DEPARTMENT OF ENVIRONMENTAL SCIENCE & ENGINEERING
GURU JAMBHESHWAR UNIVERSITY OF SCIENCE & TECHNOLOGY, HISAR -125001

Name of M.Tech. Programme	**Environmental Science & Engineering**	

Distribution of Total Credits

Program Core(PC)	Program Elective(PE)	Open Elective (OE)	Total Credits
53	**22**	**3**	**78**

Semester-wise Schedule

Semester-I

S.N	**Course No.**	**Title**	**Type**	**L-T-P**	**Credits**	**Max. Marks**
1	ESE-701(a)/ ESE-701(b)	Foundation of Environmental Engg. /Foundation of Environmental Science	PE	3-1-0	4	100
2	ESE-702	Environmental Chemistry	PC	3-1-0	4	100
3	ESE-703	Environmental Policy and Impact Assessment	PC	3-1-0	4	100
4. 5.	ESE-704 ESE-705	Industrial Health and Safety Energy & Environment	PE PE	3-1-0 3-1-0	4 4	100
6.	ESE-706	Lab-I (Environmental Chemistry)	PC	0-0-6	3	100
7.	ESE-707(a)/ ESE-707(b)	Lab-II (Foundation of Environmental Engg./ Foundation of Environmental Science	PE	0-0-6	3	100
8.	ESE-708 ESE-709	Lab-III (a)Industrial Health and Safety Lab-III (b)Energy & Environment	PE PE	0-0-6 0-0-6	3 3	100
9.		Audit Course I (Any One)*		2-0-0	0	100
Total Credit					**25**	

Semester-II

1.	ESE-711	Environmental Microbiology	PC	3-1-0	4	100
2.	ESE-712	Air Pollution & Control	PC	3-1-0	4	100
3.	ESE-713	Industrial Pollution Management	PC	3-1-0	4	100
4.	ESE-714	Design of Pollution Control Systems	PC	3-1-0	4	100
5.	ESE-715	Water & Sewage Treatment	PC	3-1-0	4	100
6.	ESE-716	Lab-IV (Environmental Microbiology)	PC	0-0-6	3	100
6.	ESE-717	Lab-V (Industrial Pollution Management)	PC	0-0-6	3	100
7.	ESE-718	Lab-VI (Water & Sewage Treatment)	PC	0-0-6	3	100
8.		Audit Course II (Any One)*		2-0-0	0	100
Total Credit					**29**	

Semester-III

1.	ESE-721	Unit Operations & Processes	PE	3-1-0	4	100
2.	ESE-722	Instrumentation & Applications to Environmental Engg.	PE	3-1-0	4	100
3.	ESE-723	Solid & Hazardous Waste Management	PE	3-1-0	4	100
4.	ESE-724	Environmental Management System	PE	3-1-0	4	100
5.	ESE-725	Watershed Management	PE	3-1-0	4	100
6.	ESE-726	MOOC Courses (Available on SWAYAM website from time to time)	PE	3-1-0	4	100
7.	ESE-790	Credit Seminar	PC	0-0-0	1	100
8.	ESE-791	In-plant training (S/US)	PC	0-0-0	0	000
9.	ESE-800	Dissertation	PC	0-0-6	3	100
10.	3OE06	Open Elective (Any one)	OE	3-0-0	3	100
Total Credit					**15**	

Semester-IV

1.	ESE-800	Dissertation	PC	0-0-18	9	100
Total Credit					**9**	

*****Qualifying and non-credit course

Note: (i) In-plant training (6 weeks) to be undertaken at the end of IInd semester, the report of which has to be submitted before commencement of the 3rd semester.

(ii) Students with M.Sc. (Env.Sc.) background will take Foundation of Env. Engg. (ESE-701(a) and those with Engg. background will take Foundation of Env.Sc (ESE- 701(b).

(iii) Students will have to take one PE (out of ESE-704, 705) in Ist Semester and corresponding practical paper ESE-708 or ESE-709. Two PE is to be taken (out of ESE-721 to 726) in 3rd Semester.Open Elective Course has to be taken from the list of Open Elective Courses proposed. Students have to take one audit course in 1st Semester and one in 2nd Semester out of above mentioned list of audit courses proposed by AICTE.

(iv) Each paper will be evaluated internally 30% (Two minor tests), and externally 70% (Major Test)

(v) In case of dissertation, work load will be ½ hours per credit up to a minimum of 5 hours.

(vi) Each unit of each course should be covered within 12-15 lectures.

List of PEOs

1. To prepare PG Students with strong foundation by providing quality education in the field of Environmental Sc. & Engineering for making them compete at national and international level.
2. To impart the knowledge of basic principles and novel techniques with respect to various aspects of Environmental Science and Engineering
3. To develop human resource with high ethics & moral values, leadership qualities and having elevated efficiency to meet the growing demands of industries/ (HEI) Higher Educational Institutes/ R &D and consulting etc.

Programme Outcomes (POS)

1. An ability to independently carry out research /investigation and development work to solve practical problems
2. An ability to write and present a substantial technical report/document
3. Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program
4. Ability to design and conduct experiments with novel ideas, and to analyze and interpret data.
5. Ability to use the techniques, skills, and modern engineering tools necessary for Environmental Science and Engineering practice.

ESE-701 (a) FOUNDATION OF ENVIRONMENTAL ENGINEERING
(for students with Env. Science background)

4 Credits (3-1-0)
Maximum Marks: 100
Internal Marks: 30
External Marks: 70
Time: 3 Hours

Note:

Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	To define and understand the basic concept of ecology.	LOTS: Level 1 Remember
CO2	To apply ecological aspects in industries for pollution management.	LOTS: Level 2 Understand
CO3	To examine the ecological problems in relation to industrial pollution	LOTS: Level 3 Apply
CO4	To identify the environmental problem related to resources exploitation	HOTS: Level 4 Analyse
CO5	To evaluate the different ecological resources with regard to sustainable development	HOTS: Level 6 Create

Unit-I
Basic mathematics for environmental Engineers, Concept & domain of environmental engineering, concept of unit operations and processes, concept of material and energy balance, Concepts of flow diagrams and layout of wastewater treatment plants, Basic concept of Environmental Modeling, Examples of applied nature (Environmental Modeling), Basic concept of Suveying.

Unit-II
Fluid and its properties, fluid static on submerged surfaces, buoyancy and floatation, Fluid kinematics and dynamics, Equation of continuity, various forms of energy present in fluid flow, Basic equations of heat, energy and momentum, Examples of applied nature.

Unit-III
Laminar and turbulent flow, theory of Boundary layer, boundary layer separation, Navier storkes and momentum equation for boundary layer, Aerodynamics with some examples.

Unit-IV
Discharge measurement in pipes and channels. Concepts of dimensional analysis, methods of dimensional analysis, model testing, Concept of dimensionless numbers, pumps and its types, Calculation of different head losses and heat exchangers.

Reference Books:

1. Mathematics manual for Water and Wastewater Treatment Plant by Frank R. Spellman
2. Dynamics of Environmental Bioprocesses by J.B. Snape & I.J. Dunn

3. Fundamentals of Fluid Mechanics by Munson,Young and Okiishi,John Wiley & Sons,Inc
4. Introduction to Fluid Mechanics,Fox and Mcdonald,John Wiley & Sons,Inc
5. Mechanics of Fluids by Shames,McGraw-Hill Inc.
6. Fluid Mechanics through problems by Garde,New Age International (P) Limited
7. Fluid Mechanics by Frank M.White, Mc-Graw Hill.Inc.
8. Unit Operations by Warren

Course Articulation Matrix: Foundation of Environmental Engg.(ESE-701(a))					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	H	M	H	---	---
CO 2	L	M	H	L	M
CO 3	H	H	H	M	M
CO4	M	H	H	H	H
CO5	L	M	M	M	M

ESE-701 (b) : FOUNDATION OF ENVIRONMENTAL SCIENCES
(for students with Engg. background**)**

4 Credits (3-1-0)
Maximum Marks: 100
Internal Marks: 30
External Marks: 70
Time: 3 Hours

Note:

Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Define basic concepts environmental engineering.	LOTS: Level 1 Remember
CO2	Classification of fluids and its properties and its behaviour	LOTS: Level 2 Understand
CO3	Apply Bernoulli's equation to fluid flow problems and boundary layer theory to determine lift and drag forces on a submerged body.	LOTS: Level 3 Apply
CO4	Apply appropriate equations and principles to analyse pipe flow problems.	HOTS: Level 4 Analyse
CO5	Discharge measurement in pipes and channels	HOTS: Level 5 Evaluate

Unit-I
Biosphere: Concept of biosphere, characteristics of hydrosphere, lithosphere and atmosphere.
Population and communities: Population characteristics and models, human population growth, demographic projections, dimensions of world food problems, community characteristics, ecological succession, ecological niche, Ecotone.

Unit-II
Ecosystem : Structural and functional attributes, energy flow, food web, productivity and decomposition, biogeochemical cycles (C,N,P.& S), Theories of ecosystem stability, Ecological regulation, basic concepts of systems analysis and ecological modeling.

Unit-III
Industrial Ecology : Definition, goals and key concepts of industrial ecology, ecological & economic efficiency, materials and energy flow, strategies of environmental impact reduction- system tools to support industrial ecologies, industrial symbiosis.

Unit-IV
Environmental Resources : Concept of sustainable growth; water resources-surface water and ground water (brief account), water conservation strategies; land resources, soil erosion, water logging, soil reclamation and biodrainage; Forest Resources and management, mineral resources-reserves, prospects and problems.
Biodiversity: Importance, threats to biodiversity, conservation practices, Indian Scenario.
Basic concept of remote sensing, GIS and its applications (In brief).

Reference Books:

1. Fundamentals of Ecology by E.P. Odum
2. Basic Ecology by E.P. Odum
3. Living in the Environmental by T.J. Miller
4. National Resource Conservation by Oliver S Own & Chiras

Course Articulation Matrix: Foundation of Environmental Science (ESE-701(b))					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	L	M	H	M	M
CO 2	L	M	H	H	H
CO 3	L	M	H	H	H
CO4	L	M	H	H	H
CO5	L	M	H	H	H

ESE-702: ENVIRONMENTAL CHEMISTRY

4 Credits (3-1-0)
Maximum Marks: 100
Internal Marks: 30
External Marks: 70
Time: 3 Hours

Note:
Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Outlining of chemical characterization of water, soil and air.	LOTS: Level 1 Remember
CO2	Understand various chemical constituents present in air and water, interactions among them and manner in which changes are brought about due to pollution	LOTS: Level 2 Understand
CO3	Determine the water quality parameters in water samples	LOTS: Level 3 Apply
CO4	Analyse the problem occur due to chemical reaction in water, soil and air	HOTS: Level 4 Analyse
CO5	Choose suitable qualitative and quantitative analysis of different materials in solid, liquid forms	HOTS: Level 6 Create

Unit-I
Soil Chemistry: Nature, composition and properties of Soil, Chemical Weathering, soil clays, CEC, humus-metal interaction, soil acidity, salinity and sodicity, Effects of modern agriculture on soil geochemistry.

Unit-II
Atmospheric Chemistry : Chemical composition of atmosphere, the changing global atmosphere, green house gases and global warming, gaseous transformation in the atmosphere and removal mechanisms, residence-time, acid-rain, ozone layer depletion, nuclear winter.
Atmospheric Photochemical Reactions: Monoatomic oxygen and ozone formation, role of nitrogen in photooxidation, hydrocarbons in atmospheric photo-chemistry, oxidants in photochemical smog. Hydrocarbon reactivity.

Unit-III
Water Chemistry: Ground and surface water chemistry, water ion balancing, water pollution due to heavy metals, organic pollutants, pesticides and radionuclides**.**

Unit-IV
Instrumentation: Basic principle and working of following instruments (In breif) : **A**tomic absorption spectrophotometer, atomic emission spectrophotometer, gas chromatography, high performance liquid chromatography, mass spectrometry, SEM, TOC analyser, ICP, Ion chromatography, FTIR, RDS.

Reference Books

1. Environmental Soil Chemistry by Donald L. Sparks
2. Introduction to Soil & Plant by R.W. Miller & R.L. Dowhan
3. Climate Change by J.T. Honghton, B.A. Callander & S.K. Varney
4. Fundamentals of Air Pollution by Boubel Fox, Turner & Stern
5. Environmental Chemistry by S.C. Manhan
6. Introduction to Environmental Sc. & Engg. by Gilbert M. Masters
7. Environmental Chemistry by Colin Baird
8. Soils and the Environment by Wild
9. Composition, Chemistry and Climate of the atmosphere by H.B. Singh
10. Fundamentals of Analytical Chemistry by Skoog, West & Holler

Course Articulation Matrix: Environmental Chemistry (ESE-702)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	**PO1**	**PO2**	M	---	---
CO 2	H	M	---	---	---
CO 3	H	L	M	L	---
CO4	---	H	M	L	M
CO5	---	H	H	H	H

ESE-703: ENVIRONMENTAL POLICY & IMPACT ASSESSMENT

4 Credits (3-1-0)
Maximum Marks: 100
Internal Marks: 30
External Marks: 70
Time: 3 Hours

Note:

Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Memorize various laws and policies related to environment.	LOTS: Level 1 Remember
CO2	Understand the basic methodology of EIA and different case studies	LOTS: Level 2 Understand
CO3	Apply national and international legislation in environmental pollution management.	LOTS: Level 3 Apply
CO4	Evaluate the environmental impacts of different developmental projects.	HOTS: Level 5 Evaluate
CO5	Implement Ministry of Environment, Forests and Climate Change guidelines and its amendments for clean development	HOTS: Level 6 Create

Unit-I

Environmental Policy and Laws: Constitutional provisions for environmental protection. Some laws for environment protection with amendments e.g. Water (Prevention and Control of Pollution) Act, 1974; Air (Prevention & Control of Pollution) Act, 1981, Environmental (Protection) Act, 1986; Wild Life (Protection) Act, 1972, National Environment policy, 2006.

Unit-II

Environmental Conventions and Treaties : Chronological order of Environmental Conventions(in brief): Stockholm Conference, The Rio Earth Summit, 1992 ; Convention on climate change ; Agenda 21; Montreal Protocol, Kyoto Summit, 1997 ; World Summit on sustainable development, 2002 ; Rio+ 20, COP 21 or Paris summit

Public Interest Litigation, Concept of National green tribunal, Sustainable development goals and Movements (Chipko, Apiko & Khejarli Ka Khadana)

Unit-III

Environmental Impact Assessment: Introduction: Principles, Origin and development of EIA. Essential components of EIA: Project screening, establishing the environmental baseline, impact identification, impact prediction, evaluation and mitigation, participation, presentation and review, monitoring and auditing in EIA processes.

Unit-IV

Case Studies: Thermal power plant, refineries and water reservoir.

Eco-labeling communication to the public, EIA guidelines of Ministry of Environment and Forest and climate change (MoEFCC), 2006 and its amendments, EMP and Environment audit (in brief).

Reference Books:

1. Larry. W. Canter : Environmental Impact Assessment
2. Glasson T : Environmental Impact Assessment
3. Petter Morris: Environmental Impact Assessment
4. Eceleston, C.H. : Environmental Impact Statement
5. Paras Dewan : Environmental Administration Law & Judicial Attitude
6. K.C. Aggarwal : Environmental Law
7. Revesy, R., Sands, P.& Stewarts, B: Environmental Law & Sustainable Development
8. Khanna, P. : Primer on Environmental Management
9. Soyre, D. : Inside ISO 14000

Course Articulation Matrix: Environmental Policy & Impact Assessment (ESE-703)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	M	M	---	---	---
CO 2	M	H	---	---	---
CO 3	M	M	M	---	L
CO4	M	M	H	---	H
CO5	M	M	L	---	---

ESE-704: INDUSTRIAL HEALTH AND SAFETY

4Credits (3-1-0)
Maximum Marks: 100
Internal Marks: 30
External Marks: 70
Time: 3 Hours

Note:

Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will of 14 marks.

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Understand the Hazards associated with occupational environment.	LOTS: Level 2 Understand
CO2	Develop the Procedures of Handling and Management of hazardous waste	LOTS: Level 3 Apply
CO3	Illustrate risk management related to industrial health and safety	LOTS: Level 4 Analyse
CO4	Plan medical and engineering measures for control of hazards in occupational environment	HOTS: Level 5 Evaluate
CO5	Collaborate the legal system of handling of hazardous waste	HOTS: Level 6 Create

Unit-I

Introduction: - Occupational environment and its relation to health, physiological response of man to different environmental stresses.

Occupation Health: - Types of interaction of man in occupation environment, Types of hazards associated with occupation environment- Physical, chemical, biological, mechanical and psychosocial hazards, Occupational diseases, Ergonomics, Healthy workplace and its principles.

Unit-II

Hazardous chemicals: Classification of hazardous chemicals, transportation of hazardous chemicals, hazchem code, Storage and handling of hazardous substances, Emergency preparedness (on site & offsite), Safety audit, Concept of fire and explosion, Major accidents involving hazardous substances.

Unit-III

Health and Safety Measures: - Medical and engineering measures, Stress at work and its management, Personal protection equipment, Risk Assessment with numerical, Risk management: organization and administration ; techniques and practices.

Unit-IV

Legislation Measures :- Occupational Health and Safety Standards, OHSAS-18001, The factory Act,1948 and its amendments, Manufacturing, storage and import of hazardous chemical rules, 1989 and its amendments.

Reference Book:

1. Environmental Health by M.T.Morgan
2. Textbook of Preventive and Social medicine by J.E.Park and K.Park

3. Industrial safety and Environment by A. Prashar and P. Bansal
4. Industrial Hygiene and Chemical Safety by M.H. Fulekar
5. Aspects of Labour Welfare and Social Security by A. M. Sharma
6. Safety at work by John Ridley and John Channing.
7. Hazardous Chemicals Handbook by Phillip Carson and Clive Mumford.

Course Articulation Matrix: Industrial Health & Safety (ESE-704)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	H	L	H	----	----
CO 2	----	H	----	----	M
CO 3	M	H	L	H	M
CO4	M	L	M	L	M
CO5	L	H	M	M	L

ESE-705 ENERGY & ENVIRONMENT

4Credits (3-1-0)
Maximum Marks: 100
Internal Marks: 30
External Marks: 70
Time: 3 Hours

Note:

Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Describe the environmental aspects of renewable energy resources	LOTS: Level 2 Understand
CO2	Explore the concepts involved in solar energy, wind energy conversion system by studying its components, types and performance.	LOTS: Level 3 Apply
CO3	Illustrate hydro-electric energy, tidal energy and explain the operational methods of their utilization.	LOTS: Level 4 Analyse
CO4	Evaluate energy conservation techniques	HOTS: Level 5 Evaluate
CO5	Design energy auditing and economic assessment.	HOTS: Level 6 Create

Unit-I

Overview of energy. Indian scenario, Energy sources and their impact on environment.

Solar Energy: Characteristics of solar radiations, solar radiation measurements, solar energy conversion techniques: Solar collectors.

Photo-Voltaics: Introduction, Principle of solar cell, Physics of semi-conductor junction, Hierarchy of PV system, development of amorphous silicon solar cells technology, application of solar photovoltaic for lighting and water pumping.

Solar Thermal Energy: Thermal electric conversion system, Principle and description of solar water heating, solar distillation, solar cooking and solar pond.

Unit-II

Wind Energy: Origin of wind, quantification of wind energy in India, wind energy conversion systems, introduction to wind mill and wind electric generators.

Hydro-Power: Introduction, hydro-power generation, hydro-power potential in India, Micro, Mini & Mega-power projects potential & prospects.

Geothermal Energy: Introduction and nature of geothermal fields, geothermal energy, Physics of geothermal resources. Technology for exploiting geothermal resources. Potential and prospects in India.

Unit-III

Tidal Energy: Introduction and principle of tidal power generation, potential and prospects of tidal energy in India.

Bio-Energy: Biomass potential and production in India, biomass conversion processes. Introduction to biogas plants, biomass gasifiers and smokeless chullah.

Energy from fossil fuels: Sources, properties, production & processing.

Unit-IV

Nuclear Energy: Introduction, Fusion and Fission, chain reactions, a brief account of nuclear reactors.

Major alternative fuels: Liquefied Petroleum Gas (LPG), Compressed Natural Gas (CNG), Methanol, Ethanol and Hydrogen as a fuel, biofuels.

Energy Conservation & Economics: Principles of energy conservation and its impact on environment, energy conservation approaches/techniques, energy auditing and economic assessment.

Reference Books:

1. Renewable energy by Godfrey Boyle
2. Renewable energy by N.K. Bansal
3. Non-Conventional energy system by K.M. Mittal
4. Renewable Energy Sources and their environmental impact by S.A. Abbasi & Nassema Abbasi
5. Non –conventional energy by Ashok K. Desai

Course Articulation Matrix: Energy & Environment (ESE-705)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	H	L	M	----	----
CO 2	H	H	M	----	M
CO 3	M	M	M	M	L
CO4	L	H	L	M	----
CO5	M	L	L	M	----

Course code	Title of course	Core/Elective	Credit	L	P
ESE-706	**LAB-I Environmental Chemistry Lab**	**Core**	**3**	**0**	**6**

Note: Students are required to perform eight to ten experiments in the semester. The above list is an indicative list of experiments, which can be expanded by course coordinator depending on the course requirement

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Understand methods of measurement and analysis of various drinking water parameters	LOTS: Level 2 Understand
CO2	Determine the water quality parameters in water	LOTS: Level 3 Apply
CO3	**Analyse** the outcomes of different parameters of water	HOTS: Level 4 Analyse
CO4	**Evaluate** the outcomes of different parameters of water	HOTS: Level 5 Evaluate
CO5	**Create** written records for the given experiments with problem definition, solution, observations & conclusion.	HOTS: Level 6 Create

List of Experiments

1. Estimation of pH of water.
2. Estimation of pH of Soil.
3. Determination of Total, suspended, dissolved volatile & fixed residue in water sample
4. Determination of Turbidity
5. Determination of the Carbonate, Bicarbonate, and Hydroxide Alkalinity
6. Estimation of the Hardness of water (EDTA Method)
7. Determination of the Dissolved Oxygen (DO) of water
8. Determination of Biochemical Oxygen Demand (BOD) of water
9. Determination of Chemical Oxygen Demand (COD) of water

Course Articulation Matrix: Environmental Chemistry Lab (ESE-706)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	H		M	---	---
CO 2	---	H	M	H	M
CO 3	---	H	M	H	M
CO4	L	H	M	H	M
CO5	----	M	H	H	H

Course code	Title of course	Core/ Elective	Credit	L	P
ESE-707A	**Lab-II Foundation of Environmental Engineering**	**Core**	**3**	**0**	**6**

Note: Students are required to perform eight to ten experiments in the semester. The above list is an indicative list of experiments, which can be expanded by course coordinator depending on the course requirement

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Understand basic units of measurement, convert units, and appreciate their magnitudes. Select appropriate pressure measuring device under different condition of flow.	LOTS: Level 1 Remember
CO2	Demonstrate practical understanding of the various equations of Bernoulli.	LOTS: Level 2 Understand
CO3	Evaluate and compare different techniques of experimental analysis.	LOTS: Level 3 Apply
CO4	Demonstrate practical understanding of friction losses in internal flows.	HOTS: Level 4 Analyse
CO5	Find discharge of fluid through pipe, orifices and in open channel.	HOTS: Level 5 Evaluate

List of Experiments:

1. To calibrate Bourdon Tube Pressure Gauges
2. To verify Bernoulli's Theorem
3. To verify the Momentum Theorem with the help of Impact Jet Apparatus
4. To find out the coefficient of discharge for given Venturimeter.
5. To find out the coefficient of discharge for given Orifice meter.
6. To calibrate a V-notch.
7. To Determine the coefficient of friction for pipes of different sizes:

A) 1.5 cm, B) 2.0 cm, C) 2.5 cm, D) 3.2 cm, E) 4.0 cm

8. To determine the loss of head due to:

A) Sudden enlargement, B) Sudden contraction, C) Small bend.

9. To determine the coefficient of discharge (C_d), Velocity (C_v) and contraction (C_c).

Course Articulation Matrix: Lab-II Foundation of Environmental Engineering (ESE-707A)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	L	M	H	L	L
CO 2	L	H	H	H	H
CO 3	L	H	H	H	H
CO4	L	H	H	H	H
CO5	L	H	H	H	H

Course code	Title of course	Core/ Elective	Credit	L	P
ESE-707B	**Lab-II Foundation of Environmental Sciences**	**Core**	**3**	**0**	**6**

Note: Students are required to perform eight to ten experiments in the semester. The above list is an indicative list of experiments, which can be expanded by course coordinator depending on the course requirement

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	To understand the methodology for quality of aquatic bodies and study of plant community.	LOTS: Level 2 Understand
CO2	To determine the quality of aquatic bodies and vegetation.	LOTS: Level 3 Apply
CO3	To analyse the outcomes of various parameters related to quality of aquatic bodies and vegetation	HOTS: Level 4 Analyze
CO4	To evaluate the outcomes of various parameters related to quality of aquatic bodies and vegetation	LOTS: Level 2 Understand
CO5	To create written records for the given experiments with problem definition, solution, observations & conclusion	LOTS: Level 6 Create

List of Experiments

1. Estimation of pH and EC of water samples.
2. Estimation of total alkalinity of water and soil samples.
3. Estimation of free CO_2 in water sample
4. Estimation of dissolved oxygen contents in water sample.
5. Estimation of total hardness of a water sample.
6. Estimation of total chloride contents of a water sample.
7. Estimation of organic matter contents in a soil sample.
8. Determination of minimum size of quadrate to be laid for study of vegetation.
9. Determination of minimum numbers of quadrate to be laid for study of vegetation.
10. Determination of frequency of different species present in a community by quadrate method.
11. Determination of density of different species present in a community by quadrate method.
12. Determination of abundance of different species present in a community by quadrate method.
13. Determination of species diversity index of different species present in a community.

Course Articulation Matrix: Lab-II Foundation of Environmental Sciences (ESE-707b)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	L	L	M	---	L
CO 2	M	M	H	L	M
CO 3	H	M	H	H	M
CO4	H	M	M	M	H
CO5	M	M	M	---	---

Course code	Title of course	Core/ Elective	Credit	L	P
ESE-708	**Lab-III Industrial Health & Safety**	**Core**	**3**	**0**	**6**

Note: Students are required to perform eight to ten experiments in the semester. The above list is an indicative list of experiments, which can be expanded by course coordinator depending on the course requirement

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Understand methods of measurement and analysis of various industrial waste water parameters	LOTS: Level 2 Understand
CO2	Determine the water quality parameters of industrial waste water	LOTS: Level 3 Apply
CO3	Analyse the outcomes of different parameters of industrial waste water	HOTS: Level 4 Analyse
CO4	Evaluate the outcomes of different parameters of industrial waste water	HOTS: Level 5 Evaluate
CO5	To create written records for the given experiments with problem definition, solution, observations & conclusion	HOTS: Level 6 Create

List of Experiments:

1. Determine residual free chlorine and chlorine demand in given water sample.
2. Determine dose of alum for treatment of industrial waste water.
3. Determine nitrate content in given water sample.
4. Determine COD in given water sample.
5. To estimate Cr (VI) metal ion concentration in given water sample.
6. To estimate Ni (II) metal ion concentration in given water sample.
7. To estimate Zn (II) metal ion concentration in given water sample.
8. To estimate Pb (II) metal ion concentration in given water sample.
9. To estimate Cu (II) metal ion concentration in given water sample.
10. Prepare list of Hazardous Chemical used in occupational environment (Industrial visit).

Course Articulation Matrix: Lab-III Industrial Health & Safety (ESE-708)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	L	L	M	---	L
CO 2	M	M	H	L	M
CO 3	H	M	H	H	M
CO4	H	M	M	M	H
CO5	M	M	M	---	---

Course code	Title of course	Core/ Elective	Credit	L	P
ESE-709	**Lab-III(b) Energy & Environment**	**Core**	**3**	**0**	**6**

Note: Students are required to perform eight to ten experiments in the semester. The above list is an indicative list of experiments, which can be expanded by course coordinator depending on the course requirement

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Understand various non-conventional sources of energy	LOTS: Level 2 Understand
CO2	Demonstrate the working of various equipment used in non-conventional sources of energy.	LOTS: Level 3 Apply
CO3	Analyse observations of various equipment used in non-conventional sources of energy.	HOTS: Level 4 Analyse
CO4	Evaluate the differences between of various equipment used in non-conventional sources of energy.	HOTS: Level 5 Evaluate
CO5	To create written records for the given experiments	HOTS: Level 6 Create

List of Experiments:

1. To study Pyrheliometer
2. To study Pyranometer
3. To study Solar water heating system
4. To study Thermal electric conversion system
5. To study Solar electric power generation (solar PV cell)
6. To study Solar distillation unit
7. To study Solar pumping
8. To study Box type solar cooker
9. To study Box type solar oven (multi-reflector type)
10. To study Various type of biogas plant

Course Articulation Matrix: Lab-III(b) Energy & Environment(ESE-709)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	H		M	---	---
CO 2	---	H	M	H	M
CO 3	---	H	M	H	M
CO4	L	H	M	H	M
CO5	----	M	H	H	H

ESE-711: ENVIRONMENTAL MICROBIOLOGY

4Credits (3-1-0)
Maximum Marks: 100
Internal Marks: 30
External Marks: 70
Time: 3 Hours

Note:

Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	To enumerate and classify different groups of micro-organisms.	LOTS: Level 1 Remember
CO2	To understand the basics of microbial growth and microbial control.	LOTS: Level 2 Understand
CO3	Apply various approaches of bioremediation for pollution abatement	LOTS: Level 3 Apply
CO4	Evaluate the role of microbes in biogeochemical cycles and waste degradation	HOTS: Level 5 Evaluate
CO5	Design a bioreactor for treatment of waste water.	HOTS: Level 6 Create

Unit-I
Classification of microbes, Characteristics of major groups of micro-organisms-bacteria, fungi, algae, protozoa, viruses and bacteriophages (in brief), role of microbes in C, N, S & Fe cycling,. Microbial Growth - Methods of determining growth, factors affecting growth, types of growth, continuous, discontinuous, synchronus and non-synchronus.

Unit-II
Control of micro-organisms-physical control by biofiltration, irradiation, temperature (high & low), chemical control by antimicrobial agents and chemotherapeutic agents (a brief account).

Unit-III
Microbiology of aerobic waste water treatment process-Activated sludge process, trickling filter and rotating biological contactors & anaerobic waste water treatment process-fermentation and upflow anaerobic sludge blanket process.

Unit-IV
Bioremediation-approaches and techniques, Role of microbes in solid waste disposal, composting, degradation of xenobiotics and pesticides, Minerals and petroleum recovery.

Reference Books:

1. Microbiology by Michael J.Pelczar, Jr. E.S.S. Chan, Noel r. Krieg
2. Microbiology : Principles and Applications by Jacquelyn, G. Black
3. Microbiology by Nester
4. Microbial Ecology Fundamentals & Applications R.M. Atlas & R. Bastha

5. Wastewater Microbiology by Gabriel Bitton
6. Micro-organisms in bioremediation by Dilip K.Markandey and N.Rajvaidya Markandey
7. Biological degradation and bioremediation of toxic chemicals by G.Rasul Chaudhary

Course Articulation Matrix: Environmental Microbiology Lab (ESE-711)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	M	M	M	---	L
CO 2	M	L	M	L	M
CO 3	H	H	H	M	H
CO4	M	M	M	H	H
CO5	H	H	H	H	H

ESE-712: AIR POLLUTION & CONTROL

4 Credits (3-1-0)
Maximum Marks: 100
Internal Marks: 30
External Marks: 70
Time: 3 Hours

Note:

Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will of 14marks.

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Outlining source & effect of air pollutants on environment and air pollution episodes	LOTS: Level 1 Remember
CO2	Understand various meteorological condition and their effects in air pollutant dispersal.	LOTS: Level 2 Understand
CO3	Apply modelling techniques and to determine the fate of air pollutant with respect to time and space	LOTS: Level 3 Apply
CO4	Correlate different air sampling methods of gaseous and particulate air pollutants	HOTS: Level 4 Analyze
CO5	Plan the appropriate cost-effective air pollution control system.	HOTS: Level 5 Evaluate

Unit-I

Introduction: Definition, air quality, classification of air pollutants, air pollution episodes.
Air Pollution Sources and their Inventory: Particulate matter, carbon dioxide, carbon monoxide, oxides of sulphur, oxides of nitrogen, hydrocarbons, photochemical oxidants, asbestos and metals(Lead,Mercury,Cadmium).

Unit-II

Meteorology and Dispersion of Pollutants: Winds, wind-rose, maximum mixing depth, lapse rate, stability conditions, plume behaviour, calculation of effective stack height, The Gaussian dispersion model, heat island effect.

Unit-III

Air Pollution Monitoring: Sampling of gaseous and particulate air pollutants, measurement of SO2, Nitrogen oxides, carbon monoxide, Oxidants and Ozone, Hydrocarbons and particulate matter.
Effect of Air Pollution: Effect of air pollution on humans, animals, vegetation & materials.

Unit-IV

Control of Air Pollution: General methods of control of Gaseous pollutants(basic design & principles): scrubbers, condensers, control equipments for particulate matter-gravity settling chambers,cyclone, fabric filters, electrostatic precipitators, scrubbers, incinerator and catalytic converters
Concept of biofilters, Basics of noise pollution and its control.
Green belt development.

Reference Books:

1. Air Pollution by Boubel Fox, Turner & Stern.

2. Air Pollution & Control by C.S. Rao
3. Introduction to Environmental Engineering & Science by Gilbert M. Masters

Course Articulation Matrix: Air Pollution & Control (ESE-712)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	H	M	M	---	---
CO 2	H	M	---	---	---
CO 3	---	M	L	H	M
CO4	---	H	M	L	M
CO5	M	M	H	H	H

ESE-713: INDUSTRIAL POLLUTION & MANAGEMENT

4 Credits (3-1-0)
Maximum Marks: 100
Internal Marks: 30
External Marks: 70
Time: 3 Hours

Note:

Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Illustrate Methods of waste minimization	LOTS: Level 1 Knowledge
CO2	Relate different Processes of pollutants removal from wastewater.	LOTS: Level 2 Understand
CO3	Analyze Environmentally Balanced Industrial Complexes (EBIC).	LOTS: Level 4 Analyse
CO4	Evaluate the characteristics of various industrial waste	HOTS: Level 5 Evaluate
CO5	Develop Industrial wastewater treatment processes based on nature of industry	HOTS: Level 6 Create

Unit-I

Introduction: Standards for industrial wastes (MINAS), methods for the treatment of industrial wastes, reduction of volume and strength, neutralization, equalization and proportioning of the wastes.

Unit-II

Processes for removal of suspended solids: Sedimentation and co-agulation, colloidal solids and dissolved inorganic solids: Evaporation, Vaccum evaporation, dialysis and electrodialysis, ion exchange, membrane filtration like reverse osmosis and removal of organic solids by aerobic treatment processes: oxidation ponds, trickling filter, rotating biological contactors and activated sludge processes and anaerobic treatment processes like UASB reactor.

Unit-III

Environmentally balanced Industrial Complexes: Pulp and paper mill complex, Sugarcane complex, Textile complex, Slaughter house-tannery-rendering complex, Fertilizer-cement complex, Steel mill-Fertilizer-cement complex.

Unit-IV

Characteristics and Processes involved for the treatment of wastes from major industries like Food Processing (cannery, dairy, brewery, distillery and cane sugar), apparel (Textile, Tannery), Material Processing (Pulp and paper, steel, Metal-Plating, oil refineries, cement), chemical (Pesticide and fertilizer) and energy (Thermal Power plant).

Reference Books:

1. Industrial & Hazardous waste treatment by Nelson L. Nemerow and Avijit Dasgupta
2. Industrial Pollution Preventive Handbook by Freeman

3. Industrial water pollution control by W. Wesley Echenfelder, Jr.

Course Articulation Matrix: Industrial Pollution Management (ESE-713)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	H	M	M	L	
CO 2	L	H	L	M	M
CO 3	L	M	----	H	M
CO4	L	H	L	M	H
CO5	L	H	M	M	L

ESE-714: DESIGN OF POLLUTION CONTROL SYSTEMS

4 Credits (3-1-0)
Maximum Marks: 100
Internal Marks: 30
External Marks: 70
Time: 3 Hours

Note:

Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Recite physic-chemical & biological properties of wastewater.	LOTS: Level 1 Knowledge
CO2	Understand basic design parameters of Pollution Control Systems	LOTS: Level 2 Understand
CO3	Apply design criteria of Pollution Control Systems	LOTS: Level 3 Apply
CO4	Correlate designing of Pollution Control Systems	HOTS: Level 4 Analyze
CO5	Design the pilot plant of Pollution Control Systems	HOTS: Level 6 Create

Unit-I

Industrial and domestic effluent characteristics, Basic concepts of organic and inorganic effluent treatment, line of treatment .Basic design consideration and general procedure for design calculations. Reaction and reactors.

Unit-II

Design of preliminary Units: Design of sump and pump well, Approach channel, Equalization Tank, Screen Chamber, Grit Chamber, Aerated Grit Chamber and Oil & Grease Tank (Skimming Tank). Primary treatment units: Concepts of Primary settling Tank, Design Criteria for Primary Treatment and design examples.

Unit-III

Design of secondary biological treatment units: Design criteria of Aerobic Process, Calculation of Bio-Kinetics of coefficients of Aerobic Process, design consideration and application of Bio- kinetics of coefficients, design of Suspended growth processes: Activated sludge processes, secondary settling tank and stabilization pond, Design of Trickling Filters and Rotating Biological Contractors.

Unit-IV

General design criteria for Anaerobic Treatment Process, Design of Suspended and Attached Growth anaerobic Process, Design of Upflow anaerobic sludge blanket process (UASB), Design of sludge

treatment units and sludge drying beds.

Reference Books:

1. Mathematics Manual for Water and Waste Water Treatment Plant by Frank R. Spellman
2. Dynamics of Environmental Bioprocesses by Snape and Dunn
3. Waste water engineering: Treatment, Disposal, Reuse by Metcalf and Eddy.
4. Industrial Wastewater Pollution Control by Wesley
5. Basic Environmental Technology by Jerry
6. Waste Water Treatment by Edward
7. Design of Anaerobic Process for the Treatment of Industrial Municipal wastes by Joseph F. Reddy
8. Elements of Chemical Reaction Engineering by H.Scott Fogler
9. Air Pollution Control by Johnson

Course Articulation Matrix: Design of Pollution Control Systems (ESE-714)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	L	H	H	M	H
CO 2	L	H	H	H	H
CO 3	L	H	H	H	H
CO4	L	H	H	H	H
CO5	L	H	H	H	H

ESE-715: WATER AND SEWAGE TREATMENT

4Credits (3-1-0)
Maximum Marks: 100
Internal Marks: 30
External Marks: 70
Time: 3 Hours

Note:

Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Memorize the types of wastewater pollutants	LOTS: Level 2 Understand
CO2	Understand about principles and designing of water treatment processes.	LOTS: Level 2 Understand
CO3	Relate different wastewater treatment methods and process	LOTS: Level 3 Apply
CO4	Analyse different Disposal methods of wastewater and sludge	HOTS: Level 4 Analyze
CO5	Develop Advance treatment processes for water and wastewater analysis	HOTS: Level 4 Create

Unit-I

Water Treatment: Introduction: Quality standard of domestic and industrial water, sources and classification of water pollutants. Sedimentation: Principle of sedimentation, Design of sedimentation tank, Design example of sedimentation tank. Coagulation: Coagulation process, the constituents of coagulation-sedimentation plant, Floculation process, Design examples, methods for determining Optimum coagulation dose.

Unit-II

Filtration : Slow and filter, Rapid sand filter, Pressure filter, filter media, components, Filter operation, cleaning & backwashing process the under drain system and filter control, Design examples.

Color, Taste & odor Control: Sources of color, taste and odor-Natural and synthetic and their removal.

Disinfection and fluoridation: Introduction, objectives, primary disinfection technologies; chlorination, chloramination, chlorine dioxide, ozonation, potassium permanganate, ultraviolet radiation, advanced oxidation process.

Miscellaneous techniques: Water softening, demineralization, deflurodation, iron, manganese & arsenic removal.

Unit-III

Waste water treatment: Introduction, objective, classification of waste water treatment.
Primary treatment: Screening, sedimentation.

Secondary treatment (Aerobic & Anaerobic processes**):** Objective, design of the activated sludge process, trickling filter rotating biological contactors, Up flow anaerobic sludge blanket (UASB), Stabilization ponds & aerated lagoons.

Unit-IV

Tertiary treatment: Removal of dissolved inorganics, ion exchange, membrance processes, reverse osmosis, ultra filtration, electro-dialysis, removal of nitrogen and phosphorus (all processes in brief)
Sludge treatment & Disposal: digestion process, composting, thickening, Dewatering, Drying beds, Management and disposal of residues.

Reference Books:

1. Waste water engineering: Treatment, Disposal and reuse by Metcalf and Eddy.
2. Water supply and Sewerage by Terence J.Mc. Ghee
3. Industrial Water Pollution Control by W. Wesley and Eckenfelder, Jr.
4. Water works Engineering by Qasim, S.R., Motley and E.M. Zhu. G.
5. Water supply and sanitary Engineering by G.S. Birde and J.S. Birde
6. Water supply, Waste disposal and Environmental Engineering by A.K. Chatterjee.
7. Basic Environmental Technology by Jerry. A. Nathanson.

Course Articulation Matrix: Water and Sewage Treatment (ESE-715)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	L	L	L	H	M
CO 2	L	M	M	H	M
CO 3	L	M	M	H	M
CO4	L	L	M	H	M
CO5	L	M	M	H	H

Course code	Title of course	Core/Elective	Credit	L	P
ESE-716	**LAB-IV Environmental Microbiology Lab**	**Core**	**3**	**0**	**6**

Note: Students are required to perform eight to ten experiments in the semester. The above list is an indicative list of experiments, which can be expanded by course coordinator depending on the course requirement

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	To understand the equipments used for study of different categories of micro-organisms.	LOTS: Level 2 Understand
CO2	To determine the type of micro-organisms	LOTS: Level 3 Apply
CO3	To prepare different type of media for isolation of various micro-organisms.	HOTS: Level 4 Analyse
CO4	To evaluate the bacteriological quality of water and measure microbial growth.	HOTS: Level 5 Evaluate
CO5	To create written records for the given experiments with problem definition, solution, observations & conclusion.	HOTS: Level 6 Create

List of Experiments:

1. Isolation of bacteria from various soil samples.
2. Isolation of fungi from various soil samples.
3. Simple staining
4. Gram's staining

Course Articulation Matrix: Environmental Microbiology Lab (ESE-716)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	L	L	M	---	L
CO 2	L	M	M	H	H
CO 3	L	M	M	H	L
CO4	M	H	H	H	H
CO5	M	---	M	---	---

Course code	Title of course	Core/ Elective	Credit	L	P
ESE-717	**LAB-V-Industrial Pollution Management (ESE 717)**	**Core**	**3**	**0**	**6**

Note: Students are required to perform eight to ten experiments in the semester. The above list is an indicative list of experiments, which can be expanded by course coordinator depending on the course requirement

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Understand methods of measurement and analysis of various waste water parameters	LOTS: Level 2 Understand
CO2	Determine the water quality parameters of waste water	LOTS: Level 3 Apply
CO3	Analyse the outcomes of different parameters of waste water	HOTS: Level 4 Analyse
CO4	Evaluate the outcomes of different parameters of waste water	HOTS: Level 5 Evaluate
CO5	To create written records for the given experiments with problem definition, solution, observations & conclusion	HOTS: Level 6 Create

List of Experiments:

1. To estimate COD in given waste water sample.
2. To estimate BOD in given waste water sample.
3. To estimate VFA in given waste water sample.
4. To estimate SVI in given waste water sample.
5. To estimate SPM in given air sample.
6. To estimate NOx in given air sample.
7. To estimate SOx in given air sample.
8. To estimate CO in given air sample.
9. To estimate Nitrogen in given soil sample.
10. To estimate Potassium in given soil sample.
11. To estimate Phosphorus in given soil sample.

Course Articulation Matrix: Lab V- Industrial Pollution Management(ESE 717)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	L	L	M	---	---
CO 2	L	M	M	H	M
CO 3	L	M	M	H	M
CO4	M	H	H	H	M
CO5	M	---	M	H	H

Course code	Title of course	Core/ Elective	Credit	L	P
ESE-718	**Lab-VI Water and Sewage Treatment**	**Core**	**3**	**0**	**6**

Note: Students are required to perform eight to ten experiments in the semester. The above list is an indicative list of experiments, which can be expanded by course coordinator depending on the course requirement

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	To estimate coagulant dose required for coagulation	LOTS: Level 4 Evaluate
CO2	To study the effect of pH, dose, time and concentration using charcoal as adsorbent	LOTS: Level 4 Evaluate
CO3	To evaluate the efficiency of adsorbent for colour removal	LOTS: Level 4 Evaluate
CO4	To determine the break point chlorination	HOTS: Level 4 Evaluate
CO5	To estimate different types of COD for given sample of waste water	HOTS: Level 4 Evaluate

List of Experiments:

1. To estimate coagulant dose required for coagulation.
2. To study the effect of pH on removal of color using adsorbent.
3. To study the effect of dose on removal of color using adsorbent.
4. To study the effect of contact time on removal of color using adsorbent.
5. To study the effect of initial metal ion concentration on removal of color using adsorbent.
6. To study the effect of pH on removal of COD using adsorbent.
7. To study the effect of dose on removal of COD using adsorbent.
8. To study the effect of contact time on removal of COD using adsorbent.
9. To study the effect of initial metal ion concentration on removal of COD using adsorbent.
10. To determine break point chlorination.
11. Experimental related numerical.

Course Articulation Matrix: Lab-VI Water and Sewage Treatment (ESE-718)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	L	H	L	M	H
CO 2	L	H	M	H	H
CO 3	L	H	M	H	H
CO4	L	H	M	H	H
CO5	L	H	M	H	H

ESE-721: UNIT OPERATION & PROCESSES

4Credits (3-1-0)
Maximum Marks: 100
Internal Marks: 30
External Marks: 70
Time: 3 Hours

Note:

Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Memorize the unit operations and processes.	LOTS: Level 1 Remember
CO2	Understand physiochemical and biological process for treatment of wastewater	LOTS: Level 2 Understand
CO3	Relate different physiochemical and biological process for treatment of wastewater	LOTS: Level 3 Apply
CO4	Illustrate applications of physiochemical and biological process for treatment of wastewater	HOTS: Level 4 Analyze
CO5	Plan processes for treatment of wastewater	HOTS: Level 6 Evaluate

Unit-I

Introduction: Concept of unit process and operations, Standard & requirement, water treatment process & system, waste water treatment process & treatment.

Reactors: A simplistic view of reactors. Homogeneous reactions, Non homogeneous reactions. Effectiveness factor models. Continuous homogeneous reactors, conversion. Nonhomogeneous reactors. Problems.

Unit-II

Physico-chemical removal of dissolved materials: Adsorption, Ion exchange, Membrane Processes, chemical oxidation, precipitation, problems.

Gas transfer: Mass- transfer models, bubble aeration, temperature effects. The effect of surface-active agents. Agitation resulting from aeration , aeration by mechanical mixers, Maximum oxygen transfer rates and comparison of operating systems, film-flow oxygen transfer, gas stripping, air requirements for gas stripping, problems.

Solids removal: Ideal sedimentation, coagulation, flocculation, discrete particle sedimentation, flocculent sedimentation, hindered setting and thickening, configurations used in sedimentation tanks, centrifugation, filtration, problems.

Unit-III

Activated sludge and other suspended culture processes: Activated sludge, process parameters, mass-transfer limitations on removal rate , cell yield, process operation-performance and control, extended aeration processes, step aeration, high-rate activated sludge, biosorption on contact stabilization, pure-oxygen-activated sludge-aerated lagoons,aerobic digestion, centrifugal screens, nitrification, anaerobic bacterial denitrification, oxidation lagoons, problems,

Biological film-flow processes: Trickling filters, development of a design equation at maximum influent concentrations, airflow rate, physical factors in trickling filter design, rotating biological contractors, FDAS, IFAS.

Unit-IV

Anaerobic processes: Biological process characteristic, cell production, pH effects, temperature, process operating parameters, fermentation rates, application of anaerobic process, loading rates, anaerobic digestion, anaerobic contact process, anaerobic packed beds, anaerobic ponds.

Process selection and system synthesis: Waste waters, industrial waste waters, interaction of system components, mixing waste waters and regional plants, system economics, water treatment systems, experimental studies.

Reference Books:

1. Waste Water Treatment by Edward
2. Unit Operations in Environmental Engg. by R. Elangovan
3. Design of anaerobic processes for the treatment of industrial and municipal wastes by Joseph F. Malina.
4. Waste Water Engg. by Metcalf and Eddy.
5. Elements of Chemical Reaction Engg. by H. Scott. Fogler
6. Dynamics of Environmental Bio-processes by J.B. Snape and I J Dunn

Course Articulation Matrix: Unit Operations and Processes (ESE-721)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	L	M	H	M	M
CO 2	L	H	H	H	H
CO 3	L	H	H	H	H
CO4	L	H	H	H	H
CO5	L	H	H	H	H

ESE-722 INSTRUMENTATION AND ITS APPLICATIONS TO ENVIRONMENTAL ENGINEERING

4 Credits (3-1-0)
Maximum Marks: 100
Internal Marks: 30
External Marks: 70
Time: 3 Hours

Note:

Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Memorize measurement systems, their types, calibration and sensitivity of instruments.	LOTS: Level 1 Remember
CO2	Summarize the analytical techniques for various pollution management	LOTS: Level 2 Understand
CO3	Apply analytic techniques in wastewater and air quality monitoring and	LOTS: Level 3 Apply
CO4	Correlate analytic techniques in wastewater and air quality monitoring	HOTS: Level 4 Analyze
CO5	Correlate analytic techniques in wastewater and air quality monitoring	HOTS: Level 5 Evaluate

Unit-I
Introduction and applications of instruments in the field of environmental engg., units and standards of measurement of various quantities, generalized measurement systems, their types, calibration and sensitivity of instruments.

Unit-II
Performance characteristics of instruments (static and dynamic), errors and uncertainties in performance parameters. Transducer and its types, detectors, sensor systems, types of sensors (mechanical, hydraulic, pneumatic, electrical and electronic etc) modifying and transmitting methods.

Unit-III
Indicating system for static and dynamic quantities, recorders and data storage system.

Unit-IV
Applications of instruments, leakage detector, corrosion detector, flow measuring devices for air and water, sound level meter.
Principal structure and working of pH meter, nepthalo-meter, fluoride meter, electronic conductivity meter, Bomb calorimeter and Spectrophotometer.

Reference Books:

1. Principles of measurement system by John P. Bentley

2. Principles of measurement and instrumentation by Morries
3. Principle of industrial instrumentation by Patranabis
4. Industrial instrumentation and control by Singh

Course Articulation Matrix: Instrumentation & Applications to Environmental Engineering (ESE-722)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	L	H	M	H	H
CO 2	L	H	M	H	H
CO 3	L	H	M	H	H
CO4	L	H	H	H	H
CO5	L	H	H	H	H

ESE-723-SOLID AND HAZARDOUS WASTE MANAGEMENT

4Credits (3-1-0)
Maximum Marks: 100
Internal Marks: 30
External Marks: 70
Time: 3 Hours

Note:

Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Summarize Sources and generation of solid waste.	LOTS: Level 2 Understand
CO2	Apply Methods of solid waste disposal.	LOTS: Level 3 Apply
CO3	Analyse Techniques of energy and material recovery from solid waste	LOTS: Level 4 Analyse
CO4	Evaluate Methods of handling and management of hazardous waste	HOTS: Level 5 Evaluate
CO5	Compile various Rules and Regulations for handling and management of hazardous waste	HOTS: Level 6 Create

Unit-I

Introduction: Types, sources and characteristics of solid wastes. Solid waste generation, handling and storage. Collection of solid wastes-Collection services, types of collection system and their analysis, transfer and transport. Solid waste management. An overview, reduction, reuse and recovery.

Unit-II

Processing Techniques- Shredding and pulverizing, baling, component separation, incineration, gasification and pyrolysis.

Disposal: Dumping, land filling- site selection, Leachate contamination, land filling methods, design and operation of landfills, occurrence and movement of gases and leachate in landfills, treatments of leachates, land farming, Biogas plant, Deep well injection, Utilization of fly ash, Economics of waste disposal.

Processing of recyclable materials, metals recovery from solid wastes.

Unit-III

Hazardous Waste Management : Definition and classification of Hazardous Waste, Characteristics and Transportation of Hazardous Waste, treatment, storage and disposal, Hazardous Waste Minimization and Remediation Techniques.

Unit-IV

Biomedical waste: Generation, risk to human health and storage, transportation and treatment.

E-Waste: Definition, Environmental impacts, recycling and management.

The Hazardous waste (Management, Handling and Transboundary movement) Rules, 2008 and its

amendments.

Reference Books:

1. Environmental Hazards-Smith, Keith
2. Environmental Hazards-Iqbal, M,Srivastava, A.S. and Siddiqu, T.Q.
3. Basic Environmental Technology-Nathanson, J.A.

Course Articulation Matrix: Solid & Hazardous Waste Management (ESE-723)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	H	H	----	----	M
CO 2	L	L	M	-----	M
CO 3	L	H	M	H	M
CO4	M	H	M	H	L
CO5	L	L	L	H	

ESE-724 ENVIRONMENTAL MANAGEMENT SYSTEM

Credit 4 (3-1-0)
Maximum Marks: 100
Internal Marks: 30
External Marks: 70
Time: 3 Hours

Note:

Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Explain basic concepts of EMS	LOTS:Level 1 Knowledge
CO2	Understand stages of Environmental Management System implementation	LOTS: Level 2 Understand
CO3	Apply Methods of Environmental Management System	LOTS: Level 3 Apply
CO4	Compare various ISO14000, ISO 14010, ISO 14031, ISO 14040	LOTS: Level 4 Analyse
CO5	Evaluate best practice techniques in various ISO Standards.	HOTS: Level 5 Evaluate

Unit-I

The evolution of environmental management standard, British Standard 7750, Technical Committee 207, ISO 9000 and ISO 14000 series, origin, objective, scope and applicability of ISO 14000, components parts of ISO 14000 and their relationship, legal considerations and requirements of ISO 14000.

Unit-II

ISO 14000 based Environmental Management System : definition, principle, elements, structure and benefits of Environmental Management System, preparation of documents for ISO 14000, sites, implementation steps, internal audit for ISO 14000 compliance.

Unit-III

ISO 14010: EMS Audit-definition, objective, general principles, scope, types and guidelines of environmental auditing process. Registration process for implementing ISO 14000: organization decision to implement ISO 14000, potential registration problems, minimizing registration costs, steps to registration, ISO 14024: Eco-labelling communication to the public. How a company will participate in ISO 14024 based eco-labelling programme.

Unit-IV

ISO 14031: Evaluating the organization environmental performance. ISO 14020: Guidelines & standards on environmental claims & declarations.
ISO 14040: Guidelines standards for a company's management system; general principle of conducting life cycle assessment (LCA), definition, stages and scope of LCA and LCA inventory. ISO guide 64: its purpose. ISO 14000 checklist.

Reference Books:

1. Khanna, P. : Primer on Environmental
   Management Soyre. D. : Inside ISO 14000

Course Articulation Matrix: Environmental Management System (ESE-724)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	L	H	L	M	H
CO 2	L	H	M	H	H
CO 3	L	H	M	H	H
CO4	L	H	M	H	H
CO5	L	H	M	H	H

ESE-725 WATER SHED MANAGEMENT

Credit 4(3-1-0)
Maximum Marks: 100
Internal Marks: 30
External Marks: 70
Time: 3 Hours

Note:

Nine questions will be set by the examiners, two from each unit and one question of short answer/objective type covering the whole syllabus, which will be compulsory. Students will have to attempt five questions in all, including one question from each unit and the compulsory question. Each question will be of 14 marks.

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Describe the basic Concepts of hydrology	LOTS: Level 1 Knowledge
CO2	Understand hydraulics of groundwater and distribution of water	LOTS: Level 2 Understand
CO3	Solve equations for calculating precipitation, infiltration, evapotranspiration, runoff, hydrographs, unit hydrographs.	LOTS: Level 3 Apply
CO4	Evaluate the precipitation, infiltration, evapotranspiration, runoff, hydrographs, unit hydrographs.	HOTS: Level 5 Evaluate
CO5	Design of channels for open channel flow & pipe flow	HOTS: Level 6 Create

Unit-I

Elements of hydrology, measurement of precipitation, losses and run off, statistical analysis of rainfall and run off data-prediction of desired magnitudes-methods of estimating run off from rainfall. Flood forecasting, analysis of storage requirements, sediment inflow-selection of reservoir sites-Flood moderation damage mitigation, computation of height of dam.

Unit-II

Hydrology of ground water-common aquifers. Hydraulics of ground water flow-Darcy's Law, Measurement of permeability of formation-Well equations, unconfined and confined-Evaluation of formation constants-Aquifer Interference, design, construction and maintenance of wells and infiltration galleries-well strainer and its functions and selection-development of wells-yield tests-hydraulics of salt water and their prevention-Ground Water recharge. Soil erosion & control.

Unit-III

Distribution of water- Pressure and capacity requirements of system-provision for the fire fighting-field and office analysis of distribution net works. Service and equalizing storage-capacity requirements-Maintenance of distribution systems-Detection and prevention of faults: Emerging disinfection of mains. Transmission of Water: types and materials of conduits- Hydraulic characters-size, capacity, number and shape of conduits.

Unit-IV

Hydraulics of sewers-open channel flow with special reference of sewers, length of side weirs and capacity of street inlets. Measurement of flowing sewers. Rational method of estimating storm

drainage-intensity-duration. Relationship-time of concentration-frequency of storms.

Reference Books:

1. Water Supply Engineering by S.K.Garg
2. Sewage disposal and Air Pollution Engineering by S.K. Garg
3. Water Shed Management and Water Studies by Michael
4. Engineering Hydrology by Subramanye
5. Water Supply and Sewerage 628.I/MC 173 W
6. Ground water contamination 628.16/B 399
7. Water flow on soils 631.432/M 699 W

Course Articulation Matrix: Environmental Management System (ESE-724)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	L	M	H	H	H
CO 2	L	H	H	H	H
CO 3	L	H	H	H	H
CO4	L	H	H	H	H
CO5	L	H	H	H	H

Course code	Title of course	Core/Elective	Credit	L	P
ESE-790	**Credit Seminar**	**Core**	**1**	**0**	**0**

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Describe any topic of interest and develop a through process for technical presentation	LOTS: Level 1 Remember
CO2	Explain technical issues and give oral presentations related to work completed	LOTS: Level 2 Understand
CO3	Demonstrate ability to use technical resources available	LOTS: Level 3 Apply
CO4	Compare technical issues and develop competence in presenting	HOTS: Level 5 Evaluate
CO5	Develop their communication skills	HOTS: Level 6 Create

This course is introduced for the students to learn fundamental principles, concepts or theories and to identify & compare technical and practical issues related to the area of specialization. It also motivates the students to prepare a well-organized report employing elements of technical writing and critical thinking for promotion and development of presentation skills.

Course Articulation Matrix: Credit Seminar (ESE-790)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	L	M	H	H	H
CO 2	L	H	H	H	H
CO 3	L	H	H	H	H
CO4	L	H	H	H	H
CO5	L	H	H	H	H

Course code	Title of course	Core/Elective	Credit	L	P
ESE-791	**In-plant training (S/US)**	**Core**	**0**	**0**	**0**

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO1	Participate in the projects in industries during his or her industrial training.	LOTS: Level 3 Apply
CO2	Describe use of advanced tools and techniques encountered	LOTS: Level 3

	during industrial training and visit.	Apply
CO3	Interact with industrial personnel and follow engineering practices and discipline prescribed in industry.	HOTS: Level 4 Analyse
CO4	Develop awareness about general workplace behaviour and build interpersonal and team skills.	HOTS: Level 5 Evaluate
CO5	Prepare professional work reports and presentations.	HOTS: Level 6 Create

Course Articulation Matrix: IN-PLANT TRAINING (ESE-791)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	M	H	H	L	H
CO 2	L	L	H	L	H
CO 3	----	H	L	L	H
CO4	M	H	L	H	H
CO5	H	H	H	M	H

Course code	Title of course	Core/Elective	Credit	L	P
ESE-800	**Dissertation Part-1**	**Core**	**9**	**0**	**18**

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO 1	Summarize the findings of research papers related to a topic and identify the gaps through extensive literature survey.	LOTS: Level 2 Understand
CO 2	Use different modern hardware and software tools to carry out research in the domain of Environmental Science & Engg.	LOTS: Level 3 Apply
CO 3	Analyze the existing research critically to formulate the research problems.	HOTS: Level 4 Analyze
CO 4	Compile research ideas in the form of a synopsis/report and present them in an effective manner.	HOTS: Level 5Create

The dissertation work should be of Research nature only and it should be started during the third semester and the candidate must do the following:

a) Literature Survey

b) Problem Formulation

Around 40% of the dissertation work should be completed in this semester. The remaining 60% work will be carried out in the fourth semester. Each student is required to submit a detailed report about the work done on topic of dissertation as per the guidelines decided by the department. The dissertation work is to be evaluated internally through Presentations during the semester and Viva-Voce at the end of semester as per the guidelines decided by the department from time to time.

Course Articulation Matrix: Dissertation Part -I (ESE-800)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	M	H	H	L	H
CO 2	L	L	H	L	H
CO 3	----	H	L	L	H
CO4	M	H	L	H	H

Semester IV

Course code	Title of course	Core/Elective	Credit	L	P
ESE-800	**Dissertation-Part II**	**Core**	**9**	**0**	**18**
Max Marks: 100 (Evaluation will be done by external exam conducted jointly by the external examiner and the supervisor concerned as internal examiner.)					

Course Outcomes:

Sr. No.	At the end of the semester, students will be able to	RBT Level
CO 1	Apply advanced concepts, research methodology and knowledge of simulation tools to solve the research problems.	LOTS: Level 3 Apply
CO 2	Analyze research objectives critically and explore a logical solution through experimentation / simulation for the proposed research work.	LOTS: Level 4 Analyze
CO 3	Evaluate the experimentation /simulation results of the proposed research.	HOTS: Level 5 Evaluate
CO 4	Devise a novel & effective solution to the research problems and write dissertation/papers in a professional and ethical manners	HOTS: Level 6 Create

Around 40% of the dissertation work should be completed in third semester. The remaining 60%work will be carried out in this semester. Each student is required to submit a detailed Dissertation report of the work done (III Sem + IV Sem) on topic of Dissertation as per the guidelines decided by the department.

The Dissertation work is to be evaluated continuously through presentations during the semester. The candidate will be required to present his/her research work before submitting his/her Dissertation (pre-submission) in front of dept. committee including Chairperson of the department. Final dissertation evaluation/ viva voce will be done at the end of semester as per the guidelines decided by the department/university from time to time.

Research work should be carried out at GJUS&T Hisar. However, candidate may visit research labs/institutions with the due permission of Chairperson on recommendation of supervisor concerned.

Course Articulation Matrix: Dissertation-Part II (ESE-800)					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**
CO 1	M	H	H	L	H
CO 2	L	L	H	L	H
CO 3	----	H	L	L	H
CO4	M	H	L	H	H