Annexure-I

M. Tech. Programme
in
Environmental Science and Engineering

COURSES OF STUDY
(Effective from Academic Session:2024-25)
(Batch 2024-2026)

P. G. Department of Environmental Sciences

SAMBALPUR UNIVERSITY
Jyoti Vihar-768019, Sambalpur, Odisha

SAMBALPUR UNIVERSITY
P.G. DEPARTMENT OF ENVIRONMENTAL SCIENCES

JYOTI VIHAR-768 019, ODISHA

REVISED COURSE STRUCURE AND CREDIT HOUR DISTRIBUTION IN M.TECH. IN ENVIRONMENTAL SCIENCE AND ENGINEERING
(Batch 2024-2026)

FIRST SEMESTER

Core Course No.	Title of the Course	Credit Hours
ESE 611	Fundamentals of Ecology and Environmental Sciences	3
ESE 612	Environmental Chemistry, Pollution and Control	3
ESE 613	Environmental Policies and Laws	3
ESE 614	Environmental Microbiology	3
ESE 615	Environmental Toxicology	3
ESE 616	Laboratory: Environmental Monitoring I	3
ESE 617	Seminar presentation	2
	Total Credit hours	**20**
ESDMS 419	Environmental Field Survey	2
	TOTAL CREDIT HOURS	**22**

SECOND SEMESTER

Core Course No.	Title of the Course	Credit Hours
ESE 621 A	Instrumental Techniques and application in Environmental Science and Engineering	3
ESE 621 B	Advanced Applied Statistics ,Environmental System Optimization and modelling	3
ESE 622 A	Environmental Impact Assessment, Environmental Audit and Environmental Management System Standards	3
ESE 622 B	Hazards Control and Management in Industries	3
ESE 623 A	Air Quality Management	3
ESE 623 B	Remote Sensing and Geographical Information System	3
ESE 623 C	Industrial Safety and Management	3
ESE 624	Laboratory: Environmental Monitoring II	3
ESE 625	Seminar Presentation	2
Elective Course	A student shall have the option to choose any one of the following groups of Elective Course consisting of two papers, each of 3CH	
	GROUP I: Pollution Control and Management in Mining Industries	

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ESE 626 A	Environmental Aspects of Mining Industries	3
ESE 626 B	Solid and Hazardous Waste Management and Land Reclamation	3
	GROUP II: Hydrology and Waste Water Engineering	
ESE 627 A	Hydrology	3
ESE 627 B	Waste Water Engineering	3
	GROUP III: Environmental Geology and Remote Sensing	
ESE 628 A	Environmental Geology	3
ESE 628 B	Remote Sensing and Geographical Information System	3
	GROUP IV: Green Technology and Management	
ESE 629 A	Green Technology and Sustainable Development	3
ESE 629 B	Soil Pollution and Waste Management	3
	Total Credit hours	**20**
IDC <Code as per the course opted>	Interdisciplinary Course	3
	TOTAL CREDIT HOURS	**23**

A candidate shall select any one elective paper each under ESE 621, ESE 622 & ESE 623

- At the end of Second Semester, each student shall undergo one-month summer training in an Industrial Establishment or Scientific Institution or any other organization and submit a Project Report on the activities for evaluation during Third Semester. The student may, in lieu of summer training, work on a minor project and submit the report for evaluation during the third semester.
- From the beginning of the third Semester, a student shall work on a dissertation under the supervision of a suitable Guide from the P.G. Departments or outside including Scientists and Technocrats from Industries and Corporate Sectors with the approval of the Academic Committee. The dissertation will be evaluated both during Third semester (Interim) and Fourth Semester. The student will read a paper on Research Methodology (ESE-713)
- ENS 623 B can only be opted by students who do not offer Environmental Geology and Remote Sensing group of Specialization

THIRD SEMESTER

Course No.	Title of the Course	Credit Hours
ESE 711	Research Methodology	4
ESE 712	Evaluation of Summer Training Report/Minor Project Report	4
ESE 713	Seminar and Viva-Voce on Summer Training Report/Minor Project Report	4
ESE 714	Evaluation of Dissertation(Interim) ,Seminar and Viva-Voce	8
	Total Credit Hours	**20**
EDPS 439	Entrepreneurship Development	2
MOOC's <Code as per the course opted>	MOOC Course is to be opted by the candidate <One Number>	3
	TOTAL CREDIT HOURS	**25**

REVISED SYLLABUS FOR 2 YEARS M.TECH. DEGREE IN ENVIRONMENTAL SCIENCE AND ENGINEERING
(Effective for 2024-2026 Batch)

I[st] Semester

ESE 611 Fundamentals of Ecology & Environmental Sciences 3CH

Objectives: Since the Stockholm conference sustainability of the Ecosystem has been an important point of discussion in the human society. At the same time development has been responsible for land use and land cover change and destruction of biodiversity and depletion of resources. Therefore, a student working in the area of Environment science needs to study the Ecosystem in terms of its structure, resource, biodiversity and human ecology. The course aims to provide the students with an understanding of structure and function of ecosystem, energy resources, biodiversity its significance, loss and conservation methods, population growth, economic development and their impacts on different components of the ecosystem.

Outcome: On completion of the course, the candidate will be able to understand a) the ecosystem structure and functions b) resources; their advantages and disadvantages c) factors affecting human population, d) environmental economics The student will develop skill to develop sustainable ecosystem model and will be imbibed with the knowledge on environmental ethics.

Unit-I: Concept of Ecosystem: Structure (component parts) and function (food chain, food web, energy flow, nutrient cycling, productivity) of ecosystem, examples of natural and man -made ecosystem and concept of biotic community.

Unit-II: Resources: Concept and classification with examples (renewable, non renewable and perpetual) , energy resource: fossil fuel (coal and petroleum) , hydroelectric, nuclear, geothermal, wind, tidal, solar, biomass energy, their advantages and disadvantages

Unit-III: Biodiversity: Definition, type of biodiversity, global distribution of biodiversity, mega biodiversity countries, biodiversity hot spots, significance of biodiversity, factors influencing biodiversity loss, IUCN classification and Red Data book, biodiversity conservation (in situ and ex situ)

Unit-IV: Human Ecology: Population growth, factors affecting human population (death rate, net population change, migration, fertility, age structure), human population control methods (biological & socio-cultural), economic development and demographic transition, environmental ethics, environmental economics, sustainable earth society.

Books & References:

1. Fundamental of Ecology, E.P. Odum, W.B Saconders
2. Fundamentals of Ecology M.C. Dash, Tata Mc Graw Hill
3. Ecology: Science and Practices, Fauria ,Ferra ,Medora and Devaux Oxford and IBH
4. Ecology: Principles and Applications, J. L. Chapman, M. J. Reiss, Cambridge University Press. 1999
5. Ecology: Concepts and Applications 7th Edition Manuel C Molles, Tata McGraw Hill
6. Fundamentals of Ecology 5th Edition, Eugene Odum , Gary W. Barrett Cengage Learning, USA

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6. Fundamentals of Ecology 5th Edition, Eugene Odum , Gary W. Barrett Cengage Learning, USA

FOURTH SEMESTER

Course No.	Title of the Course	Credit Hours
ESE 721	Evaluation of Dissertation	12
ESE 722	Seminar on Dissertation	4
ESE 723	Viva-Voce on dissertation	4
	Total Credit Hours	**20**
	TOTAL CREDIT HOURS FOR FOUR SEMESTERS	**90**

Questions will be asked from each unit with 50% choice for the students from each unit. The students shall be asked to answer four questions. A maximum of 50% of the questions should be of objective and short answer type. Full mark in each theory paper shall be 100 to be finally scaled down to Grade Point and the examination will be of 3 hrs duration. Practical Experiments and Fields projects will be designed by the concerned course teachers.

ESE 613 Environmental Policies & Laws 3CH

Objectives: The environment is degrading because of the human intervention on its different spheres. This demands implementation and refinement of national and internal laws and rules on environment and policy frameworks. The course aims to provide the students with an understanding on i) environmental policies ii) important acts and rules for prevention and control of pollution, iii) rules and notifications on waste management, and iv) Laws related to forest, wildlife and forest dwellers. The student will be exposed to different provisions under these policies, acts and laws.

Outcome:
On completion of the course, the candidate will be able to understand a) different national and international policies b) different acts and rules on prevention and control of pollution and protection of environment and c) forest and wildlife acts. Develop skill to participate and contribute to the areas where legal compliance on pollution and protection of environment is required.

Unit-I: Environmental Policies: Environment and constitutional provisions in India National & International Trend. Changes in Global Prospective, International Treaties. Environmental Conventions and Agreements: Stockholm Conference on Human Environment 1972, Montreal Protocol, 1987, Conference of Parties (COPs), Basel Convention (1989, 1992), Ramsar Convention on Wetlands (1971), Earth Summit at Rio de Janeiro, 1992, Agenda-21, Global Environmental Facility (GEF), Convention on Biodiversity (1992), UNFCCC, Kyoto Protocol, 1997, Clean Development Mechanism (CDM), Earth Summit at Johannesburg, 2002, RIO+20, UN Summit on Millennium Development Goals, 2000, Copenhagen Summit, 2009. IPCC, UNEP, IGBP. National Authorities: Green Tribunal

Unit-II: Acts relating to major pollution. Water Pollution act 1974 and Air Pollution Act 1981
Constitution of Central and State Pollution Control Boards, Power, Function and responsibility of Central and State Boards. Power and function of state and central Government, Responsibility of an industry, Cognizance of offence, Penalties and Punishment) The Environment Protection Act 1986. Necessity and Scope of the Act. Powers of the Central Government, Parallel Provisions with the Water and the Air act. The Public Liability Insurance Act 1991

Unit-III: Important rules & notification for Environment Protection: The Hazardous and Other Waste (Management and Transboundary Movement) Rules, 2016, The Plastic Waste Management Rules, 2016, The Bio-Medical Waste Management Rules, 2016, The Solid Waste Management Rules, 2016, The e-waste (Management) Rules 2016, The Construction and Demolition Waste Management Rules, 2016, The Manufacture, Storage and Import of Hazardous Chemical (Amendment) Rules, 2000, The Batteries (Management and Handling) Rules, 2010 with Amendments, The Public Liability Insurance Act, 1991 and Rules 1991, Noise Pollution (Regulation and Control) Rules, 2000, Coastal Regulation Zones (CRZ) 1991 amended from time to time.

Unit-IV: Laws relating to Forest, Wild life and Forest Dwellers: Brief account of The Forest Act 1927, Forest *conservation Act. 1980*: Objective and Jurisdiction, Responsibility of Industry. Wildlife Protection Act 1972 Authorities under the Act. Wild life Advisory Boards and their functions, Detection and prevention of offences. Cognizance of offences, The wildlife (protection) Amendment Act. 1991. Biological Diversity Act, 2002. National Forest Policy, 1988, National Water Policy, 2002, National Environmental Policy, 2006.

Selected References:

1. Hand Book of Environment,Forest and Wild life laws in India ,WPSI /Natraj
2 Environmental Science ,Santra ,Central
3. Environmental Law in India ,Gurdip Singh ,Quality Law Books

ESE 612 Environmental Chemistry, Pollution & Control 3CH

Objectives: The quality of air, water and soil are degrading day by day. There has been the necessity to generate trained manpower to prevent the pollution. Therefore, a student working in the area of Environmental science and Technology needs to understand different aspects of the air, water, soil and radiation pollution and their remediation methods. The course aims to provide the students with an understanding on i) the structure and physical as well as chemical functions of the air, water and soil, ii) pollution effects on air, water and soil and their prevention and control technologies.

Outcome: On completion of the course, the candidate will be able to understand a) Chemical, physical processes operative in the atmosphere, hydrosphere and pedosphere b) effects of pollution on atmosphere, hydrosphere and pedosphere and c) pollution prevention and control technologies. The student will develop skill to work in the areas of air, water and soil quality assessment and pollution remediation programs.

Unit-I: Water Chemistry, Pollution & Control: Unique Properties of water, water quality parameters: Physico-Chemical, biological & bacteriological, water quality Criteria and Standard sources and classification of water pollution. Pollution due to Municipal & domestic wastes, Industrial and agriculture wastes, eutrophication, Ecological magnification due to heavy metals & pesticides Conventional methods of waste water Treatment: Preliminary, Primary, secondary and Tertiary Treatment Removal of nitrogen & Phosphate from water. Water disinfection.

Unit-II: Atmosphere Chemistry, Pollution & Control: Structure and Properties of Atmosphere. Micrometeorology of atmosphere Type and Source of air pollution: Natural and man-made Chemistry of major air pollutants. Atmospheric Photochemistry, Chemical & Photochemical reactions in atmosphere. Ozone layer Depletion, Green House effect, Acid rain and Photochemical smog. Ambient Air quality, Control technologies for air pollution: absorption, adsorption combustion, mass transfer.

Unit-III: Soil Chemistry, Pollution and Control: The nature and importance of soil. Physical and Chemical properties of soil, pollution of soil by Municipal solid wastes. Soil Pollution by pesticides. Municipal solid wastes disposal and Management Control of Pesticide Pollution, Remediation of contaminated Soil. Biofertilizer and organic farming.

Unit-IV: Pollution due to Noise and Radiation: Basics of acoustics and Specification of sound. Sound intensity and sound pressure levels, Effect of noise on health, noise standards and limit values. Noise indices Noise instruments & monitoring procedure. Prevention and control of Noisae Pollution. Source and Classification of radiation. Units of measurement of radiation. Effect of radiation on environmental health. Control of radiation Pollution.

Books & References:

1. Environmental chemistry 10th Edition - Stanley E. Manahan, CRC Press,(2017)
2. Environmental Chemistry 7th Edition (2010) A.K. De, New Age International Pvt. Ltd.
3. Environmental Pollution. Man and Environment - M.C.Dash, & P.C.Mishra, Mcmillan Publication
4. Ecology, Chemistry & Env. Pollution -M.C.Dash, Mcmillan
5. Environmental Engineering: A Design Approach – 1st edition (1995) A.P. Sincero and G.A. Sincero, Prentice Hall
6. Air Pollution Control Equipment 1st Edition (1981) Brauer, H., Varma, Y. B. G., Springer-Verlag Berlin Heidelberg

Books & References:

1. Microbiology – Fundamentals and application R.M.Atlas ,Maxwell-Mcmillan International Ed. 1996
2. Broke –Biology of Microorganisms M.T.Madigan , J.M Martinko and J.Parker ,Prentice Hall International 1998
3. Microbiology -L.M.Prescott ,J.P.Harley and D.A.Klein , Tata Mc Graw Hill 2003
4. Fundamentals of Microbiology and immunology, A.K.Banerjee and N.Banerjee ,Central Book Deport 2006
5. Microbiology -Michael J. Pelzer,Tata Mcgraw Hill
6. Environmental Microbiology, Raina M. Maier, Ian L. Pepper, Charles P. Gerba, Elsevier

ESE 615 Environmental Toxicology 3CH

Objectives: Toxic substances are released to the environment by natural process and some developmental activities. This leads to hazards and pose risk on the human society. To minimize the toxicity related risk an understanding on the natural laws concerning toxicology, toxicity pathways and tolerance limits is required. The course aims to provide the students with an understanding on i) natural laws concerning toxicology ii) Body processes and their response to toxic substances iii) toxic effects of heavy metals and insecticides

Outcome: On completion of the course, the candidate will be able to understand a) natural laws concerning toxicology ii) absorption, distribution and excretion of toxic substances iii) Biotransformation and bioacumulation of xenobiotics. The student will develop skill to work in the areas where assessment of toxicity effects, toxicity related risk are important.

Unit-I: Introducing Toxicology: History, types of toxicology, Toxicity, Hazards, Risks, Benefit-to-risk-ratio, tolerance limits, Acceptable daily intake, Threshold value.

Unit-II: Natural Laws Concerning toxicology: Factors affecting toxicity: Host factor, Age, species and strain, sex, feed and feeding, Idiosyncratic toxicity, interaction between chemicals (synerism, antagonism). Environmental factors, Physico-chemical properties of toxic substances, route and rate of administration, Dose, Effect and response, Dose-response curves, & Dose effect relationships (Graded & Quantal response). Statistical concept of toxicity (Acute toxicity, margin of safety).

Unit-III: Absorption, Distribution and Excretion of toxic substances: Absorption: membrane permeability, mechanism of chemical transfer, absorption (Gastrointestinal, skin, lungs), Distribution: tissue affecting distributions and tissues retention. Excretion: Renal excretion, Biliary excretion and Gastrointestinal.

Unit-IV: Biotransformation and Bioaccumulation of xenobiotics: Mechanism of action of toxicants. Toxic action and toxic effect of heavy metals Mercury, Lead and Arsenic) and insecticides (DDT, Malathion & Carbaryl)

Books & References:

1. Gupta, P.K. (1986). Pesticides in Indian Environment. Inter Print, The University of Michigan. p 206.
2. Gupta, Toxicology. Vol I, II and III. Metropolitan book Co.
3. Ray Choudhury and Gupta. Environmental Pollution and Toxicology, Today 7 tomorrow Publ.
4. Moriarty, F. (1999). Ecotoxicology: The study of pollutants in the Ecosystem. Academic press. Elsevier. p 347.

4. CPCB: Pollution Control Acts, Rules and Notifications issued there under, Pollution Control Law series: PCLS/02/2010, GSR 475(E), Gazette no. 202 dated 05.05.92. Central Pollution Control Board (CPCB). Ministry of Environment and Forests. Government of India. Parivesh Bhawan, East Arjun Nagar, New Delhi. India. 1992.
5. CPCB: Pollution Control Acts, Rules and Notifications issued there under, Pollution Control Law series: PCLS/02/2010, GSR 422 (E), Gazette no. dated 19.05.93. Central Pollution Control Board (CPCB). Ministry of Environment and Forests. Government of India. Parivesh Bhawan, East Arjun Nagar, New Delhi. India. 1993.
6. Agrawal, K. C. (2000). Environmental Laws: Indian Perspectives. Nidhi Publisher, Bikaner.

Books and References:

1. Hand Book of Environment,Forest and Wild life laws in India ,WPSI /Natraj
2 Pollution Control Acts, Rules and Notifications issued under Central Pollution Control Board, New Delhi
3. Environmental laws, New perspectives K.C.Agrawal, Nidhi Publisher, Bikaner
4. Handbook of Environment ,Forest and Wildlife Protection laws in India WPSI,New Deli Natraj Publ. Dehradun
5. Wild Life of India ,Conservation and Management- K.C.Agrawal ,Nidhi Publisher
6. Environmental Law in India ,Gurdip Singh ,Quality Law Books

ESE 614 Environmental Microbiology 3CH

Objectives: Microbial organisms play an important role for the sustenance of the environment. Sometimes it is also necessary to save the human society from the adverse effects of the microbes. Thus there has been the necessity to generate trained manpower to prevent the loss of microbes and loss caused to animal kingdom by microbes. The course aims to provide the students with an understanding on i) the microbial diversity in different spheres of the environment ii) microbial culture, growth and metabolism iii) physical and chemical techniques used to control microorganisms and iv) use of microbes for different purposes.

Outcome: On completion of the course, the candidate will be able to understand a) cellular organization of microbes ii) microbial biodiversity iii) Microbial culture, iv) techniques to control microbes and use microbes for different purposes The student will develop skill to work in the areas where microbes are employed to control air, water and soil pollution and in areas where microbes are used to increase the fertility of the soil.

Unit–I: Fundamentals of environmental microbiology: An over view of microbial diversity (Archaea, Eubacteria, Eukaryotic microbes) cellular organization of bacteria and their types and distribution, microorganisms as component of the environment

Unit-II: Microbial culture, growth and metabolism: Concept of microbial culture (culture media, culture techniques like enrichment culture, pure, synchronous and continuous culture), microbial growth (different growth phases, multiplication and kinetics of growth), microbial metabolism (aerobic, anaerobic, fermentative pathways)

Unit-III: Control of microorganisms: Physical agents (temperature, pressure, radiation), chemical agent (bacteriocidal and bacteriostatic compounds, halogens and phenolics) for control of microbes, chemotherapeutic agents (drugs and antibiotics) and their mode of action

Unit-IV: Applied microbiology: Microbes as biofertilizers, biopesticides and single cell protein, mycorrhiza and their significance, microbial leaching of metals, microorganisms as source of fuel, role of microbes in degradation of xenobiotics, microbes for biological treatment of waste water.

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II[nd] Semester

ESE 621 A Instrumental Techniques & Application in Environmental Science & Engineering 3CH

Objectives:
Identification of the presence of chemical species in the different entities of the environment and estimation of their concentration in those entities are necessary for assessment and management of the environmental quality. Thus, there has been the need to generate trained manpower to analyse different chemical species using sophisticated analytical instruments and techniques. The course aims to provide the students with an understanding on i) the spectrophotometry, ii) mass spectrometry iii) electrochemical methods and iv) chromatographic techniques for the identification and concentration estimation of different chemical species in environmental samples.

Outcome: On completion of the course, the candidate will be able to understand the principles and techniques of a) spectrophotomentry b) Electrochemical methods, c) Chromatography and d) Fluorimetry, Nephlometry and ICP-MS . The student will develop skill to i) work in the NABL recognized state and national and laboratories where environmental samples are analysed and to ii) use these techniques in research.

Unit-I: Principles of Instrumentation, advantage, applications and limitations of the following analytical techniques Spectrochemical Methods: Spectrophotometry, FTIR, NMR, Atomic Absorption and Emission spectrophotometers,

Unit-II: Applications and limitations of following analytical techniques. Fluorimetry, Nepheleometry, Inductively coupled plasma spectrometry and MS

Unit-III: Electrochemical Methods: Polarography,Pulse Polarography, Ion selective electrodes Oscilloscopic polarography, cyclic voltametry, anodic stripping Voltametry.

Unit-IV: Chromatography: Classification, General ideas about adsorption, partition and column Chromatography, paper and Thin layer chromatography, Gas Chromatography, High Performance liquid Chromatography, Ion Chromatography

Books & References:

1. Instrumental Methods of Analysis-H H Willard & L L Dean John Willey
2. Modern Methods of Chemical Analysis-R.L.Recsok and L.D. Shields Johnwiley & Sons
3. Instrumental Methods of Chemical analysis-G.W.Euing Mc Grand Hill
4. Fundamentals of Molecular Spectroscopy-C N Banwell, Mc Grad Hill
5. Instrumental Methods of Chemical analysis-Chatwal and Anand Himalay Publ.

ESE 621 B Advanced Applied Statistics, Environmental System Optimization & Modelling 3CH

Objectives: Statistical Modelling is an important tool for the understanding of the Environmental processes and development of management methods. The models are based on different statistical measures and algorithms. The models provide solutions to environmental problems. Therefore, it is necessary generate trained manpower with skill to analyse and interpret the environmental data on spatial and temporal scales. The course aims to provide the students with an understanding on i) research designs, ii) non parametric and parametric tests iii) model constructions and their validation in the areas of waste water treatment, air pollution control etc.

5. Omkar, Ahmad Pervez and Prof. Bhoomittra Dev (2017). Concept of toxicology. Vishal Publishing Co. p.295
6. Sood, A. Toxicology. Sarup and Sons. New Delhi.

ESDMS 419 Environmental Field Survey 2CH

Objectives:
Survey of different components of the environment are necessary for assessment and management of the environmental quality. Thus, there has been the need to generate trained manpower to ably survey the different components of the environment. The course aims to provide the students with an understanding on survey techniques relating to Biodiversity, Soil, Water, Air, demography and impact assessment methodologies

Outcome: On completion of the course, the candidate will be able to understand the principles and techniques of survey relating to a) Biological entity b) Physical Entity, c) Sociological Entity and d) Environmental Impacts

Unit-I: Biological Entity: Flora: General vegetation patterns, Plant species, Tree species, Rare plant species in entire area, Others Fauna: Amphibians, Reptiles, Mammals, Birds, Rare faunal species. Biodiversity: surface, below ground

Unit-II: Physical Entity: Water Quality, Air Quality, Noise Level, Traffic Density, Wind Velocity and Direction, Soil Quality

Unit-III: Sociological Entity: Socio-economic survey procedures, Likert Scale, Bogardus Social, Thurstone Scale, Semantic Differential Scale

Unit-IV: Environmental Impact Assessment Matrices: Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods

1. Kothari, C.R. (2016). Research Mehoodology: Methods and Techniques. New age international, New Delhi, p. 403
2. *Hill, D., Fasham, M. Tucker, G., Shewry, M. and Shaw, P. (2005). Handbook of Biodiversity Methods: Survey, Evaluation and Monitoring. Cambrideg University Press. 573 p.*
3. Anjaneyulu, Y. and Minickam, V (2007) Environmental Impact Assessment Methodologies: BS Publications, Hyderabad, p.437 p.
4. CPCB (2011) Guide Manual: water and Wastewater Analysis, p.183
5. CPCB (2011). Guidelines for the measurement of Ambient air pollutants, p. 243
6. USDA (1993). Soil Survey Manual

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various projects. e) acquire basic skills to take up environmental auditing and lifecycle analysis at specific industries.

Unit-I: Origin and Development of EIA. Frame work for Environmental Impact Assessment screening, scoping and baseline studies. Techniques for assessment of impacts on Physical resources, ecological resources, human use values and quality of Life values. Relationship of EIA to sustainable Development. EIA in Project planning & Implementation, EIA process: Evaluation of proposed action: Scoping EIA methodologies, Role of GIS in EIA baseline studies. Risk Assessment and Risk Management: Mitigation measures, comparison of alternatives, Reviews and decision making, compensatory action, EIA notifications/regulations in India, Green belts: Review of procedure, practices and guidelines in India. EIA vs.SEA, Carrying capacity, Cummulative impact assessment.

Unit-II: Case Studies on EIA: EIA of a) River valley Projects, b) Thermal Power Plants, c) Mining Projects d) Integrated Iron and Steel Industries, e) Cement Industries, f) Alluminium industry g) Oil Refineries and Petrochemicals g)Tourism h) Coastal zone Development.

Unit-III: Environmental Audit: Concept of Environmental Audit, Objectives of Audit, Types of Audit, Audit methodology, Features of effective auditing, Elements of audit process, Programme Planning, Organisation of auditing Programme, Pre-visit data collection, Audit Protocol, On site audit: Data sampling, Inspection, Evaluation and Presentation, Audit report, Action Plan, Management of audit, Waster audits and pollution prevention assessment, Liability audit and site assessment, auditing of EMS, SWOT Analysis (Strength, Weakness, Opportunities and Threats analysis) for EIA, Audit Assessing, Economic & Environmental benefits direct from Environmental Audit.Life Cycle Assessment

Unit-IV: Environmental Management System Standards: Core elements of EMS, Benefits of EMS, Certification Body Assessment of EMS, Documentation for EMS, EMS standard (ISO 14000 series): evolution, principles and structure, supporting systems, EMS specification standards & Certification procedures, EMS specification standards:ISO14001, Benefits of Implementing ISO 14001: Indian scenario.

Books & References:

1. Environmental Impact Assessment: Canter, L.W. 1977. Mc Graw Hill, New York
2. Environmental Impact Assessment Methodologies: Anjaneyulu, Y. and Minickam, V., BS Publications, Hyderabad
3. Environmental Quality Management: Bindu N Lohani 1984, South Asia Publ.
4. Environmental Impact Assessment: Alan Gilpin 1995, Cambridge Univ. Press
5. A guide to the implementation of the ISO 14000 series on Environmental Management-Ritchie I and Hayes co Prentic Hall New Delhi .
6. Kulkarni, V. and Ramachandra, T.V. (2009). Environmental Management, TERI press, New Delhi

ESE 622 B Hazards Control and Management in Industries 3CH

Objectives: The demand for trained practitioners in environmental assessment at both the project level (environmental impact assessment (EIA)) and the strategic level (strategic environmental assessment (SEA)), and related environmental management fields continues to grow. To meet this demand, the course on EIA, EA and EMSS provides an opportunity for specialist study in this area. The course aims to provide the students with an understanding of theories and techniques in environmental assessment management, and environmental auditing and imbibe them with skills in analytical decision-making, design and project management. This course aims at apprising the students with an insight into environmental impact assessment (EIA) methodologies, environmental settings, prediction, evaluation of impacts and their mitigation plan. The students will be inculcated with the capabilities to interpret environmental management plans and EIA documents. A comprehensive understanding of the need and procedures for environmental auditing will be provided to the students.

Outcome: On completion of the course, the candidate will be able to: a) Understand the methods and tools of identification, prediction and evaluation of environmental impacts of developmental projects, b) Understand the

Outcome: On completion of the course, the candidate will be able to understand the principles and methods of statistical techniques such as a) research designs b) use of different statistical parameters for interpretation of data, c) model construction. The student will develop skill to work in the programmes involving forecasting and remediation of pollution through models.

Unit-I: Review of binomial, Poisson and Normal Probability distribution. Test of significance for Mean, Variance, correlation and Regression Coefficients, $\chi 2$ test and Goodness of fit, Attributes and contingent tables, Analysis of Variance (One & two ways), Complete randomized Design, Randomized block design, Latin Square design

Unit-II: Nonparametric tests: Wald – Wolfowitz run test, Test of randomness, Median Test, Sign test, Mann – Whiteney wilcoxon U-test. Time series Analysis, Introduction to reliability and Life testing experiments in engineering problems.

Unit-III: System approach. Concept and analysis, Problems formulation, Model Construction and deriving solutions from models. Modeling of Waste water management systems – Model General Liner Programming Models formation & Solution for Air Quality Management. Optimization Model for planning municipal wastewater treatment.

Unit-IV: Application of Integer programming to municipal solid waste Management. Transportation Models. Dynamic programming models – application to land use planning and air pollutants emission control

Books & References:

1. Fundamentals of applied Statistics–S.C. Gupta & V.K.Kapoor Sultan & Chand
2. Miller and Freunds Probability and statistics for Engineers- Richard A Johnson
3. Hand book of Environmental and Ecological Modeling-Halling-Sorensen B, Nielsen S N. and Jargensen, S.E.,Lewis Publ.
4. Fundamentals of Atmosphere Modeling-Jacobson Mark Z, Kluar Academic Press
5. An Introduction to water quality Modeling James A.(ed)
6. Statistical methods for Environmental and Agricultural Science-A Reza Hoshamand CRC Press

ESE 622 A Environmental Impact Assessment, Environmental Audit and Environmental Management System Standards (EIA, EA and EMSS) 3CH

Objectives: The demand for trained practitioners in environmental assessment at both the project level (environmental impact assessment (EIA)) and the strategic level (strategic environmental assessment (SEA)), and related environmental management fields continues to grow. To meet this demand, the course on EIA, EA and EMSS provides an opportunity for specialist study in this area. The course aims to provide the students with an understanding of theories and techniques in environmental assessment management, and environmental auditing and imbibe them with skills in analytical decision-making, design and project management. This course aims at apprising the students with an insight into environmental impact assessment (EIA) methodologies, environmental settings, prediction, evaluation of impacts and their mitigation plan. The students will be inculcated with the capabilities to interpret environmental management plans and EIA documents. A comprehensive understanding of the need and procedures for environmental auditing will be provided to the students.

Outcome: On completion of the course, the candidate will be able to: a) Understand the methods and tools of identification, prediction and evaluation of environmental impacts of developmental projects, b) Understand the legal requirements for getting environmental clearance for new projects c) equipped with the requirements to become EIA consultant. d) equipped with the requirements to be a part of EIA team to conduct EIA study for

Unit-II: Air Quality Monitoring: Ambient air quality monitoring. Methods of air pollutant analysis. Stack monitoring. Biomonitoring of air pollution. Design of monitoring net work

Unit-III: Air Quality Management: Source-emission inventory. Air quality criteria. Air quality standards (Ambient and Emission Standards). Dispersion air pollutants into the atmosphere. Lapse rate. Negative lapse rate and inversion. Impact of winds on dispersion of pollutants. Lapse rate and dispersion of pollutants. Impact of atmospheric pressure, moisture and precipitation.

Unit-IV: Industrial Air Emission, Prevention and Control: Natural self cleansing properties of the environment. Dilution methods for controlling air pollution from stationary source. Prevention methods control of particulate pollutants in industries. Gravitational settling chambers. Centrifugal collectors. Wet scrubbers. Fabric filters & Electrostatic precipitation. Control of gaseous pollutants (Absorber. Absorber & Combustion)

Books & References:

1. Air pollution Control Engineering. Noel de Nevers Mc Graw Hill
2. Air Pollution, its origin & Control-Kennneth work & Cecil F Warner. J.E.P Newyork
3. Air Pollution Control Equipments-H Braur & YBG Verma Springer Verlag
4. Air Pollution-P. K. Goel
5. Environmental Engineering-G. Kiely. Tata MC. Graw Hill
6. Sewage Disposal & Air Pollution Engineering-S.K.Garg. Khanna Publisher

ESE 623 B Remote Sensing and Geographical Information System 3CH

Objectives: Remote Sensing and GIS techniques are versatile tools to handle, manipulate and interpret the spatial and temporal data. The environmental attributes are interpreted in both the spatial and temporal domain. Therefore a student opting for Environmental Science and Engineering should be trained to understand and use the tools of remote sensing and GIS. The course aims to provide the students with an understanding on i) Electromagnetic radiation and its use in remote sensing, ii) principles and data acquisition mechanism of Remote sensing satellites, iii) digital image processing, iv) GIS to handle spatial data.

Outcome: On completion of the course, the candidate will be able to understand the principles and applications of Remote Sensing and GIS techniques in the Environmental monitoring, forecasting and management. The student will develop skill to work in the programmes in industrial and government sectors that involve the study on spatial and temporal data on different entities of the environment.

Unit-I: Introduction to Remote Sensing: Principles of Remote sensing. Physical basis of Remote sensing. The nature and generation of Electromagnetic radiation (EMR) Interaction of EMR with the atmosphere and earth's surface features, spectral quantities Spectral signatures and characteristics spectral reflectance curves for rocks, soil vegetation and water features within near and near Infrared

Unit-II: Remote Sensing Observation and platforms. Air borne and space borne platform their relative importance and applications. Aerial Stereo coverage and Remote Sensing Satellites. Sensors Aerial cameras and type of aerial photography, single and multi band scanners USS sensor and other type of sensors Details of sensors on board latest Earth resources Satellites viz. LANDSAT 6/7/8, SPOT, IKONOS, IRS, and ERS.

channels Essential rules for communication, Two way communication Barriers in communication, essentials of effective communication.

Unit-4: Organisational Behaviour & Safety: Human behaviour: industrial difference, behaviour as function of self and situation, perception of danger and acceptance of risk, knowledge and responsibility Vis-a Vis Safety performance, theories of motivation and their application to safety. Role of Management, Supervisors and Safety. Department in motivation, Psychological factors in industrial Safety. Conflicts & Frustration: Identification of situations leading to conflicts & Frustration & techniques of Management. Safety Education & Training and Employees Participating in Safety.

Books & References:

1. Industrial Safety Hand Book IInd Ed. William Handley, Mc Graw Hill Book Co. UK
2. Occupational Accident Prevention, Judson & Brown, John Wiley, New York
3. Protecting Personnel at hazardous waste sites. S P Levine Martin Butterworthy Publishes, Landon
4. Techniques of safety Measurement. Dan Paterson II ed.-Mc Graw Hill, New Delhi
5. Occupational Accident Prevention Judson & Brown. Hohn Wiley, Landon.

ELECTIVES

Group I Pollution Control and Management in Mining Industries

ESE 626 A Environmental Aspects of Mining Industries 3CH

Objectives: The quality of air, water and soil are degraded by the mining activities. The mining activities change the landscape and there is risk of land subsidence in mining belts. Thus, there is necessity to generate trained manpower to take appropriate timely measures to prevent hazards in the mining sectors. The course aims to provide the students with an understanding on i) mining related impacts on the environment, their prediction and prevention ii) mine closure principles.

Outcome: On completion of the course, the candidate will be able to understand a) landscape analysis and planning b) abatement and control of air and noise pollution in mining areas, c) prediction of deformation and subsidence and their management and d) environmental laws related to mining industries. The student will develop skill to work in environment related issues in mining industries.

Unit-I: Mining and the Environment Mineral production, history of environmental problems, casual aspects, range and importance, Nature and extent, influencing factors. Visual Impact. Sources, Landscape analysis and planning.

Unit-II: Air Pollution: Mining related pollutants. Emission factors, abatement and control, Water pollution. Water in mineral industries, nature and effect, abatement and control, Noise and air blast. Sources and levels, remedial measures. Blast vibration Ground vibration due to blasting measurement and recording, Damage and nuisance criteria and standards.

Unit-III: Land degradation: Causes and abatement, Reclamation: Reclamation of mind land and waste dumps, specific problems, revegetation, case subsidence: Prediction of deformation and damage, subsidence damage control Waste utilization waste – quantity and types, current uses and emerging trends. Social impacts of mining & its management.

Unit-IV: Mine closure Principles: Planning, financial provisions, implementation, standards for closure criteria Process: System approach, developing closure plans, progressive and final mine closure. Environmental laws related to mining environment: Overview, Provisions of MMDR Act, MCR and MCDR General and specific environmental standards applicable to mining under various laws.

Unit-III: Digital Image Processing Introduction to digital structure and data recording format sets, Image Restoration, Enhancement and classifications, Significance of Ground Truths and Training Sets in Image Processing and in automated processing. Visual Photo-Interpretation Techniques based on Photo elements and Terrain elements.

Unit-IV: Geographic Information system: Introduction, Definition and Terminology, Map Protection and Co ordinate system, GIS system hardware, software and infrastructures. Basic Components of GIS software. Data structures. Data models, Data acquisition, Data Input and Data processing and management including topology, DEM/DTM generation, overlying and Integration and final data product and report generation Integration of Revenue sensing and GIS techniques and its applications in Environmental Impact Assessment and management including some case studies.

Books & References:

1. Remote Sensing and GIS Angi Reddy M. The Books Syndicate, Hyderabad, 2000
2. Principles of Geographical Information Systems-P. A Burrough and R. A. Mc Donnel, OUP, Oxford, 1998.
3. Remote sensing for Earth Resource-Rao, D. P., AEG Publication, Hyderabad, 1987.
4. Geographical Information System-Kang Tsung Chang, Tata Mc Graw Hill, Publication Edition, 2002
5. Remote Sensing and Its Application –LRA Narayan University Press
6. Remote Sensing of the Environment: An earth resource Perspective. Jensen, J. R.. Dorling Kindersley India Pvt. Ltd. (Indian edition). 2009

ESE 623C Industrial Safety and Management 3CH

Objectives: Safety in an Industrial sector is a primary requisite for the health and life of workers and also for the well being of the surrounding environment. The Industrial safety involves management concept. Therefore, a student opting for Environmental Science and Engineering should be trained to understand and use the tools of Industrial safety and management. The course aims to provide the students with an understanding on i) the concept of management, ii) the leadership styles in safety management, iii) role of psychological and behavioral factors in safety in industry iv) the principles of accident prevention in safety planning.

Outcome: On completion of the course, the candidate will be able to understand different management objectives and its role in industry safety policy formation. The student will develop skill to assesses the possibility of incident in an industry and can develop appropriate management plan to prevent accident.

Unit-1: Management: Concept, definition, nature and importance, Evaluation of Management thought and Principles. Role and function of Managers, Elements of Management functions. General Principles of Management, Managerial role, authority, responsibility and Power. Delegation and decentralization of authority.

Unit-2: Principles of Accident prevention & Safety Planning: Definitions of Incident, accident, Injury, dangerous occurrences, unsafe acts, unsafe conditions hazards, error, oversight, mistakes etc. Theories/Models of accident occurrences. Principles of accident prevention: Definition, purpose, nature, Scope, Nature, Scope and procedure of planning, Range and varieties of plans. Strategic Planning and process of implementation, Management objectives and its role in Safety Policy formation.

Unit-3: Organising and Directing for Safety: Definition, need, nature and principles of organizing, organizing structure and safety Department Structure and Function of Safety Committee Staff Function on safety. Definition, process, principles and Techniques of direction. Leadership, its role, function and attributes. Leadership styles in Safety Management Communication, its purpose, process, types and

Books & References:

1. Solid Waste Engineering Principles & Management Issues-G. Tchobanoglous, GH Theisen & R. Eliassen-Mc Graw Hill Int. Ed. Singapore 1977
2. Environmental Engineering. HS Peavy, DR Rowe & G. Tchobanoglous. Mc Grow Hill Int. Ed. Singapore, 1985
3. Quarry Reclamation-N J Goppin and AD Bradshaw, Mining Journal Books, London 1982
4. Hazardous Waste Management (2nd ed) Lagrega MD, PL Buchingham & JC Evans Mc Graw Hill NY 2001
5. Bioremediation Principles-Eweis, JB Ergas SJ, Chang DYP and Schroeder ED. Mc Graw-Hill. Singapore, 1998.

Group II: Hydrology and Waste Water Engineering

ESE 627 A Hydrology 3CH

Objectives: Water is the elixir of life. The hydrological cycle is the most precious cycle linking all the spheres of the environment. Development perturbs the hydrological cycle. Therefore in any region it is essential to assess the hydrology and adopt water quality management methods. Thus, there is necessity to generate trained manpower to assess the water availability of a region, change in water quantity with time and to take appropriate timely measures to prevent pollution of the water bodies. The course aims to provide the students with an understanding on i) hydrological cycles and hydrographic analysis ii) groundwater quantity and quality assessment, iii) water quality management iv) water supply methods.

Outcome: On completion of the course, the candidate will be able to understand a) concepts on surface and subsurface hydrology b) concepts on water demand and water quality management and c) water sop[ply methods . The student will develop skill to work in watershed planning and management, city water supply progammes of government and corporate sectors.

Unit-I: Concepts of Hydrology: Definition, the hydrologic cycle, the hydrologic budget. Surface water and ground water. Basic hydrologic principle, precipitation, abstraction, rainfall, run-off. Catchment, drainage pattern, drainage area, basin shape, basin relief. Peak discharge analysis. Hydrographic analysis, subsurface analysis, soil characteristics. Hydraulics: Flow regimes, Bernouli's equation, Hazen-William equation, Flow measurement, Manning equation. Various methods of catchment routing. Assessment of routing techniques.

Unit-II: Concepts of Ground Water: Water resource and water supply. Aquifer properties and ground water flow, hydrological characteristics of aquifers, porosity and permeability, transmissivity, specific retention, diffusivity. Laws of ground water movement: Darcy's law and equation of groundwater flow, well hydraulics. Aquifer safe yield. Causes of groundwater pollution, diffusion and dispersion of pollutants.

Unit-III: Water Quality Management: Concept of water demand and water quality management. Overview of water treatment process: theory and application. Sedimentation: Type 1, Type 2, Type 3 settling, settling operation, design and construction of sedimentation tank. Coagulation dose, coagulation practice – rapid mixing, design consideration. Flocculation processes – design aspects. Water softening – single stage and two stage, recarbonation, ion exchange, filtration. Filter hydraulics, filter components, operation and design aspects of slow and rapid sand filters, dual-media filter and mixed media filter. Disinfection-chlorination and other means of disinfection. Removal of dissolved solids. Fluoride, iron and manganese removal. Operation of water distribution net-work systems.

Books and References:

1. Environmental Impact of Mining-Down CG and Stocks J Applied Science Publishers , London 1978
2. Environmental Impacts of Mining Monitoring, Restoration and control lewis Publishers, Boca Raton 1993
3. Best Practices Environmental Management in Mining-EPA (Australia) 1997-2004
4. Tailing Management-Ritcey GM Elsevier 1997
5. Environmental Management in Mining Areas – Saxena NC. Singh Gurdeep and Ghosh R.(Ed), Scientific Publishers (India) Jodhpur 2003.

ESE 626 B Solid & Hazardous Waste Management & Land Reclamation 3CH

Objectives: Human activities generating waste in different form and scales from different sectors viz. municipal, medical, industries etc. Wastes if not properly disposed lead to environmental problems. Some wastes are hazardous and their management and disposal require appropriate scientific methods. Therefore it is necessary to train the students of Environmental Science and Engineering to learn appropriate techniques for solid and hazardous waste disposal. Further, land reclamation being sometimes associated with the waste disposal a student is required to learn the land reclamation techniques. The course aims to provide the students with an understanding on i) solid waste disposal methods including municipal, biomedical and industrial wastes ii) land reclamation methods.

Outcome: On completion of the course, the candidate will be able to understand a) different engineering, biological and bio-engineering methods on solid waste management b) Land reclamation planning, methods and monitoring mechanism, d) regulatory framework on biomedical wastes .The student will develop skill to work in waste management related issues in government and corporate sectors.

Unit-I: Solid Waste Management: Municipal solid waste management, Engineering principles. Sources, nature and characteristics, quantitative and qualitative, solid waste problems Industrial mining, agricultural and domestics (Urban) waste, Hydrologic aspects of solid, Regulatory aspects of solid waste management

Unit-II: Solid waste disposal: sanitary landfill planning, site selection, design and operation, equipment, costs, Aerobic landfill stabilization, Biological oxidation composting, optimum conditions for composting Pyrolysis, Incineration-waste characterization, combustion calculation, unit operation, supply of air, products of combustion, furnace temperature, Fumes calculation. Storage of refuse, waste reduction and environmental control.

Unit-III: Biomedical waste categorization, generation, collection, transport, treatment and disposal. Hazardous waste-landmark episodes. Classification, generation. Guidelines for HWM. Regulatory framework in the USA, EU and Indian, Basal Convention and other international statistics. Treatment and disposal remediation of contaminated sites, Disposal & Management of Fly-ash & Red mud.

Unit-IV: Land Reclamation: Reclamation planning-pre-project land use planning. Post project land use monitoring, physical reclamation – regarding and recontouring, terracing, slope preparation, segregation and burial of toxic substance, reclamation alternatives, reclamation equipment, scheduling and costs. Factors affecting plant establishment. Soil characteristics physical, chemical and biological; soil amendments, selection of species, ecological succession theory, top soil conservation, mine spoil evaluation, nitrogen fixation, mycorrhiza, financial aspects of reclamation Current bioremediation practice and application, factors influencing bioremediation, bioremediation system and process, In situ bioremediation.

Unit-IV: Ecotechnology for Treatment of Wastewater, Management Of Waste Water through Land Treatment, Utilization of Biological Waste in Aquaculture, Root Zone Technology, Membrane Technology, and Water Hyacinth – Based Waste Water Treatment Systems.

Books & References:

1. Wastewater Engineering Treatment disposal Reuse – Metacalf & Eddy Inc. 4th ed TMGH ,New Delhi, 2003
2. Environmental Engineering Peavy,HS, Donald RR & G Tchobanoglous MGH Int. Ed. New York 1985
3. Wastewater Treatment for Pollution Control – Soil J Arceivala, Tata Mc Graw Hill 2nd ed. 1998
4. Wastewater Treatment Plants: Planning, Design and Operation-S.R. Qasim, Holt, Rinehart & Winston, NY.1985
5. Industrial Water Pollution Control – WW Eckenfelder, Jr. McGraw Hill 2nd Edition NY 1989
6. Sewage Disposal and Air Pollution Engineering, S.K. Garg, Khanna Publisher

GROUP III Environmental Geology and Remote Sensing

ESE 628 A Environmental Geology 3CH

Objectives: Human society is intricately associated with the Geological endowments and processes. We get resources from the earth. Earth processes at times results in hazardous situations for human society. Human activities also affects the geological endowments of a region. Thus, there is necessity to generate trained manpower to assess the earth's environment and its change in space and time to take appropriate disaster management plans. The course aims to provide the students with an understanding on i) concepts on earth processes ii) land-use planning and disaster management iii) geo-ecological reconstruction.

Outcome: On completion of the course, the candidate will be able to understand a) geological processes and timescales b) geological hazards c) soil capabilities assessment d) geo-ecological reconstruction methods. The student will develop skill to work in watershed planning and management, disaster management, eco-restoration programmes of government and corporate sectors.

Unit-I: Environmental geology: Its importance and scope. Earth resources-renewable and non-renewable. Formation of rocks. Their common types, composition and physical properties, Weathering, erosion transportation, deposition, structural relations and formation of landforms. Concept of geological time scale. Geological studies required for safety and long life of dams and reservoirs, highways, tunnels and building.

Unit-II: Geological studies for constructing roads on hill slope and safe waste disposal, Impact of geological and geographical characteristics on human life. Mining and geo-environment; environmental impacts of geological hazards: earthquake, landslide, floods and dams. Soil capability classification Impacts of various human, industrial and natural activities on soil and their management.

Unit-III: Disaster Management: Concept of land-use and land use planning. Land degradation due to human and industrial activities Principle and procedures of land protection and management. Preparation of consequence maps and consequence charts. Principles of land use planning.

Unit-IV: Characterization and classification of degraded Soil – plant-animal combination for speedy reclamation. Financial aspects of land management. Land management modeling, development of alternative scenarios. Geo-ecological reconstruction of mining degraded lands

Unit-IV: Water Management and Water Supply Methods: Meteorology, watershed characteristics, drainage area, watershed relief. Storm water management, channel and reservoir routing. Dams and barrages. Soil surveys and land capability classification. Erosion and sedimentation. Measures for erosion control, watershed/catchment modeling. Hydrologic design criteria. Water Supply: Aqueducts and water pipes, Collection and distribution of water, Quality of water supply.

Books & References:

1. Water Resources Engineering – Larry W Mays Wiley Text Books 2000
2. Water quality and treatment Handbook-American Water Works Association Mc Graw Hill Publ. 1999
3. Water supply and Sewerage – Steel and Mc Graw Hill NY latest ed
4. Environmental Hydrology-Eds Andy D Ward & William J. Eiliot, Lewis Publishers p 995
5. Hydrology and Quality of Water Resources-MJ Hammer & KA Mackichan. John Wiley & Sons NY, 1981
6. Hydrology – H M Ragunath, Wiley Eastern Limited 1990

ESE 627 B Waste Water Engineering 3 CH

Objectives: Wastewaters are generated from settlements and industries. To have water for different human usages, there is necessity to generate trained manpower to supervise the treatment of waste water for purification. The course aims to provide the students with an understanding on i) sewage and sewer design and ii) wastewater treatment methods.

Outcome: On completion of the course, the candidate will be able to understand a) concepts on Sewage characterization, b) Hydraulic designs of sewers c) wastewater treatment methods. The student will develop skill to work in industries and municipalties where wastewater are treated through effluent treatment plants.

Unit-I: Sewage Characteristics: Quantity and Quality of Sewage, Types of Sewage and Sewerage Systems, Variations in Sewage Flow and their Effects on the Design of Various Components of a Sewerage Scheme. Hydraulic Design of Sewers: Chezy's Equation, Kutter's Equation, Crimp and Burge's Formula, William-Hazen Equation. Maximum and Minimum Velocities to be Generated in Sewers. Construction of Sewers (Asbestos Cement Sewers, Plain and Reinforced Cement Concrete Sewers, Vitrified Clay or Salt Glazed Sewers, Brick Sewers, Cast Iron and Plastic Sewers), Sewer Appurtenances.

Unit-II: Wastewater Treatment: Wastewater Flow Rates and Characteristics, Design of Wastewater Networks. Wastewater Treatment Processes: Preliminary, Primary Treatment Processes, Secondary Treatment: Activated Sludge System, Attached Growth System, Nutrient Removal, Secondary Clarification. Advanced Treatment Process, Disinfection, Problem Solving

Unit-III: Anaerobic Digestion and Sludge Treatment: Anaerobic Digestion , Microbiology of Anaerobic Digestion , Reactor Configuration , Methane Production , Application of Anaerobic Digestion, Biosolid Characteristics, Processing Routes for Biosolids ,First Stage Treatment of Sludge, Second Stage Treatment of Sludge, Sludge Disposal, Integrated Sewerage Sludge Management, Problem Solving

Books & References:

1. Remote Sensing and GIS Angi Reddy M. The Books Syndicate, Hyderabad, 2000
2. Principles of Geographical Information Systems-P. A Burrough and R. A. Mc Donnel, OUP, Oxford, 1998.
3. Remote sensing for Earth Resource-Rao, D. P., AEG Publication, Hyderabad, 1987.
4. Geographical Information System-Kang Tsung Chang, Tata Mc Graw Hill, Publication Edition, 2002
5. Remote Sensing and Its Application –LRA Narayan University Press
6. Remote Sensing of the Environment: An earth resource Perspective. Jensen, J. R.. Dorling Kindersley India Pvt. Ltd. (Indian edition). 2009

GROUP IV GREEN TECHNOLOGY AND MANAGEMENT

ESE 629A Green Technology and Sustainable Development 3CH

Objectives: Green technology refers to the methods and processes that do not have adverse impacts on the environment. Conventional energy generation systems have developed through the progress of civilization and resulting in pollution to different spheres of the environment. Therefore, there is always a need for green technology, trained manpower to work in the sectors fostering green technology for sustainable development.
The course aims to provide the students with an understanding on i) conventional energy technologies and resulting pollution ii) technology for air pollution control, iii) Bioengineering techniques for waste removal and iv) use of environmental biotechnology for sustainable agriculture.

Outcome: On completion of the course, the candidate will be able to understand a) effects of conventional energy technologies on the environment and b) principles and mechanism of different methods for air pollution control, bioengineering methods for waste removal and biotechnology methods for sustainable agriculture. The student will develop skill to work in the above areas for industries. This would lead the industries to be operative under the hallmark of "Green Industry".

Unit-I: Conventional and Existing Energy Systems of Civilization: Coal Power , Hydropower ,Nuclear Power. Technologies to make conventional Energy System more sustainable (Clean Coal Production , Microhydropower , Biofuel).

Unit-II: Appropriate Technology for air Pollution Control: Removal of Sulphur from autofuel, Removal of SO_2 from waste gases of Smelters processing sulphide ores, Removal of SO_2 from Coal Power Plants by Flue-gas desulphurization, clean coal technology, Fluidized (Lime stone) Bed Combustion of coal to reduce SO_2 emission. Coal gasification Technology to convert high sulphur coal to low-sulphur coal gas control Technology of NOx (Modifying combustion technology, Recirculation of flue gas in to burners & dilution of flame, use of reducing agents to convert oxidizing NOx in to nitrogen) Control technologies for VOCs Control of green house gases.

Unit-III: Bioengineering for Waste removal: Micro remediation Technology, Bioabsorption, Bioleaching etc.(using Fungi & bacteria), Phytoremediation Technology, plant species involved in phytoremediation , Mechanism of Phytoremediation. Vetiver Grass Technology (VGT) with case studies, use of water hyacinth & duck weed in water pollution control. Composting Technology: Environmental. Factors controlling composting. Composting methods (Microbial slurry-windrows Technology, Vermitechnology) Composting of hazardous wastes & their Significance .

Unit-IV: Environmental Biotechnology for Sustainable Agriculture: High tech agriculture in India, concept of Sustainable agriculture, Agriculture biotechnology, the gene revolution, Biofertilizer

Books & References:

1. Environmental Geology-Dr Coates. John Willey & Sons NY 1981
2. The state of India's environment A citizen Report Anil Agrawal Vol 1 & 2 1985
3. Textbook of Soil Science-Biswas and Mukherjee. TMH New Delhi 1984
4. Reclaimed Land Erosion Control, Soils and Ecology-Martin J High(ed) A Balkema, 2000
5. Environmental Geology-Indian Context-KS Valdiya. Tata Mc Grow Hill New Delhi, 1987.
6. Environmental Geology-Keller . ,C.E.Merril Publ.TorontoTata Mc Grow Hill New Delhi, 1987.

ESE 628 B Remote Sensing and Geological Information System 3CH

Objectives: Remote Sensing and GIS techniques are versatile tools to handle, manipulate and interpret the spatial and temporal data. The environmental attributes are interpreted in both the spatial and temporal domain. Therefore a student opting for Environmental Science and Engineering should be trained to understand and use the tools of remote sensing and GIS. The course aims to provide the students with an understanding on i) Electromagnetic radiation and its use in remote sensing, ii) principles and data acquisition mechanism of Remote sensing satellites, iii) digital image processing, iv) GIS to handle spatial data.

Outcome: On completion of the course, the candidate will be able to understand the principles and applications of Remote Sensing and GIS techniques in the Environmental monitoring, forecasting and management. The student will develop skill to work in the programmes in industrial and government sectors that involve the study on spatial and temporal data on different entities of the environment.

Unit-I: Introduction to Remote Sensing Science & Technology Principles of Remote sensing, Physical basis of Remote sensing. The nature and generation of Electromagnetic radiation (EMR) Interaction of EMR with the atmosphere and earth's surface features, spectral quantities Spectral signatures and characteristics spectral reflectance curves for rocks , soil vegatation and water features within near and near Infrared

Unit-II: Remote Sensing Observation and platforms, Air borne and space borne platform their relative importance and applications. Aerial Stereo coverage and Remote Sensing Satellites. Sensors Aerial cameras and type of aerial photography, single and multi band scanners USS sensor and other type of sensors Details of sensors on board latest Earth resources Satellites viz. LANDSAT 6/7/8, SPOT, IKONOS, IRS, and ERS.

Unit-III: Digital Image Processing Introduction to digital structure and data recording format sets, Image Restoration, Enhancement and classifications, Significance of Ground Truths and Training Sets in Image Processing and in automated processing. Visual Photo-Interpretation Techniques based on Photo elements and Terrain elements.

Unit-IV: Geographic Information System: Introduction, Definition and Termiinology, Map Protection and Co ordinate system, GIS system hardware, software and infrastructures. Basic Components of GIS software. Data structures. Data models, Data acquisition, Data Imput and Data processing and management including topology, DEM/DTM generation, overlying and Integration and final data product and report generation Integration of Revenue sensing and GIS techniques and its applications In Environmental Impact Assessment and management including some case studies.

technology (Rhizobiun, Azospirillum, Mycorrhizal, Bluegreen algae, Azobacter, Azolla-BGA Symbiotic biofertilizer, Biomanure technology, vermiculture biotechnology), Biotechnology for Pest & disease control. Technologies for a alternative methods of Food production (Hydropines, Saline agriculture, green house forming etc.

Books & References:

1. Green Technology-P K Sinha & Margaret Green way Pioneer Publ. Jaipur 2004
2. Environmental Biotechnology S.K. Agarwal APH
3. Biological and Biotechnological control of insect Pests ,Rechcigl and Rechcigl ,Lewis
4. Hand book of Bioremediation , Norris et al Lewis
5. Soil Biotechnology: Lynch, Blackwell
6. Soil Microbiology and Biochemistry: Paul and Clark, Acd.Press.

ESE 629 B Soil Pollution and Waste Management 3CH

Objectives: Soil provides nutrients to the living organisms. Bulk of the below-ground biodiversity remains within the pedosphere. However, soil pollution through heavy metals, fertilizers and pesticides and soil loss by erosion is becoming alarming day by day. Therefore, there is a need for trained manpower to safeguard the pedosphere.
The course aims to provide the students with an understanding on i) soil pollution through heavy metals, pesticides and fertilizers ii) soil erosion and soil conservation methods and iii) waste management.

Outcome: On completion of the course, the candidate will be able to understand a) toxic and ecological effects because of the pollution through heavy metals b) management of soil erosion and c) waste management. The student will develop skill to work in the above areas for restoration of the soils in different watersheds under the soil conservation plans of government and corporate sectors.

Unit-I:Soil Pollution: Source of soil pollution, agricultural practices and soil pollution, Pollution through heavy metal; Source translocation, distribution and uptake of heavy metals, toxic and ecological effect.

Unit-II: Pollution through Fertilizers and Pesticides: Type and rate of application, fate of fertilizers, effect of nitrate, phosphate and potash fertilizers, Pollution through irrigation water; Evaluation of water quality, changes in soil by irrigation water. *Pollution through Pesticides:*Type, demand, production and consumption of pesticides, persistence, fate and degradation of pesticides in soil, Toxicity and effect of pesticides on soil organisms and plants, Alternatives to conventional pesticides and fertilizers.

Unit-III: Pollution through soil erosion and runoff: Factors responsible for soil erosion, siltation and soil sediments, some soil conservation techniques (cover crops. strip cropping, contour strip cropping, wind breaks, contour tillage, mulching, terracing, controlling gullies). Pollution through mining and under ground mining), Environmental impacts of mining (socio economic impact, land degradation; air, water, noise, pollution, effect on flora and fauna)and control of various mine pollution.

Unit-IV: Waste Management: Source and nature of waste, their characteristic and classification, different methods of disposal of wastes(Hug feeding, open dumps, ocean dumping, sanitary land fills, pyrolysis, incineration, controlled tipping, composting), Management of wastes utilization, recovery, reuse recycling)some examples of waste conversion(agricultural, Sewage sludge, Paper waste, sugar mill wastes, tannery sludges) to feed stuffs and fertilizers.

Books & References:

1. Soil Pollution and soil organisms –Mishra, Ashish Publ
2. Soil Microbiology and Biochemistry -Paul and Clark, Acad.Press
3. Pesticides in the Indian Environment -Gupta, Interprint
4. Soil Biotechnology-Lynch, Blackwell
5. Hand book of organic waste conversion-Bewicks, Acad. press
6. Solid waste Pollution- Trivedi and Raj, Akashdeep

IDC: < code as per the course opted> Interdisciplinary Course 3CH

Inter-disciplinary course offered by different departments to be opted by the student

III[rd] Semester

ESE: 711 Research Methodology 4CH

Objective: The Course Structure is designed in a way that the learning of Research Methodology can move from Mugging up syndrome to fun-practical method; from a teaching process to an experimental process, from memorizing to brainstorming, from clearing the examination to feedback learning, from knowledge transfer to knowledge creation, from competitive learning to collaborative learning. The objective of including this paper are to i) familiarize students with the different aspects of research, ii) provide an idea of good scientific writing and proper presentation skills, iii) provide an understanding of philosophical questions behind scientific research, iv) provide a brief background on the historical legacy of science, v) familiarize students with the different aspects of research, vi) provide an idea of good scientific writing and proper presentation skills vii) provide an understanding of philosophical questions behind scientific research, viii) provide a brief background on the historical legacy of science, ix) Focus on research in mathematical and engineering sciences.

Outcome: This course will provide an opportunity for students to establish or advance their understanding of research through critical exploration of research language, ethics, and approaches. The course introduces the language of research, ethical principles and challenges, and the elements of the research process within quantitative, qualitative, and mixed methods approaches. The students will use these theoretical underpinnings to begin to critically review literature relevant to their field or interests and determine how research findings are useful in forming their understanding of their work, social, local and global environment.

Unit-I: Application of statistical concepts/ procedures, Data, Diagramatic representation of data, Probability, Measure of central tendency, Measures of dispersion, Skewness and Kurtosis, Normal distribution, Simple correlation, multiple correlation, regression analysis, Sampling, Sample random sampling, Stratified random sampling, Systematic sampling

Unit-II: Testing of Hypothesis tests, χ^2(chi-square), t and F tests; Analysis of variance, Covariance, Principal component analysis, Experimental design: Completely randomized block design, Randomised block design, Latin square design, One-way analysis of variance, two -way analysis of variance, follow up tests, Non parametric procedures, writing of research reports

Unit-III: Windows and /or Linux operating system, programming fundamentals, Basics of a high level programming language-C, Editing, Compilation and running a program, storing data, Elementary numerical methods(as per requirement of the subject), Plotting graph, Preparing paper/report using Latex.

Unit-IV: Use of Application software for statistical analysis like Correlation, Regression, t- test, chi-square test, ANOVA(one-way and two-way), Different operations of Minitab 15, SPSS, Statistica, ExcelStat etc., Use of Power Point for preparation of Scientific lecture

I. Yuva Sanskar – 1st Semester – HOD of the concerned Department will take care of this course
II. N.C.C. / N.S.S./ Sports/ Performing Arts/ Yoga (only one is to be opted) – 2nd or 3rd Semester
The course in-charge of the University will float the course at the beginning of the semester

Course	In-Charge
NCC	Officer In-Charge NCC Cell
NSS	Coordinator NSS Cell
YOGA	Coordinator School of Performing Arts
SPORTS	Physical Education Officer
PERFORMING ARTS	Coordinator School of Performing Arts

QUESTION PATTERNS (COURSE STARTS FROM THE SESSION 2023)

Each Paper: 100 marks

Theory Papers:

Periodical Test: 20 marks

(Internal assessment =10 marks and Home assignments = 10 marks)

Mid-term for 20 marks will consists of 10 marks each for two class tests, 5 for assignment, 5 for case study

End term Test: 80 marks

Part-A: 20 marks: Each question 1 mark x 20 questions

(Preferably multiple choice type covering 5 questions from each unit)

Part-B: 60 marks: Question carrying 15 marks will be asked from each unit separately. The distribution of 15marks will be decided by the paper setter. Suggested patterns of distribution of 15 marks are 15, 8+7, 7.5 +7.5, 5+10, 2+3+10, 5+5+5.

(Each question must carry an alternative)

Practical Papers:

Total : 100 marks (70 Marks Practical+15 Marks Viva Voce, 15 Marks Records)
List of Practicals will be provided to the students at the beginning of the semester

Theory Papers ESDMS 419 and EDPS 439

Periodical Test: 40 marks

(Internal assessment =20 marks and Home assignments = 20 marks)

Mid-term for 40 marks will consists of 20 marks each for two class tests, 10 for assignment, 10 for case study

End term Test: 60 marks

Part-A: 12 marks: Each question 1 mark x 12 questions

(Preferably multiple choice type covering 5 questions from each unit)

Part-B: 48 marks: Question carrying 12 marks will be asked from each unit separately. The distribution of 12 marks will be decided by the paper setter. Suggested patterns of distribution of 12 marks are 12, 8+4, 6 +6, 5+10, 2+3+7, 4+4+4.

(Each question must carry an alternative)

IDC <Code as per the course opted by the candidate >: IDC course will be chosen by the candidate and the candidate will register in the programme paying the registration fee in consultation with the MOOC Course coordinator of the Department. The Distribution of marks is as per the University Notification.

Books & References:

1. Research Methodology by C. R. Kothari
2. Fundamentals of Mathematical Statistics by S. C. gupta and V. K. Kapoor, S. Chand, New Delhi
3. Programming in C by Balguruswamy
4. Computer Fundamentals by P. K. Sinha and Priti Sinha, BPB Publication
5. Linux: The complete reference by P. Richard, Mc Graw hill
6. Statistical Methods for Environmental & Agricultural Sciences by A Reza Hoshmund, CRC

ESE: 712 to 713 Summer Training/ Minor Research Project 16CH

Course No.	Title of the Course	Credit Hours
ESE 712	Evaluation of Summer Training Report/Minor Project Report	4
ESE 713	Seminar and Viva-Voce on Summer Training Report/Minor Project Report	4
ESE 714	Evaluation of Dissertation(Interim), Seminar and Viva-Voce	8

To be evaluated by Departmental Teachers

ESE:714 Major Research Project Work (Interim Report) 8CH

Course No.	Title of the Course	Credit Hours
ESE 714	Evaluation of Dissertation(Interim), Seminar and Viva-Voce	8

To be evaluated by Departmental Teachers and External Expert

EDPS: 439 Entrepreneurship Development 2CH

Entrepreneurship Development Course (Offered by Department of Business Management)

MOOCs Massive Online Courses 3CH

MOOCs < Code as per the Course opted> Massive Open Online Courses (**MOOCs**) are free online courses available for anyone to enroll **NPTEL, mooKIT, edX, Coursera, and SWAYAM** are the prominent online platforms in India. MOOC Coordinator of the Department will guide the students

IVth Semester

ESE 721 to 723: Major Research Project Work (Final Report) 20CH

Course No.	Title of the Course	Credit Hours
ESE 721	Evaluation of Dissertation	12
ESE 722	Seminar on Dissertation	4
ESE 723	Viva-Voce on dissertation	4
	Total Credit Hours	**20**
	TOTAL CREDIT HOURS FOR FOUR SEMESTERS	**90**

To be evaluated by Departmental Teachers and External Expert

Non-Credit Course

COURSE AT A GLANCE

SUBJECT: **M.Tech. Environmental Science & Engineering**
ACADEMIC SESSION: **2024-26**
First Semester-December,2024

Course Number	Course Title	Credit Hour	Mark Distribution	Maximum Mark
ESE 611	Fundamentals of Ecology and Environmental Sciences	3	PT-20, ET-80	100
ESE 612	Environmental Chemistry, Pollution and Control	3	PT-20, ET-80	100
ESE 613	Environmental Policies and Laws	3	PT-20, ET-80	100
ESE 614	Environmental Microbiology	3	PT-20, ET-80	100
ESE 615	Environmental Toxicology	3	PT-20, ET-80	100
ESE 616	Laboratory: Environmental Monitoring I	3	ET-100	100
ESE 617	Seminar presentation	2	ET-100	100
ESDMS 419	Environmental Field Survey	2	PT-40, ET-60	100
	TOTAL CREDIT HOURS	**22**		

Second Semester-April, 2025

Course Number	Course Title	Credit Hour	Mark Distribution	Maximum Mark
Core Course A student shall have the option to choose any one of the following groups of Core course ESE 621 A/ESE 621B, ESE 622 A/ESE 622B, and ESE 623 A/ESE 623B/ESE623C.				
ESE 621 A	Instrumental Techniques and application in Environmental Science and Engineering	3	PT-20, ET-80	100
ESE 621 B	Advanced Applied Statistics ,Environmental System Optimization and modelling	3	PT-20, ET-80	100
ESE 622 A	Environmental Impact Assessment, Environmental Audit and Environmental Management System Standards	3	PT-20, ET-80	100
ESE 622 B	Hazards Control and Management in Industries	3	PT-20, ET-80	100
ESE 623 A	Air Quality Management	3	PT-20, ET-80	100
ESE 623 B	Remote Sensing and Geographical Information System	3	PT-20, ET-80	100
ESE 623 C	Industrial Safety and Management	3	PT-20, ET-80	100
ESE 624	Laboratory: Environmental Monitoring II	3	ET-100	100
ESE 625	Seminar Presentation	2	ET-100	100
Elective Course A student shall have the option to choose any one of the following groups of Elective Course consisting of two papers				
GROUP I: Pollution Control and Management in Mining Industries				
ESE 626 A	Environmental Aspects of Mining Industries	3	PT-20, ET-80	100
ESE 626 B	Solid and Hazardous Waste Management and Land Reclamation	3	PT-20, ET-80	100
GROUP II: Hydrology and Waste Water Engineering				
ESE 627 A	Hydrology	3	PT-20, ET-80	100
ESE 627 B	Waste Water Engineering	3	PT-20, ET-80	100
GROUP III: Environmental Geology and Remote Sensing				
ESE 628 A	Environmental Geology	3	PT-20, ET-80	100
ESE 628 B	Remote Sensing and Geographical Information System	3	PT-20, ET-80	100

MOOC Course: MOOCs course will be chosen by the candidate and the candidate will register in the programme paying the registration fee in consultation with the MOOC Course coordinator of the Department

Summer Training Minor Project Work:

A student will have to take the Summer Training/ Minor Project work in 3rd Semester for which mark distribution is as follows:

Marks assigned to ESE712 (100 Marks) ESE713 (100 Marks)

Background of the Problem (5% = 5 marks)	**Review of Literature (5%= 5 marks)**	**Objectives (5%= 5 marks)**	**Methodology (5%== 5 marks)**
Project work (50%= 50 Marks)		**Viva-voce (30%=30 Marks)**	

Major Project Work:

Major Project work will be given to the student at the beginning of the III[rd] semester and will be completed in the IV[th] semester. The distribution of the work/marks will be as follows

Semester-wise distribution of Major Project work			
Completion During III[rd] Semester (20% work) Marks assigned to ESE 714: 100 Marks			
Background of the Problem (5%)	**Review of Literature (5%)**	**Objectives (5%)**	**Methodology (5%)**
Completion During IV[th] Semester (80% work) Marks assigned to ESE 721, ESE 722, ESE 723 (each100 Marks)			
Project work (50%)		**Viva-voce (30%)**	

7/8/24 7/8/24 9.8.24

Head of the Department

GROUP IV: Green Technology and Management				
ESE 629 A	Green Technology and Sustainable Development	3	PT-20, ET-80	100
ESE 629 B	Soil Pollution and Waste Management	3	PT-20, ET-80	100
IDC <Code as per the course opted>	Interdisciplinary Course	3	PT-10, ET-40	50
	TOTAL CREDIT HOURS	**23**		

Third Semester-December, 2025

Course Number	Course Title	Credit Hour	Mark Distribution	Maximum Mark
ESE 711	Research Methodology	4	PT-20, ET-80	100
ESE 712	Evaluation of Summer Training Report/Minor Project Report	4	ET-100	100
ESE 713	Seminar and Viva-Voce on Summer Training Report/Minor Project Report	4	ET-100	100
ESE 714	Evaluation of Dissertation(Interim) ,Seminar and Viva-Voce	8	ET-100	100
EDPS 439	Entrepreneurship Development	2	PT-40, ET-60	100
MOOCs <Code as per the course opted>	MOOC Course is to be opted by the candidate <One Number>	3	ET-100	100
	TOTAL CREDIT HOURS	**25**		

Fourth Semester-April, 2026

Course Number	Course Title	Credit Hour	Mark Distribution	Maximum Mark
ESE 721	Evaluation of Dissertation	12	ET-100	100
ESE 722	Seminar on Dissertation	4	ET-100	100
ESE 723	Viva-Voce on dissertation	4	ET-100	100
	Total Credit Hours	**20**		

TOTAL CREDIT HOURS FOR THE PROGRAMME = **90**

NON-CREDIT COURSES

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II. N.C.C. / N.S.S./ Sports/ Performing Arts/ Yoga (only one is to be opted) – 2nd or 3rd Semester
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