

**CVM UNIVERSITY, VALLABH VIDYANAGAR, GUJARAT**  
**FACULTY OF SCIENCE**  
**COURSE OF STUDY**  
**PROPOSED SYLLABUS**

**RULES FOR DEGREE OF THE MASTER OF SCIENCE (M.Sc.) IN ENVIRONMENTAL SCIENCE AND TECHNOLOGY (EST)**

**RPG.EST.1:** A candidate, who has obtained the degree of Bachelor of Science (B.Sc.) in Environmental Science, Earth Science, Chemistry, Chemical Technology, Health Science, Geography, Geology, Microbiology, Biotechnology, Genetics, Bioinformatics, Forensic Science, Botany, Zoology, Biochemistry, Home Science, Agriculture, Forestry, Fire & Safety, Bachelor of Engineering (B.E.), Pharmacy (B. Pharm.), Bachelor of Arts (B.A.), Bachelor of Commerce (B. Com.), Bachelor of Business Administration (B.B.A.), Bachelor of Architecture (B.Arch.), Medical or Laboratory Technology (M.L.T.) of this University or any other university recognized as equivalent there to may, after successful completion of the course work prescribed for the M.Sc. degree examination, for a period of two years subsequent to his / her passing the B.Sc. degree examination, will be admitted to the examination for the degree of M. Sc. The degree of the Master of Science will be taken by papers, practical and project work only.

**RPG.EST.2:** The examination for the various theory courses and laboratory work will be conducted under semester system. For this purpose, each academic year will be divided into two semesters.

**RPG.EST.3:** The ratio between the external and internal assessment will be 70:30

**RPG.EST.4:** Candidate will be required to attend at least 75% of the total theory, lectures, practical, and project work organized under each of the course by them during the semester.

**RPG.EST.5:** (i) The head of the department, in consultation with other teachers of the department, will prepare a detailed scheme of the periodic test(s), seminars, quizzes etc. in the beginning of the semester, and the program for the test examinations, and the same will be announced to the candidates. (ii) The record of the test examinations as well as seminars and quizzes will be maintained by the department. (iii) Every candidate shall maintain a regular record of practical and project work, which shall be duly certified by teacher(s) from time to time.

**RPG.EST.6:** Candidate will be required to obtain at least 33% marks in the internal evaluation separately in each head of passing. A candidate, who fails to obtain 33% marks in not more than two heads of passing, may be allowed to appear at the university examination by the Head of the department concerned on the recommendation of the committee appointed to assess the candidate's overall performance. (**Note:** Head of passing will mean a course in theory or practical, or project work).

**RPG.EST.7:** A teacher offering a particular course will be one of the examiners at the university examination and the examiner may be either a teacher from same university or from outside the university.

**RPG.EST.8:** The results for the awards of the degree will be declared on the basis of the grand total of all the semesters examinations prescribed for the degree examination.

**RPG.EST.9:** No candidate will be allowed to reappear in course in which he / she has already passed.

**RPG.EST.10:** Standard of passing: The standard of passing of M.Sc. (Environmental Sciences and Technology) degree examination will be as under:-

- i. To pass any semester examination for the M.Sc. degree, a candidate must obtain at least 40% marks in the university examination and 40% marks in the aggregate of university and internal examination in each course of Theory, Practical and project work.
- ii. Those of the successful candidates who obtain 50% or more marks in the aggregate of all the semesters taken together will be placed in the Second class and those who obtain 60% or more marks in the aggregate will be placed in the first class.
- iii. The successful candidates who obtain 70% or more marks in the aggregate of all the semesters taken together will be declared to have passed the examination in the first class with distinction.

**RPG.EST.11:** **i)** A candidate, who fails in more than two courses (any two out of total heads of passing in the particular semester) in a particular semester, will not be admitted for further study at a subsequent semester, and will be required to repeat the courses in which he/she has failed by joining the department as a regular student in the semester in which these courses are again offered. A candidate failing in not more than two courses at any semester examination will be promoted to the subsequent semester according to the following scheme. **ii)** A candidate failing in the first semester will be permitted to prosecute his / or study up to the third semester but will not be permitted to go to the fourth semester until he / she has cleared all the courses of the first semester even though he / she may have passed in the second and / or third semester. **iii)** A candidate failing in the second semester will be permitted to prosecute his / her studies up to the fourth semester.

**Syllabus (Effective from Academic Year June, 2020),  
Institute of Science & Technology for Advanced Studies & Research (ISTAR)  
CVM University, Vallabh Vidyanagar – 388 120, Gujarat**

**M.Sc. (Environmental Science and Technology) Choice Based Credit System (CBCS)**

<b>SEMESTER – I</b>	<b>CREDITS</b>	<b>Total Marks</b>	<b>Exter. Marks</b>	<b>Inter. Marks</b>
<b>CORE COURSES</b>				
101350101 Environmental Biology and Restoration Ecology	4	100	70	30
101350102 Air Pollution and Climate Change	4	100	70	30
101350103 Water Pollution and Control Technology	4	100	70	30
<b>ELECTIVE COURSE</b>				
101350106 Environmental Chemistry and Geology	4	100	70	30
101350104 PRACTICALS BASED ON 101350101 AND 101350102	6	100	70	30
101350105 PRACTICALS BASED ON 101350103 AND 101350106	6	100	70	30
101350207 Comprehensive Viva	1	50	50	
<b>SEMESTER – II</b>				
<b>CORE COURSES</b>				
101350201 Remote Sensing and Geographic Information System	4	100	70	30
101350202 Meteorological and Environmental Instruments	4	100	70	30
101350203 Occupational and Environmental Toxicology	4	100	70	30
<b>ELECTIVE COURSE</b>				
101350206 Industrial Hygiene and Occupational Health	4	100	70	30
101350204 PRACTICALS BASED ON 101350201 AND 101350202	6	100	70	30

101350205 PRACTICALS BASED ON 101350203 AND 101350206	6	100	70	30
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101350307 Comprehensive Viva	1	50	50	
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### **SEMESTER – III**

#### **CORE COURSES**

101350301 Environnemental Biotechnology	4	100	70	30
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101350302 Environmental Impact Assessment and Legislation	4	100	70	30
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101350303 Industrial Safety and Control technology	4	100	70	30
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#### **ELECTIVE COURSE**

101350306 Industrial Pollution and Control Technology	4	100	70	30
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101350304 PRACTICALS BASED ON 101350301 AND 101350302	6	100	70	30
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101350305 PRACTICALS BASED ON 101350303 AND 101350306	6	100	70	30
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101350307 Comprehensive Viva	1	50	50	
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### **SEMESTER – IV**

#### **CORE COURSES**

101350401 Waste Management and Control Technology	4	100	70	30
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101350402 Environmental Resources and Biodiversity Conservation	4	100	70	30
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101350403 PRACTICALS BASED ON 101350401 AND 101350402	6	100	70	30
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101350404 Comprehensive Viva	1		50	50
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101350405 Project Work / Dissertation*	12		300	300
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\* Project work / Dissertation is offered compulsorily in 4th semester in Industry or Research centers or ISTAR.

\*\* Classroom Teaching of Industrial orientation/ exposure in each course atleast one period per week will be given as this master program is industrial oriented and multidisciplinary.

**Scope:** The scope of the course is very wide. The students passing with the M.Sc. degree in Environmental Sciences are expected to have opportunity at:

- a. Industries in ETP, CETP
- b. Industries as Hygienists, Safety officers
- c. Pollution Control Boards
- d. Chemical, Pharmaceutical, Fermentation Industries
- e. Environmental consultants
- f. Public health laboratories
- g. Academic institutions, Colleges and University departments
- h. Pollution control boards (Central and State Government)
- i. Various disciplines of Science and Engineering
- j. Research scientist at various research laboratories, and
- k. The students may develop their own laboratory to undertake water, soil, solid and hazardous wastes and air pollutants analyses
- l. Space research centers

**Duration:** Two years Master Degree Course in Science with Four Semesters (CBCS).

**Eligibility:** Bachelor of Science (B.Sc.) in Environmental Science, Earth Science, Chemistry, Chemical Technology, Health Science, Geography, Geology, Microbiology, Biotechnology, Genetics, Bioinformatics, Forensic Science, Botany, Zoology, Biochemistry, Home Science, Agriculture, Forestry, Fire & Safety, Bachelor of Engineering (B.E.), Pharmacy (B. Pharm.), Bachelor of Arts (B.A.), Bachelor of Commerce (B. Com.), Bachelor of Business Administration (B.B.A.), Bachelor of Architecture (B.Arch.), Medical or Laboratory Technology (M.L.T.)

**Number of Seats:** 70 (Seventy)

## **COURSE STRUCTURE**

### **SEMESTER - I**

#### **CORE COURSES**

- 101350101 Environmental Biology and Restoration Ecology
- 101350102 Air Pollution and Climate Change
- 101350103 Water Pollution and Control Technology

#### **ELECTIVE COURSE**

- 101350106 Environmental Chemistry and Geology
- 101350104 Practicals Based on 101350101 and 101350102
- 101350105 Practicals Based on 101350103 and 101350106
- 101350107 Comprehensive Viva

### **SEMESTER - II**

#### **CORE COURSES**

- 101350201 Remote Sensing and Geographic Information System
- 101350202 Meteorological and Environmental Instruments
- 101350203 Occupational and Environmental Toxicology

#### **ELECTIVE COURSE**

- 101350206 Industrial Hygiene and Occupational Health
- 101350204 Practicals Based on 101350201 and 101350202
- 101350205 Practicals Based on 101350203 and 101350206
- 101350207 Comprehensive Viva

### **SEMESTER - III**

#### **CORE COURSES**

- 101350301 Environmental Biotechnology
- 101350302 Environmental Impact Assessment and Legislation
- 101350303 Industrial Safety and Control Technology

#### **ELECTIVE COURSE**

- 101350306 Industrial Pollution and Control Technology
- 101350304 Practicals Based on 101350301 and 101350302
- 101350305 Practicals Based on 101350303 and 101350306
- 101350307 Comprehensive Viva

### **SEMESTER - IV**

#### **CORE COURSES**

- 101350401 Waste Management and Control Technology
- 101350402 Environmental Resources and Biodiversity Conservation
- 101350403 Practicals Based on 101350401 and 101350402
- 101350404 Comprehensive Viva
- 101350405 Project Work / Dissertation

\* Project work / Dissertation is offered compulsorily in 4th semester in Industry or Research centers or ISTAR.

\*\* Classroom Teaching of Industrial orientation/ exposure in each course atleast one period per week will be given as this master program is industrial oriented and multidisciplinary.

## SEMESTER - I

### 101350101: ENVIRONMENTAL BIOLOGY AND RESTORATION ECOLOGY

- Environmental complexes- Ecology, Ecosystem, Environment and their concepts, limiting and inhibiting affects of light and temperature. Biotic factors- Relationship between organisms- Mutualism, commensalisms, parasitism, competition, antibiosis, predation. Concept of ecology- Food chain - grazing food chain and detritus food chain, food web. Ecological pyramids - Number, biomass and energy, energy flow models and budget. Concepts of productivity and determination of productivity in different ecosystems.
- Autecology- biological clocks along with influence factors, Liebig's law of minimum and Shelford's law of Tolerance. Population ecology - Describing population characters, Dynamics and regulation. Community Ecology- Composition, structure, origin and characters used in community structure. Analytical and synthetic characters. Methods of study of community. Ecological succession: primary and secondary processes of successions, climax community.
- Aquatic ecosystems- Wetlands, Ramsar sites and conservation of wetland. Physical, chemical and biological characters of lentic, lotic ecosystems. Eutrophication: Sources and consequences. Restoration of biological diversity: reintroduction of biota, Degradation and restoration of Forests ecosystems, grassland ecosystems, aquatic ecosystems (wetlands), Restoration of wastelands and degraded soils.
- Marine Environment: Zonation pattern, physical – tides, light, temperature, density, salinity, chemical –Phosphate, sulphate, nitrate, D.O, and biological characters- plankton, nektons and benthos, types of biomes. Coastal pollution: Coral reefs, Estuaries and Mangrooves.

### Suggested Books

1. Dash, M.C. 2011. Fundamentals of Ecology.
2. David, A. 1995. Stream Ecology. Kluwer Academic Publications.
3. Horney, A.R. 1978. Marine Chemistry. Wiley.
4. Nelson, S.L., Gerry, T.B. Morten., F.P. 2004. Estuarine Nutrient Cycling: Influence of Primary Producers. Kluwer Academic Publications.
5. Odum, E.P. Fundamentals of Ecology. Nataraj Publishers, Dehradun
6. Priya Rajan Trivedy et al. 1994. International Encyclopedia of Ecology and Environment. Indian Institute of Ecology and Environment, New Delhi. Vol. I to 16.
7. Robert, J.L. 2001. Eutrophication Process in Coastal Ecosystems. CRC Press.
8. Santra, S.C. 2001. Environmental Science. New Central Book Agency.
9. Sharma, P.D. 2012. Ecology and Environmental Biology.
10. Verma & Agarwal. 2010. Environmental Biology

### 101350102: AIR POLLUTION AND CLIMATE CHANGE

- Definition, history, sources of air pollution - natural and anthropogenic, primary and secondary, Aeroallergens - sources, biology and health effects, general effects of

atmospheric pollutants (PM, HC, CH<sub>4</sub>, CO<sub>2</sub>, H<sub>2</sub>S, CO, NO<sub>x</sub>, SO<sub>x</sub>) on humans, animals, plants and materials; Ambient air quality emission standards, automobile pollution (photochemical oxidants, photochemical smog), characteristics - auto exhaust, and its control (catalytic converters), air pollution episodes (Bhopal, Chernobyl, Los Angeles, London smog, Indonesian forest fire), recent case studies on air pollution

- Environmental factors and air pollution - heat, insulation, wind, precipitation, plume behavior, sampling and measurement of air pollution - ambient air and stack monitoring, indoor air pollution, indoor air quality, prevention and control of air pollutants - particulate matter & gaseous pollutants – absorption, adsorption, settling chambers, fabric filters, scrubbers, cyclone & electrostatic precipitators, Clean development mechanisms
- Climate Change: Definition of Climate and weather, Evolution of atmosphere, composition and structure, Particles, ions and radicals in atmosphere, Chemical reactions of different chemical species in the atmosphere, Oxygen and ozone chemistry and ozone hole formation. Green house gases - global warming, temperature inversion, global effects of GHGs, Classification of Climates, causes and consequences of Climate changes, Impacts of climate change on ecosystems, Global dispersion of toxic substances: Dispersion and circulating mechanisms of pollutants, ozone depletion, dust dome effect, acid rain, photochemical smog, heat island, Kyoto Protocol, Role of IPCC, Climate change methodologies
- Disaster management: Concept of disasters, causes, prevention and correction hazards related to Earthquakes, Tsunami, Volcanic eruption, Cyclones, Floods, Drought, Landslides, Forest fires, Avalanches, El Nino and La Nina

### **Suggested Books**

1. A.K.DE. 1987. Environmental Chemistry. Wiley Eastern Limited
2. Blaikie, P., Cannon, T., Davies, I. and Wisner, B. (1994) At Risk: Natural Hazards, People's Vulnerability, and Disasters. London: Routledge. Bohle, H., Downing, T. and
3. Burroughs, W.J. 2001. Climate Change. Cambridge University Press.
4. Hobbes, P.V. 2002. Atmospheric Chemistry. Cambridge University Press.
5. Houghton, J. 2001. Global Warming. Cambridge University Press.
6. Maslin, M. Global Warming: A Very Short Introduction. (Oxford: Oxford University Press, 2008) [ISBN 9780199548248].
7. Rao, M. 2002. Air Pollution. Prentice & Hall.
8. Sainfeld, J.H. 1975. Air Pollution. Physical and Chemical Fundamentals, McGraw Hill, N.Y.
9. Sharma, B.K. 2002. Air Pollution. Academic Press.
10. Wayne, R.P. 2003. Chemistry of Atmosphere. Oxford University Press.

### **101350103: WATER POLLUTION AND CONTROL TECHNOLOGY**

- Supply of water: Sources of water and their characteristics: water from precipitation (Strom water), surface water, ground water. Water Quantity: Water and Its Properties, Necessity of Water, Water Demand, Factor Affecting Water Demand, Population Forecast by Different Methods. Sampling, sample preservation, physical characteristics, chemical characteristics and biological characteristics, drinking water standards.
- Groundwater: Introduction, types of aquifers, means to draw groundwater, Ground water conservation, seepage from surface water, artificial recharge, saline water intrusion - Causes and remedies of saline intrusion.



- Water treatment: Conventional water treatment process, Screening, chemical handling and feeding, coagulation and flocculation, sedimentation, Filtration, Theory of filtration, filtration slow sand, rapid sand and pressure, filters. Disinfection; Criteria for good disinfectant, mechanisms of disinfection, factors affecting efficiency of disinfection, chlorination – chlorine chemistry, chlorination practices in India. Aeration, limitation of aeration, types of aerators.
- Advanced water treatments – membrane technology; Microfiltration, Ultrafiltration, Nanofiltration Reverse Osmosis, Other treatment technologies: Ion Exchange, Water Softening, Adsorption, Electrodialysis.

### **Suggested Books**

1. Besseliere, E and Schwartz. 1975. Treatment of Industrial Wastes, McGraw Hill.
2. Birdie, G.S. 2002. Water Supply and Sanitary Engineering. Dhanpatraj and Sons Press.
3. Fair, G.M. Geyer, T.C. and Okun, D.A. 1984. Water and waste water Engineering. Vol. I and II, John Wiley and Sons.
4. Garg, S.K. Water and Sewage Treatment. 2002. Blackwell Publishing.
5. Mahajan 1985. Pollution control in process industries. Tata McGraw Hill
6. Metcalf and Eddy Inc. 1979. Waste water Engineering treatment, Disposal, Reuse. Tata McGraw Hill Publ. Co. Ltd.
7. Mitchek, Ralph. 1978. Water Pollution Microbiology, Wiley and Sons.
8. Nemrow. N.L. 1971. Liquid waste of Industry – theories, practices and treatment, Addison Wesley.
9. Peavy, Rowe Tchobanoglous. Environmental Engineering. McGraw Hill International ed.
10. Weber, W.J. 1969. Physico-chemical processes for water quality control, Wiley Inter Science.

### **101350106: ENVIRONMENTAL CHEMISTRY AND GEOLOGY**

- Fundamental of Chemistry: Elements, Chemical bonding, chemical reactions and equations, Organic functional groups, classes of organic compounds, Free radical reactions, catalytic processes, acid base reactions, solutions, solubility product, solubility of gases in water, the carbonate system, unsaturated and saturated hydro carbons, radio-nuclides.
- Green Environmental Chemistry & Issues: Principles- tools of green chemistry- alternative feed stocks starting materials, alternative reagents, alternative solvents, alternative products and alternative catalysis, Introduction- ecological and carbon foot prints- polluters pay principle- consumerism- sustainable mining- urban forestry green buildings- green building practices- approaches to green computing
- Environmental Segments: Lithosphere, atmosphere, hydrosphere and biosphere. Lithosphere- Rocks and Minerals. Principles of weathering of rocks, processes, effects of physical, chemical and biological factors, Physical Geology: Geological work of wind, Running water, Underground water, Glaciers. Drainage systems and patterns. Structural Geology: Dip and Strike, Folds, Faults, Joints, Unconformity, Overlap. Mountains
- Soil Chemistry & Soil Composition: Organic & Inorganic, physical, chemical and biological properties, cation exchange capacity, soil pH, environmental properties of soils, leaching and erosion and conservation, reactions with acids and bases, geochemical reactions that neutralize acidity- biological process that neutralize acidity – salt affected soils- trace metals in soils. Bio-geo-chemical cycles: Carbon, nitrogen, phosphorous, sulfur, involvement of organisms.

## Suggested Books

1. A.K.DE. 1987. Environmental Chemistry. Wiley Eastern Limited
2. Baird, C. 2001. Environmental Chemistry. Hopkins Press.
3. Kumar,V. 2000. Introduction to Green Chemistry. Narosa Publications.
4. Manahan, S.E. Environmental Chemistry. Cambridge University Press.
5. Rashmi Sanghi and M. M. Srivastava Green Chemistry: (Narosa Publishing house)
6. Roy, A.B. 2002. Fundamentals of Geology. Narosa Publications.
7. Sanghi & Srivastava. 2000. Green Chemistry. Narosa Publications.
8. Sharma B.K. and Kaur, H. Environmental Chemistry. Goel Publishing House, Meerut.
9. Singh, P. 2002. General Geology. Oxford Publications.
10. Turk, A, Turk, J. Wittes J.T. and Wottes, R.E. 1978. Environmental Science, W.B. Saunder Company, Philadelphia.
11. Watt, K.E.F. 1973. Principles of Environmental Sciences, McGraw Hill Book Company.

### 101350104: Practicals Based on 101350101 and 101350102

- Interactions between organisms, productivity of phytoplankton by chlorophyll method (biomass) and Light and dark bottle method, determination of light penetration, DO of surface water, Macrophyte productivity
- Marine water quality analysis: Salinity, TDS, TSS, Phosphates, silicates, Nitrates, Sulphates, Hydrocarbon, Planktons: Phytoplankton measurement by micrometry, Water transparency by Sechchi Disc
- Prepare case study on latest disasters. Field visits to Forest, coastal environments and wetlands, Prepare a report and submit at the time of university Exam.

### 101350105: Practicals Based on 101350103 and 101350106

- Preparation and Standardization of solutions and reagents - Normal, Molar, percentage, solutions, working solution, Determination of pH, conductivity, Acidity, Total alkalinity, solids-TS, TDS, TSS, Hardness, Dissolved Oxygen, calcium, sulfate, phosphate, Nitrate, Chloride, Residual Chlorine, Fluoride, boron , Iron of tape water (ground) and surface waters, Determination of total and fecal coli-form in water and Most Probable Number. Visit to various industry-ETP, CETP, STP prepare a report and submit at the time of university Exam.
- Soil Properties: Determination of Water holding capacity, particle density, bulk density, moisture content, porosity, N, P, K, Ca, Mg, SO<sub>4</sub>, Cl<sup>-</sup>, organic carbon, matter content of soil. Study of Geological maps, topo-maps, drainage patterns, preparation of land use maps. contour cross-sections.

### 101350107: Comprehensive Viva

## SEMESTER - II

### 101350201: REMOTE SENSING AND GEOGRAPHIC INFORMATION SYSTEM

- Remote Sensing: Remote sensing: definition and scope; Electro-magnetic radiation: characteristics, interaction with matter and spectral regions. Active & Passive Sensors, Resolution: Spectral, Spatial, Radiometric & Temporal

- Image Classification & RS Applications: Elements of Visual Interpretation, Supervised and Unsupervised classifications, Satellite Imageries and its application in Environmental Monitoring, Coastal zone planning, Flood & Drought mapping, Urban sprawl monitoring
- Geographic Information System: GIS – definition, terminology, Map and GIS, Components of GIS, Data types: Point, Line, Polygon / Area, Surface, Non-spatial Attribute Data, Topology, Basic Spatial Analysis, Geo-referencing: Datum projection & Coordinate System, GPS-GIS unification
- Data Quality and Basic Spatial Analysis: Raster Models, Vector Models, Accuracy, Precision and Resolution, Consistency and Completeness, Error Sources, Queries, Measurement, Classification, Symbolization, Union, Intersection, Data Merging

### **Suggested Books**

1. Concepts and Techniques of Geographic Information Systems, C. P. Lo, A. K. W. Yeung, PHI
2. Fundamentals of Geographic Information System, Michael DeMers, Wiley
3. Fundamentals of Remote Sensing, George Joseph, University Press
4. Geographical Information Systems Principles, Techniques, Management & Applications, Paul A. Longley, Michael F. Goodchild, David J. Maguire, David W. Rhind by John Wiley & Sons Inc.
5. Global Navigation Satellite Systems, B. Bhatta, B S Publication
6. Global Positioning System: Signals, Measurements & Performance, Pratap Misra, Per Enge
7. GPS satellite Surveying, Alfred Leick, Wiley
8. Remote Sensing & Image Interpretation, Lillesand, Kiefer, Chipman, Wiley

### **101350202: METEOROLOGICAL AND ENVIRONMENTAL INSTRUMENTS**

- Meteorological instruments- Meteorology as a discipline. Meteorology and Environment. Meteorological observatory and meteorological instruments: Cup anemometer, wet and dry bulb thermometer, minimum and maximum thermometer and hygrometers, rain gauge. Sunshine recorder, aneroid barometer, Environmental monitoring and related Instruments- Secchi disc, Soil samplers, Soil leachate collectors. Water and sediment samplers. Soil tensiometer. Soil gas samplers, high volume air sampler and other air samplers – stack monitoring, and its working, applications
- Analytical Instruments- U.V.-Visible and IR Spectrophotometer, Atomic Absorption spectrophotometer, Flame photometer, Bomb calorimeter, TOC analyzer, ICPAES, ICPMS, NMR, LCMS, Centrifuge
- Chromatography- Paper, thin layer, HPLC, GCMS, GLC, Microscopy- Light microscope, Dark field, Bright field, Phase contrast, Electron microscope - SEM, TEM (Principle, ray diagram/figure, various important parts in brief and applications).
- Biostatistics: Sampling, Data presentation, mean, median, mode, standard deviation, correlation, regression, descriptive statistics, skewness, kurtosis, ANOVA, t-test, Chi square, statistical softwares (BD-Pro, PAST, Ky-Plot, Piper Diagrams)

### **Suggested Books**

1. Arora & Malhan. 2000. Biostatistics. Scientific Publishing.
2. Negi, M.S. 2002. Fundamentals of Biostatistics. Enviro Publication.
3. Scoorg et al. 2000. Instrumental Analysis. Blackwell Publishing.

4. Turk, A, Turk, J. Wittes J.T. and Wottes, R.E. 1978. Environmental Science, W.B. Saunder Company, Philadelphia.
5. Watt, K.E.F. 1973. Principles of Environmental Sciences, McGraw Hill Book Company.
6. Willard, H.H. Merit, L.L. and Dean, J.A. 1976. Instrumental methods of analysis, Van Nostrand Reinhold 5<sup>th</sup> ed.

### **101350203: OCCUPATIONAL AND ENVIRONMENTAL TOXICOLOGY**

- Introduction to Occupational pollutants: Types of effects and entry, preventive measures, industrial cancer causing agents. Toxicology- Acute and chronic toxicity, LC<sub>50</sub>, LD<sub>50</sub>, Dose and Response, ADME, Photosynthesis- Structure of Chlorophylls , photosystems, pigment systems, light reaction, C3 Plants, environmental factors governing these process.
- Basic structure: Human tissue, skin, kidney, lungs, - dermal, Nephro, cardiac, pulmonary toxicity and hepatic toxicity.
- Basic structure of Nervous system, eye, heart, liver and their toxicity due to environmental pollutants: Neuron toxicity and ophthalmic toxicity, Respiration (ATP synthesis, biological oxidation) Glycolysis, Kreb's Cycle, Electron transport Chain
- Mode of action of herbicide- absorption, translocation, biochemical fate, metabolic response, morphological variations of herbs in general. Herbicide toxicology- classification and mode of action of urea, phenoxy, triazine substituted herbicides. Heavy metal toxicity- Mode of action of Lead, Mercury, Chromium and Cadmium and their impact on plants and animals including human organs. Teratogenicity and carcinogenicity, Persistent Organic Pollutants (POPs): Chemistry, distribution, long range transformation at Global level

### **Suggested Books**

1. Ashton and Crafts. Mode of Herbicides. Tata McGraw Hill Publishers
2. David, A.W. & Pamela, W. 2002. Environmental Toxicology. CUP.
3. Donald, G. Crosby. 1998. Environmental Toxicology & Chemistry. OUP.
4. Floyd M. Ashton and Alden S. Craft: 1981. Mode of Action of Herbicide Physiology. A Wiley – Inter Science Publications
5. Landis, W.G. and Ming-Hoyo. 1998. Introduction to Environmental Toxicology. Lewis Press, London.
6. M. O. Amdur, John Doull and Curtis B. Klaassen, Casarett and Doull's Toxicology: The basic science of poisons. (4<sup>th</sup> edition). Pergamon press.
7. Mary O Amdur, John Doull and Curtis D Klaassen 1991 Toxicology The Basic science of Poisons Pergamon Press.
8. Nene YL and Thapliyal P N Fungicides in Plant Disease Control.
9. NIIR. 1998. Pesticides, Insecticides and Fungicides.
10. Pandey & Shukla. 2001. Environmental Toxicology. Dominant Press.
11. Tortora and Grabowski. 2003 Principles of Anatomy and Physiology, John Wiley and Sons co.
12. Trivedi, R.K. 2000. Introduction to Toxicology.
13. Wayne G Landis and Ming-Ho YU Introduction to Environmental Toxicology. 2000 Lewis Publishers.

## **101350206: INDUSTRIAL HYGIENE AND OCCUPATIONAL HEALTH**

- Industrial hygiene: definition of hygiene, industrial hygiene practices, role of industrial hygienist and scope, difference between industrial hygiene and occupational health, Environment benefits of industrial hygiene workplace environment. Introduction to Occupational hazards: definition and classification, adverse health effects and controls, Chemical, physical and biological hazards. Definition of various TLVs.
- Occupational Health Hazards in specific industries like Power plants, Textile mills, Cement industries, chemical and pharmaceutical, petrochemical industries, coal mines etc. Occupational Carcinogens & Occupational Cancer. First aid and Antidotes for certain commonly used chemicals.
- Recognition and evaluation of occupational health hazards, exposure assessment (Qualitative and quantitative), types of monitoring-air, workplace area, personal exposure. Physiology of work, assessment of workload, assessment of work capacity, nutrition, diets, physical fitness and their relationship, Ergonomics-principles, major heads, muscular physiology, work station design.
- Occupational health services- occupational health centre, qualification and practices. Factory medical officer, staff and equipment, ambulance van, Control of occupational diseases-hierarchy of controls, engineering controls (local exhaust ventilation, general ventilation), substitution, elimination, administration, personal protective equipments. OSHA standards. Accident statistics, Medical emergency plan.

### **Suggested Books**

1. Barbara A. Plog and Patricia J. Quimlan Fundamentals of Industrial hygiene. (NSC Press)
2. Browning, E. 1963. Toxicology of Industrial Organic Solvents, Chemical Publishing, N.Y.
3. K.U. Mistry Fundamentals of Industrial safety and Health: Dr. Siddharth Prakashan, Ahmedabad)
4. Kohn & Bisesi. 2005. Environmental Health and Safety. CRC Press.
5. Patty, F.A. Industrial Hygiene and Toxicology, Vol.I and II. Inter science, N.Y.
6. Raval, H.R. Industrial Safety and its Applications.

### **101350204: Practicals Based on 101350201 and 101350202**

- Determination of wind velocity by anemometer, atmospheric pressure by aneroid barometer, temperature by minimum and maximum thermometer, relative humidity by wet and dry thermometer, sunshine hour by sunshine recorder, Aerial photograph and remote sensing data interpretation. Principle, working method of HVAS, Stack monitoring kit. Estimation of PM, CO<sub>2</sub>, NO<sub>2</sub>, SO<sub>2</sub> and NH<sub>3</sub> in atmosphere by high volume air sampler, Preparation of Windrose.
- Instruments- Principle, working methods, PH meter, Flame photometer, spectrophotometer, colony counter, centrifuge. Visit to Meteorological department, AAU and SICART laboratories.
- Statistics: Graphical representation of data (bar, column, compound, pie, scatter), frequency distribution (histogram, frequency polygon, ogive), central tendency, mean, median, mode, correlation, Regression

### **101350205: Practicals Based on 101350203 and 101350206**

Extraction and estimation of pigments, carbohydrates, proteins, amino-acids, phenol, protease, amylase in treated and untreated samples, Separation of pigments and amino acids by using paper chromatography, quantification of heavy metals by spectrophotometer method / ICPA - Iron, Chromium, Determination of heavy metal/industrial toxicity by germination and seedling growth tests.

### **101350207: Comprehensive Viva**

## **SEMESTER - III**

### **101350301: ENVIRONMENTAL BIOTECHNOLOGY**

- Single Cell Protein technology- Types of media, substrates used in Spirulina cultivation, Biofertilizer technology- Isolation, mass cultivation and application of Rhizobium, Cyanobacterium, Mycorrhizal technology- Structure and VAM- Ecto and Endo phleoc mycorrhizae, isolation and cultivation. Vermi-technology- process, Vermi compost and vermi-wash, Mushroom technology- Basic structure of mushroom, nutritional value, general process, Cultivation of edible mushroom
- Enzyme technology- Selection, isolation, purification, use of industrial enzymes, immobilized enzymes and types. Fermentation technology: Microbial production of alcohol, antibiotics, fine chemicals and use of bacteria and yeast. Biogas technology- conditions for biogas production, biogas plant and commercial and laboratory type. Methane production through anaerobic fermentation. Biofuel production from Jatropha and other plants
- Recombinant DNA technology: DNA and RNA structure, forms and types, Isolation of Gene, Isolation of Plasmid Vector, types of vectors, restriction enzymes, ligase, insertion of foreign DNA into vector, transfer the recombinant into bacterial cells, selection of recombinants, Gene cloning, Gene amplification through PCR and its technique. Mapping of DNA markers RFLP, RAPD, AFLP, STS.
- Plant tissue culture technology and significance- Callus, embryo, anther and protoplast cultures. Pollution monitoring biotechnology- Bioremediation, phytoremediation, Biosensors, Root zone technology, bio-degradation, bio-sorption

### **Suggested Books**

1. Agarwal, S.K. 2002. Environmental Biotechnology, ABH Inc.
2. Das, H.K. 2005. A Textbook of Biotechnology. Willey Publishers.
3. Evans, J.C., Furlong, C. 1998. Environmental Biotechnology: Theory & Applications. John Willey Press.
4. Gaudy, A.F. and Gaudy, E. 1983. Microbiology for Environmental Scientists and Engineers. McGraw Hill, N.Y.
5. Mc Kinnery: Microbiology for Environmental Engineering, McGraw Hill, N.Y.
6. Norris et al. 1993. Handbook of Bioremediation. CBC Press.
7. Patel, A.H. 2001. Industrial Microbiology. MCMill Print Ltd.
8. Pelczar, Chang Krieg. 2002. Microbiology. Tata McGraw Hill.
9. Purohit, S.S. 2008. Biotechnology: Fundamentals and Applications.
10. Singh, D.B. 2006. Biotechnology: Expanding Horizons. Kalyan Press.
11. Stephan, P.C. 2010. Bioremediation Methods and Protocols. Humana Press.

12. Subbarao, N.S. 1997. Biofertilizers in Agriculture and Forestry. Oxford & IBH Press.

### **101350302: ENVIRONMENTAL IMPACT ASSESSMENT AND LEGISLATION**

- Environmental Impact Assessment: Concepts of EIA, origin, development, objectives, methodologies of impact analysis, preparing report on EIA, GPCB guidelines, MoEF updates on EIA, Components of EIA, Generation of baseline data & preparation of EIA report, procedure for reviewing EIA report, Authorities/ Institutions involved in granting environmental clearance at Central & State Government levels
- Environmental Clearance: Screening, Scoping, Public consultation (hearing), Appraisal & recommendations and grant of environmental clearance and its validity, Procedure for obtaining environmental clearance (NOC, Industrial License, Consent, rule – 14), Sitting guideline for industries and areas to be avoided, Form V (Environmental statement), EIA Notifications & Guidelines, Stages of granting new projects (modernization, expansion)
- Environmental management plan / system (EMP / EMS), Environmental Information System (EIS), Environmental auditing, preparing audit report, Introduction to ISO 9000 & 14000 series, cleaner production assessment (History, Basic concept, Basic requirements, environment benefits, methodology, tools and financial analysis), Green belt development
- Study of important provisions of following environmental legislations: Water (Prevention and Control) of Pollution) Act, 1974; Air (Prevention and Control of Pollution) Act, 1981; Environment Protection Act, 1986. Wildlife (Protection) Act, 1973. Energy conservation Act, 2001. Forest Conservation Act, 1972; Public Liability Insurance Act, 1991, Disaster Management Act 2005

### **Suggested Books**

1. Arya & Abbasi. 2000. EIA & Legislation.
2. Gilpin, A. 2002. Environmental Impact Assessment – An Overview, Prentice & Hall Inc.
3. Hosetti & Kumar. 2002. Methodologies of EIA.
4. Mohanty, S.K. 2009. Environment & Pollution Laws.
5. Trivedi, R.K. Handbook of Environmental Laws. Vols. I & II.
6. Shukla & Srivastava. 2000. Methodology of Environmental Monitoring and Assessment. Narosa Press.
7. Kulkarni & Kaul. 1998. Handbook of EIA. Scientific Publishing.
8. Uberoi, C. 2004. Environmental Management System. Scientific Publishing.

### **101350303: INDUSTRIAL SAFETY AND CONTROL TECHNOLOGY**

- The Concept of safety management: Philosophy, Psychological factors, Behavior based safety principles. Overview of Safety Engineering: - Sitting & Layout, Machine guarding, Total Productive Management, ventilation, vibration. Overview of Safety Appraisal: Accident analysis, performance rates, Risk Assessment techniques. Industrial Safety Approaches, Overview of Safety Legislation: The Factories Act & Rules, Labor Acts and Rules (WC, ESI, Petroleum, Explosives etc.) for Safety provisions.
- Chemical Hazards: Safety, Definition and types, Chemical hazards, Material Safety Data Sheet, Hazard Identification Technique (HAZOP etc.), Safety during Material handling (Manual/Mechanical), Safety during loading and unloading, Safety devices and system: Safety valve, Rupture disc. Safety Checklist, House Keeping: Statutory Provisions and Indian standards, Methods of house keeping, Management of house keeping, Japanese

Concept of Five S, Housekeeping of specific industries. Accident Hazards: Definition and major accident hazards.

- Work Permit concept, Safe Operating Procedures, Safety Audits, Safety Tag System, Job Safety Analysis, Electrical Safety( Electricity usefulness and hazards, statutory provisions, effects on humans, safety measures, portable electrical apparatus) and Static Electricity, Hazardous area Classification.
- Fire and Explosion: Chemistry of fire, Classification of fire, Types of fire extinguisher and Explosion Phenomena. Onsite and Offsite Emergency plans: Need and Types of Emergency plans, Disaster Management Plan, Statutory Provision, Onsite and offsite plans. Risk Assessment: Qualitative and Quantitative, Types or Methods of Risk Assessment, Risk counters, Risk Control measures, Risk management activities and Risk reduction activities, Duties of Risk Manager.

### **Suggested Books**

1. Browning, E. 1963. Toxicology of Industrial Organic Solvents, Chemical Publishing, N.Y.
2. K.U. Mistry Fundamentals of Industrial safety and Health. Siddharth Prakashan, Ahmedabad
3. Kohn & Bisesi. 2005. Environmental Health and Safety. CRC Press.
4. Patty, F.A. Industrial Hygiene and Toxicology, Vol.I and II. Inter science, N.Y.
5. Sarma, A.M. 2001. Safety & Health in Industry. BS Publications.

### **101350306: INDUSTRIAL POLLUTION AND CONTROL TECHNOLOGY**

- Industrial scenario-Types of industrial wastewater, Influent and effluent, Waste Water, definition of waste water, Constituents in wastewater, Sources of domestic and Industrial waste water, Domestic waste water-Define: Septage (septic tank), Sewage, Fluctuation in generation of domestic waste water and their quality. Characteristics of Domestic wastewater, Waste water collection point, types of sewers, types of sewerage systems, House Hold drainage system- Traps, Manholes, Waste collection Pipes, Treatment of Domestic waste Water- racks, screens, grit chamber, aeration units, primary & secondary clarifiers, activated sludge plant and trickling filter units, Low cost sanitation systems, septic tanks, soak pit, stabilization ponds.
- Waste Water unit operation: CETP - concept, Objectives, advantages and disadvantages and Ownership. Physical unit operation, Chemical unit operation, Biological unit operation-Introduction to Biological Treatment: Role of micro-organisms, types of biological processes for wastewater treatment, Disposal standards, disposal of effluents (Land, water bodies). Residuals (Sludge) Management: Residuals of industrial wastewater treatment - Quantification and characteristics, treatment and disposal- Thickening, digestion, conditioning, dewatering and disposal.
- Sources of pollution, oil-pollution, Hydrocarbons- polycyclic and petroleum hydrocarbons, Origin (Manufacturing process) and characterization, standards of industrial waste water and common and specialized treatment of industrial effluents of – Pharmaceuticals, Textile, paper and pulp, dairy industries. Noise pollution: Acoustical concepts, Sources, Measuring instruments and techniques, , Health effects , Traffic Noise index (TNI), Noise pollution level (NPL), Sound exposure level Noise standards and limits, Noise control methods (source, path and receiver end)
- Radioactive pollution: Types of radiation, radiation units, types of radioactive materials, radiation sources (natural, commercial and industrial) effects and radiation protection.



Radiation interaction with biological materials; Nucleic acids (DNA & RNA), proteins, carbohydrates, lipids and membranes. Thermal pollution: Sources, effects, Control and prevention.

### **Suggested Books**

1. Besselviere, E and Schwartz. 1975. Treatment of Industrial Wastes, McGraw Hill.
2. Birdie, G.S. 2002. Water Supply and Sanitary Engineering. Dhanpatraj and Sons Press.
3. Browning, E. 1963. Toxicology of Industrial Organic Solvents, Chemical Publishing, N.Y.
4. Fair, G.M. Geyer, T.C. and Okun, D.A. 1984. Water and waste water Engineering. Vol. I and II, John Wiley and Sons.
5. Gharpure, V.N. A Text Book of Sanitary Engineering. Allied Book House.
6. Joseph A. Salvato. 2001. Environmental engineering and sanitation: (4<sup>th</sup> edition).
7. Mahajan 1985. Pollution control in process industries. Tata McGraw Hill
8. Metcalf and Eddy Inc. 1979. Waste water Engineering treatment, Disposal, Reuse. Tata McGraw Hill Publ. Co. Ltd.
9. Nemrow. N.L. 1971. Liquid waste of Industry – theories, practices and treatment, Addison Wesley.
10. Peavy, Rowe Tchobanoglous. Environmental Engineering. McGraw Hill International ed.
11. S. P. Singhal. 2004. Noise Pollution and Control Strategy.
12. Steel and Terence. 2004. Water Supply and Sewerage. McGraw Hill Book Co.
13. Trivedy & Raj. 1999. Nuclear & Thermal Pollution. Akasdeep Publications.

### **101350304: Practicals Based on 101350301 and 101350302**

- Estimation of DNA and RNA; Embryo and anther culture; Biosorption- Activated Charcoal test for Removal of nutrients - Phosphates/Sulphates/Nitrates, heavy metals Cr /Fe, Enzyme- Nitrate reductase, Isolation and identification of fungal and bacterial (*Rhizobium* on YEMA media) from air/soil/wastewater/sewage/various concentrations of pesticides, gram staining, Determination of Standard Plant Count, Vermitechnology and mushroom cultivation techniques
- EIA: Introductory aspects (as per MoEFCC), Preparation of EIA forms - New construction, New industrial estates, New towns, River valley project (Stage I & II), Hydal project
- Visit to be conducted to any one Environmental biotech lab/industry and report submission at the time of examination.

### **101350305: Practicals Based on 101350303 and 101350306**

- Characterization of wastewater- Sewage, industrial effluent and receiving water body for physico-chemical and biological properties: pH, conductivity, colour, temperature, total solids, dissolved solids, suspended solids, chloride, phosphate, nitrate, sulfate, hardness, Calcium, Magnesium, total alkalinity, Oil and grease, Ammonical nitrogen, phenolic compounds, BOD, COD, total acidity, Sludge Volume index, MLSS and MLVSS.
- Determination of Iron, Chromium, Pb, Hg (ICP at SICART), Measurement of Noise using SLM.
- Visit to various industry-ETP, CETP, STP, Land Fill sites and prepare a report and submit at the time of university examination.

### **101350307: Comprehensive Viva**

## SEMESTER - IV

### 101350401: WASTE MANAGEMENT AND CONTROL TECHNOLOGY

- Solid Waste handling and Management: sources, types, quantitative estimation, methods of collection, storage, transportation. Biological and chemical techniques for energy and other resource recovery: composting, termigradation, Incineration of solid wastes. Disposal in landfills: site selection, design, and operation of sanitary landfills; Leachate and landfill gas management; landfill closure and post-closure environmental monitoring; landfill remediation. Regulatory aspects of municipal solid waste management. Solid wastes management and handling rules, 2000.
- Biomedical Waste management: definition, health and environmental issues. Category of waste, segregation, collection and transportation. Treatment systems. Biomedical Waste Management and Handling Rules, 1998. Electronic waste (E-waste): Sources and types, constituents of E-wastes, recycling of e-waste and its environmental consequences, Transboundary movement and management of e-wastes.
- Hazardous waste management: Types, Recycle, Disposal: site selection criteria, hydrological assessment and design consideration for land disposal facilities and regulations. TSDF concept Hazardous waste disposal site cleanup, site safety and sampling plans, remediation and feasibility study, Hazardous waste reduction and Recycling-Regulatory aspects of HWM. Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2010.
- Nano-Science and Technology: Types of nonmaterial, nanoparticles in aquatic and terrestrial and atmospheric environment, Instruments used in studying nanoparticles, Occupational exposure to nanoparticles, Toxicological properties of nanoparticles and nanoparticles to cure human diseases and in mitigating water pollution

#### Suggested Books

1. Besselviere, E and Schwartz. 1975. Treatment of Industrial Wastes, McGraw Hill.
2. King, R. W. and Magid, J. 1982. Industrial Hazards and Safety, Handbook, Butterworth
3. LaGrega. 2004. Hazardous Waste Management. McGraw Hills.
4. Mahajan 1985. Pollution control in process industries. Tata McGraw Hill
5. Ronald E. Hester Roy M. Harrison 2007 Nanotechnology: Consequences for Human Health and the Environment.

### 101350402: ENVIRONMENTAL RESOURCES AND BIODIVERSITY CONSERVATION

- Energy and Environment - Environmental Conservation- Natural resources and their conservation, Non-conventional Energy sources – process, mechanisms, mitigation of fuel, coal, oils & natural gas, Conventional / Renewable sources of energy- hydroelectric power, solar, tidal, wind, geothermal energy.
- Fossil fuels and related environmental impacts, Household energy conservation, Urbanization and environment, Environmental impacts of mining, Wasteland development and reclamation, Energy use pattern in India and the world, Bioresource management – social forestry, Grassland, Cropland, Freshwater, Marine, Wildlife management, role of regional bodies, MoEFCC, NBA, WWF, CITES, TRAFFIC, IUCN, red list categories, Red data book.

- Biodiversity: Concept, Types- genetic, species, ecosystem, importance of biodiversity, principles of biodiversity conservation, Alpha, Beta and Gamma diversity, Hot spots, mega diversity countries, dwindling or extinct of biodiversity, monitoring(case study), management and in-situ and ex-situ conservation strategies. Threatened and endangered flora and fauna of Gujarat. Wildlife: reasons for decline, anthropogenic pressures, biosphere reserves, sanctuaries, national parks of Gujarat. Anthropogenic pressures on protected areas (Case study)
- Forestry- Characters used for classification of forest, major types of forests- Tropical wet ever green, tropical semi-ever green, moist deciduous forest, thorny forest, pine and alpine forests, Vegetation types of Himalayas. Uses of biodiversity: MFP (minor forest produce), Ethnobotany, conservation of forests, Agroforestry, Forest management systems, joint forest management, Primary productivity of forest ecosystems, litter production and decomposition.

### **Suggested Books**

1. CEE. 1999. Energy & Environment. Enviro Scape Publications.
2. Christopherson, R.W. 1998. Geosystems. Prentice Hall Inc., NJ.
3. Cotton, C.G. 2001. Fundamentals of Ethnobotany. Prentice Hall.
4. Dwivedi, A.P. 1999. Forests: Non-timber Resources. International Book Distributors.
5. Jain. S.K. 2000. Manual of Ethnobotany.
6. Kumar & Asija. 2010. Biodiversity: Principles and Conservation. Agrobios, India.
7. Negi, M.S. 2005. Forests of India. MoEF Publications.
8. Negi, S.S. 2005. Handbook of Forestry. International Book Distributors.
9. Odum, E.P. Fundamentals of Ecology. Nataraj Publishers, Dehradun
10. Safi & Raza. 1992. Forest Ecosystems of the World. Rawat Publications.
11. Singh, S.P. 1999. Handbook of Agroforestry. Agrotech Press.
12. Singh, V.P. 2004. Tropical Forest Ecosystem: Structure and Functions. Scientific Publications.

### **101350403: Practicals Based on 101350401 and 101350402**

- Study of minimum size of quadrat, minimum number of quadrat, Community structure by quadrat – a) Qualitative community structure- Odum's index, Koth's index, Shannon's index, b) Quantitative community structure – frequency, density, abundance, Minor Forest Produce, Medicinal Plants.
- Characterization of municipal solid waste including heavy metals: Particle density, ignitibility, bulk density, moisture content, porosity, proximate analysis, sulphide, TS, TDS, Cr, Fe, Cu
- Project work: Dissertation, thesis and report writing, reference writing, tabular and graphical representation, research paper presentation: importance of clear title, abstract or summary, Outline and format of chapters - Introduction, Review of Literature, Materials & Methods, Results, and Discussion, Bibliography, Plagiarism check
- Field Visit- Field visit to be made to study the national park, protected areas and prepare report and submit at the time of examination (Information on collection of MFP, Ethnobotanical and medicinal plants and anthropogenic pressures, Visit to Medicinal garden, AAU, Anand, Solar Research Station for Biogas Plant (SPRERI), Vallabh Vidyanagar.

### **101350404: Comprehensive Viva**

**101350405: Project Work / Dissertation** is offered compulsorily in fourth semester in Industry or Reseach centers or ISTAR.

### **Suggested Books**

1. APHA. 2012. Standard Methods for the Examination of Water and Wastewater. American Public Health Association, New York.
2. Gupta, P.K. Methods for Environmental Analyses. 242 pp.
3. Maiti, S.K. 2004. Practical Manual for Water, Soil, Noise and Air Analyses. Vols. I & II.
4. Trivedy, R.K. and Goel, P.K. 2004. Chemical and Biological Methods for Water Pollution. Karad, MH.