AC 12/5/2017
Item No.

UNIVERSITY OF MUMBAI

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**M.Sc. in Sustainable Development and Environment Management** (M.Sc.SDEM)
2	Eligibility for Admission	1. **B.Sc. degree / B.E or equivalent.** 2. Admissions on the basis of Written Test followed by an Interview.
3	Passing Marks	50% PASSING MARKS
4	Ordinances / Regulations (if any)	
5	No. of Years / Semesters	2 YEARS / 4 SEMESTERS
6	Level	GRADUATE
7	Pattern	SEMESTER
8	Status	NEW
9	To be implemented from Academic Year	From Academic Year 2017-18

Date: 12/5/2017 Signature:

Dr. Anil Karnik, I/C. Director, Garware Institute of Career Education & Development

University of Mumbai`s

Garware Institute of Career Education and Development

Proposed Syllabus for the course of

M.Sc In Sustainable Development and Environment Management

Credit Based Semester and Grading System with effect from year the academic year (2017-2018)

UNIVERSITY OF MUMBAI

GARWARE INSTITUTE OF CAREER EDUCATION & DEVELOPMENT

SYLLABUS RELATING TO THE
M.Sc in Sustainable Development and Environment Management
New course w.e.f. the academic year 2017-2018.

PREAMBLE

Managing sustainability is one of the most challenging and rapidly growing areas in both the public and private sectors. Securing economic development, social equity and justice, and environmental protection is the goal of sustainable development.

Sustainable development encourages us to conserve and enhance our resource base, by gradually changing the ways in which we develop and make use of sound and sustainable technologies.

Rapid industrialization coupled with uncontrolled exploitation of natural resources has affected environment, by ultimate changes in the natural cycle, causing impact and/or effects on air, water, land, flora, fauna, human settlement and health of people. Industrial development, besides economic growth, brings along with it many environmental problems.

Environmental Management is the process of controlling any potential negative impact on the external environment from the human activities in general and industrial activities in particular.

Though industrialization is an integral part of India's progressive economy qualified trained professionals in the field are scarce to find. There is a strong need for professional adept at providing solutions/ expertise in the fields of Sustainable Development And Environment Management in the context of globalization and India's progressive economy.

The course is thus designed to fill up these gaps by imparting the knowledge in the field of Sustainable Development And Environment Management to those interested to make their rewarding career in this field.

Objectives:

- To inculcate the knowledge base on sustainable development with a view to balance our economic, environmental and social needs, allowing prosperity for now and future generations. To train students to undertake major initiatives in the efficient management of natural resources and the prevention of environmental pollution with focus on Sustainable Development.
- To equip individuals to solve problems of environmental pollution and environmental degradation through before end of pipe (BEOP) interventions, over and above the use of conventional way of end-of-pipe (EOP) interventions.
- To promote understanding of efforts that can be made at the Industry and Government level to improve the environment, the economy and the quality of life of biotic and abiotic communities.
- To use environmental management tools that help to improve the quality of environment, to assess local vulnerabilities with respect to climate, natural disasters and to achieve sustainable developmental needs.

CAREER OPPORTUNITIES

Candidates would have opportunity to get placement in:

- Every Industry sector (such as Automobile, Food Processing, Chemical, Pharmaceutical, Power including Renewable Energy, Textile, Fertilizer, Cement, Infrastructure, Steel, Refinery, Tyre, etc. and other industry sectors),
- Pollution Control Boards, Municipal Corporations,
- Environmental Consultancy firms,
- NGO's, Banks (study feasibility of environmental projects),
- Research & Development Laboratory,
- Multi-star Hotels (manage Waste Water Treatment Facilities, Environmental Management Systems),
- Hospitals (Environmental Quality Control, Hospital Waste Management),
- Waste Management Industries
- Certifying / Audit agencies.

The passed out candidates/students can have opportunity to serve as

- Sustainability Executives
- Operations and Marketing Managers
- Environmental Engineers
- Industrial Production Managers
- Environmental Managers
- Environmental Scientists
- Environmental Chemists
- Environmental Consultants
- Project Officers
- Freelancers In the Field Of Environment
- Many more alike as stated above.

Masters in Sustainable Development and Environment Management
Duration 2 years

	Subject Code	Core Subject	Assessment Pattern			Teaching Hours			
SEMESTER- 01		**Topics**	**Internal Marks 60**	**External Marks 40**	**Total Marks 100**	**Theory Hours**	**Practical Hours**	**Total Hours**	**Total Credits**
	1.1	**Environmental Chemistry**	60	40	100	60	-	60	4
	1.2	**Environmental Microbiology**	60	40	100	60	-	60	4
	1.3	**Environmental Physics & Statistics**	60	40	100	60	-	60	4
	1.4	**Environmental Monitoring**	60	40	100	60	-	60	4
	1.5	**Ecology and Biodiversity**	60	40	100	60	-	60	4
	1.6	**Practicals I**	200		200		240	240	8
		Total	**500**	**200**	**700**	**300**	**240**	**540**	**28**
SEMESTER- 02	2.7	**Unit Operations & Processes**	60	40	100	60	-	60	4
	2.8	**Air & Noise Pollution Prevention & Control**	60	40	100	60	-	60	4
	2.9	**Water Pollution Prevention & Control**	60	40	100	60	-	60	4
	2.10	**Environmental Compliance Requirements**	60	40	100	60	-	60	4
	2.11	**Management of Solid Wastes**	60	40	100	60	-	60	4
	2.12	**Practicals II**	200	-	200		240	240	8
		Total	**500**	**200**	**700**	**300**	**240**	**540**	**28**

	Subject Code	Core Subject	Assessment Pattern			Teaching Hours			
		Topics	Internal Marks 60	External Marks 40	Total Marks 100	Theory Hours	Practical Hours	Total Hours	Total Credits
SEMESTER- 03	3.13	Industrial Safety and Hygiene	60	40	100	60	-	60	4
	3.14	Environmental Management Tools	60	40	100	60	-	60	4
	3.15	Designing Of Water And Waste Water Treatment Systems	60	40	100	60	-	60	4
	3.16	Sustainability and CSR I	60	40	100	60	-	60	4
	3.17	Environmental Modelling And Computer Application	60	40	100	60	-	60	4
	3.18	Dissertation and Placement Grooming	200	-	200	-	240	240	8
		Total	**500**	**200**	**700**	**300**	**240**	**540**	**28**
SEMESTER- 04	4.19	Information and Communication Technology (including APTIS Module)	60	40	100	60	-	60	4
	4.20	Sustainability and CSR II	60	40	100	60	-	60	4
	4.21	Risk Management	60	40	100	60	-	60	4
	4.22	In plant Training-3 Months	200	-	200	-	540	540	12
		Total	**380**	**120**	**500**	**180**	**-**		**24**
		FINAL TOTAL	**1880**	**720**	**2600**	**1080**	**1260**	**2340**	**108**
No of Industrial Visits : 4 (per semester from Semester I to Semester III)									

SUBJECT-WISE SYLLABUS

	SEMESTER -I	Total Hours	Sessions of 3 hrs each
1.1	**ENVIRONMENTAL CHEMISTRY**		
	Unit I The composition and the chemistry of the atmosphere, the hydrosphere, the lithosphere and their interactions with each other and with the biosphere.	**12**	**4**
	Unit II Basic concepts of chemistry, inclusive of the concepts of chemical equilibrium, colloidal chemistry, adsorption, absorption and catalysis as well as behavior pattern of pollutants in aqueous solutions.	**12**	**4**
	Unit III References/ case studies of different industries, and specific polluting parameters present in air, water and wastewater.	**9**	**3**
	Unit IV Water pollution: Definition, Sources of water pollution and their effects, water quality criteria, specification of water as per the application.	**9**	**3**
	Unit V Air pollution: Definition, Sources of air pollution and their effects, Ozone depletion, Global warming and climate change, primary pollutant, secondary pollutant, NAAQS and emission standards.	**9**	**3**
	Unit VI Soil pollution: Definition, sources & types, classification of soil pollutants, effects of pollution on soil, health and productivity. Effects of pesticides on soil: toxic, inorganic &organic pollutants, soil deterioration, concentration of infecting agents in soil.	**9**	**3**
	Reference books: ▪ Environmental Chemistry by De Anil Kumar ▪ Air Pollution Vol. I. and II by Stern Arthur C. ▪ Fundamental Concepts of Environmental Chemistry by G. S. Sodhi ▪ Introduction to Air Pollution by R. K. Trivedi and P.K. Goel ▪ Chemistry For Environmental Engineering by Sawyer Clairn & McCarthy Perry L. ▪ Pollution Management Vol III- Pesticides Pollution by S. K. Agarwal		
1.2	**ENVIRONMENTAL MICROBIOLOGY**		
	General Microbiology: **Unit I** Introduction to Microbiology: Five kingdom system, binomial nomenclature, group of micro-organisms and their environmental	9	**3**

	significance. Structure of Prokaryotic and Eukaryotic cells, functions of each part.		
	Unit II Biochemistry of micro-organisms [Pathways] - Respiration, anaerobic, aerobic, energy generation - Photosynthesis - Introduction to Genetics	6	**2**
	Unit III Nutrition of micro-organisms - Overview of proteins, carbohydrates, lipids, nucleic acids - Nutritional classification of micro-organisms	6	**2**
	Unit IV Growth of micro-organisms [Biological growth curve, significance of each stage]; factors affecting growth. Death of micro-organisms [Physical and chemical sterilization techniques]	3	**1**
	Unit V Disease causing micro-organisms [water borne diseases and fecal organisms including coliforms]	6	**2**
	Environmental Microbiology **Unit VI** Microbiology of Air - Distribution and types of micro-organisms in air - Factors affecting the kind and no. of micro-organisms - Dust, Droplet & Droplet Nuclei - Communicability of infections - Methods of Air Purification	6	**2**
	Unit VII Microbiology of Water - Natural water environment [Freshwater, Marine water & Other] - Eutrophication – causes, sources & consequences - Factors influencing micro-organisms present in aqueous environment - Drinking Water Purification [Individual water supplies & Municipal water supplies]	6	**2**
	Unit VIII Microbiology of Wastewater - Microbiology of domestic wastewater [sewage]: types of micro-organisms present, treatment methods for single dwelling unit and sewage treatment plants [STP] - Microbiology of industrial wastewater [effluent]: variety of micro-organisms present in different types of effluents, treatment methods for individual effluent treatment plants [ETP] and CETP	6	**2**
	Unit IX Biodegradation & Bioremediation - Micro-organisms as indicators of pollution		

	- Acclimatization and microbial biodegradation of pesticides, hydrocarbons, detergents & oil - Microbial bioremediation to clean up the environment Reference books: ▪ Microbiology by Pelczar Michael J. & Others ▪ General Microbiology by Stanier Roger Y. & Others ▪ Fundamentals Of Microbiology by Frobisher Martin & Others ▪ Microbiology for Environment and Public by R M. Sterritt & J N. Lester ▪ Bioremedition by Baker, K H., and Herson, D.S. ▪ Bioremediation technology recent advances M.H.Fulekar	12	**4**
1.3	**ENVIRONMENTAL PHYSICS & STATISTICS** **Unit I** Ionizing Radiation – radioactive decay, Interaction of radiation with matter. Biological effects of radiation with matters. Health hazards associated with radiations. Units of health hazards associated with radiations. Units of radioactivity and radiation dose. Radiochemical Methods of monitoring air and effluent. Methods for monitoring air emission, Radiation Protection, Principles and Techniques. **Unit II** Noise Pollution: Physics of the sound wave, Noise- Sources, measurement and effects, Control techniques, with special reference to noise in industrial units and their limits. Sonic boom. **Unit III** Metrology: Atmospheric transport of pollutants, Metrological parameters such as wind direction, wind velocity, temperature, solar radiation, humidity topography, precipitation, inversion etc. Instruments and systems of their measurements, Atmosphere transport processes like dispersion, and dilution atmospheric stability and turbulence including plume behavior. **Unit IV** Statistical Analysis of Environmental Data and QA/QC. Descriptive Statistics; Averaging times; Sample size determination; sampling frequency and duration; Measurement uncertainty; Accuracy and precision; sample and dynamic blanks; Error propagation; Basic concepts of Linear regression and its application. Reference books: ▪ Essentials of Nuclear Chemistry (ED. 2) by Arnikar H.J. ▪ Fundamental Of Applied Statistics By Gupta S.C. &Kapoor ▪ Environmental Physics by Sood D.D. ▪ Practical Statistics (E.D. 7) by Gupta S. P. ▪ Pollution Management Vol IV- Noise Pollution by S. K. Agarwal ▪ Air Pollution by Rao & Rao.	**15** **12** **15** **18**	**5** **4** **5** **6**

1.4	**ENVIRONMENTAL MONITORING** **Unit I** Various ranges of the electromagnetic spectrum and their interaction with matter. Beer- Lambert law. UV. VIS, IR Spectrophotometery, Applications in the analysis of air, water and soil samples. Turbidity and Nephelometry. Determination of turbidity, Sulfate in water. **Unit II** Flame-Photometry and atomic absorption Spectrophotometery. Metal Ions in water, soil and waste samples. **Unit III** Chromatographic Methods- Definition, Theory of chromatographic separation, Stationary and Mobile phase. Classification of chromatographic separation. Gas Chromatography – instrumentation. Detector, FID, ECD and TCD. GC-MS and GC-AES, Application of chromatographic methods in the Environmental analysis with reference to Hydrocarbons in air samples. Phenol. Pesticides in the water samples. **Unit IV** Electro-analytical methods: Potentiometry including Ion Selective Electrode, Conductometry, Voltametry including Differential Pulse Voltametry and Stripping Voltametry **Unit V** Separation Methods- solvent extraction and Ion exchange **Unit VI** Sampling of air pollutants- Ambient and stack emissions sampling. Analysis of air pollutants eg: SO_2, NO_x,NH_3, TSPM & RSPM Sampling of water from different sources, preservation techniques. **Unit VII** Analysis of common quality parameters: pH, solids, DO, BOD, COD, oil& grease, etc Continuous Environmental Monitoring Systems Reference books: ▪ Principles of Instrumental Analysis by Skoog Douglas A. ▪ Instrumental Methods Of Chemical Analysis by Chatwal & Anand ▪ Air Pollution Vol. III.: Measuring, Monitoring & Surveillance Of Air by Stern Arthur C. ▪ Basic Concepts Of Analytical Chemistry by Khopkar S. M. ▪ Analytical Chemistry (E.D.8) by Gary D. Christian. ▪ Fundamentals Of Analytical Chemistry – Skoog & Others	6 9 12 12 6 9 6	2 3 4 4 2 3 2
1.5	**ECOLOGY AND BIODIVERSITY:** **Unit I** Ecosystem Concept: Biotic and abiotic factors in the environment.	**15**	**5**

	Food chains, Food web, Ecological pyramids and energy flow, Ecological niche, Ecological limits, adaptation to environment, Biogeochemical Cycles [N, S & P] **Unit II** Major Ecosystems, Biogeography Aquatic: Marine & Freshwater Terrestrial: Forests, Deserts & Grasslands **Unit III** Biodiversity and interrelationships between species and their environment and how these interrelationships sustain biodiversity. **Unit IV** Biodiversity ay Global level, Major Biodiversity areas of the world, Biodiversity Hot Spots, Biodiversity at Indian level **Unit V** Biodiversity and Natural Capital assessment **Unit VI** Biomimetics Reference books: ▪ Modern Concepts Of Ecology (E.D. 5) by Kumar H. D. ▪ Ecology (ED. 2) by Odum Eugene P. ▪ Global Biodiversity Assessment by Heywood V.H. & Watson, R.T. ▪ Conservation biology: voices from the Tropics by Gibson, L. & Raven, P.HG.	**12** **9** **9** **6** **9**	**4** **3** **3** **2** **3**
1.6	**PRACTICALS I** **Unit I** **WASTE WATER ANALYSIS:** ▪ Sampling and Preservation Techniques. ▪ Determination of Chlorides in the given sample. ▪ Determination of Acidity in the given sample. ▪ Determination of Alkalinity in the given sample. ▪ Determination of Hardness in the given sample. ▪ Determination of pH value in the given sample. ▪ Determination of Dissolved Oxygen in the given sample. ▪ Determination of Total Solid in the given solution. ▪ Determination of Chemical Oxygen Demand in the given sample. ▪ Determination of Bio Chemical Oxygen Demand in the given sample. ▪ Determination of Chromium in the given sample. ▪ Determination of Iron in the given sample. ▪ Determination of Sulfates in the given sample. ▪ Determination of Phosphates in the given sample. ▪ Determination of Residual Chlorine in the given sample. ▪ Determination of Heavy Metals by AAS	**180**	**60**

	▪ Determination of sodium/potassium by Flame Photometer **Unit II** **MICROBIOLOGICAL ANALYSIS:** ▪ Study of various sterilization and disinfection techniques. ▪ Preparation of culture media for cultivation of microorganisms. ▪ Inoculation and Isolation, Enumeration of bacteria by Dilution techniques. ▪ Study the Growth curve of bacterial culture in nutrient medium. **Unit III** **INDUSTRIAL VISITS & SEMINAR PRESENTATIONS** Industrial visits (4) Reference books: ▪ Standard Methods For The Examination Of Water And Waste Water (E.D. 17) by American Public Health Association & Others ▪ Chemistry For Environmental Engineering (E.D. 3) by Sawyer Clairn& McCarthy Perry L. ▪ Laboratory Manual For The Examination Of Water, Waste Water & Soil by Rump H. H. &Krist H.	**60**	**20**
	SEMESTER -II		
2.7	**UNIT OPERATIONS AND PROCESSES** **Unit I** Fluid Mechanics and Fluid Dynamics Properties of fluids – Hydro statics and hydrodynamics, physical properties and fluid flow patterns. Measurements of flow or fluids in closed conduits and in open channels. **Unit II** Heat Transfer - General Principles and its applications, Basic Equation of Heat Transfer Different methods of Heat transfer, Heat Exchangers **Unit III** Evaporation: Types of evaporators and its applications **Unit IV** Mass transfer - Ideal Mixtures. Raoult's and Henery's laws. X-Y diagram the distillation column reflux ratio. **Unit V** Operations involving particulate solids – filtration. Mixing. Size separation. **Unit VI** Hydraulic Profiles of a water treatment plant and waste water treatment plant. **Unit VII**	**9** **9** **6** **6** **6** **9**	**3** **3** **2** **2** **2** **3**

	Materials of pipes and conduits. Their properties and applications. **Unit VIII** Pumps and pumping systems. Reference books: ▪ Hydraulics, Fluid Mechanics & Hydraulic mechanics by R. S. Khurmi ▪ Introduction To Chemical Engineering by Badger Walter L. &Banchero Julius ▪ Fluid Mechanics (E.D.2) by Douglas J.F. & Others ▪ Unit Operations & Processes in Environmental Engineering by Tom D Reynolds ▪ Unit Operations by Brown ▪ Hydraulics by Dr. R S. Mathur.	**9** **6**	**3** **2**
2.8	**AIR & NOISE POLLUTION PREVENTION & CONTROL** **Unit I** Introduction of various air pollutants. **Unit II** Control of particulate: Behavior of particulate matter: settling velocity: deposition from stacks. Particulate collection mechanisms, filtration, Impaction, electrostatic processes, settling etc. **Unit III** Particulate control equipment: gravity settling chambers, cyclone separators, wet collectors, venturi scrubbers, fabric filters, absolute filters, High Efficiency Particulate Air (HEPA) & Ultra Low Particulate Air (ULPA) Filters**,** electrostatic precipitators, collection efficiencies of various systems. (The scope is to give working principles). **Unit IV** Control of Gases & Vapors: absorption, basic design of a packed absorption tower, scrubbers. Control of Sulphur Dioxide: Flue gas desulphurization, Desulphurization of coal and oil. Control of oxides of Nitrogen: Thermal combustion, Incineration and Catalytic Incineration. **Unit V** Control of Odour: Ventilation, absorption, adsorption & oxidation. **Unit VI** Control of Auto-exhaust emissions: after burners, catalytic convertors: importance of maintenance. **Unit VII** Control by stacks: Determination of stack height from meteorological data: deriving emission limits. **Unit VIII** Noise Pollution Abatement and Control methods.	**3** **6** **15** **12** **6** **9** **6** **3**	**1** **2** **5** **4** **2** **3** **2** **1**

	Reference books: ▪ Fundamentals Of Air Pollution by Stern Arthur C. & Others ▪ Air Pollution Vol. IV.: Engineering Control Of Air Pollution (ED 3) by Stern Arthur C. ▪ Catalysis and Automative Pollution Control by Crucq, A. &Frennet, A. ▪ Environmental Pollution Control Engineering by Rao C.S. ▪ Pollution Management. Vol I S.K. Agarwal ▪ Pollution Management. Vol II by S.K. Agarwal		
2.9	**WATER POLLUTION PREVENTION & CONTROL** Pollution prevention **Unit I** Characterization of Waste Water, Need of Waste Water Treatment Treatment Methods: **Unit II** Preliminary & Primary treatment: screening, grit removal, oil water separation, equalization & Neutralization, Sedimentation, Coagulation, Flocculation. **Unit III** Secondary Treatment: Activated sludge process and its modifications: Aerobic, Facultative & Anaerobic, Attached growth & suspended growth (waste stabilization ponds, lagoons, conventional and extended aeration process, bio-tower, RBCs) and advanced biological treatment methods (MBR, SBR) **Unit IV** Handling, treatment and disposal of sludge from wastewater treatment plant **Unit V** Tertiary and Advanced treatment with reference to water renovation technologies and concept of zero waste water discharge. Objectives of tertiary treatment viz., recovery & reuse of water, destruction of residual COD/TSS &pathogens. Removal of nitrogen & phosphorus Tertiary treatment: Activated carbon treatment, reverse osmosis, filtration (ultra-filtration, membrane filtration, nano filtration),disinfection & softening. **Unit VI** Advanced oxidation, UV, Ozone, Wet air Oxidation, Fenton's reactor, electro dialysis. **Unit VII** Guidelines and notification: Central Ground Water Authority	**9** **6** **12** **3** **12** **9** **9**	**3** **2** **4** **1** **4** **3** **3**

	guidelines for bore wells. Reference books: ▪ Waster Water Engineering Treatment, Disposal, Reuse by Metcalf & Eddy Inc. ▪ Waste Water Treatment: Rational Methods Of Design & Industrial By NarayanaRao M. & Data Amol K. ▪ Principles Of Environmental Engineering by Jorgensen S.E. ▪ Waste Water Treatment for Pollution Control by Soli J Arceivala ▪ Chemical and Biological Methods For Water Pollution Studies by Trivedi R.K. &Goel P.K. ▪ Environmental Engineering by Hardward S Peavy& Others		
2.10	**ENVIRONMENTAL COMPLIANCE REQUIREMENTS** **Under the following legislations:** **Unit I** The Water (Prevention and Control of Pollution) Act, 1974, amended 1988 and rules The Water (Prevention and Control of Pollution) Cess Act, 1977, amended 1992 and 2003 including Cell Rules of MOEFCC, **Unit II** The Air (Prevention and Control of Pollution) Act 1981, amended 1987 and rules **Unit III** The Environment (Protection) Act, 1986, amended 1991 and rules under therein **Unit V** Plastic Waste (Management & Handling) Rules, 2011 The Recycled Plastics Manufacture and Usage (Amendment) Rules, 2003 **Unit VI** Biological Diversity Act, 2002 & Rules 2004 **Unit VII** Noise Pollution (Regulation and Control) Rules, 2000 with (Amendment) Rules, 2010 International conventions: **Unit VIII** The Vienna Convention for the Protection of the Ozone Layer and the Montreal Protocol on Substances that Deplete the Ozone Layer and the Ozone Depleting Substances (Regulation and Control) Rules, 2000 **Unit X**	**9** **6** **9** **9** **6** **6** **6**	**3** **2** **3** **3** **2** **2** **2**

	Basel Convention on the control of transboundary movement **UnitXI** Framework Convention on Climate Change (UNFCCC), New York, 1992, including the Kyoto Protocol, 1997 and with the latest amendments. **UnitXII** Guidelines and notification: Coastal Regulation Zone notification Reference books: ▪ Legal Aspects of Environmental Pollution and Management, S.M.Ali, 1992 ▪ Environmental Protection and Laws, Jadhav and Bhosale, V.M. ▪ Environmental Policy in India, Shekhar Singh ▪ Declaration of :The Stockholm Conference,Rio, Rio+5 and Rio +10 ▪ Our Common Future,WECD,1991 ▪ Environmental Law and Policy of India ,Diwan,S. and Rosencranz, A,	**3** **3** **3**	**1** **1** **1**
2.11	**MANAGEMENT OF SOLID WASTES** **Unit I** **Solid Waste:** Generation of solid wastes, On-site handling, storage and processing, collection of solid waste, transfer and transport. Processing techniques and equipments & disposal of solid waste including sanitary landfill, technologies for landfill gas collection, Composting, incineration and pyrolysis. Reduce, Recovery & reuse, conversion of waste products into energy The Municipal Solid Wastes (Management and Handling) Rules, 2016 Construction and Demolition Waste Management Rules, 2016. **Unit II** **Hazardous waste:** Management issues: Definition, classification and Generation of HW, HW Management and handling rules and regulatory processes. Leachate Management, packaging requirements under DOT regulations for safe transport of hazardous wastes, Use of environmental sound technologies for treatment and disposal of hazardous wastes including recycling and goal of minimizing HWs with appropriate case studies to demonstrate the use of in-plant control measures and cleaner production technologies. Treatment and disposal methods of HW. Physico-chemical processes, Biological process, stabilization and solidification; Thermal methods,	**15** **15**	**5** **5**

	land filling ((Engineered land fill) The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules,2008 **Unit III** **Biomedical Waste Management:** Definition, sources, categories of Biomedical waste as per the legislation. Segregation, transportation, treatment and disposal methods. Bio-Medical Waste (Management and Handling) (Amendment) Rules, 2003 **Unit IV** **E waste & Battery Waste Management:** Sources, effects, segregation, recycling treatment and disposal Batteries (Management and Handling), Amendments Rules, 2010. E-waste (Management and Handling) Rules 2011. Reference books: ▪ Solid Waste Management - A Manual by All India Institute of Local Self-Government Publications ▪ Toxic and Hazardous Waste by Sinha P.C. ▪ Manual on Solid Waste Management by Palnitkar, Sneha ▪ Basic Hazardous Waste Management by William C. Blackman ▪ Management Of Municipal Solid Waste by Ramchandra T. V. ▪ Solid Waste Management by H V. Bijalani	**15** **15**	**5** **5**
2.12	**PRACTICALS II** **UNIT I** **WASTE WATER ANALYSIS:** ▪ Treatability studies: Determination of optimum dose of alum and alkalinity, pH, period of mixing experimentally in the laboratory by Jar test method. ▪ Determination of the amount of activated carbon required for removal of pollutants from waste water by adsorption. ▪ Development of Activated sludge. ▪ Monitoring of activated sludge. ▪ Acclimatization of Activated sludge in the given sample. ▪ Biodegradability studies using Activated sludge process. ▪ Lechate Analysis **UNIT II** **AIR ANALYSIS:** ▪ Sampling of Air pollutants ▪ Estimation of NO_x in the ambient air by Saltzman method.	120 60	**40** 20

	▪ Estimation of SO_2 in the ambient air by West & Gaeke Method ▪ Estimation of suspended particulate matter i.e. SPM by high volume sampling method. ▪ Estimation of Average Noise Level of the given area. ▪ Determination of predominant wind direction using Wind rose. ▪ Air Quality and Noise Modelling **UNIT III** **MICROBIOLOGICAL ANALYSIS:** Determination of bacteriological quality of water with Most Probable Number technique. **UNIT IV** **INDUSTRIAL VISITS & SEMINAR PRESENTATIONS :** ▪ Exercise on Sustainability reporting ▪ Biodiversity index reporting ▪ Experience of ISO14001 Auditing ▪ Study of EIA report ▪ Industrial visits (4) Reference books: ▪ Standard Methods For The Examination Of Water And Waste Water (E.D. 17) by American Public Health Association & Others ▪ Chemistry For Environmental Engineering (E.D. 3) by Sawyer Clairn& McCarthy Perry L. ▪ Laboratory Manual For The Examination Of Water, Waste Water & Soil by Rump H. H. &Krist H.	30 30	10 10
	SEMESTER III		
3.13	**INDUSTRIAL SAFETY AND HYGIENE** **UNIT I** Industrial and Occupational health hazards Industrial toxins (organic and inorganic –physicochemical and Biological properties) Toxic materials their metabolism and effects, Tolerance limits, man vegetation, organisms etc. TLVS, STEL and BTLVC. Sampling for toxic material, analytical determinations and techniques. **UNIT II** Introduction to Industrial Safety and Accident Prevention, Types of Accident and Reporting Systems, Heinrich theory of accident prevention, Different Methods for accident prevention, cost of accident, management control on accident prevention, safety permit system. Safety in hazardous chemical handling, transport and storage. **UNIT III**	**15** **15**	**5** **5**

	Personal protective equipment's, Respiratory and non-respiratory. **UNIT IV** Fire safety, Types of fire, Fire prevention methods, Fire detection system, Fire extinguisher (fixed and portable) **UNIT V** Related requirements under Factories Act, 1942, Explosive Act etc., Public Liability Insurance Act 1991 and Rules Manufacture, Storage and Import of Hazardous Chemicals (MSIHC) Rules 2000 Reference books: ▪ Industrial Safety and Pollution Control Handbook (ED. 2) by National Safety Council. ▪ Safety Management Practices for Hazardous Materials by Chermisinoff Nicholas &Graffia Madelyn ▪ Manual for EHS : Environment, Health, Safety by Ram S. Hamsagar ▪ Safe Handling Of Hazardous Chemicals by Rohatgi ▪ Safety in the Chemical Industry by Kharbanda&Stallwotthy ▪ Healty, Safety & Environmental Control by Reynold& Others	**6** **12** **12**	**2** **4** **4**
3.14	**ENVIRONMENTAL MANAGEMENT TOOLS** **UNIT I** Environmental Impact Assessment: - Definition and terminologies: Description of EIA Process, methodologies & EIA notification 2006, Eco-sensitive zone notification, process of environmental clearance and public hearing requirements. **UNIT II** Environmental Policy Statement of MOEFCC & its implementation. **UNIT III** Environmental Audit (MOEFCC) notification, submission of the environmental statement report. **UNIT IV** Environmental Management System based on ISO14001 standard. **UNIT V** Basic concepts of Life Cycle Assessment: Definition, process, benefit and case study. **UNIT VI** Concept of use of ESM (environmentally sound management) of wastes and use of Environmentally Sound Technologies (EST) as basic management tool with few case studies.	12 6 9 9 12 12	4 2 3 3 4 4

	Reference books: ▪ Environmental Impact Analysis by Jain R.K. & Others ▪ Pollution Management in Industries by Trivedi R. K. ▪ ISO14001 by Schoffman A. &Tordini A. ▪ Environmental Impact Assessment by Canter Larry W. ▪ Environmental Auditing by A.K. Srivastava ▪ Handbook Of Environmental Laws, Acts Guidelines, Compliances & Standards Vol-I & VII by R.K. Trivedi		
3.15	**DESIGNING OF WATER AND WASTE WATER TREATMENT SYSTEMS** **UNIT I** Types of water Different methods of treatment, selection of methods as per inlet quality and discharge limits/ reuse application **UNIT II** General considerations for source of drinking water; Water treatment plant design Economic sizing of pumping mains **UNIT III** Design of Screens; Grit chamber Aerated grit chamber; Communitor; Sizing of flow equalization tank, Design of primary sedimentation tank, Dissolved air floatation unit, **UNIT IV** Basis of design parameters (F:M ratio, MLSS, MLVSS, HRT, Sludge age, organic loading) and designing of activated sludge process and its modifications, bio-towers, rotating biological contactor, aerated lagoon, waste stabilization pond, MBR, SBR, MBBR) **UNIT V** Anaerobic treatment process, design of upflow anaerobic sludge blanket reactor, design of anaerobic sludge digester, Types and design of clarifier **UNIT VI** Design basis for tertiary treatment-Activated carbon filter, HRSCC(high rate solid contact *clarifier)*, membrane filtration, adsorption and ion exchange column **UNIT VII** Case study of Sewage Treatment Plant, Effluent Treatment Plant, Common Effluent Treatment Plant and Drinking Water treatment plant. Reference books: ▪ Waster Water Engineering Treatment, Disposal, Reuse by Metcalf	**6** **6** **12** **12** **9** **9** **6**	**2** **2** **4** **4** **3** **3** **2**

	& Eddy Inc. ▪ Waste Water Treatment: Rational Methods Of Design & Industrial By NarayanaRao M. & Data Amol K. ▪ Principles Of Environmental Engineering by Jorgensen S.E. ▪ Waste Water Treatment for Pollution Control by Soli J Arceivala ▪ Chemical and Biological Methods For Water Pollution Studies by Trivedi R.K. &Goel P.K. ▪ Environmental Engineering by Hardward S Peavy& Others		
3.16	**SUSTAINABILITY AND CSR I** Sustainability: **UNIT I** Principles of Sustainable Development: History and emergence of the concept of Sustainable Development, Definitions, Environmental issues and crisis, Resource degradation, greenhouse gases, desertification, social insecurity, Industrialization, Globalization and Environment. **UNIT II** Sustainable Development and International Contribution: Components of sustainability, Complexity of growth and equity, International Summits, Conventions, Agreements, Transboundary issues, Action plan for implementing sustainable development, Moral obligations and Operational guidelines. **UNIT III** Socio-economic Sustainable Development Systems: Socio-economic policies for sustainable development, Strategies for implementing eco-development programmes, Sustainable development through trade, Economic growth, Carrying Capacity, Public participation. **UNIT IV** Agenda for Future Global Sustainable Development: Role of developed countries in the sustainable development of developing countries, Demographic dynamics and sustainability, Integrated approach for resource protection and management **UNIT V** Triple bottom line concept for Sustainable Business. CSR: **UNIT VI** Meaning & Definition of CSR, History & evolution of CSR. Concept of Charity, Corporate philanthropy, Corporate Citizenship, CSR-an overlapping concept. Concept of sustainability & Stakeholder Management. Relation between CSR and Corporate governance; environmental aspect of CSR; Chronological evolution of CSR in India. Reference books:	**9** **9** **9** **6** **6** **21**	**3** **3** **3** **2** **2** **7**

	▪ The Sustainability Revolution: Portrait of a Paradigm Shift by Edwards, Andres R.,New Society Publishers, 2005. ▪ Sustainable development in India: Stocktaking in the run up to Rio+20: Report prepared by TERI for MoEF,2011. ▪ Report of the Department for Policy Coordination and Sustainable Development (DPCSD), United Nations Division for Sustainable Development. ▪ Corporate Social Responsibility Part I, Part II, Part III by David Crowther and Guler Aras		
3.17	**ENVIRONMENTAL MODELLING AND COMPUTER APPLICATION** **UNIT I** Definition: Classification, Examples of models for environmental systems. **UNIT II** Introduction to air quality models; Meteorology, Atmospheric stability and turbulence, Gaussian plume model and modifications. Transport and fate of pollutants in aquatic systems **UNIT III** Introduction to river, estuarine and lake hydrodynamics, Stratification and eutrophication of lakes. Dissolved oxygen model for streams, Temperature models. **UNIT IV** Fundamentals of the noise, noise and sound intensity, power, pressure, noise attenuation, methods and calculations, noise scales and ratings, highway noise model. Highway noise barriers and their designs, noise contouring estimation of noise impacts. **UNIT V** **GIS**: Components of GIS, Hardware, Software and Organization Context, Data: Spatial and Non Spatial, Maps: Types of Maps, Projection: Types of Projection, Data Input : Digitizer, Scanner: Editing, Raster and Vector data structures: Comparison of Raster and Vector Date structure, Analysis using raster and Vector Data: Retrieval, Reclassification, Overlaying, Buffering, Data Output : Printers and Plotters. **UNIT VI** **Autocad** for designing of an ETP/STP/CETP- equipment layout, Hydraulic profile, P&ID	**6** **9** **9** 12 12 12	**2** **3** **3** **4** **4** **4**

	Reference books: ▪ Atmospheric Chemistry and Physics by Seinfeld, J.H and Pandis, S.N. ▪ Princples of Surface Water Quality Modelling and Control by Thomann, R.V and Muller, J.A. ▪ Survival models and data analysis : Elandt . Johnson and Johnson, John wiley and sons Inc. ▪ Mathematical models in Biology and Medicine : J. N. Kapur Affiliated East-west press Pvt. Ltd. Bangalore. ▪ Remote Sensing and GIS - M. Anji Reddy ▪ Principles of GIS for Land - Burrough P.A. Resources Assessment		
3.18	**DISSERTATION AND PLACEMENT GROOMING** Preparation of a project report under the guidance of an industrial expert and presentation of the report along with viva-voce examination. Placement Grooming Industrial Visits(4)	**240**	
	SEMESTER IV		
4.19	**INFORMATION AND COMMUNICATION TECHNOLOGY (including APTIS Module)** **UNIT I** **INFORMATION TECHNOLOGY** Microsoft Windows Office: Word, Excel, Advance Excel, Power Point **UNIT II** Internet Browsing Information on Programming Languages and Operating Systems **UNIT III** DBMS, Elementary understanding of Database. Management Information Systems **UNIT IV** Customer relationship management (CRM) **UNIT V** **COMMUNICATION SKILLS** Introduction to communication-Elements and process of communication, barriers to effective communication and types of communication Listening skills- Process of listening –strategies for effective listening. **UNIT VI** Group Discussion & Personal interviews.	**12** **9** **6** **3** **6** **3**	**4** 3 2 1 2 1

	UNIT VII Business letters: Principles importance and objective Written communication Reports – significance, salient features, preparation and planning, types of reports. Project Presentation to clients. **UNIT VIII** **APTIS module** Reference books: ▪ Rajaraman V: Fundamentals of Computers, New Delhi, Prentice Hall ▪ Computer Fundamental : P. K. Sinha BPB Publications New Delhi ▪ Das &Rao : Communication skills ▪ Effective communication – UrmilaRai/S.M.Rai – Himalaya Publishing House ▪ Lal: Business Communication, Mumbai, Himalaya Publications	**3** **18**	1 6
4.20	**SUSTAINABILITY AND CSR II** **UNIT I** Types of Energy (Conventional, Non Conventional and Renewable) Alternative energy sources, economics and sustainability **UNIT II** Energy Measurement Systems Energy Efficiency and Case studies **UNIT III** Sustainability Reporting: Flavor of GRI, Dow Jones Sustainability Index, CEPI etc. Investor interest in Sustainability. **UNIT IV** Environmental Footprint **UNIT V** Business Relevance and decision making in Sustainability Context Project Planning, Go-No Go Decision Making **UNIT VI** CSR: International framework for Corporate Social Responsibility. CSR notification (MOEFCC and amendment to Company Act) **UNIT VII** Watershed Management: Definition, Concepts, principals and classification in watershed management. Rainfall and runoff, water balance approach, water budgeting, topographic surveying, water conservation and harvesting methods – importance and techniques, artificial recharge of groundwater	9 9 9 9 6 6 12	3 3 3 3 2 2 4

	Reference books: ▪ Conventional and Non conventional Energy sources G. D Rai ▪ Reneweable Energy Programmes in India : some recent developments , Sinha P.C ▪ Renewable Energy Resources: Basic Principles And Applications Tiwari, G.N., Narosa Publishing House . ▪ The Sustainability Revolution: Portrait of a Paradigm Shift by Edwards, Andres R.,New Society Publishers, 2005. ▪ Sustainable development in India: Stocktaking in the run up to Rio+20: Report prepared by TERI for MoEF,2011. ▪ Report of the Department for Policy Coordination and Sustainable Development (DPCSD), United Nations Division for Sustainable Development. ▪ Corporate Social Responsibility Part I, Part II, Part III by David Crowther and Guler Aras		
4.21	**RISK MANAGEMENT** **UNIT I** Concept of Risk, Types of Risk **UNIT II** Risk Assessment and Mitigation **UNIT III** Business Continuity Plan - Quantitative Risk Assessment - HAZAN & HAZOP studies - Probability and Frequency Of Risk - Valuation of Risk **UNIT IV** Risk Management Systems and Certification Requirement **UNIT V** Risk Matrix Development **UNIT VI** Introduction to Disasters Management and Disaster management Plan; - Offsite emergency Plan - Onsite emergency Plan - Conduct of Mock drills - Disaster Management and Emergency Preparedness Reference books: ▪ Occupational safety management and engineering, Willie Hammer,	**9** **6** **18** **6** **15**	**3** **2** **6** **2** **2** **5**

	Dennis Price, Prentice Hall, 2001 ▪ Fundamentals of Occupational Safety and Health, Mark A. Friend, James P. Kohn ▪ Occupational Hygiene. Blackwell Science, Harrington, J.M. & K. Gardiner. ▪ Risk assessment of chemicals by Van Leeuwen, C. J., & Vermeire, T. G.		
4.22	**IN PLANT TRAINING** ▪ Practical training for atleast 12 weeks of intensive training in the industry to correlate theoretical knowledge with practical work. ▪ Students should be given a detailed briefing on objectives of training with specific instructions on code of conduct while on training. ▪ Students should prepare their resumes and should be advised to go on training placements as planned by faculty incharge. ▪ Students should submit report 1 – joining report marks 50, report 2 task handling marks 50, report 3 final report in formal presentation in file format marks 50, report 4 industry feedback with viva marks 50	**3months**	

PASSING STANDARD AND PERFORMANCE GRADING:

MARKS	GRADE POINTS	GRADE
75 TO 100	7.5 TO 10.0	O
65 TO 74	6.5 TO 7.49	A
60 TO 64	6.0 TO 6.49	B
55 TO 59	5.5 TO 5.99	C
50 TO 54	5.0 TO 5.49	D
0 TO 49	0.0 TO 4.99	F (FAILS)

The performance grading shall be based on the aggregate performance of Internal Assessment and Semester End Examination.

The Semester Grade Point Average (SGPA) will be calculated in the following manner:
SGPA = ∑CG / ∑C for a semester, where C is Credit Point and G is Grade Point for the Course/ Subject.

The Cumulative Grade Point Average (CGPA) will be calculated in the following manner :
CGPA = ∑CG / ∑C for all semesters taken together.

R. _____ PASSING STANDARD FOR ALL COURSES :

Passing 50% in each subject /Course combined Progressive Evaluation (PE)/Internal Evaluation and Semester-End/Final Evaluation (FE) examination taken together. i.e. (Internal plus External Examination)

R. _____

A. Carry forward of marks in case of learner who fails in the Internal Assessments and/ or Semester-end examination in one or more subjects (whichever component the learner has failed although passing is on total marks).
B. A learner who PASSES in the Internal Examination but FAILS in the Semester-end Examination of the Course shall reappear for the Semester-End Examination of that Course. However his/her marks of internal examinations shall be carried over and he/she shall be entitled for grade obtained by him/her on passing.
C. A learner who PASSES in the Semester-end Examination but FAILS in the Internal Assessment of the course shall reappear for the Internal Examination of that Course.

However his/her marks of Semester-End Examination shall be carried over and he/she shall be entitled for grade obtained by him/her on passing.

R. _____ ALLOWED TO KEEP TERMS (ATKT)

A. A learner shall be allowed to keep term for Semester II irrespective of number of heads/courses of failure in the Semester I.

B. A learner shall be allowed to keep term for Semester III wherever applicable if he/she passes each of Semester I and Semester II.

OR

C. A learner shall be allowed to keep term for Semester III wherever applicable irrespective of number of heads/courses of failure in the Semester I & Semester II.

D. A learner shall be allowed to keep term for Semester IV wherever applicable if he/she passes each of Semester I, Semester II and Semester III.

OR

E. A learner shall be allowed to keep term for Semester IV wherever applicable irrespective of number of heads/courses of failure in the Semester I, Semester II, and Semester III

F. A learner shall be allowed to keep term for Semester V wherever applicable if he/she passes each of Semester I, Semester II, Semester III and Semester IV.

OR

G. A learner shall be allowed to keep term for Semester V wherever applicable irrespective of number of heads/courses of failure in the Semester I, Semester II, Semester III, and Semester IV.

H. The result of Semester VI wherever applicable OR final semester shall be kept in abeyance until the learner passes each of Semester I, Semester II, Semester III, Semester IV , Semester V wherever applicable.

OR

I. A learner shall be allowed to keep term for Semester VI wherever applicable irrespective of number of heads/courses of failure in the Semester I, Semester II, Semester III, Semester IV and Semester V.