

Semester III & IV



SOLAPUR UNIVERSITY, SOLAPUR

REVISED SYLLABUS - M.Sc.II ENVIRONMENTAL SCIENCE

To be implemented from the year 2015 onwards

SOLAPUR UNIVERSITY, SOLAPUR
M.Sc. I & II ENVIRONMENTAL SCIENCE
Year 2014 – 2015
STRUCTURE OF THE COURSE
SEMESTER - I

SR. NO	PAPER CODE	TITLE OF THE PAPER	LOAD / WEEK (hrs)	TOTAL LOAD (hrs)	CREDITS
1	EST 101	FUNDAMENTALS OF ENVIRONMENT	04	56	04
2	EST 102	ENVIRONMENTAL CHEMISTRY	04	56	04
3	EST 103	ENVIRONMENTAL STATISTICS AND COMPUTER APPLICATIONS	04	56	04
4	EST 104	INTRODUCTION TO GEO-SCIENCE	04	56	04
5	ESP 105	PRACTICAL RELATED TO EST 101 & EST 102	04	56	04
6	ESP 106	PRACTICAL RELATED TO EST 103 & EST 104	04	56	04
7	EST 107	SOFT SKILL ICT, SCIENTIFIC ENGLISH	01	07	0.75
		SEMINAR	01	07	0.25
8	TOTAL			350	25

SEMESTER - II

SR. NO	PAPER CODE	TITLE OF THE PAPER	LOAD / WEEK (hrs)	TOTAL LOAD (hrs)	CREDITS
1	EST 201	BIODIVERSITY AND CONSERVATION	04	56	04
2	EST 202	ANALYTICAL TECHNIQUES AND INSTRUMENTATION	04	56	04
3	EST 203	WATER AND WASTEWATER ENGINEERING	04	56	04
4	EST 204	REMOTE SENSING AND GIS IN ENVIRONMENTAL SCIENCE	04	56	04
5	ESP 205	PRACTICAL RELATED TO EST 201 & EST 202	04	56	04
6	ESP 206	PRACTICAL RELATED TO EST 203 & EST 204	04	56	04
7	EST 207	SOFT SKILL ICT, SCIENTIFIC ENGLISH	01	07	0.50
		TOUR & TOUR REPORT			0.25
		SEMINAR	01	07	0.25
8	TOTAL			350	25

SEMESTER - III

SR. NO	PAPER CODE	TITLE OF THE PAPER	LOAD / WEEK (hrs)	TOTAL LOAD (hrs)	CREDITS
1	EST 301	ENVIRONMENTAL POLLUTION	04	56	04
2	EST 302	ENVIRONMENTAL BIOTECHNOLOGY	04	56	04
3	EST 303	ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL AUDIT	04	56	04
4	EST 304	NATURAL RESOURCE MANAGEMENT	04	56	04
5	ESP 305	PRACTICAL RELATED TO EST 301 & EST 302	04	56	04
6	ESP 306	PRACTICAL RELATED TO EST 303 & EST 304	04	56	04
7	EST 307	SOFT SKILL ICT, SCIENTIFIC ENGLISH	01	07	0.75
		SEMINAR	01	07	0.25
8	TOTAL			350	25

SEMEVTER - IV

SR.NO	PAPER CODE	TITLE OF THE PAPER	LOAD / WEEK (hrs)	TOTAL LOAD (hrs)	CREDITS
1	EST 401	ENVIROMENTAL POLICY, ACTS, LAWS AND ENVIRONMENTAL MANAGEMENT SYSTEM	04	56	04
2	EST 402	ENVIRONMENTAL TOXICOLOGY	04	56	04
3	EST 403	WATERSHED MANAGEMENT	04	56	04
4	EST 404	RESEARCH METHODOLOGY	04	56	04
5	ESP 405	PRACTICAL RELATED TO EST 401 & EST 402	04	56	04
6	ESP 406	PRACTICAL RELATED TO EST 403 & EST 404	04	56	04
7	EST 407	RESEARCH PUBLICATION / SEMINAR PAPER PRESENTATION	01	07	0.75
		TOUR & TOUR REPORT	01	07	0.25
8	TOTAL			350	25

NOTE:

Each semester will have 1 credit (25 marks) for- field training for long tour/ in plant training/remote sensing institute visit or field work, data acquisition related to dissertation.

**SCHOOL OF EARTH SCIENCES,
DEPARTMENT OF ENVIRONMENTAL SCIENCE,
SOLAPUR UNIVERSITY, SOLAPUR**

PART- II

SEMESTER – III

EST-301: ENVIRONMENTAL POLLUTION

**Marks: External 70
Internal 30**

Unit	Topic	Credit	Lectures
UNIT-1	<p>a) Air pollution: Concept of air pollution, natural and anthropogenic sources, major air pollutants, Meteorological aspects of air pollution, Oxides of nitrogen and sulphur, particulate matter, air pollution standards, Indoor air pollution, Vehicular air pollution, air pollution episodes and disasters, Effects of air pollution on human health, animals, plants, material and climate. Formation of fog and photochemical smog, acid rain, Monitoring of air pollution</p> <p>b) Noise Pollution: Concept of noise, sources of noise, measurement of noise, religious festival and noise, Noise exposure levels and standards, effects noise on plants animals and human beings, control of noise at source, industrial noise control, prevention of community noise control</p>	1	14
UNIT-2	<p>Water Pollution: Principal forms of water pollution, sources of water pollution, phenomenon of eutrophication, water pollution monitoring, physicochemical and bacteriological sampling and analysis of water, water quality parameters, water quality standards, ocean pollution sources of pollution, effects, control. Oil pollution-sources of pollution, effects, control, ground water pollution - sources of pollution, effects, control, water pollution episodes, consequences of water pollution, water pollution prevention.</p>	1	14
UNIT- 3	<p>Soil Pollution: Importance and types of soil, concept of soil pollution, analysis of soil key parameters, soil acidity, saline and alkaline soil., causes of soil salinity, major types, physicochemical and biological methods of soil reclamation, Different causes of soil degradation, Chemical and metallic pollution in agricultural soil, Mining and soil pollution, Control of soil pollution.</p>	1	14
UNIT-4	<p>a) Solid Waste Pollution: Concept and types of solid waste, Major sources of solid waste, effects of solid waste classification of waste. Domestic, Industrial, Municipal, Hospital, Nuclear, E-waste and Agriculture waste. Transfer and transport, waste minimization technologies -recycle, reuse, recovery, conversion of solid waste to energy / manure, sea disposal, incineration, compost and land disposal</p> <p>b) Radiation Pollution: Types, sources- natural and manmade, Measurement and detection of radiation intensity, consequences of radiation life, coefficient units for measurement of radiation, control of radiation pollution., Nuclear reactor safety, case studies</p>	1	14

INTERNAL EVALUATION

30 MARKS

(Seminar + term paper + test)

Reference books:

1. Environmental Pollution Control, C.S. Rao, Wiley Eastern Ltd.,1993
2. Air Pollution Control and Engineering, De Nevers, Mc Graw? Hills, 1993
3. Fundamentals of Environmental Pollution, Krishnan Khannan S.Chand & Company Ltd.,1994.
4. Environmental Chemistry, A. K. De., New Age Intl. pub Co, New Delhi, 1990
5. Ground water contamination (Transport and remediation), Philp Bedient, Hanadi. S. Rifai and Charles. Publishers: Prentice Hall.
6. Environmental Science, S.C. Santra , 2014.
7. Environmental Pollution Control, C.S.Rao, Wiley Eastern Ltd.,1993
8. Air Pollution Control and Engineering, De Nevers, Mc Graw Hills, 1993
9. Fundamentals of Air Pollution, Samuel, J.W., 1971, Addison Wesley Publishing
10. Fundamentals of Environmental Pollution, Krishnan Khannan S.Chand & Company Ltd.,1994.
11. Noise Pollution, Vandana Pandey, Meerut Publishers,1995

EST-302: ENVIRONMENTAL BIOTECHNOLOGY

**Marks: External 70
Internal 30**

Unit	Topic	Credit	Lectures
UNIT-1	Microbial Environment Nature and function of micro-organisms in soil, water and air, Environmental Significance of Bacteria, Fungi, and Algae, Microbial Metabolism, Growth and Bio-kinetics Structure and Functions of Procaryotic Cells & Eucaryotic Cells, Microbial Nutrition and Metabolism, Microbial Growth and Energy, Effect of Environment on Enzyme activity, Microbial Growth and Substrate Utilization Kinetics	1	14
UNIT-2	Environmental Biotechnology Scope of environmental biotechnology; Biodegradation of macromolecules; Degradation of xenobiotic compounds-Simple, aromatic, chlorinated, polyaromatic hydrocarbons, heavy metals, petroleum products, pesticides and surfactants. Genetically modified microorganisms types and applications	1	14
UNIT- 3	Biopesticides: Historical background, Antagonism, Amensalism, competition, predation and parasitism, Biofertilizer for bio control: Vegetative part and soil inoculation, mycorrhizal fungi, Microbial pesticide: Bacterial pesticide, Mycopesticide, transgenic plant, Mycoherbicide, insect as bio control	1	14

UNIT-4	<p>Bioremediation</p> <p>Soil Environment: Biotechnologies for Ex-Situ and In Situ Remediation of Soil, Bioleaching, biosorption and oil degradation, creation of superbug, Phytoremediation Technology for Soil Decontamination, Sequestering Carbon Dioxide</p> <p>Air Environment: Biological Filtration Processes - Air Stream, Biofiltration, Biotrickling Filtration and Bioscrubbers</p> <p>Water Environment: Ex-situ and In situ Decontamination of Groundwater, Bioaugmentation, Landfill Leachate Biotreatment</p> <p>Biotreatment of Metals: Microbial Transformation of Metals, Bioleaching and Biobenificiation Bioaccumulation Oxidation/Reduction Processes, Biomethylation, Biomonitoring</p>	1	14
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INTERNAL EVALUATION
(seminar+term paper+test)

30 MARKS

Reference books:

1. Introduction to Environmental Biotechnology, A.K.Chatterji,Prentice Hall of India Pvt. Ltd, New Delhi
2. Environmental Biotechnology-Basic Concepts and Applications Indu Shekhar Thakur I.K. International Pvt. Ltd. New Delhi.
3. Environmental Biotechnology S.K. Agawal,APH Publishing Corp., New Delhi.
4. Elements of Biotechnology, P.K.Gupta, Rastogi Publishing House, New Delhi.
5. Environmental Biotechnology ,Jogdand S.N., Himalaya Publishing House, New Delhi
6. Biotechnology,B.D.Singh, Kalyani Publishers , New Delhi
7. Molecular Buiotechnology- Principles and Applications of Recombinant DNA, Glick and Pasternak. Panima Publishiong Corporation, New Delhi
8. A Text Book of Biotechnology, R.C. Dubey,S. Chand & company Ltd., New Delhi

EST-303: ENVIRONMENTAL IMPACT ASSESSMENT AND ENVIRONMENTAL AUDIT

Marks: External 70
Internal 30

Unit	Topic	Credit	Lectures
UNIT-1	Environmental impact assessment (EIA): Definition of EIA and EIS, Environmental inventory, Concepts, scope and objectives of EIA; National Environmental Policy Act (NEPA, 1969); EIA guidelines-1994 (Notification of Government of India), Procedure to review report of Environmental impact assessment.	1	14
UNIT-2	Impact assessment methodologies: Definition and concept of impact; Types of impacts (Negative & Positive: Primary & Secondary; Reversible and Irreversible; Tangible and Intangible); Impact identification; Methods for impact identification: Matrices, networks and checklists, Advantage	1	14

	& disadvantages of EIA methodologies.		
UNIT- 3	<p>Components of EIA: Environmental Setting; Baseline data; Prediction and evaluation of impacts; Environmental management plan and monitoring, Baseline information, Prediction, evaluation and mitigation of impacts on socio-economic, air water, soil and noise environment.</p> <p>Public participation in EIA: Decision making, Public participation in environmental decision making, Objectives and techniques for public participation, Advantages and Disadvantages of public participation.</p> <p>Preparation and writing of EIA: For water resources, Dams and irrigation projects; Mining and Infrastructural projects etc.</p>	1	14
UNIT-4	<p>Environmental Audit: Audit tools and technology, Procedure of environmental auditing Safety audit, Notification and guidelines for Environmental audit: Scope, applicability and objective of environmental audit, Environmental auditing in India, ISO 14001</p>	1	14

INTERNAL EVALUATION
(seminar+term paper+test)

30 MARKS

Reference books:

1. Handbook of Environmental Impact Assessment (Vol. I): Judith Petts, Blackwell Science, USA (1999).
2. Handbook of Environmental Impact Assessment (Vol. II): Judith Petts, Blackwell Science, USA (1999).
3. Methods of Environmental Impact Assessment: Peter Morris, Ricky Therivel, UGC Press Limited, London (1994).
4. Environmental Impact Assessment & Management: Daya Publishing House, New Delhi (1998).
5. Environment Impact Assessment: Larry W. Canter, Mc-Graw Hill Inc., New York (1996).
6. Introduction of Environmental Impact Assessment: John Glassion, Rikay Therival and A. Chadwick, UGC Press Ltd., London (1994).
7. A monograph on Environmental Audit: The Institute of cost and works Accounts of India, New Delhi (1994)
8. Using Environmental Management system to improve profits: B. Pearson, BFP Little and M. J. Brierley, Graham & Thotrman, Kluwer Academic Publisher Group, London (1992).

EST- 304: NATURAL RESOURCE MANAGEMENT**Marks: External 70
Internal 30**

Unit	Topic	Credit	Lectures
UNIT-1	Definition, broad classification of natural resources. Renewable: Solar, Wind, Geothermal, Tidal, Biomass (Bio Gas), Ocean and Magneto- hydrodynamic Power. Non Renewable: Thermal Power, Hydro Energy, Nuclear Energy and Fossil fuels. Impact on Environment and their applications. Energy Production Consumption and Energy use pertain in different part of the world	1	14
UNIT-2	Conservation of Energy: Importance, Methods of Conservation, Measures for Promoting Energy Conservation. Mineral Resources: metals and non-metals, formation of mineral deposits, Conservation of mineral resources and their distribution in India.	1	14
UNIT- 3	Water Resources: Surface, Ground and Frozen Water, Desalination, Uses for Agriculture, Energy Generation, Domestic Consumption. Causes for Water Stress, Water Availability and its Demand. Types of dam and impacts Water Conservation Strategies in India, Rain Water Harvesting.	1	14
UNIT-4	Land & Forest Resources: Agricultural Practices in India, Exploitation of Agricultural Land. Range Land Management. Mining, Quarrying and their Impacts. Land degradation, its causes and consequences. Importance of Forestry, Forest Products, Forest-Based Industries. Forest Fire and its Control. Afforestation and Joint Forest Management, Social Forestry, Agro-Forestry.	1	14

**INTERNAL EVALUATION
(Seminar + term paper + test)****30 MARKS****Reference Books:**

1. Biomass Energy and Environment: H.R. Ravindranath, Oxford University Press, New York. 1995.
2. Ecology and Environment: P.D. Shrama, Rastogi Publications, New Delhi, 2004.
3. Energy Resources and Environment: V.K. Prabhakar, Anmol Publisher Environmental Biology: Biswarup Mukharjee by Tata McGraw Hill Publishing Company Ltd, New Delhi.
4. Environmental Ecology: Gurudeep Raj, P.R.Trivedi, Akashdeep Publishing House, New Delhi.
5. Forests in India : V. P. Agrawal, Oxford & IBH Publishing Co. Pvt.Ltd. New Delhi, (1968).
6. Introduction to Social Forestry: Sitram Rao, Oxford and IBH Pub. Co. Pvt. Ltd. An Introduction to Environmental Management: Dr. Anand S. Bal, Himalaya Publishing House (2005).

7. Non Conventional Energy Sources: G.D. Rai, Khanna Publication, New Delhi Renewable Energy Sources and Emerging Technologies: D.B. Kothari and K.C. Singal, PHI Learning Pvt. Ltd. New Delhi, 2011

PRACTICAL

PRACTICAL ESP – 305 (BASED ON ENVIRONMENTAL POLLUTION AND ENVIRONMENTAL BIOTECHNOLOGY)

ENVIRONMENTAL POLLUTION

**Marks: External 35
Internal 15**

1. Study of Air micro flora
2. PM 10 and PM 2.5 measurement by Fine Air Dust Sampler
3. SO_x and NO_x measurement by Fine Air Dust Sampler
4. Measurement of Noise by Noise Level Meter
5. Calculation of Noise levels from different locations
6. Estimation of chlorophyll, polyphenol and vanadium from affected plant leaves
7. Estimation of Total Hardness from provided water sample
8. Determine MPN from water samples
9. Determination of Primary production by light and dark bottle technique
10. Physical composition of solid waste / refuse
11. Physical characterization of solid waste / refuse
12. Construct the composting pit and vermiculture
13. Estimation of WHC, Soil texture and soil profile
14. Study of physico-chemical parameters of soil

ENVIRONMENTAL BIOTECHNOLOGY

**Marks: External 35
Internal 15**

1. Aseptic techniques:
 - i. Safe handling of Microbes
 - ii. List of cultures
 - iii. Preparation of Culture media
 - iv. Preparation of slant, butt and plate
 - v. Transferring of culture
 - vi. Establish pure culture by streak plate method
 - vii. Storage of culture
2. Differential (Gram's) staining

3. Study of Growth curve
4. Preparation of azofertilizers
5. Preparation of rhizofertilizers
6. Isolation of bacteria from Air
7. Isolation of Fungi from Air
8. Design of root zone bed for bioremediation
9. Sampling of aquatic weeds for bioremediation

INTERNAL EVALUATION
(Viva-voce + journal + data evaluation)

30 MARKS

PRACTICAL ESP – 306 (BASED ON ENVIRONMENTAL IMPACT ASSESSMENT & ENVIRONMENTAL AUDIT AND NATURAL RESOURCE MANAGEMENT)

ENVIRONMENTAL IMPACT ASSESSMENT & ENVIRONMENTAL AUDIT

Marks: External 35
Internal 15

1. Case study on EIA Mining,
2. Case study on EIA Irrigation Plant
3. Case study on EIA Thermal Power Plant
4. Case study on EIA Airports
5. Case study on EIA Highways
6. Case study on EIA Nuclear Power Plants
7. Case study on EIA Building Construction/ Townships
8. Case study on EIA Ports and Harbors

NATURAL RESOURCE MANAGEMENT

Marks: External 35
Internal 15

1. Study on water budget.
2. Estimation of roof top water harvesting.
3. Study on land capability classification.
4. Determination of ecological foot print.
5. Proximate analysis of coal for moisture volatile matter and carbon contain.
6. Study of calorific value of biomass.
7. Estimation of biogas generation.
8. Preparing mineral distribution map of India.

INTERNAL EVALUATION
(Viva-voce + journal + data evaluation)

30 MARKS

**SCHOOL OF EARTH SCIENCES,
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PART- II

SEMESTER – IV

**EST 401: ENVIRONMENTAL POLICY, ACTS, LAWS AND ENVIRONMENTAL
MANAGEMENT SYSTEM**

Marks: External 70
Internal 30

UNIT	TITLE	CREDIT	LECTURES
UNIT-1	Environmental policy: International and Government of India's policies in the protection of environment, Environment action plan National Forest Policy, 1989, National Water Policy, 2002 Policy statement: Introduction, problems, objectives and future directions, Constitutional provision regarding Environmental Protection (article 48 and 58 A)	1	14
UNIT-2	Environmental Conferences: Stockholm Conference (UNCHE); Montreal Protocol; UN conference on environment and development, Rio (UNCED) Summit; Population conference, Cairo and climatic change conference, Kyoto; International union for conservation of nature and natural resources (IUCN); UN environmental programmers (UNEP); World-wide fund for nature (WWF).	1	14
UNIT-3	Environmental laws in India: The Factories Act, 1948 and Amendment thereof, The Water (prevention and control of pollution) Act,1974; The Forest (conservation) Act,1980; The Air (prevention and control of pollution) Act,1981; The Environment (protection) Act,1986, Public Liability Insurance Act,1991, The Wildlife (protection) Act,1972.	1	14
UNIT-4	Environmental Management: Environmental Monitoring, Environmental Modeling, Principles of Environmental Management, Definition and Scope, Ethics and Environment, Application of Remote Sensing and GIS in Environmental Management.	1	14

INTERNAL EVALUATION
(Seminar + term paper + test)

30 MARKS

Reference books:

1. Environmental Laws of India - An Introduction: CPR Environmental Education Centre, Chennai (2001).

2. Introduction to Social Forestry : Sitram Rao, Oxford and IBH Pub. Co. Pvt. Ltd.
3. An Introduction to Environmental Management : Dr. Anand S. Bal, Himalaya Publishing House (2005).
4. Environmental Pollution – Management & Control for Sustainable Development : R. K. Hitoliya, S.Chand and Co.Ltd.New Delhi (2004).
5. Environmental Science : S. C. Santra, New Central Book Agency, Kolkata, 2005
6. Environmental Law and Policy in India: Divan S and Rosencraz A,Oxford University Press, New Delhi. (2001)
7. Labour and Industrial Law: Sing, A, K. and Agrawal R. K., Pioneer Printers, Agra (2000).
8. Environmental Policies: Sinha P. C., Anmol Publications Pvt. Ltd, New Delhi (1998).
9. Environmental Guidelines and Standards in India:Goel P. K and Sharma K. P, Techno Science Publications, Jaipur (1996).
10. Commentaries on water and air pollution law: Lal, Universal Publication,New Delhi(1992).
11. Earth Summit, Vol. I & II: Bhaskar Rao, Universal Publication, New Delhi (1996).

EST 402: ENVIRONMENTAL TOXICOLOGY AND SAFETY

Marks: External 70
Internal 30

UNIT	TITLE	CREDIT	LECTURES
UNIT-1	Introduction to Environmental Toxicology: Definition, classification, Basic Concepts, origin of toxicants , general nature of toxicants in environment, Evaluation of toxicity, Bioassay, factors affecting toxicity, mutagenesis, spermatogenesis, carcinogens, hallucinogens, phytotoxins and animal toxins	1	14
UNIT-2	Ecotoxicology: Routs of entry of toxicants, Toxic response of different body systems likes respiratory, gastro-intestinal tract, liver, kidney, immune system, reproductive System. Problems and approach, effects of toxicants on ecosystem, detoxification of Toxicants in resistant biota.	1	14
UNIT-3	a. Environment, Health and Environmental stress: Basic principles of environmental health, community health, impact of changing environment on biota, effect of stress on environment, adaptations and tolerance level of various organisms and stress factors, micro-organisms of extreme Environment. b. Bio-assay techniques: Study design protocols to evaluation of toxicants. Tests for assessing carcinogenicity and muta toxicity of compounds. TLC	1	14

	techniques for determination of toxicants in water & Vegetable samples.		
UNIT-4	<p>General principles of safety: Need for safety humanitarian, sequence of accident occurrence-occupational injuries-effects of industrial accidents, personal protective equipment's.</p> <p>Legal and social consideration, role of management in industrial safety. Hazards in chemical plant-Material handling hazards –classification of hazardous chemical their storage and safe keeping, Acts and Rules, Safety standards and codes. Safety policy-safety organization & responsibilities and authorities of different levels.</p>	1	14

INTERNAL EVALUATION
(seminar+term paper+test)

30 MARKS

Reference books:

1. Water Toxicology: V. V. Metelev, A. I. Kanaev, N. G. Dzasokhova, Amerind Publishiing Company, Pvt, Ltd, New Delhi (1971).
2. Water Pollution and Toxicology: S. K. Shukla & P. R. Srivastava, Commonwealth Publisher, New Delhi (1992).
3. Toxicology – Principles & Methods: M. A. Subramanian, MJP, Publishers, Chennai (2004).
4. Industrial Toxicology: Raymond D Harbison, A Times Mirror Company, 5th Edition, New Delhi (2006).
5. Environmental Science: S.C. Santra, New Central Book Agency, Kolkata (2001).
6. Environmental Pollution Health & Toxicology : S V S Rana, Narosa Publishing House, New Delhi (2006).
7. Environmental Science Hazardous Gas & Waste : R K Sinha, Commonwealth Publisher, New Delhi (1994).
8. Toxicology: P D Sharma, Rastogi & Company, Meerut (1995).
9. Industrial Safety and pollution control handbook:- National safety council, New Delhi.
10. Handbook of Environmental Health and Safety:- Herman Keren and Michal Biseis (1999).
11. Safety Evaluation of Environmental Chemicals: - T.S.S. Diksheth (1995).
12. Handbook of Environmental Risk Assessment and Management, Peter Calow (1998) Black well Science Ltd.

EST- 403: WATERSHED MANAGEMENT

Marks: External 70
Internal 30

Unit	Topic	Credit	Lectures
UNIT-1	Watershed definition, size, characteristics, factors affecting, watershed operations. Causes and consequences of watershed deterioration. Definition, different approaches and objectives of watershed management. People's participation and organization. Watershed management plan.	1	14
UNIT-2	Erosion processes: Factors effecting erosion, soil erosion and its types, modeling of erosion using Universal Soil Loss Equation. Ground water table – depth, perched, capillary rise, recharge. Land capability classification: purpose and basic eight of classes.	1	14
UNIT- 3	Rainfall and its measurements: formation precipitation/rainfall, rainfall pattern in India, rainfall parameters, rainfall measurements types. Estimating runoff: runoff processes, factors affecting runoff, design of peak runoff through rational and cook's method.	1	14
UNIT-4	Agronomic measures of soil and water conservation. Basic engineering measures for soil and water conservation, contour cultivation, bunding, terracing, continuous contour and staggered trenches, treatment of catchments, gully plugging, check dams, small storage structures, designing of simple bund structure.	1	14

INTERNAL EVALUATION
(seminar+term paper+test)

30 MARKS

Reference books:

1. *Common Guidelines for Watershed Development Projects* (2008) Government of India.
2. Dhruva N.V.V., Sastry G. and Patnaik U.S. (1990) *Watershed Management*, Indian Council of Agricultural Research, New Delhi.
3. Frevert R.K., Schwab G.O., Edminster T.W. and Barnes K.K. (2009) *Soil and Water Conservation Engineering*, 4th Ed, John Wiley and Sons, New York.
4. Jain S.K. and Singh V.P. (2006) *Water Resources Systems Planning and Management*, Reed Elsevier India Pvt. Ltd., New Delhi.
5. *Monitoring & Evaluation for Results* (2009) World Bank Institute Training Program: South Asia Regional Course, New Delhi, February, World Bank Institute Evaluation Group, World Bank Institute.
6. Mukherjee A. (2004) *Participatory Learning and Action: Monitoring and Evaluation and Participatory Monitoring and Evaluation*, Concept Publishing Company, New Delhi.
7. Rao K.V.S. (2003) *Watersheds: Comprehensive Development*, B.S. Publications, Hyderabad.
8. Sharda V.N., Sikka A.K. and Juyal G.P. (2006) *Participatory Integrated Watershed Management: A Field Manual*, Central Soil and Water Conservation Research and Training Institute, 218, Kaulagarh Road, Dehradun.
9. Singh G.D. and Poonia T.C. (2003) *Fundamentals of Watershed Management Technology*, Yash Publishing House, Bikaner.

10. 19. Singh R.V. (2003) *Watershed Planning and Management*, Yash Publishing House, Bikaner.
11. Tideman E.M. (1999) *Watershed Management–Guidelines for Indian Conditions*, Omega Scientific Publishers, New Delhi.

EST- 404: RESEARCH METHODS FOR DISSERTATION

Marks: External 70

Internal 30

Unit	Topic	Credit	Lectures
UNIT-1	Basic concepts: Meaning, Objectives, Motivation and Approaches. Nature of Scientific Inquiry, science and logic, Types of Research Descriptive, Analytical, Applied, Fundamental, Quantitative, Qualitative, Conceptual, and Empirical. Research methods versus Methodology, Research and scientific method. Research Process.	1	14
UNIT-2	Research formulation: Observation and Facts, Prediction and explanation, Induction, Deduction. Defining and formulating the research problem, Literature review - Importance of literature reviewing in defining a problem, Critical literature review, and Identifying gap areas from literature review. Sampling Design and Fundamentals, Sample Size; Concept of Hypothesis Testing.	1	14
UNIT- 3	Research Design and its types; Methods of Data Collection, Sources of Data Collection- Use of Secondary Data and Methods of Collecting Primary Data, Observation and Interviews, Questionnaires and Schedules. Need for Multi-Disciplinary and Inter-Disciplinary Research.	1	14
UNIT-4	Writing the Research Report (Dissertation, publications, patents): Components of research report - Title, Authors, Addresses, Abstract, Keywords, Introduction, Materials and Methods, Results, Discussion, Summary, Acknowledgements and Bibliography. Use and availability of Internet resources for research, search engines and using advanced search techniques	1	14

INTERNAL EVALUATION

30 MARKS

(Seminar + term paper + test)

Reference Books:

1. Montgomery, Douglas C. (2007), 5/e, *Design and Analysis of Experiments*, (Wiley India).
2. Montgomery, Douglas C. & Runger, George C. (2007), 3/e, *Applied Statistics & Probability for Engineers* (Wiley India).
3. Clough,P.and C.Nutbrown.2002. *A Student's Guide to Methodology: Justifying Enquiry*. Sage, London.
4. Dharmapalan, Biju. 2012. *Scientific Research Methodology*. Narosa Publishing House, New Delhi.

5. Kothari C.R., 2009. *Research Methodology: Methods and Techniques* (2nd edn.). NewAge International Publishers, New Delhi.
6. Paul Oliver.2005. *Writing Your Thesis*. Vistaar Publications.New Delhi.
7. Ahuja,V.K. 2010. *Law of Copy Rights and Neighbouring Rights : National and International Perspectives*..Lexis Nexis- Butterworths Wadhwa, Nagpur.
8. Research Methodology – Text and Cases with SPSS Applications, by Dr S.L. Gupta and Hitesh Gupta, International Book House Pvt Ltd.

PRACTICAL

PRACTICAL ESP – 405 (BASED ON ENVIROMENTAL POLICY, ACTS, LAWS AND ENVIRONMENTAL MANAGEMENT SYSTEM AND ENVIRONMENTAL TOXICOLOGY)

ENVIROMENTAL POLICY, ACTS, LAWS AND ENVIRONMENTAL MANAGEMENT SYSTEM

Marks: External 35

Internal 15

1. Case Study on Air Pollution
2. Case Study on Noise Pollution
3. Case Study on water Pollution
4. Case Study on Solid-waste Pollution
5. Case Study on Hazardous Waste
6. Case Study on Biomedical waste
7. Case Study on Sardar Sarovar
8. Case Study on Tehri Dam
9. Case Study on Silent valley

ENVIRONMENTAL TOXICOLOGY

Marks: External 35

Internal 15

1. Estimation of Lead (Pb)
2. Estimation of Mercury (Hg)
3. Estimation of Cadmium (Cd)
4. Estimation of Tin (Sn)
5. To Study the Effect of Temperature on bacterial Growth.
6. Study the Effect of P^H on bacterial Growth.
7. Determination of LC 50
8. Determination of LD 50
9. Effect of H₂S on Plant material
10. Effect of NH₃ on Plant material
11. Effect of SO₂ on plant material

INTERNAL EVALUATION (Viva-voce + journal + data evaluation)

30 MARKS

PRACTICAL ESP – 406 (BASED ON WATERSHED MANAGEMENT AND RESEARCH METHODOLOGY)

WATERSHED MANAGEMENT

**Marks: External 35
Internal 15**

1. Study of drainage patterns.
2. Determination of contour intervals and profile.
3. Determination of drainage density.
4. Study of water holding capacity.
5. Study of wilting coefficient.
6. Estimation of peak runoff.
7. Estimation of soil erosion.
8. Studies based on bund geometry.
9. Demarcating contour intervals on the field.

RESEARCH METHODOLOGY

**Marks: External 35
Internal 15**

Project work/ Dissertation topic may be allotted by the department at the beginning of the III Semester. Each student will be allotted individual guide for the dissertation work. Dissertation work will be carried out in laboratory and/or supported by field work. A report has to be submitted and evaluated for the practical exam.

**INTERNAL EVALUATION
(Viva-voce + journal + data evaluation)**

30 MARKS