploration, dredging offshore structures and agriculture impacts of pollution on water quality – algal blooming.

Unit-IV **9 hours**

Soil Pollution – causes of soil pollution, effects of soil pollution on environment; soil quality parameter, sampling, physicochemical and microbiological analysis of soil pollution, soil pollution control, industrial effluents and heavy metals and their interaction with soil components – Bioremediation of contaminated soil.

Unit-V **9 hours**

Thermal and Noise Pollution, measurement and indices, permissible ambient noise levels – Noise Act – Effects of thermal and noise pollution on human beings, plants, animals and climate – Remedial measures, Green belt.

TEXTBOOKS:

1. Sharma, P.D. 1990. *Ecology and Environment*. Rastogi Publications. Meerut.
2. Verma, P.S. and V.K. Agarwal (1996) *Principles of Ecology*. S.Chand& Co. New Delhi.
3. GowrikrishnaDasmohapatra (2009) *Environment and Ecology* (III Edn) VIKAS Publishing House Pvt Ltd, New Delhi.
4. Misra, S.P and Pandey, S.N. (2009) *Essential Environmental Studies*, Ane Books Pvt Ltd, New Delhi.

REFERENCE BOOKS:

1. K.V.S.G. Murlikrishan, 2016. *Air pollution and control* Laxmi Publications Pvt. Ltd.
2. Southwick,C.H. 1976.*Ecology and the quality of Environment*. D.VasNostrand Co.
3. Odum,E.P. (1971) *Fundamentals of Ecology*, W.B. Saunder's Co. Philadelphia.
4. Ahluswalia, VK & Sunita M, 2009. *Environmental Sciences*, Ane Books, New Delhi.
5. Agarwal, S.K. *Water Pollution*, APH Publishing Corporation.

Section –B Skill Component

Contact Hours per semester: 30 **Credits: 2**

1. Determination of moisture content of soil
2. Determination of pH value of different water samples
3. Collection and analysis of freshwater plankton
4. Effect of light on plankton
5. Sampling of animal population by using Quatrad method

LAB: ENVIRONMENTAL CHEMISTRY

Contact Hours per week : 6 **Subject Code: EV22CP11**
Contact Hours per semester: 90 **Credits:** 4 (Skill)

(Practical exam – to be conducted at the end of first semester)

1. Preparation of solutions and standardization.
2. Separation of mixtures by physical and chemical methods.
3. Colour Identifications of various water samples.
4. pH determination (pH meter and Universal indicator) of various samples.
5. Conductance measurement of various samples.
6. Determination of Dissolved Oxygen (DO) in water by Winklers method.
7. Determination of Total Dissolved Solids (TDS) in water.
8. Determination of Alkalinity of water samples.

Microbiology Laboratory-I

1. Microbiological laboratory safety procedures.
2. Microscopy - simple staining, Hanging drop and wet mount.
3. Preparation of bacteriological Media – Nutrient Agar and Broth.
4. Serial dilution method.
5. Pure culture technique – Spread, Pour, Streak
6. Isolation and Identification of Microbes from air using air sampler.

SEMESTER - II
COMMUNICATIVE ENGLISH – PAPER II

Contact Hours per week : 6 **Subject Code: EV22E21/** EV15E2
Contact Hours per semester: 90 (Theory 60 + Skill 30) **Credits:** 4 (2 Theory + 2 Skill)

Section- A: Theory (2 credits)

Course Outcomes (CO)

On successful completion of the course, the learners will be able to

CO1: develop in students the proficiency in speaking and writing for different purposes.
CO2: demonstrate communication skills in English.
CO3: understand the nuances of the language.
CO4: classify the business English
CO5: use the situational speech

Unit I – Grammar **12 hours**

i. Concord, Voice, Speech, Article, Preposition
ii. Error Spotting

Unit II – Conversational English **12 hours**

i. Dialogue building on various situations

Unit III – Business English **12 hours**

i. Letter writing (Formal Letters & Resume)
ii. Memo / Notice / Agenda / Minutes Writing
iii. Report writing

Unit IV – Situational Speech **12 hours**

i. Welcome address / Vote of thanks
ii. Group Discussion

Unit V – Writing Skill **12 hours**

i. Describing a thing / place / person
ii. Writing Stories from outline

Note: (Allocation: 24 hours Laboratory, 36 hours theory)

TEXT BOOK

1. V.JeyaSanthi and A. Sankar- *Advanced Skills for Communication in English*: Book II:

REFERENCE BOOKS:

1. G.Radhakrishna Pillai - *Emerald English Grammar & Composition*, Emerald Publishers
2. Board of Editors - *Synergy – Communication in English and Study Skills*, Orient Blackswan
3. Dr.S.Vincent - *Let's Speak English (A Course in Spoken English)*Soundra Publications
4. K.R.Lakshminarayanan, T.Murugavel - *Communication Skills in English*, SciTech Publications, Chennai.

5. G.Radhakrishna Pillai, K.Rajeevan - *Spoken English for You: Level One* Emerald Publishers
6. Bikram K.Das - *Functional Grammar and Spoken and Written Communication in English*, Orient Longman Pvt., Ltd.
7. A.R.Thorat, B.S.Valke, S.B.Gokhale - *Enriching Your Competence in English* Orient Longman Pvt. Ltd.

Section –B Skill Component

Contact Hours per semester: 30 **Credits: 2**

1. To enrich the students knowledge in the English language.
2. To equip the student with necessary skills for employment
3. To prepare students for career in media
4. To develop ability of all students to read, write, listen, speak and think critically
5. To produce students with advanced skills in writing, reading and reasoning.

MATHEMATICS - II

Contact Hours per week : 6 **Subject Code: EV22M21/** EV15M2
Contact Hours per semester: 90 (Theory 60 + Skill 30) **Credits:** 4 (2 Theory + 2 Skill)

Section- A: Theory (2 credits)

Course Outcomes (CO)

On successful completion of the course, the learners will be able to

CO1: learn about Algebra of matrices, basics of sampling techniques
CO2: understand basic test of significance
CO3: demonstrate the effective presentation of data.
CO4: define the statistical hypothesis
CO5: appraise the test of significance

Unit-I: **12 hours**

Matrices: Types of Matrices – Addition and multiplication of matrices – simple properties

Unit-II: **12 hours**

Statistical Inference: Introduction – procedure of testing hypothesis - standard error and sampling distribution- estimation

Unit-III: **12 hours**

Test Of Significance For Small Samples: Student's t- distribution – To test the significance of the mean of a random sample –Testing difference between means of 2 samples (independent)- Testing difference between means of 2 samples (dependent samples)

Unit-IV: **12 hours**

Theoretical distribution: Binomial distribution – Poisson distribution

Unit-V: **12 hours**

Chi-square test: Degrees of freedom – Test of goodness of fit – Test of independence – Yates correction

[All units are from text books only. Include the theory parts without proof and derivations. Problems only]

TEXT BOOKS:

1. R.S.N. Pillai and V. Bagavathi, 2016. *Statistics*, S Chand Publishing
2. S.Arumugam, A.Thangapandi Isaac, A. Somasundaram, 2010. *Numerical Method*, Second Edition, SCITECH Publications.

REFERENCE BOOKS:

1. S.P. Gupta, 2018. *Business statistics*, SBPD Publications
2. D. C. Sancheti, V. K. Kapoor, 2010. *Statistics: Theory, Methods & Application* 7th Edition, Sultan Chand And Sons
3. J. H. Mathews, 1987. *Numerical Methods for Mathematics, Science and Engineering*, Prentice Hall, New Delhi, 2001.

Section –B Skill Components

Contact Hours per semester: 30 **Credits: 2**

1. Binomial distribution (4 coins)
2. Binomial distribution (6 coins)
3. Poisson distribution (one book)
4. Poisson distribution (well packed blade packet)
5. Chi-square test (one dice-120 times)
6. Chi-square test (one dice-150 times)
7. Fitting a Poisson distribution (100 car radios)
8. Fitting a Poisson distribution (200 car radios)
9. Student t-test (5 person IQ test)
10. Student t-test (6 person IQ test)

SBE 2: BASICS OF COMPUTERS FOR REPORTS MAINTENANCE

Contact hours per week: 2 **Subject Code: EV22CS21**
Contact hours per semester: 30 (20 Theory + 10 Skill) **Credits: 3** (2 Theory + 1 Skill)

Course Outcomes (CO)

On successful completion of the course, the learners will be able to

CO1: demonstrate the ability to produce a quality manual.
CO2: understand the knowledge of certification and accreditation.
CO3: discuss the knowledge and insight of different quality management systems i.e. product quality management, safety and environmental management.
CO4: appraise the knowledge of auditing and auditing systems.
CO5: critique the current state of the art in Quality Management

Section- A: Theory

Unit I **4 hours**

Introduction to Computers: History of Computers – generation of Computers – Characteristics of Computers – Classification of Computers – Components of Computers – Block Diagram – Hardware Vs Software – System Software Vs Application Software – Programming Language.

Unit II **4 hours**

Input Devices: Key board - Mouse – Touch Pad / Touch Screen Magnetic Ink Character Recognition (MICR) – Optical Character Recognition (OCR) – Optical Mark Recognition (OMR) – Output Devices: Monitor – Printers – Plotter Storage Devices: Magnetic tape – Hard Disk – Floppy Disk –Pen drive - CD-ROM, DVD Blue Ray Disc etc., - System Memory – RAM – ROM – PROM– EPROM.

Unit III **4 hours**

Open office- MS office- Word Processing – Spread sheet – Power point presentation – Introduction to internet - Browsers- Search engines- Email- Google educational applications.

Unit IV **4 hours**

Interpretation – Meaning of interpretation – Technique of interpretation – Precaution in interpretation – Interpretation of tables and figures.

Unit V **4 hours**

Reporting – Significance of report writing – Different steps in writing report – Types of reports – Mechanics of writing reports – Precautions of writing research reports.

REFERENCE BOOK:

1. Barbara Kasser, 1998. "*Using the internet*" Fourth edition, EE Edition, New Delhi.
2. Dinesh Maidasani, 2008. "*Learning Computer fundamentals, MS Office and Internet and Web Technology*", Firewall media.
3. Alexis Leon Mathews Leon, 2012. "*INTERNET for EVERONE*", Leon Vikas Press, Chennai.

Section- B: Skill components

Contact hours per semester: 10 **Credits: 2**

1. To learn the basic anatomy of a computer.
2. To connect the hardware components in a computer.
3. To type a report on the word document.
4. To store the data in Microsoft excel.
5. To learn the management of E-mail in a computer.

WATER QUALITY ASSESSMENT

Contact Hours per week : 5 **Subject Code : EV22C21**/EV15T21
Contact Hours per semester: 75 (Theory 45 + Skill 30) **Credits:** 5 (3 Theory + 2 Skill)

Section- A: Theory (3 credits)

Course Outcomes (CO)

On successful completion of the course, the learners will be able to

CO1: provide adequate knowledge about water.
CO2: study the chemical composition of water.
CO3: get knowledge about control measure of water pollutants
CO4: define the fundamentals idea about water analysis.
CO5: demonstrate the water analysis

Unit – I: **9 hours**

Types of Water – Structure of liquid water – Sources of water – water quality, drinking water standards – comparison of chemical composition of mineral water, ground water and sea water.

Unit – II: **9 hours**

Water Pollutants – Contents of domestic sewage water – Industrial wastewater: Paper & Pulp, Distilleries, Fertilizer, Electroplating, Cement, Detergents, Dye, Tanning, Oils, Hazardous chemicals and radioactive wastes.

Unit – III: **9 hours**

Sampling of water for analysis: Bacteriological test, complete mineral analysis, and dissolves gas determinations – Water analysis units – Methods of analysis of water: Hardness, Alkalinities, Chlorides, Caustic alkalinity, Nitrate, Sulphate, Phosphate, Sulphite, Dissolved CO_2, Dissolved O_2, Dissolved H_2S.

Unit – IV: **9 hours**

Nutrients analysis of water: Nitrates, Nitrite, Ammonia, Phosphate, Silicates, Alkalinity, Hardness, Salinity, Microbiological methods of analyses of water – MPN count and Serological test. Ozonation of water.

Unit – V: **9 hours**

Marine Oil Pollution – Fate of oil spills in the marine environment – Photochemical oxidation – Microbial degradation – Biodegradation mechanisms – Biofouling.

TEXTBOOKS:

1. Kaur, K, 2007. Handbook of Water and Wastewater Analysis. Atlantic Publishers
2. Khanna, DR., Bhutiani, R, 2008. Laboratory Manual of Water and Wasteland Analysis. Daya Publishing House

REFERNCE BOOKS:

1. Escher, B., Neale, P., and Leusch, F. 2021. Bioanalytical Tools in Water Quality Assessment., IWA Publishing
2. Raven Spoon, 2021. Water Quality: Assessment and Treatment. States Academic Press
3. Chapman, D., 1996. Water Quality Assessments: A guide to the use of biota, sediments and water in environmental monitoring, Second Edition. CRC Press

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Section –B Skill Component

Contact Hours per semester: 30 **Credits: 2**

1. Determination of Acidity of given water sample
2. Determination of Alkalinity of given water sample
3. Determination of hardness of given water sample
4. Determination of presence of carbonate and bicarbonate in a water sample
5. Determination of presence of dissolved nutrients in a water sample

WATER AND WASTEWATER REMEDIATION TECHNIQUES

Contact Hours per week : 5 **Subject Code : EV22C22**
Contact Hours per semester: 75 (Theory 45 + Skill 30) **Credits:** 5 (3 Theory + 2 Skill)

Section- A: Theory (3 credits)

Course Outcomes (CO)

On successful completion of the course, the learners will be able to

CO1: outline adequate knowledge about water treatment process.
CO2: explain the various methods of sewage treatment.
CO3: get awareness about natural water purification.
CO4: understand the fundamentals idea about instrument methods of water analysis.
CO5: asses the Instrumental method of analysis

Unit – I: **9 hours**

Potable water – Sources and Characteristics – Drinking water quality standards – WHO – ISI – CPCB –USEPA – Water Softening techniques – Disinfection techniques – Chlorination – UV irradiation – Ozonization – Packaged drinking water – Mineral water.

Unit – II: **9 hours**

Wastewater treatment – Primary treatment, Screening and Grit removal – Sedimentation – secondary treatment – Chemical treatment, Coagulation – Precipitation and Disinfection – Biological treatment – Aerobic methods – Activated sludge process – anaerobic method – Up flow anaerobic sludge bed (UASB).

Unit – III **9 hours**

Tertiary treatment, advanced waste water treatment – nutrient removal – Chemical methods – Precipitation – biological nutrient removal system.

Unit – IV **9 hours**

Removal of Dissolved inorganic pollutants – Electro dialyses – Ion exchange – Reverse osmosis – sludge removal – water reuse and recycling.

Unit – V **9 hours**

Instrumental method of analysis – Instrument working and application of pH meter, colorimeter, dissolved oxygen measuring kit – Absorption spectroscopy.

TEXTBOOKS:

1. Maulik, 2018. Water Supply, Waste Water Treatment and Sewage Disposal. Standard Book house
2. Srivastava, 2018. Waste Water Treatment and Water Management. Notion Press, Chennai
3. Modi, 2020. Sewage Treatment & Disposal & Waste Water Engineering. Standard Book House

REFERENCE BOOKS:

1. Peirce, J.J., Vesilind, P.A. and Weiner, R.F. 1997. *Environmental Pollution and Control*, 4th Edition, Elsevier Science and Technology Books.
2. Saravanan, K., Ramachandran, S. and Baskar, R. 2005. *Principles of Environmental Science & Technology*. New Age International (P) Ltd., Publishers, New Delhi
3. Droste, 2009. Theory and Practice of Water and Wastewater Treatment, Wiley

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Section –B Skill Component

Contact Hours per semester: 30 **Credits: 2**

1. Sludge digestion and treatment
2. Find out the sources of waste water nearby your area
3. Study the techniques used in mineral water units
4. Study the major pollutants in the water resources of your place
5. Study the how the wastewater recycles in the industries in your area

LAB: WATER ANALYSIS

Contact Hours per week : 6 **Subject Code : EV22CP21**
Contact Hours per semester : 90 **Credits:** 5 (Skill)

(Practical exam – to be conducted at the end of second semester)

1. Determination of Total hardness of water by Versenate (EDTA) method.
2. Determination of Calcium contents in water by Versenate method.
3. Determination of Chemical Oxygen Demand (COD).
4. Determination of Total phosphate content in water.
5. Determination of Turbidity in water.
6. Determination of Carbonates and Bicarbonates (total alkalinity) of water.
7. Determination of sulphate in water.
8. Determination of Fluoride content in water.

Microbiology laboratory-II

1. Water sampling methods for microbiological analysis.
2. Isolation of indicator organisms from water by membrane-filtration Method
3. Most probable number (MPN) method – water analysis
4. Water analysis by Single-application (disposable) test kits.

Course Name: **Bachelor of Vocational (B.Voc.)**
Discipline: **Environmental Assessment and Remediation**
(For Those Who Join In 2016and After)

Duration of the Course: Three Years

1. Course Objectives

The objective is to recognize that curriculum, course content and assessment of academic achievement play complementary roles in shaping education. The course has been designed to improve the understanding of the students about different pollution control strategies and the skills of application of remediation techniques to combat pollution in three environmental compartments i.e. water, air and soil. The course will also be dealing with the sources of pollution in water, air, soil, solid-waste, thermal and noise and the impacts these sources on the environment and health. In addition, the students will be given the training to develop the particular skills required in pollution related structured study and conservation methods.

- To study sources and classification of water pollutants.
- To study air pollution: sources and effects.
- To study sources of soil contamination and management of solid waste.
- To develop skill in practical work, experiments, equipment's and laboratory use along with collection of sample and interpretation of data for environmental Assessment.
- Make aware of natural resources and environment and the importance of conservation.

2. Eligibility for admission:

A pass in the Higher Secondary with Biology background / other streams also and its equivalent as per Madurai Kamaraj University rules.

II -Year Syllabus

COURSE SCHEME:

Part	Title of the Paper	Hrs	Theory	Skill	Total	Int.+Ext.= Total	Local	Regional	National	Global	Professional Ethics	Gender	Human Values	Environment & Sustainability	Employability	Entrepreneurship	Skill Development	Subject Code
III	Soft Skills Development	4	2	1	3	25+75=100	✔				✔						✔	EV16T31
	Human impact on the Environment	4	2	1	3	25+75=100		✔						✔			✔	EV16T32
	Environmental Pollution- II	4	2	1	3	25+75=100				✔				✔			✔	EV16T33
	Air Quality Assessment & Remediation	5	3	1	4	25+75=100			✔					✔			✔	EV16T34
	Climate change and Carbon Sequestration	5	3	1	4	25+75=100				✔				✔			✔	EV16T35
	LAB: Air Quality Assessment I	10	0	5	5	40+60=100			✔					✔			✔	EV16P31
	Internship	8	0	4	4	50(Internal)	✔				✔						✔	EV16ISP3
	Industrial Visit	2	0	1	1	20(Internal)		✔			✔						✔	
	Project Work	6	0	3	3	30(Internal)		✔			✔						✔	
	Total	**48**	**12**	**18**	**30**													

Part	Title of the Paper	Hrs	Theory	Skill	Total	Int.+Ext.= Total	Local	Regional	National	Global	Professional Ethics	Gender	Human Values	Environment & Sustainability	Employability	Entrepreneurship	Skill Development	Subject Code
IV	Remote sensing and GIS	4	2	1	3	25+75=100			✔								✔	EV16T41
	Air Pollution Control Technologies	4	2	1	3	25+75=100			✔								✔	EV16T42
	Hazardous Waste Management	4	2	1	3	25+75=100			✔								✔	EV16T43
	Bioremediation	5	3	1	4	25+75=100				✔							✔	EV16T44
	Indoor Environment Monitoring	5	3	1	4	25+75=100			✔								✔	EV16T45
	LAB: Air Quality Assessment II	10	0	5	5	40+60=100			✔								✔	EV16P41
	Internship	8	0	4	4	50(Internal)	✔										✔	EV16ISP4
	Industrial Visit	2	0	1	1	20(Internal)		✔									✔	
	Project Work	6	0	3	3	30(Internal)		✔									✔	
	Total	**48**	**12**	**18**	**30**													

Semester – 3
Soft Skills Development

Contact Hours per week : 4 **Subject Code: EV16T31**
Contact Hours per semester : 60 (Theory 30 + Skill 30) **Credits:**3 (2 Theory +1 Skill)

Section- A: Theory (2 credits)

Contact Hours: 30
Objectives:

- To develop effective communication skills, presentation skills,self-confident individuals by mastering inter-personal skills, team management skills, and leadership skills.

Unit I Introduction **6 Hours**
Meaning of soft skills – Soft skills versus hard skills – The importance of soft skills in the competitive job market today – Selling your soft skills – Attributes regarded as soft skills – Identifying your soft skills – Enhancement of your soft skills through training.

Unit II Resume preparation **6 Hours**
What is resuming? – The importance of a resume in an interview – Details to be included in a resume – Do's for resume preparation – Don't' for resume preparation – Resume preparation for freshers – Resume preparation for candidates with experience.

Unit III Career Goal **6 Hours**
Meaning of career goal – The importance of "Know Thyself" or self-assessment – What is SWOT analysis – Long term goal and short term goal – Career opportunities today – Source of career information – Importance of career guidance.

Unit IV Group Discussion **6 Hours**
What is GD? – Necessity of GD in an interview – Characters tested in a GD – Skills required in a GD – Types of GD – Body language in a GD – Movements and gestures to be avoided in GD – Topics for GD – GD etiquette.

Unit V Personal interview **6 Hours**
Why an interview – Types of interview – Anticipated interview questions – Body language in an interview dress code in an interview – Do's in interview – Don'ts in an interview – Post interview etiquette – Salary negotiation in an interview.

Text Book:
SOFT SKILLS, 2015, Career Development Centre, Green Pearl Publications.

Section –B Skill component (1 credit)
Soft Skills Development

Contact Hours:30 **Credit:**1

Unit I Introduction **6 Hours**

1. Make the students give "self – introduction" in front of others in order to eradicate their stage fear.
2. Make the students identify their strength and weaknesses and give a summary of them.

Unit II Resume preparation **6 Hours**

3. Ask them to prepare a resume and let it be corrected.
4. Conduct Aptitude Test periodically and correct it
5. Ask them to gather information about career opportunities from various sources.

Unit III Career Goal **6 Hours**

6. Conduct GD very often and evaluate the students. Presentation skill, communication skill, body language etc.
7. Conduct Mock- interviews very often and assess the students.

Unit IV Group Discussion 6 Hours

8. Organize events very often to assess their team spirit and leadership quality. Discuss the contemporary issues.

Unit V Personal interview **6 Hours**

9. Ask them to prepare speeches in English on environmental relative topics and deliver them in front of others.
10. Ask them to organize events in order to assess their organization skill.
11. Assign them many works and ask them to finish it within a particulate time to assess their time management skill and priority management skill.

Human impact on the Environment

Contact Hours per week : 4 **Subject Code: EV16T32**
Contact Hours per semester : 60 (Theory 30 + Skill 30) **Credits:**3 (2 Theory +1 Skill)

Section- A: Theory (1 Credit)

Contact Hours:30
Objectives:

- To provide plenty knowledge about Human impacts.
- To understand the various pollutants of environment.

Unit – I **6Hours**

Define: Environment and types,causes of population explosion, degradation of natural resources, pollution of air, water and soil, urbanization, food security and people health.

Unit – II **6 Hours**

Environmental Degradation: Man and Environment – Man made Degradation – Deforestation – Urbanization – Industrialization – Mining – Dam building and other activities.

Unit – III **6 Hours**

Mining and Eco restoration. Mineral Resources- Types, effects on environment, Conservation of Mineral Resources and Restoration of Mining Sites.Introduction-Energy Resources, Types, Origin, Conventional, Non-Conventional, Energy crisis and its effect on the environment.

Unit – IV **6 Hours**

Define: urbanization causes effect on environment, solution for urban energy problems. Water conservation: Need for water conservation – strategies of water conservation– methods of water conversion: rain water harvesting- watershed management.

Unit – V **6 Hours**

Define: Industrialization, advantage and disadvantage of industrialization. Impact of Industrialization on the Environment

Suggested Books for study

1. Benny Joseph, Environment science and engineering, Tata McGraw-Hill publishing Company limited, New Delhi, 2006.
2. Dr.A.Ravikrishnan, Environment science and engineering.

Section –B Skill component (1 credit)

Contact Hours:30 **(1 credit)**

1. To study the urbanization any nearest one city.
2. To study the impact of Industrialization and Urbanization on Environment from sivakasi.
3. The effect of mining process and health hazards to workers
4. Any one place study about the impact of mining induced urbanization.

Environmental Pollution- II

Contact Hours per week : 4 **Subject Code: EV16T33**
Contact Hours per semester : 60 (Theory 30 + Skill 30) **Credits:**3 (2 Theory +1 Skill)

Section- A: Theory(2 Credit)

Contact Hours:30

Unit: 1 **6 Hours**

Introduction, definition of general and hazardous health care waste and diseases, Infectious waste, genotoxic waste, waste sharps, biomedical waste categories categorization and composition of Biomedical waste.Sources of Health care wastes.Its safety precaution and prevention of diseases.

Unit: II **6 Hours**

Define; E-waste, sources and environmental impact on e-waste. Its component of e-waste and recycling process, awareness and implementation rules of e-waste and reduction steps.

Unit : III **6 Hours**

Define: Radioactive pollution, Types, Sources, Effects, Control of Radiation Pollution. Mobile phone tower radiation and its impacts on environment.

Unit : IV **6 Hours**

Define photo pollution, Impact of energy usages, type of pollution, Effect on human and environmental of this pollution. Control measures of light pollution.

Unit : V **6 Hours**

Environmental rules in India: Hazardous Waste (management and handling) Rules,1989; Rules framed under industrial waste; Biomedical waste management rules; Noise and Environmental Pollution under Motor Vehicles Rules,1989,Coastal Zone Regulation,1991.

Section –B Skill component (1 credit)

Environmental Pollution- II

Contact Hours:30 **Credit:**1

1. To study the various symbol of biohazards waste and radiation waste.
2. To study the nearest biomedical waste deposit area.
3. To demonstrate the e-waste in to useful products.
4. To study cell phone tower effect and nearest environment.
5. To study the nearest coastal pollution area.

Air Quality Assessment & Remediation

Contact Hours per week : 5 **Subject Code: EV16T34**
Contact Hours per semester : 75 (Theory 45 + Skill 30) **Credits:** 4 (3 Theory + 1 Skill)

Section- A: Theory (3 credits)

Contact Hours:45

Objective:

- To understand the various the air quality and measurement and remediation.

Unit I- EMISSION INVENTORIES **9 Hours**

The purpose of emission inventories- Atmospheric emission inventory initiatives - Types of emission release and sources- Industrial emissions- Domestic emissions- Agricultural emissions- Motor vehicle emissions- Aircraft emissions- Examples of national emission inventories.

Unit II- AIR POLLUTION MONITORING **9 Hours**

Air pollution monitoring and Site selection- Monitoring standards and accreditation- Monitoring methods and techniques -Carbon monoxide- Sulphur dioxide- Oxides of nitrogen- Ozone -Volatile organic compounds-- National and municipal air quality monitoring networks

Unit III- AIR QUALITY **9 Hours**

Define : Air quality index, Air quality standards and limits, sources various pollutant, control measures of air quality national and international level.

UNIT: IV ALTERNATIVE PRACTICE

Carbon sequestration, Carbon dioxide as a feed stock for biofuel production, waste Co2 used as renewable power.

Unit V- IMPACT SIGNIFICANCE AND LEGISLATION **9 Hours**

Impact significance-Air pollution indices-Indoor air pollution-Air pollution legislation-National air pollution control regimes-pollution control regime

Suggested Books for Study

Harrop, Owen. Air quality assessment and management: A practical guide. CRC Press, 2001.

Section –B Skill component (1 credit)

Contact Hours:30 **Credit:**1

1. To study the microorganism's from polluted area
2. To determination of particulate matter from the industrial area by High Volume Sampler/ Settling method.
3. List out the effects air pollution to human beings and environment.
4. To study the power plant gas used as a Carbon sequestration
5. A review of vehicular pollution in urban areas and its effects on human health

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Climate change and Carbon Sequestration

Contact Hours per week : 5 **Subject Code: EV16T35**
Contact Hours per semester : 75 (Theory 45 + Skill 30) **Credits:** 4 (3 Theory + 1 Skill)

Section- A: Theory (3 credits)

Contact Hours:45
Objectives:

- To provide knowledge about Climate and carbon sequestration.

Unit – I **9 Hours**

Climate – causes of climate change: Industrialization,Green house effect- Greenhouse gases and their main anthropogenic sources- main greenhouse gases – Green house gases and global climate changes – Global warming.

Unit – II **9 Hours**

Possible impact of Global warming – Sea level change – crop yield – water balance – human health. Green house effect – policy response: possible way in which human activities may cause climate change. Effect of Climate change.

Unit – III **9 Hours**

Ozone in the atmosphere – Ozone hole forming sequences. Ozone depletion process – Ozone hole – Worldwide ozone trends. Consequences of Ozone depletion: Human health- Terrestrial plants – Aquatic eco systems – climate. Intergovernmental Panel for Climate Change (IPCC) emission scenarios, impact of climate change.

Unit – IV **9 Hours**

Define Climate change agreement, koyto protocol, UN Framework Convention on Climate Change (UNFCCC), importance of COP8 conference, New Delhi.

Unit – V **9 Hours**

Define: carbon Sequestration, types, sources of carbon, and impacts on environment. Control methods of carbon sources. Carbon sinks.

Suggested Books for study

1. Benny Joseph, Environment science and engineering, Tata McGraw-Hill publishing Company limited, New Delhi, 2006.
2. Dr.A.Ravikrishnan, Environment science and engineering.

Section –B Skill component (1 credit)

Contact Hours: 30 **Credit:**1

1. To study the climate change in Virudhunagar and surrounding cities.
2. To demonstrate that through the burning of fossil fuels (fields as well as forests) humans release additional CO2 into the atmosphere.
3. Case studies on effects of climate change: crop productivity, human diseases.
4. Case studies on effects of climate change: greenhouse gas emissions, sea level rise.
5. Case studies on successful green energy initiatives: Hybrid vehicles.
6. A review of El Niño and La Niña events are a natural part of the global climate system.

Lab: III – LAB: Air Quality Assessment I

Contact Hours: 150 **Credits:** 5

Subject Code: EV16P31

1) Methods of air sampling.
2) Determination of bacteria in air by open plate method.
3) Determination of fungi in air by open plate method.
4) Assessment of indoor micro flora by open plate method.
5) Determination of particulate matter from the industrial area by High Volume Sampler/ Settling method.
6) Assessment of outdoor bacteria by air sampling device.
7) Enumeration of fungi in outdoor/indoor air by air sampling device.

Semester- IV

Remote sensing and GIS

Contact Hours per week : 4 **Subject Code: EV16T41**

Contact Hours per semester : 60 (Theory 30 + Skill 30) **Credits:**3 (2 Theory + 1 Skill)

Section- A: Theory (2 credits)

Contact Hours:30

Objectives

This subject explains the basic concepts of Remote Sensing and Geographic Information Systems with its applications.

Unit - I Basics of Remote Sensing **6 hours**

Basic concepts of Remote Sensing - Introduction to remote sensing -Electromagnetic radiation -Characteristic of real remote sensing systems – Platforms – Satellite - Indian remote sensing satellite - Sensors - Satellite Retrievals

Unit -II Image interpretation & Processing **6 hours**

Image processing - Elements of image interpretation - Concepts of digital image processing

Unit -III Basics of GIS **6 hours**

Basic concepts of GIS - Introduction to GIS - History of development of GIS - Elements of GIS -Computer software's (ArcGIS (Esri), QGIS (Quantum GIS), GRASS GIS. Global Mapp).

Unit - IV GIS Analysis **6 hours**

Map overlay - Vector and raster data model - Mapping concept - Data storage and database management Development of map overlay - Overlay operation

Unit - V Applications **6 hours**

Applications of GIS and remote sensing in Energy & Environmental Engineering.

Text Books

1. A.N. Patel and Surendra Singh (1999), Remote Sensing Principles and Applications, Scientific Publisher, Jodpur.
2. P.A. Burrough (2000), Principle of Geographical Information Systems for Land Resources Assessment, Clarendon Press, Oxford.

Section –B Skill component (1 credit)

Contact Hours:30 **Credit:**1

1. Study of topographic maps – identification of scale, latitude and longitude in any one of city.
2. Study of various geomorphic and environmental features in the maps.
3. Case study about GIS and uses in current applications
4. To study the Remote Sensing Applications in Hydrology & Water Resources Management.
5. To study Land use/ Land Cover Mapping in Virudhunagar area.
6. To study the fundamentals of aerial photos and satellite images at Madurai city.
7. To study the future applications of remote sensing and GIS.
8. Demonstration and use of GPS

Air Pollution Control Technologies

Contact Hours per week : 4 **Subject Code: EV16T42**
Contact Hours per semester : 60 (Theory 30 + Skill 30) **Credits:** 3 (2 Theory + 1 Skill)

Section- A: Theory (2 credits)

Contact Hours:30

Objectives:

- To understand various components of air pollution
- To study various techniques for controlling air pollution

Unit-I **(6 Hours)**

Introduction to control of gaseous pollutants-Engineering control concepts- control on stationary and mobile sources- Concentrations and deposition- Mitigation of air pollution: the role of vegetation.

Unit-II **(6 Hours)**

Absorption and Thermal Oxidation for Volatile organic compounds (VOC) Control- Design Techniques for Countercurrent Absorption Columns- Countercurrent Flow Packed Absorption Tower Design.

Unit-III **(6 Hours)**

Control of VOC and Hazardous Air Pollutants (HAP) by Condensation- VOC and HAP by Biofiltration- Design Parameters and Conditions- Performance evaluation of Biofilter technologies.

Unit-IV **(6 Hours)**

Introduction to NOx, SOx, NH_4 and H_2S control- techniques for NOx control- techniques for SOx control- techniques for HCl, NH_4 and H_2S control.

Unit-V **(6 Hours)**

Air handling devices and types, Fundamentals of Particulate Control- Hood, Ductwork and Cyclone Design- Wet Scrubbers- Filtration and Baghouses- Electrostatic Precipitators.

Suggested Books for Study

1. Fundamentals of Air Pollution, by Richard W. Boubel, Donald L. Fox, D. Bruce Turner, Arthur C. Stern, [2008],Academic Press, an imprint of Elsevier, 30 Corporate Drive, Suite 400, Burlington, MA 01803, USA, ISBN: 978-0-12-373615-4

2. Air pollution Control Technology Handbook, Authored by K. B. Schnelle and C. A. Brown, [2002], CRC Press LLC, 2000 N.W. Corporate Blvd., Boca Raton, Florida 33431.USA, ISBN 0-8493-9588-7.

Section –B Skill component (1 credit)

Contact Hours:30 **Credit: 1**

1) To study the chimneys types and pollutants.
2) To visit the fire industry to determine the air pollution and content.
3) Comparative analysis of air sampling from clean and polluted area using key parameters.
4) To study the significance of Laminar flow chamber and components.
5) To study various filter system for air pollution control technologies

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Hazardous Waste Management

Contact Hours per week : 4 **Subject Code: EV16T43**
Contact Hours per semester : 60 (Theory 30 + Skill 30) **Credits:** 3 (2 Theory + 1 Skill)

Section- A: Theory (2 credits)

Contact Hours:30

Objectives:

- To understand medical waste generation and their health and environmental impact.
- To study the various disposal and processing technology of medical waste.
- To understand the various other Hazardous materials and their management techniques.

Unit-I- Hazardous Materials **(6 Hours)**

Definition: Hazardous Waste, classification waste, sources Hazardous Waste-Waste-Toxicology and the Standard-Setting Processes-Hazardous Waste Sources/Generators.

Unit-II Medical Waste an Introduction **(6 Hours)**

Introduction- medical waste classification- nature of medical waste- potential impacts (risks) associated with medical waste- environmental hazards related to medical waste- consequences of improper disposal or non-disposal of medical waste.

Unit-III Toxicity evaluation of Hospital waste **(6 Hours)**

Introduction- Healthcare waste generation- Segregation at source- Collection- Transport- Storage- Recycling – reuse- Treatment – disposal- Measurements- BOD/COD

Unit-IV Medical Waste Treatment and Disposal Methods (6 Hours)

Medical Waste Disposal- Medical Waste Treatment and Disposal Methods- Hydrothermal techniques- radiation methods- fast pyrolysis and gasification techniques for medical waste conversion in to carbon and energy.

Unit-V: Hazardous waste management (6 Hours)

Define Atomic waste, sources and types, Transportation of Hazardous Wastes- Modes and Scope of Hazardous Waste Transportation- Regulation and Disposal Methods, Waste Minimization, Reuse, and Recycling-Resource Conservation and Recovery Act (RCRA)Permits, Compliance and Enforcement- Assessment Techniques for Site Remediation.

Suggested Books for Study

1. Akter, Nasima. "Medical waste management: a review." Asian Institute of Technology, School of Environment, Resources and Development, Thailand 3 (2000): 485-486.
2. Tsakona, M1, E. Anagnostopoulou, and E. Gidarakos. "Hospital waste management and toxicity evaluation: a case study." Waste management 27.7 (2007): 912-920.
3. Blackman Jr, William C. Basic hazardous waste management. CRC Press, 2001.

Section –B Skill component (1 credit)

Contact Hours: 30 C**redit:**1

1. A Visit to the Hazardous waste Generation or disposal site.
2. Visit to Industrial area, especially the handling of Hazardous materials
3. Ecology baseline and impact of waste – disposal on vegetation
4. Preparation of report based on a case study of one hospital hazardous solid waste
5. Practical knowledge and uses of incinerators
6. Case study about pyrolysis unit uses

Bioremediation

Contact Hours per week : 5 **Subject Code: EV16T44**
Contact Hours per semester : 75 (Theory 45 + Skill 30) **Credits:** 4 (3 Theory + 1 Skill)

Section- A: Theory (3 credits)

Contact Hours:45 **Credits:**3

Objectives

- To impart sufficient scientific understanding of the current environmental tribulations and global concern.
- To focus the process of bioremediation, mechanisms, types, success stories& monitoring strategies.
- To focus the advance molecular techniques to facilitate bioremediation technology.
- To apply the concepts of bioremediation technology to the real time problems.

Unit-I (9 Hours)

Introduction to Bioremediation: Types- Factors affecting – Mechanisms- Limitations- Microbes for Bioremediation: Essential Characteristics of Microbes for Bioremediation, Microbial Adapadation for Adverse conditions. Microbes involved in Bioremediation. Metabolic process involved in bioremediation. Bioremediation Techniques: Insitu & Exsitu bioremediation techniques.

Unit-II (9 Hours)

Specific Bioremediation Technologies - Application, specific advantages and disadvantages- land farming, prepared beds, biopiles, composting, bioventing, biosparging, pump and treat

method, constructed wet lands, use of bioreactors for bioremediation. Phytoremediation, restoration of coal mines a case study.

Unit-III **(9 Hours)**

Define Bioleaching, process, advantage and disadvantage. Bio mining and process.

Unit-IV **(9 Hours)**

Nuclear Waste Bioremediation - Spent fuel characterization, storage and disposal- Partitioning, transmutation and conditioning- Measurement of Radioactivity in the environment- Basic actinide research.

Unit-V **(9 Hours)**

Heavy metal pollution- sources-Microbial interactions with heavy metals -resistance & tolerance- Microbial transformation- Accumulation and concentration of metals- Biosorption of heavy metals by microbial biomass and secondary metabolites – Biosurfactants- Advantages of biosurfactants over chemical surfactants-Biotechnology and oil spills- Improved oil recovery.

Suggested Books for Study

1. Phillip L. Buckingham, Jeffrey C. Evans," *Hazardous Waste Management"* Waveland PrInc; Reissue edition 1, 2010.
2. Agarwal S. K., *"Environmental Biotechnology*", APH Publishing, 2000.
3. Rajendran P., P. Guansekaran, "*Microbial Bioremediation*", MJP Publishers, 2011.

Section –B Skill component (1 credit)

Contact Hours: 30 **Credit:**1

1. To study bioremediation of Polluted sites from Virudhunagar district.
2. Bioremediation of organic and inorganic pollutants from polluted sites.
3. To study the Phytoremediation: Mechanisms & techniques of Phytoremediation from one site.
4. Microbial bioremediation of pesticides and Xenobiotic compounds.
5. Composting of organic wastes.

Indoor Environment Monitoring

Contact Hours per week : 5 **Subject Code: EV16T45**
Contact Hours per semester : 75 (Theory 45 + Skill 30) **Credits:** 4 (3 Theory + 1 Skill)

Section- A: Theory (3 credits)

Contact Hours:45 **Credits:**3

Unit : I **(9 Hours)**

Define: Indoor Air Pollution and outdoor pollution, Sources of Indoor air pollution, particulate matter, Combustion byproducts; Radon and its decay products. Volatile organic compounds: odors and sick-building syndrome, Humidity Bio-aerosols: infectious disease transmission. Special indoor environments: A/C units in indoor; museum slabs; Measurement methods, Control technologies.

Unit-II **(9 Hours)**

Indoor activities of inhabitants -residence time. Levels of many pollutants in indoor and outdoor air. Design and operation of buildings for improvements of public health. IAQ policy issues: sustainability; indoor air quality as a basic human right.

Unit: III **(9 Hours)**

Air pollutants in indoor environments, private residences, offices, schools, sand public buildings, factors that govern pollutant indoors concentrations, including ventilation. Characteristics, Consequences. Laboratory safety and standards at indoor condition.

Unit : IV **(9 Hours)**

Control of several pollutant classes, such as radon, toxic organic gases, combustion byproducts, and microorganisms such as molds and infectious bacteria. Case study by an exploration of public policy related to indoor air.

Unit : V **(9 Hours)**

Industrial and domestic air handling systems, Design of air pollution control equipment's Principle and design of minimum stack height - Settling chamber - Cyclone collector - Fabric filter and Electrostatic Precipitators (ESP).

References: 1. Thaddes Godish, Indoor air and Environmental Quality, CRC press, 2000
2. Nazaroff W.W and L Alvarez-Cohen, Environmental Engineering Science Wiley sons, New York, 2001.
3. Moroni Marco, Seifet Bernd and Lindrall Thomas, Indoor Air Quality: A Comprehensive Reference Book, Elsvier Science, Vol. 3, 1995.

Section –B Skill component (1 credit)

Contact Hours:30 **Credit:**1

1. To study of one of closed room and open room air flow condition in our campus.
2. To study the Indoor air chemicals and Indoor air microbiology, health cause to human beings.
3. To Review of research on air-conditioning systems and indoor air quality control for human health.
4. To study the Indoor air quality (IAQ) and green building rating systems.
5. To study the various types of Heating, ventilation and air conditioning (HVAC) system

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Lab IV: LAB: Air Quality Assessment II

Contact Hours: 150 **Credits:** 5

Subject Code: EV16P41

1. Determination of relative humidity from the atmosphere.
2. Determination of CO2 in the atmosphere by volumetric method
3. Determination of NO2 from the atmosphere by Colorimetric method using high volume sampler.
4. Determination of SPM in ambient air by high volume sampler and their analysis
5. Estimation of areal average precipitation/ volume of precipitation
6. Measurement and analysis of meteorological data
7. Comparative analysis of air sampling from clean and polluted area using key parameters.

Course Name: **Bachelor of Vocational (B.Voc)**
Discipline: **Environmental Assessment and Remediation**
(For Those Who Join In 2016 and After)

Duration of the Course: Three Years

1. Course Objectives

The objective is to recognize that curriculum, course content and assessment of academic achievement play complementary roles in shaping education. The course has been designed to improve the understanding of the students about different pollution control strategies and the skills of application of remediation techniques to combat pollution in three environmental compartments i.e. water, air and soil. The course will also be dealing with the sources of pollution in water, air, soil, solid-waste, thermal and noise and the impacts these sources on the environment and health. In addition, the students will be given the training to develop the particular skills required in pollution related structured study and conservation methods.

- To study sources and classification of water pollutants.
- To study air pollution: sources and effects.
- To study sources of soil contamination and management of solid waste.
- To develop skill in practical work, experiments, equipment's and laboratory use along with collection of sample and interpretation of data for environmental Assessment.
- Make aware of natural resources and environment and the importance of conservation.

2. Eligibility for admission:

A pass in the Higher Secondary with Biology background / other streams also and its equivalent as per Madurai Kamaraj University rules.

III-Year Syllabus

COURSE SCHME:

Part	Title of the Paper	Hrs	Theory	Skill	Total	Int.+Ext.= Total	Local	Regional	National	Global	Professional Ethics	Gender	Human Values	Environment & Sustainability	Employability	Entrepreneurship	Skill Development	Subject Code
V	Solid Waste Recycling and Processing	5	3	1	4	25+75=100		✔						✔		✔	✔	EV16T51
	Bioremediation-II	5	3	1	4	25+75=100				✔				✔		✔	✔	EV16T52
	Ecotoxicology and Human Health	4	2	1	3	25+75=100			✔					✔		✔	✔	EV16T53
	Circular Economy	4	2	1	3	25+75=100		✔						✔		✔	✔	EV16T54
	Workplace Hazardous and Occupational Health	4	2	1	3	25+75=100			✔					✔		✔	✔	EV16T55
	LAB: V Solid Waste Assessment and Remediation-I	10	0	5	5	40+60=100			✔					✔		✔	✔	EV16P51
	Internship	8	0	4	4	50(Internal)	✔				✔						✔	EV16ISP5
	Industrial Visit	2	0	1	1	20(Internal)		✔			✔						✔	
	Project Work	6	0	3	3	30(Internal)		✔									✔	
	Total	**48**	**12**	**18**	**30**													

Part	Title of the Paper	Hrs	Theory	Skill	Total	Int.+Ext.= Total	Local	Regional	National	Global	Professional Ethics	Gender	Human Values	Environment & Sustainability	Employability	Entrepreneurship	Skill Development	Subject Code
VI	Applied Pyrolysis and Gasification	5	3	1	4	25+75=100			✔					✔			✔	EV16T61
	Waste to product Conversion Techniques	5	3	1	4	25+75=100		✔						✔			✔	EV16T62
	Industrial Hazardous Waste Management	4	2	1	3	25+75=100		✔						✔			✔	EV16T63
	Natural Resources and Conservation	4	2	1	3	25+75=100			✔					✔			✔	EV16T64
	Environmental Nanotechnology	4	2	1	3	25+75=100		✔						✔			✔	EV16T65
	LAB: VI Solid Waste Assessment and Remediation-II	10	0	5	5	40+60=100		✔						✔			✔	EV16P6
	Internship	8	0	4	4	50(Internal)	✔				✔						✔	EV16ISP6
	Industrial Visit	2	0	1	1	20(Internal)		✔			✔						✔	
	Project Work	6	0	3	3	30(Internal)		✔									✔	
	Total	**48**	**12**	**18**	**30**													

Semester – V

Solid Waste Recycling and Processing

Contact Hours per week : 5 **Subject Code:** EV16T51
Contact Hours per semester : 75 (Theory 45 + Skill 30) **Credits:** 4 (3 Theory + 1 Skill)

Section- A: Theory (3 credits)

Contact Hours:45
Objectives:

- To study the various waste management and reduction, waste recycling, and discuss the recycling processing

Unit I Municipal solid waste 9 Hours

Definition - Sources and types of solid waste- composition and its determinants of Solid waste-factors influencing generation-quantity assessment of solid wastes-methods of sampling and characterization.

Unit II Collection and Transfer: 9 Hours

Collection of Solid waste – collection services – collection system, equipments – time and frequency of collection – labour requirement – factors affecting collection – analysis of collection system – collection routes – preparation of master schedules

Unit III Processing techniques and Recovery of Energy 9 Hours

purposes mechanical volume reduction – necessary equipments – chemical volume reduction – incinerators – mechanical size reduction selection of equipments – components separation – methods – drying and dewatering. Recovery of Resources, conversion products and energy recovery – recoverable materials – processing and recovery systems – incineration with heat recovery.

Unit IV Disposal of Solid Wastes 9 Hours

Refuse disposal – various methods – incinerations – principle features of an incinerator – site selection and plant layout of an incinerator - sanitary landfill- methods of operation – advantages and disadvantages of sanitary land fill - site selection – reactions accruing in completed landfills.

Unit V Management of hazardous wastes 9 Hours

Identifying a hazardous waste – methods – Quantities of hazardous waste generated – Components of a hazardous waste management plan – Hazardous waste minimization – Disposal practices in Indian Industries – Future challenges.

References Book:

1. George Techobanoglous et al, Integrated Solid Waste Management" McGraw - Hill, 1993.
2) Techobanoglous Thiesen Ellasen; Solid Waste Engineering Principles and Management, McGraw - Hill 1997.

Section –B Skill component (1 credit)

Solid Waste Recycling and Processing

Contact Hours:30 **Credit:**1

1. To prepare the list of Kitchen waste including food waste of all kinds, cooked and uncooked, including eggshells and bones from your locality
2. To study the Waste from tea stalls/shops etc. from your regions
3. Study the Flower and fruit waste including juice peels and vegetable market waste from your cities
4. To study the Solid Waste Reduction techniques

5. To study the Solid waste processing methods (storage, conveying, compacting, shredding, pulping, granulating, etc.).
6. Arrange site visits to show different activities related with solid waste recycling management

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Bioremediation-II

Contact Hours per week : 5 **Subject Code:** EV16T52
Contact Hours per semester: 75 (Theory 45 + Skill 30) **Credits:** 4 (3 Theory + 1 Skill)

Section- A: Theory (3 credits)

Contact Hours:45
Objectives:

- To provide plenty knowledge about Bioremediation
- To understand the various pollutants of environment.

Unit – I **9Hours**

Bioremediation: Advantages of Bioremediation, types of bioremediation. Monitoring the efficacy of Bioremediation. Bioventing Bioremediation for controlling oil spills. Biosorption: Use of bacteria and fungi, Bio reaction for biosorption

Unit – II **9 Hours**

Problems associated with disposal of xenobiotic compounds, Hazardous wastes. Biodegradation of xenobiotics: Persistent compounds, Degradation mechanisms, naphthalene, benzene, phenol, PCB's, propanil (Herbicide), urea. Biodegradation of petrochemical effluents.

Unit – III **9 Hours**

Bioremediation: Microbes in mining, ore leaching, oil recovery, waste water treatment, biodegradation of non cellulose and cellulosic wastes for environmental conservation.

Unit – IV **9 Hours**

Detoxification of Hazardous chemicals: Factors causing molecular recalcitrance – Biodegradations of problem environmental contaminants – Bioremediation of problem environmental contaminants – Bioremediation: Engineering strategies for Evaluating bioremediation.

Unit – V **9 Hours**

Define: Industrialization, advantage and disadvantage of industrialization. Impact of Industrialization on the Environment

Suggested Books for study

1. El-mans, E.M.T., and Bryce, C.F.A 2002. Fermentation microbiology and Biotechnology. Taylor and Francis group.
2. Martin Alexander. Biodegradation and Bioremediation. Academic Press; 2nd edition (April 15, 1999) ISBN: 0120498618.
3. George Techobanoglous et al,"Integrated Solid Waste Management" McGraw - Hill, 1993.
4. Techobanoglous Thiesen Ellasen; Solid Waste Engineering Principles and Management, McGraw - Hill 1997.

Bioremediation - II
Section –B Skill component (1 credit)

Contact Hours:30 **(1 credit)**

1. To study the bioremediation by using plants.
2. To study the bioremediation by using Microbes.
3. To Develop environmentally friendly processes such as integrated waste management
4. Any one place study the need for management of resources.
5. To study the Biogas and biofuel production from natural resources

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Ecotoxicology and Human Health

Contact Hours per week : 4 **Subject Code:** EV16T53
Contact Hours per semester : 60 (Theory 30 + Skill 30) **Credits:**3 (2 Theory +1 Skill)

Section- A: Theory(2 Credit)

Contact Hours:30

Objectives: To provide knowledge about Ecotoxicology and Human Health
To study the various toxic substances and effect on Human health

Unit: 1. **6 Hours**

Introduction to Toxicology: Concepts of toxins, toxicity and toxicology, sub disciplines of toxicology- Environmental toxicology, aquatic toxicology, forensic toxicology, chemical toxicology, Toxicogenomics; Types of toxicants, classification of toxicants - factors that affect environmental concentration of toxicants.

Unit: II **6 Hours**

Toxic chemicals in the Environment: a) Air Pollutants; SO2,NOX,H2S, particulate matter, ozone, Hydrocarbons, Industrial chemicals, agro chemical and fertilizers- Ammonium Sulphate, Potash, urea, pesticides-organ chlorines (DDT, BHC, and Endosulphan), organic phosphates (Malathion, Parathion) and carbamates.

Unit : III **6 Hours**

Pesticides – microcosms - compartment models. Absorption – Translocation and Excretion of chemicals (xenobiotics) – membranes permeability and mechanisms of chemical transfer Bio-transformation of xenobiotics – Selective toxicity. Biomonitoring of Toxic chemicals – Monitoring Program Parameters of biomonitoring.

Unit : IV **6 Hours**

Individual health parameters Determinants of Health, Importance and Source of Public-health Standards, Relevance to social aspects Future challenges in public health

Unit : V **6 Hours**

Determinative factors: Family health history, Physique, Environment, Life-style and Social cultural aspects Overview of Healthcare Systems in India. Primary healthcare hand-washing, immunization, Drugs, Tobacco and Alcohol: Chemical agents, Effects and Side effects.

References Book:

1. George Techobanoglous et al, Integrated Solid Waste Management" McGraw - Hill, 1993.
2) Techobanoglous Thiesen Ellasen; Solid Waste Engineering Principles and Management, McGraw - Hill 1997.

Section –B Skill component (1 credit)
Ecotoxicology and Human Health

Contact Hours:30 **Credit:**1

1. To study the various Ecotoxicology substances.
2. To study the nearest ecotoxicology affected area.
3. To demonstrate the Health hygienic by using organic products.
4. To study ecotoxicology effect nearest pond
5. To visit the nearest Hospital and study the health aspects.

Circular Economy

Contact Hours per week : 4 **Subject Code:** EV16T54
Contact Hours per semester : 60 (Theory 30 + Skill 30) **Credits:**3 (2 Theory +1 Skill)

Section- A: Theory (2 Credit)

Contact Hours:30

Objective:

- To provide knowledge on linear and circular economic practices
- To understand the impact of circular economic practices in environment, economic and employment.
- To understand the various emerging business sectors based on Circular Economy

Unit I- **6Hours**

Linear Economy and its Limits: The success and limits of linear consumptions- Linearity of consumer goods industry- Facts of linear model that causes economic losses- Agricultural supply chain

Unit II- **6 Hours**

Linear to Circular transformation: The goals of circular economy policy- The circular economy is based on a few simple principles- Making the shift to a circular economy- The Ellen MacArthur Foundation's perspective on the circular economy.

Unit III- **6 Hours**

Environmental perspectives of the circular economy: Reduction of waste generation- Managing and recovering the waste- Utilization of greener feedstocks

UNIT: IV **6 Hours**

Circularity of Materials: Sources of value creation in a circular economy- Long-term effects of circularity on material stocks and mix - Case examples of circular products

Unit V- **6 Hours**

Life and the Circular Economy: Circularity in production- consumption - secondary raw materials- Priority sectors

References

1. LIFE and the circular economy, EUROPEAN COMMISSION ENVIRONMENT DIRECTORATE-GENERAL, ISBN 978-92-79-64147-3, ISSN 2314-9329, (doi:10.2779/29436), © European Union, 2017
2. "Towards the circular economy", Volume 1 & 2, Ellen MacArthur Foundation, 2013.

Section –B Skill Component (1 credit)
Circular Economy

Contact Hours:30 **Credit:**1

1. Investigate the various circular economic components/ practices.
2. Analysis of market and profit strategy involved in plastic waste collection and recycling.
3. Analyses the circular practices of nearby food industry.
4. Study on the circular practices in plastic industry
5. Recycling process in post consumed batteries.
6. Study of circular economic practices towards electronic waste managements

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Workplace Hazardous and Occupational Health

Contact Hours per week : 4 **Subject Code:** EV16T55
Contact Hours per semester : 60 (Theory 30 + Skill 30) **Credits:**3 (2 Theory +1 Skill)

Section- A: Theory (2 Credit)

Contact Hours:30
Objectives: To know the workplace hazarders and occupational Health on various occasion

Unit – I **6 Hours**
Key elements of a safety and Health Management System- Policy & commitment, Safety and health Management System model, safety and Health policy- Developing a workplace Safety and Health Policy, Planning – safety and Health objectives and Targets, performance standards, Safety Consultation

Unit – II **6 Hours**
Definition : Incident, accident, injury, dangerous occurrences, unsafe acts, unsafe conditions, hazards, error, oversight, mistakes, etc. Accident Prevention: Principles of accident prevention, Accident and Financial implications, Hazard identification and analysis, fault tree analysis. Job safety analysis with examples.

Unit – III **6 Hours**
Body structure and Functions, Position of causality, the unconscious casualty, fracture and dislocation, Injuries in muscles and joints, Bleeding, Burns, Scalds and accidents caused by electricity, Respiratory problems, Rescue and Transport of Casualty. Cardiac massage, poisoning, wounds. Personal Protective Equipments: Need, selection, supply, use, care and maintenance.

Unit – IV **6 Hours**
Design and location ,distance between hazardous units, color coding, Lighting, ventilation, Flow charts, pilot plant applications and machine guarding and it's types, Housekeeping. Work permits systems - Significance of documentation.

Unit – V **6 Hours**
Bureau of Indian standards on safety and health 14489 - 1998 and 15001 - 2000 OSHA, Process Safety Management (PSM) as per OSHA, PSM principles, OHSAS – 18001, EPA Standards, Performance measurements to determine effectiveness of PSM

References:

1. George Techobanoglous et al, Integrated Solid Waste Management" McGraw - Hill, 1993.

2) Techobanoglous Thiesen Ellasen; Solid Waste Engineering Principles and Management, McGraw - Hill 1997.

Section –B Skill component (1 credit)
Workplace Hazardous and Occupational Health

Contact Hours: 30 **Credit:**1

1. To study the laboratory work hazardous and risks
2. To study and demonstrate the first aid steps on various occasions
3. To study hazards that may be associated with these jobs (Welder, Textile worker, Agricultural worker, Construction worker etc.)
4. To study the general health issues of various workers
5. To study the work hazardous magazines, reports and videos

LAB: V Solid Waste Assessment and Remediation-I

Contact Hours: 150 **Credits:** 5

Subject Code: EV16P51

1) Determination of total dissolved solids
2) Determination of pH of the solid waste
3) Determination of optimum coagulant dosage
4) Determination of chlorine from the solid waste
5) To study the Clariflocculator and Trickling filter systems
6) Determination of Chromium, Lead and Zinc from any one Solid waste
7) Determination of Solid waste from any one school or college campus
8) Estimation of E-waste and Hazardous waste

Semester- VI
Applied Pyrolysis and Gasification

Contact Hours per week : 5 **Subject Code:** EV16T61
Contact Hours per semester : 75 (Theory 45 + Skill 30) **Credits:** 4 (3 Theory + 1 Skill)

Section- A: Theory (3 credits)

Contact Hours:45

Objectives To Know the pyrolysis and gasification process, biochemical and high energy producing biomass etc.

Unit - I **6 hours**

Biomass – types – fuels from biomass. Terms and units used in biomass production. Biomass fuel characterization – physical, chemical and thermal – energy release. Supply chain – harvesting / collection – transportation and processing. Briquetting – types – pelletizing

Unit -II **6 hours**

Energy sources, Introduction, Classification, Energy from Biomass, Types of biogas plants, constructional details, Biogas production and its utilization, Agricultural wastes, Principles of combustion, pyrolysis and gasification, Types of gasifiers, Producer gas and its utilization.

Unit -III **6 hours**

Biochemical degradation – factors affecting biogas production - types of biogas plants – construction details – operation and maintenance – utilization of biogas - slurry handling, utilization and enrichment – high rate biomethanation process – landfills – bioethanol – feedstock – process – utilization - composting - methods – machinery.

Unit - IV **6 hours**

Biomass gasification – chemistry of gasification – types of gasifier – Gas cleaning & conditioning - utilization of producer gas - emissions – commercial gasifies plants. Pyrolysis – product recovery – types - biochar – bio oil – operation – recovery

Unit - V **6 hours**

Energy sources (renewable and non-renewable). Classification of fuels and their calorific value. Coal: Uses of coal (fuel and nonfuel) in various industries, its composition, carbonization of coal. Coal gas, producer gas and water gas—composition and uses. Coal gasification (Hydro gasification and Catalytic gasification).

References

1. Song, Y. L.; Tsai, W.; Yao, Y. D. (2004). "Ultrasonic Spray Pyrolysis for Synthesis of Spherical Zirconia Particles" (PDF). Journal of the American Ceramic Society. **87** (10): 1864–1871. doi:10.1111/j.1151-2916.2004.tb06332.x. Archived (PDF) from the original on 2014-04-08.
2. Heffungs, Udo (June 2010). "Effective Spinneret Cleaning". Fiber Journal. Archived from the original on 30 June 2016. Retrieved 19 April 2016.

3.Ringer, M.; Putsche, V.; Scahill, J. (2006) Large-Scale Pyrolysis Oil Production: A Technology Assessment and Economic Analysis Archived 2016-12-30 at the Way back Machine.; NREL/TP-510-37779; National Renewable Energy Laboratory (NREL), Golden, CO.

Section –B Skill component (1 credit)
Applied Pyrolysis and Gasification

Contact Hours:30 **Credit:**1

1. To study the type biogas plants; Field visit to biogas plants;
2. To study the different types of gasifiers Testing of gasifiers;
3. To study the Briquette preparation from biomass
4. To study and find the efficiency of solar cooker;
5. To study the performance of different types of wind mills.
6. To study the Bio-diesel production from Algae

Waste to product Conversion Techniques

Contact Hours per week : 5 **Subject Code:** EV16T62
Contact Hours per semester : 75 (Theory 45 + Skill 30) **Credits:** 4 (3 Theory + 1 Skill)

Section- A: Theory (3 credits)

Contact Hours:45

Objectives: To Know the waste products and Waste Processing Techniques in the form useful products

Unit-I **(6 Hours)**

Waste as a Renewable Energy Source, Waste-to-Energy Conversion: Thermochemical Conversion, Biochemical Conversion, Physico-chemical Conversion, Factors affecting Energy Recovery from waste, Agricultural Residues, Animal Waste, Industrial Wastes, Forestry Residues, Municipal Solid Waste (MSW), Converting Waste Heat to Electricity

Unit-II **(6 Hours)**

Bio energy as by product of waste processing, Environmental significance, Introduction to anaerobic digestion, Process fundamentals and design considerations, Process analysis and reactor configurations, Methane production, Energy assessment, Bio-methanation from sludge digestion, Types of reactors

Unit-III **(6 Hours)**

Waste generation rates and variation – Composition, physical, chemical and biological properties of solid wastes – Hazardous Characteristics –waste sampling and characterization plan -– Waste exchange – Extended producer responsibility - Recycling and reuse

Unit-IV **(6 Hours)**

Objectives of waste processing – material separation and processing technologies – biological and chemical conversion technologies – methods and controls of Composting - thermal conversion technologies and energy recovery – incineration – - treatment of biomedical wastes

Unit-V **(6 Hours)**

Waste disposal options – Disposal in landfills - Landfill Classification, types and methods – site selection - design and operation of sanitary landfills, secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring — landfill remediation

References:

1. "Costs compared for waste treatment options". letsrecycle.com. 15 August 2008.
2. Wrap.org.uk
3. Ryan, Michael (2008). "Maximum and minimum Infant Mortality Rates 2003–06 in Coventry's electoral wards (ONS data)" (PDF). UK Health Research.
4. "Hazardous Waste: Treatment and Landfill" (PDF). Grundon. 2004. Archived from the original (PDF) on 2 March 2013.

Section –B Skill component (1 credit)
Waste to product Conversion Techniques

Contact Hours:30 **Credit: 1**

1) To study the waste generation and sources
2) To Study on classification all types of wastes
3) Study of hazardous waste producing industry with details of points of generation in various forms.
4) To study waste product from convert to useful products
5) To study local availability source convert to vermicomposting farming

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Industrial Hazardous Waste Management

Contact Hours per week : 4 **Subject Code:** EV16T63
Contact Hours per semester : 60 (Theory 30 + Skill 30) **Credits:**3 (2 Theory +1 Skill)

Objectives:

- To understand Industrial hazardous waste generation and their health and environmental impact.
- To study the various disposal and processing technology of Industrial hazardous waste.
- To understand the various other Industrial Hazardous materials and their management techniques.

Content

Section- A: Theory (2 credits)

Unit-I **(6 Hours)**

Textile waste water effluent -Introduction-Textile Waste Characteristics-Textile Wastewater Problem-Textile Effluents and its management-Treatment of textile Wastewater-Major Environmental concern.

Unit-II **(6 Hours)**

Ternary industry waste -Introduction-Pollutants in tannery Effluent-chemicals in Ternary Effluent- Treatment of Ternary industry waste water-Major Environmental concern.

Unit-III **(6 Hours)**

Mining industry -Introduction- The principal waste-waters associated with mines-Water treatment-Removal of toxic materials-Molecular Encapsulation- Treatment of Ternary industry wastewater-Major Environmental concern.

Unit-IV **(6 Hours)**

Radioactive waste -Introduction-Low-level waste-Long term management – Geologic disposal - Re-use-Space disposal-National management plans-Nuclear weapons decommissioning- Associated hazard warning signs-Major Environmental concern.

Unit-V **(6 Hours)**

Pesticide pollution -Introduction- Agricultural pollution-Pesticides-Pesticide leaching Leaching, runoff, and eutrophication -Organic contaminants-Heavy metals-Bio pesticides-Genetically modified organisms-Major Environmental concern. Suggested**.**

References

1. Akter, Nasima. " Waste management: a review." Asian Institute of Technology, School of Environment, Resources and Development, Thailand 3 (2000): 485-486.
2. Tsakona, M1, E. Anagnostopoulou, and E. Gidarakos. "Industrial waste management and toxicity evaluation: a case study." Waste management 27.7 (2007): 912-920.
3. Blackman Jr, William C. Basic hazardous waste management. CRC Press, 2001.
4. LaGrega, Michael D., Phillip L. Buckingham, and Jeffrey C. Evans. Industrial Hazardous waste management. Waveland Press, 2010.

Section –B Skill component (1 credit)
Industrial Hazardous Waste Management

Contact Hours: 30 C**redit:**1

1. A Visit to the Industrial Hazardous waste Generation or disposal site.
2. Visit to Industrial area, especially the handling of Hazardous materials.
3. Ecology baseline and impact of Textile industries waste disposal site.
4. Preparation of report based on a case study of one pesticide pollution.

5. Practical knowledge of handling Hazardous materials.
6. Case study about Ternary industry waste unit.

Natural Resources and Conservation

Contact Hours per week : 4 **Subject Code:** EV16T64
Contact Hours per semester : 60 (Theory 30 + Skill 30) **Credits:**3 (2 Theory +1 Skill)

Section- A: Theory (2 Credit)

Contact Hours:30

Objectives: To study the Natural resources and different conservation process

Unit-I **(9 Hours)**

Introduction to Natural Resource Bases: Concept of resource, classification of natural resources. Factors influencing resource availability, distribution and uses. Inter relationships among different types of natural resources. Ecological, social and economic dimension of resource management Natural resources and development.

Unit-II **(9 Hours)**

Forest resources: Forest vegetation, status and distribution, contribution as resource .Use and over-exploitation, deforestation. Timber extraction, mining, dams and their effects on forest and tribal people, Forest products. Developing and developed world strategies for forestry.

Unit-III **(9 Hours)**

Energy resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Food resources: World food problems, changes caused by agriculture and over-grazing, effects of modern agriculture, fertilizer-pesticide problems,. Fish and other marine resources.

Unit-IV **(9 Hours)**

Land resources: Land as a resource. Dry land, land use classification, land use planning and desertification. Land resource management and major issues. Water resources: Use and over-utilization of surface and ground water, drought, conflicts over water, dams-benefits and problems. Water ecology and management.

Unit-V **(9 Hours)**

Introduction – Definition : genetic, species and ecosystem diversity. Value of biodiversity consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversity at global, National and local levels. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.

Suggested Books for Study

Francois Ramade 1984. Ecology of Natural Resources. John Wiley & Sons Ltd. 2.Odum, E.P. 1971. Fundamentals of Ecology. W.B. Saunders Co. USA, 574p

Section –B Skill component (1 credit)
Natural Resources and Conservation

Contact Hours: 30 **Credit:**1

1. To study Measurement of Relative Humidity from throughout the year.
2. To Study the Measurement of rainfall from any one city.
3. To study Plotting line graphs for illustrating climatic factor such as temperature from any one city.
4. To study water conservation from Dam and channels etc.
5. To list out endangered plant species from western Ghats
6. To list out endangered animal species from western Ghats

Environmental Nanotechnology

Contact Hours per week : 4 **Subject Code:** EV16T65
Contact Hours per semester : 60 (Theory 30 + Skill 30) **Credits: 3** (2 Theory +1 Skill)

Section- A: Theory (2 Credit)

Contact Hours:30

Objectives:

To understand the concept of nanoscience, nanotechnology and nanomaterials
To study the various uses of nanostructured materials for environmental applications
To understand the nano enabled devices for environmental monitoring
To understand the nano toxicity and common lab safety practices

Unit: I **(6 Hours)**

The over view of nano: Introduction to nanoscience, nanotechnology and nanomaterials,- nanomaterials and their diversity- fabrication and characterization techniques.

Unit: II **(6 Hours)**

Nano Catalytic degradation of organic pollutants- Catalytic materials and mechanisms for organic degradation- Photocatalytic degradation of organic pollutants using semiconducting materials- Impact of functional materials in environmental remediation.

Unit: III **(6 Hours)**

Carbon nanotechnology for absorption techniques- Carbon allotropes- Various carbon nanomaterials- Carbon based absorption for water and air purification.

Unit: IV **(6 Hours)**

Nano devices for environmental monitoring: basics of sensor- various sensing mechanisms- environmental sensors using nanomaterials- various sensor materials and their applications.

Unit : V **(6 Hours)**

Nano toxicity and common lab safety practices: Natural versus Engineered nanomaterials- nano toxicity- common lab safety practices for nanomaterials handling, storage and transportation.

References:

1. Environmental, Nanotechnology, Applications and Impacts of Nanomaterials, Editors, M. R. Wiesner and J. Y. Bottero, (2007) The McGraw-Hill Companies, DOI: 10.1036/0071477500.
2. A Laboratory Course in Nanoscience and Nanotechnology, Dr.Gérrard Eddy Jai Poinern (2015) CRC Press, Taylor & Francis Group.

Section –B Skill component (1 credit)
Environmental Nanotechnology

Contact Hours:30 **Credit:**1

1. Greener synthesis of metal nanoparticles
2. Photocatalytic degradation of organic dyes
3. Activated carbon nanomaterials for dye absorption
4. Biomass in to carbon nanostructures

LAB: VI Solid Waste Assessment and Remediation-II

Contact Hours: 150 **Credits:** 5

Subject Code: EV16P6

1. Qualitative and Quantitative estimation of solid waste from Household/commercial /Institutional areas.
2. Estimate energy content of household solid waste.
3. Cost estimation of recyclable waste generated from households /commercial /Institutional areas.
4. Making recycled paper/paper items from used newspapers/paper.
5. Preparation and collection of items from recycled/reused material.
6. Laboratory demonstration of Vermi –composting
7. Laboratory demonstration of Aerobic Composting
8. Field visits to e waste dumping/disposal site
9. Field visits to Solid Liquid Resource Management(SLRM)
10. Construction and working of Incinerators/biogas plants
11. Site selection and siting criteria for sanitary landfills in your area

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