UNIVERSITY OF CALCUTTA

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To
The Principals
of all the Undergraduate Colleges
offering B.Sc. (Honours) in Environmental Science
affiliated to the University of Calcutta

Sir/Madam,

The undersigned is forwarding here with the **revised draft Syllabus for Environmental Science (Honours)** Courses of Studies, prepared by the **U.G. Board of Studies in Environmental Science , C.U.**, to be implemented from the academic session 2017-2018, to get feedback from the Department of Environmental Science in your college.

You are requested to send your feedback within 17th March, 2017.

In this regard you may send your observation/ suggestion to the **Department of U.G. Councils, C.U.** or through email (u.g.councilsc.u@gmail.com), and you also may contact **Prof. Aniruddha Mukherjee Chairperson, U.G.B.O.S., Environmental Science** through **e-mail** (am_cuenvs@yahoo.co.in).

Your cooperation in this regard will be highly appreciated. Kindly treat the matter as urgent.

Thanking you,

Enclo: Copy of the draft syllabus.

Yours faithfully,
03.03.17
(Milan Kr. Pal)
O.S.D., C.U.

University of Calcutta: Syllabus and Regulation for 3 -year Degree Course (Honours) in Environmental Science

Total Marks – 800

Theoretical – 500 (Part I – 100, Part II – 100, Part III – 300)

Practical – 300 (Part I – 100, Part II – 100, Part III – 300)

Group	Unit	Subject	Full Marks	Time
		PART – I		
Paper I (Theoretical)			**100**	**4 hrs**
Group A	Unit I	Fundamentals of Environment	50	2 hrs
	Unit II	Physico-chemical principles of Environment		
Group B	Unit III	Living system and biomolecules	50	2 hrs
	Unit IV	Ecology		
Paper II (Practical)			**100**	**6 hrs**
		PART – II		
Paper III (Theoretical)			**100**	**4 hrs**
Group A	Unit I	Biological diversity	50	2 hrs
	Unit II	Environmental Microbiology and Biotechnology		
Group B	Unit III	Environmental Geoscience	50	2 hrs
	Unit IV	Soil Science		
Paper IV (Practical)			**100**	**6 hrs**
		PART – III		
Paper V (Theoretical)			**100**	**4 hrs**
Group A		Natural Resource Management	50	2 hrs
Group B		Sustainable Development & Environmental Management	50	2 hrs
Paper VI (Theoretical)			**100**	**4 hrs**
Group A		Environmental Law and Accounting	50	2 hrs
Group B		Environmental Health and Toxicology	50	2 hrs
Paper VII (Theoretical)			**100**	**4 hrs**
Group A		Environmental Pollution	50	2 hrs
Group B		Environmental measurement and Application technique	50	2 hrs

Paper VIII (Practical) **100** **6 hrs**

PART – I

Paper I (Theoretical)

GROUP – A: 50 Marks

UNIT – I : Fundamentals of Environment (Marks : 25; Lectures – 25)

I. **Concept of Environment and Ecology:** Definition, Types and Components of Environment (Atmosphere, Hydrosphere, Lithosphere and Biosphere); History and definition of Ecology; Scopes and Objective of Environmental and Ecological science; Man – Environment relationships; Growth of environmental and Ecological science in India; Environmental history – a brief account; Environmental ethics and awareness; Environmental literacy (formal and non-formal education); Environmentalism; Ecofeminism, Green concept in politics; Environmental Organisations at National and International level.

II. **Current Global Environmental Issues:** Green House effect, Climate change, North – South conflict, Acid deposition, Desertification, Ozone layer depletion, El Nino phenomena, ENSO.

UNIT – II : Physico-chemical principles of Environment (Marks : 25; Lectures – 25)

I. **Basics of General Chemistry:** Molecular weight; Equivalent Weight; Molarity; Normality; Valency; Oxidation state and bonding; Oxidation and Reduction Reactions; Introduction to Periodic table.

II. **Basics of Chemical Equilibrium and Kinetics:** Stoichiometry; Chemical equilibrium; Gibbs energy; Chemical Potential; Acid-base reactions (acidity, alkalinity, buffer and buffer capacity); Solubility product; Complexation of metal ions and organic complexes in natural water.

III. **Water Chemistry:** Fundamentals of water quality. Concept of BOD, COD, Hardness, Carbonate-bicarbonate system, Basic concept of colloid chemistry. Principles of sedimentation, coagulation.

IV. **Air Chemistry:** Classification of elements, particles, ions and radicals in the atmosphere; Chemical process for formation of inorganic and organic particulate matters in air.-Air pollutants as gaseous and particulates such as CO_2, O_3 , SOx, NOx, Flyash, PM-10, PM-2.5, VOCs (Volatile Organic Compounds), PAHs (Polycyclic Aromatic Hydrocarbons), Peroxyacetyl nitrate (PAN) and Photochemical smog. Ozone chemistry.

V. **Thermodynamics:** Concept of System. First and second law of thermodynamics; Entropy; Enthalpy, Free energy; Chemical potential; Heat transfer process; Mass and energy transfer across the various interfaces; Material balance;

VI. **Meteorology:** Concept of atmospheric stability; Mixing height, Ground level concentration, Inversion, Basic knowledge of climatological parameters for environmental study; Classification of Climate. Fundamentals of temperature, pressure, relative humidity, rainfall and wind speed.

VII. **Energy Interactions:** Energy budget concept: Radiation fluxes, metabolism of latent heat exchange.

VIII. **Biogeochemical cycles:** Carbon Cycle, Nitrogen Cycle, Phosphorus Cycle, Sulphur cycle.

GROUP – B : 50 Marks

UNIT – III : Living system and biomolecule (Marks : 25; Lectures – 25)

I. **Life support system –** Biochemical and molecular basis of Origin of Life; Diversification of life: Theories on organic evolution; Isolating mechanism and Concept of discontinuous distribution; Mechanism of Speciation; Basic concept of Hardy Weinberg Equilibrium; Concept of Genetic drift.

II. **Cell and Cell organelles: Structure and Functions – U**ltrastructure, composition and functions of plasma membrane, mitochondria, ribosome, Golgi body, chloroplast, lysosome, endoplasmic reticulum, nucleus. Gene functions (Replication, Transcription and Translation.)

III. **Introduction to Bio-molecules:** Chemistry and Classification of Carbohydrate, Protein, Lipid, nucleic acids and enzymes.

UNIT – IV : Ecology (Marks : 25; Lectures – 25)

I. **Ecological Concepts:** Subdivisions and development phases of ecology; Ecological features on the basis of factors such as climatic, edaphic, physiographic and biotic; Autecology – definition, distribution, phenological studies; Synecology – basic ideas, definition, food chains, food webs and trophic levels.

II. **Ecosystem ecology:** Types, structural and functional aspects of major ecosystems (terrestrial as forest, grassland, desert and aquatic as freshwater like lentic and lotic and saltwater like marine and estuary); Agro ecosystem; Raymond Lindeman – Trophic level dynamics, Ecological pyramids; Productivity concept of ecosystem; Concept of limiting factors – Liebig's law of minimum, Shelford's law of tolerance;

III. **Population ecology:** Definition; Characteristics; dynamics; Growth; Human population growth; World population; Regulation of Population; Lotka Voltera.

IV. **Community Ecology:** Ecotone and Edge effect; Habitat and Ecological niche; Ecotype; Ecophene; Ecological indicators; Community structures and characters; Predation; Competition; Symbiosis; defensive mechanism; resilience and stability; Basic concept of ecological succession.

V. **Fundamentals of Taxonomy: α,β,γ** taxonomy, Classification, Identification, Nomenclature, Concept of key and hierarchy, Concept of Biosystematics, Type concept, Ecological classification (hydrophytes, xerophytes, halophytes, mesophytes, lithophytes, chosmophytes, Pssamophytes, epiphytes) and their morphological physiological and biochemical adaptations; Basic adaptive features of arthopods,molluscs, fishes, birds and mammals.

PART – I
Paper II (Practical)

Total Marks : 100 Time: 6 Hrs.

Distribution of Marks:

1.	One Major experiment		20 Marks
2.	One Minor experiment		15 Marks
3.	Identification with reasons (six items)	5 x 6	30 Marks
4.	Field Report		15 Marks
5.	Laboratory Notebook		10 Marks
6.	Viva-voce		10 Marks

Practical course:

1. **Major Experiments:**

   a. Estimation of Water parameters: pH, Conductivity, DO, BOD, COD, Total Hardness, Alkalinity, Acidity, Chloride, Iron, TSS & TDS.

2. **Minor Experiments:**

   a. Recording of Wind speed,
   b. Recording of Relative humidity,
   c. Recording of Atmospheric pressure

3. **Identification of common flora and fauna of various ecological habitats with characteristics.**
   (List of specimen to be decided)

4. **Field study on local flora and fauna and field report submission.**

5. **Laboratory Notebook**

6. **Viva voce**

PART – II

Paper III (Theoretical)
GROUP – A: 50 Marks
UNIT – I : Biological Diversity (Marks : 25; Lectures – 25)

I. **Concept of Biodiversity:** Definition, Types, Diversity of flora and fauna in India.

II. **Biodiversity Indices:** Different types of biodiversity measurement indices viz. Shannon Wiener biodiversity index, Simpson Index, similarity index, evenness index, frequency, abundance, density, relative density.

III. **Importance of Biodiversity:** Values (Direct and indirect) and services of Biodiversity. Threats to Biodiversity: Natural and Anthropogenic factors, Mass extinction.

IV. **Biodiversity Conservation and Management:** Types, Management, Threatened, endangered and extinct species, in-situ and ex-situ conservation and reintroduction, Different types of biodiversity hotspots, mega diversity, National parks, Sanctuary and Biosphere reserve – difference and location in India. People's biodiversity register (PBR), Indigenous and traditional knowledge in India.

V. **Forest Ecosystem:** Forest types of India. Sundarbans mangroves, Indian Mangroves, Beach Forests Forest conservation efforts in India, Forest Protection Committee, Joint Forest Management.

VI. **Wetlands:** Definition, Importance of wetlands, Wetland management, wise use of wetland, Ramsar convention.

UNIT – II : Environmental Microbiology & Biotechnology (Marks : 25; Lectures – 25)

I. **Concept of Microbiology:** Classification of microorganisms (on the basis of molecular taxonomy), brief account of microbes – bacteria, fungi, algae, virus, actinomycetes, basic concept of microbial growth.

II. **Microbial identification:** Staining, biochemical properties

III. **Beneficial microbes:** Role of microbes in industry, agriculture, metals and organics extraction, Bioremediation – microbial degradation of pollutants.

IV. **Biotechnological applications:** principles of different biotechnological methods viz. Plasmid preparation, restriction digestion, DNA ligation, PCR, RAPD and RFLP, Biotechnological applications in medicine, industry. Agriculture, concepts of GMO/GEM.

GROUP – B : 50 Marks

UNIT – III : Environmental Geoscience (Marks : 25; Lectures – 25)

I. **Earth Science:** Origin and Evolution of Earth, Geological timescale, Continental drift – evidences and mechanisms, formation of mountains with special reference to plate tectonics. Formation of Landforms by running water, wind and glaciers.

II. **Geomorphology, landforms and geological structures (Folds, Faults, Syncline, Anticline etc.):**

III. **Geological hazards** – Basic concepts of flood, landslides, earthquakes, tsunami and volcanism. Disaster management: concept and policies.

IV. **Earth Resources:** Definition of resources and reserves, mineral resources, classification, Processing of minerals and environment.

V. **Water Resources:** Global water resources, fundamental equation of groundwater flow, Darcy's law, vertical distribution of ground water, zone of saturation, Geological formation as aquifers, type of aquifers and ground water basin, rock properties affecting groundwater. Surface water resources – rainfall, infiltration, springs, lakes.

VI. **Remote sensing and its Application:** Basic concept of remote sensing and GPS, its application to forest, land and water resource management. Introduction to GIS and it's application.

VII. **Landuse and Landcover study:** Basic concepts of Topographical sheets and Satellite imagery and their application.

UNIT – IV : Soil Science (Marks : 25; Lectures – 25)

I. **Pedogenesis: S**oil formation; Soil profile development; Soil classification (USDA).

II. **Properties of Soil:** Composition of soil on the basis of minerals and chemicals, Texture, Colour, Soil organic matter, pH, mechanism of nutrient uptake; NPK Economy of soil; Macro and Micro nutrients,

III. **Soil Biology:** Soil microorganisms, Flora and Fauna.

IV. **Soil Erosion and Conservation:** Causes of Soil erosion, Methods of soil conservation.

V. **Soil pollution:** Sources, types and effects of soil pollution.

VI. **Soil Agrotechnology:** Different biofertilizers, their identification, culture, raw materials and their source, organic fertilizer, vermicompost preparation technique and application in field.

PART – II
Paper IV (Practical)

Total Marks : 100 Time: 6 Hrs.

Distribution of Marks:

1.	One Major experiment	20 Marks
2.	One Minor experiment	15 Marks
3.	Study of stress metabolites	10 Marks
4.	Identification of Rocks and Minerals	20 Marks
5.	Field Report	15 Marks
6.	Laboratory Notebook	10 Marks
7.	Viva-voce	10 Marks

Practical course:

1. **Major Experiments:**
   a. Estimation of Soil parameters: Soil pH, Conductivity (ECe), Available N, Available P, Available K, Organic Carbon, Chloride.
   b. Biodiversity parameters and indices study (Field study)

2. **Minor Experiments:**
   a. Gram staining of bacteria.
   b. Study of topographical sheets.
   c. Study of imagery.

3. **Study of stress metabolites (**ascorbic acid in plant**).**

4. **Identification of Rocks and Minerals with characters.** (List to be decided)

5. **Field Study** on biodiversity of an area of ecological importance (Mountains/ Coastal/ Estuary/ Forest) using different assessment techniques and field report submission.

6. **Laboratory notebook**

7. **Viva voce.**

PART – III

Paper V (Theoretical)
GROUP – A: 50 Marks

Natural Resources Management (Marks : 50; Lectures – 50)

I. **Natural Resources:** Concepts, Classification and status of major natural resources, ideas on some major renewable and non-renewable resources, viz. Mineral, soil, fossil fuel, water, land, biomass, rangelands, agriculture, livestock, fishery, energy, wildlife, ocean, forest.

II. **Water Resource management:** Water conservation practices and their environmental consequences, (viz. Dam and reservoirs, Rain water harvesting, River linking).

III. **Land Resource Management:** Types of land resources, causes of land degradation, reclamation and conservation of land, wasteland reclamation.

IV. **Energy Resource Management:** Conventional and non-conventional energy resources. Brief Idea of energy production and environmental consequences involved (viz. Thermal, Hydel, Solar, wind, geothermal, Energy from oceans and bio-energy).

Group – B: 50 Marks

Sustainable Development and Environmental Management (Marks : 50; Lectures – 50)

I. **Environmental Management in industries/organisations:** Definition and concept on Environmental Management, environmental management system. Certification for EMS, ISO 14000 series.

II. Basic principles of Ganga Action Plan (GAP), Yamuna action plan (YAP),

III. Integrated system for waste management, Municipal solid waste (MSW) management, management of biomedical waste, plastic waste management, management of hazardous waste, Biosafety protocol, concept of e-waste.

IV. **Sustainable Development:** Principles from Rio-declaration, Business charter for sustainable development. Success stories of India viz. Johad in Rajasthan, Ralegaon Siddhi, CNG conversion in Delhi.

Paper VI (Theoretical)

GROUP – A: 50 Marks

Environmental Law and Accounting (Marks : 50; Lectures – 50)

I. **Laws and Policies:** Policy statement on environment and development; Environmental provisions in Indian constitution, PILs, Role of NGOs, National Committee on Environment Planning and coordination, National Environment Policy 2006, National Forest Policy of 1952; National Forest Policy of 1988.

a. Air (Prevention and Control of Pollution) Act, 1981; The Water (Prevention and Control of Pollution) Act, 1974; Cess Act, 1977;
b. Environment (Protection) Act, 1986. The Noise Pollution (Regulation and Control) Rules, 2000;
c. Wildlife (Protection) Act, 1972;
d. Forest (Conservation) Act, 1980;
e. Biological Diversity Act, 2002.

II. **Environmental Impact Assessment:** EIA Notification, 1994 & 2006**,** 2009, Environmental Impact Assessment: Provisions and Procedures in Inida.Environmental Management Plan (EMP), Green Belt development plan,

III. **Environmental Accounting and Auditing:** Environmental accounting, objectives of environmental accounting, accounting for environmental sustainability, overview of environmental audit, the environmental survey, developing the environmental audit, eco-management and audit scheme. Typical audit programme, Basic steps of environmental audit, benefits of environmental auditing.

IV. Life Cycle Analysis: Introduction, methodologies. Eco Labelling.

Group – B: 50 Marks

Environmental Health and Toxicology (Marks : 50; Lectures – 50)

I. **Epidemiology:** Concept of Health and Disease, principles of epidemiology and epidemiological methods, aims of epidemiology, measurement of mortality, measurement of morbidity.

II. **Disease:** Concept of screening the diseases, some communicable diseases like small pox, cholera, acute diarrhoeal disease, viral hepatitis, water borne pathogens, vector borne diseases, diseases caused by contaminated food and water, soil borne infections, insect borne diseases.

III. **Immunology – E**lementary idea about antigens and antibody, hyper sensitivity, allergic reactions, pollens and their allergens. Immunological techniques.

IV. **Community and Health:** Communication for health education, health care of the country. Occupational Health

V. **Concept of Toxicology:** Definition of toxicology, different types of toxicant, toxicity test, toxicity by different factors, exposure effect relationship, different route of exposure, synergistic and antagonistic effect, Bioaccumulation and Biomagnification. Detoxification, Toxicological dynamics.

Paper VII (Theoretical)
GROUP – A: 50 Marks

Environmental Pollution (Marks : 50; Lectures – 50)

I. **Concept of Pollution:** Definition, Types of environmental pollution, physical, chemical and biological pollutants.

II. **Air Pollution:** Types of air pollutants, primary and secondary air pollutants, Control devices and management techniques.

III. **Water Pollution:** Types of water pollutants, point and non-point sources, microbial pollution, impact of pollution on water bodies – ground water, coastal and wet lands. Water pollution control devices and management techniques.

IV. **Drinking water pollution:** Potable water and its preparation, Microbial pollution, Drinking water standards – Primary and Secondary, Sanitary aspects.

V. **Pesticide pollution:** Definition, categories, pesticide movement, Pesticides in water, effects, POPs (Persistent Organic pollutants), Biological pesticides.

VI. **Oil pollution:** Definition, Oil spills problems, Natural oil seeps.

VII. **Noise pollution:** General feature of sound, intensity and loudness of sound, measurement of noise, Human acoustics, noise classification. Health effects of noise pollution on human and animals, minimization methods.

VIII. **Radiation pollution:** Background radiation, Man-made radiation, Radiation Hazards, Nuclear accidents, disposal and safety measures. Effects on flora, fauna and human. Safety measures at the time of working with radioactive substances.

IX. **Thermal pollution**: Definition, Sources, minimisation method. Health Impacts of thermal pollution on animals and plant. Treatment methods of heated discharge from industries.

X. **Indoor pollution:** Definition of indoor air pollution, different types and sources, hazardous household products. Health Impacts of human by physical chemical and biological indoor pollutants, disposal methods of hazardous household products.

Paper VII (Theoretical)
GROUP – B: 50 Marks

Environmental Measurement and Application techniques (Marks : 50; Lectures – 50)

I. **Analytical Methods for Chemical Analysis:** Sampling, preservation, storage techniques; Principles and applications of titrimetry, gravimetry, potentiometry, spectrophotometry, conductimetry, Electrophoresis and Chromatography.

II. **Techniques related to environmental physics:** Acoustic radar; Application of LASER radiations; Electrical detection of airborne particles using surface ionisation techniques; Biosensor: Concept and application.

III. Date Information Knowledge Wisdom Loop, data analysis, errors in data representation.

IV. **Application of Statistics in Environmental Science:** Statistical sampling, Mean, Mode, Median, Standard error and deviation; Probability; Correlation and Regression, Testing hypothesis: Null and Alternative hypothesis; Student's 't' test; Chi-square test.

PART – III
Paper VIII (Practical)

Total Marks : 100 Time: 6 Hrs.

Distribution of Marks:

1.	One Major experiment		20 Marks
2.	Biostatistics		05 Marks
3.	One Minor experiment		10 Marks
4.	Identification with reasons (four items)	5 x 4	20 Marks
5.	Dissertation work and presentation		25 Marks
6.	Laboratory Notebook		10 Marks
7.	Viva-voce		10 Marks

Practical course:

1. Major Experiments:

a. Study of Meiotic stages from grasshopper testis.
b. Study of Nuclear abnormalities study in the erythrocytes of fish.
c. Study of Mitotic stages from root tip of *Allium cepa*.
d. Air quality monitoring (SPM, RSPM, NOx, SOx)
e. Study of chromatographic techniques (Paper chromatography)

2. Testing of hypothesis from supplied field data. (Student's 't' test: Paired & Unpaired; Chi-square test: Goodness of fit)**.**

3. Minor Experiments:

a. Noise Level monitoring
b. LC_{50} calculation by probit analysis with data provided.
c. Basic immunological response study (using simple kit)

4. Identification of Vectors & Parasites (with characteristics) and comment on their epidemiological impacts**.** (List of specimen to be decided)

5. Review/survey based Dissertation work and presentation

6. Laboratory notebook and

7. Viva voce.