I.MSc Courses (Systems Biology): July 15, 2010

I Semester (I year)

1) Foundation Biology- 3 credits

A course to expose students to basics of biology

Biological kingdoms, comparative account of prokaryotes and eukaryotes at cellular level; Overview of interactions between prokaryotes and eukaryotes; Cells, organization, and functions of organelles; Principles of genetics or patterns of inheritance, theory of evolution; Biomolecules: water, sugars, amino acids, nucleotides, carbohydrates, lipids, proteins and nucleic acids; Enzymes, chemical reactions, glycolysis, respiration, fermentation photosynthesis, nitrogen fixation, transpiration, osmosis Overview of development; Digestive system, circulatory system, nervous system, endocrine glands, reproductive system.

Reference Books:

Biological Science, Cambridge Low Price Edition, by N.P.O. Green, G.W. Stout, D.J. Taylor, Editor: R. Soper. XI and XII Biology CBSE Books

2. SB I: Environmental Studies-3 cr

Unit 1: The multidisciplinary nature of environmental studies: Definition, Scope and importance Environmental Milestones *Unit 2:* Ecosystems :Concept of an ecosystem (Abiotic and biotic environment), Structure and function of an ecosystemProducers, Consumers and decomposers.Energy flow in the ecosystem, (Nutrient cycle in the ecosystem) Ecological succession Food chain, food webs and ecological pyramids. Introduction, types, characteristic features, structure and function of the following ecosystems: Forest ecosystem,Grassland ecosystem, Desert ecosystem aquatic ecosystems (ponds,streams,lakes,rivers,ocean estuaries).

Unit 3: Biodiversity: Conservation: Introduction, Definition: genetic, species and ecosystem diversity, Hot spots of biodiversity, Threats to biodiversity: habitat loss, poaching of wildlife, man wildlife conflicts. Endangered and endemic species of India, Conservation of biodiversity: In- situ and Ex-situ conservation of biodiversity. *Unit 4*: Natural Resources and non-renewable resources An overview of natural resources and associated problems with references to a) Forest resources b) Water resources c) Mineral resources d) Food resources e)Energy resources f)Land resources. *Unit 5*: Environmental Pollution: Definition a) Air pollution b)Water pollution c) Soil pollution d)Marine pollution e) Noise pollution f) Thermal pollution g) Nuclear pollution Solid waste management: Causes, effects and control measures of urban and industrial wastes.Environmental impact assessment. *Unit 6*: Environment: Socio-Political Issues: Environmental Ethics: Science/Nature Debate) Global Environmental Issues a) Global Warming, Climate Change, Acid Rain, Ozone layer depletion, Pollution) Global Environmental Issues a) Deforestation, Loss of Bioidiversity, Desertification, Land Degradation) Global Conventation on Environment: Indian environmental Laws. *Unit 7:* Human –Environment Interaction: Modes of Resource Use, Development and Environment Population growth and Environment, Environment and Human Health. *Unit 8*: Project Work (Group of….) Select List of Themes: Study of simple ecosystem: pond/lake/rocks, Biodiversity Register of Campus Pollution Energy sources Water Conservation Waste Disposal and Recycling GM crops.

3) Bridge Mathematics *- 3 cr**

Real number system; Mathematical induction, Binomial Theorem, Relations, Equivalence classes, Definition of a group, Residue classes, Continuity , Differentiation, Integration (as an inverse process), Permutations and Combinations, Sequences and Series, Power Series, Tests for convergence, Trigonometric functions, Conic Sections, Equations of lines and circles in 2-D Geometry, concept of set, functions and relation, Graphs of functions.

4) Math-1

1.1 Matrices (20 Lectures)

Basic concepts of matrices, multiplication of matrices by scalars, addition and multiplication of matrices, transpose, trace, determinant of a matrix, rank and inverse of a matrix, special matrices such as Hermitian, unitary matrices, system of linear equations, solution by Crammer's rule, existence and general properties of solutions, eigenvalues, eigenvectors, diagonalization

of matrices, functions of matrices and Caley-Hamilton theorem.

1.2 Elementary functions (7 lectures)
Defnition and examples of sequences and series. Using these, study Trigonometric functions, logarithmic, exponential function, hyperbolic trigonometric functions.
1.3 Analytical geometry in 3-D (8 Lectures)
Cartesian co-ordinates in 3-D, distance between two points, direction cosines, direction ratios and their properties, equation of plane using given data, equation of straight line in different forms, image of a point with respect to a plane, distance between a point and a plane along a straight line, equation of sphere, circle.
1.4 Complex numbers, vector algebra (5 Lectures)
Algebra of complex numbers, polar form, argand diagram, triangle inequality, curves and regions in complex plane. Addition of vectors, dot product, cross product and their geometric interpre-
tation, triple product, area, volume given in terms of vector products.

5. Physics-1: Mechanics-4 cr
Physical quantities, Units and dimensions, Scalars and Vectors, Dot and cross products, Velocity and linear momentum, Acceleration and force, Motion in one and two dimensions with constant acceleration, Projectile motion, Uniform circular motion, Newton's laws of motion and their applications, Friction, Work and energy, Conservation of energy,Rotational motion, Angular momentum and torque, Collision and conservation of momentum during collisions, Moment of inertia, Elementary dynamics of a rigid body.

Books recommended: Fundamentals of Physics by Resnick, Halliday and Walker, 6thedition, Wiley; 2. University Physics, by Sears and Zemansky, 10thedition, Addison Wesley series 3. Concepts of Physics, H.C. Verma, TMH.

6. Chemistry-1: STOICHIOMETRY, SOLUTIONS AND GASSES -3cr
Prerequisite: None
Experimental evidence of the atomic hypothesis; Chemical compounds and their composition – introduction to nomenclature; Chemical reactions and stoichiometric calculations. (8h) ; Solution Chemistry – electrolytes and non-electrolytes. Colligative properties. Ideal and Non-Ideal solutions. Reactions in solution – redox, acid-base, precipitation, ion-exchange. Colloids. (14h); Properties of gases – Avagadro's hypothesis, the ideal gas law. Kinetic molecular theory. Gas mixtures. Solubility of gases. Gases at high pressure and low temperatures – critical phenomena. (14h)

7) English-1 -4cr
8) LAB Courses (1.5 cr x 2 = 3 cr)

(Following are the lab courses)
A. Physics
1. Fly wheel 2. Cater's pendulum 3. Torsion pendulum –Disc 4. Torsion pendulum Rod 5. Yong's modulus Searl's method, 6. Surface tension 7. Viscosity- Stoke's method 8. Bending of beam 9. Bifilar pendulum10. Vertical oscillations of a spring with mass 11. Air track experiment

B: Chemistry

Prerequisite: None
Reactions of common cations and anions. Semimicro analysis of mixtures

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Semester –II (I Year)

9. Introductory Biology-3cr:

Prerequisite: Biology in 11-12th class or Foundation Biology in CIS
Discoveries that lead to the identification of DNA. Detailed view of subcellular organelles and their functions: Nucleus, Endoplasmic reticulum, Golgi vesicles and Lysosomes. Chromosomes, Heterochromatin, Euchromatin, the Cell Cycle, and Cell Division, mitosis, meiosis; Chromosomes of human being that are responsible for various hereditary diseases; Nucleosomes, Histones, function and their variants, Lipid composition and structural organization, Protein components and basic functions. Bioenergetics; Membranes, Mitochondria, electron transport, ATP synthesis etc., Chloroplasts and Photo Synthesis, Nitrogen Fixation, Microbes and viruses their advantages and disadvantages Biological Defense mechanisms Development of an embryo to adult in plants and animals. Biology and Society.

Books:

1) Campbell Biology, 10th Edition. Jane B. Reece, Lisa A. Urry, Michael L. Cain, Steven A. Wasserman, Peter V. Minorsky, Robert B. Jackson

2)Biology: A Global Approach (Paperback) by Jane B. Reece, Steven A. Wasserman

3) Molecular Biology of Gene: Watson et al.,

4) Molecular Cell Biology: By Darnell, Lodish, Baltimore

5) Concepts of Genetics William S Klug and M. R. Cummings.

10. Phys-II: Waves, Oscillations, Sound & Light -4cr

Simple harmonic motion, Angular simple harmonic oscillator, damped harmonic oscillator, Forced oscillations and Resonance; Simple coupled oscillators.Traveling waves, Superposition principle, Wave speed, Power and intensity in wave motion, Interference of sound waves, Stationary waves, Beats, Waves on strings and surfaces, Audible, ultrasonic and infrasonic waves, Propagation and speed of longitudinal waves, Vibrating systems and sources of sound, Musical instruments, The Doppler effect, Shock waves, Velocity of sound and its measurement, factors affecting the speed of sound Nature and propagation of light, Images, Defects of images, Spherical and Chromatic aberrations, Achromatism of two thin lenses separated by a distance, Optical instruments (Microscopes and Telescopes), Velocity of light and its measurement

Books recommended: Fundamentals of Physics by Resnick, Halliday and Walker, 6th edition, Wiley 2. University Physics by Sears and Zemansky, 10thedition, Addison –Wesley series 3. Fundamentals of Optics, Jenkins and White 4. Light by K. G. Mazumdar 5. Geometrical and Physical Optics by P. K. Chakraborty 6. Opticsby B. K. Mathur.

2 Math-2

2.1 Multivariable calculus (25 Lectures)

Brief introduction to co-ordinate systems- spherical and cylindrical systems double integral over a rectangle, double integral over a region, change of order of integration, triple integrals, change of variables and Jacobian. Vector fields, gradient, divergence, curl, vector calculus identities, parametric curves, line integrals, path dependence, fundamental theorems of line integrals, conservative _elds, application of Greens theorem in 2-D, parametric surfaces, surface of revolution, surface integrals, applications of Stokes theorem and Gauss divergence theorem, Green's identities, statement of integration by parts.

2.2 Mathematical Analysis (15 lectures)

Rational numbers, sequences, subsequences, monotonicity, boundedness, con-
vergence, limit of a sequence, Cauchy criteria, series, di_erent tests of con-
vergence, power series, radius of convergence.

12. Chemistry- II: ENERGETICS AND KINETICS - 3cr

Thermochemistry –enthalpy and enthalpy change-calorimetry-enthalpies of formation and of reactions. Entropy and free energy. State functions. (8h), Chemical Kinetics – reaction rates – effect of concentration and temperatures. Steady state approximation. Reaction mechanism from rate laws. (8h), Chemical equilibrium in the gas phase – equilibrium constants and their relation to free energy – temperature dependence. (6h), Equilibrium in the aqueous phase- pH, buffers and indicators –complex ions. Heterogeneous equilibria – adsorption. (6h) and Electrochemistry – voltage and free energy – standard potentials Batteries, fuel cells (8h).

13. English II- 4cr

14. IT: Information Technology (IT-1) -1.5 cr

15. LAB Courses- (1.5cr x 3= 4.5 cr)

A: Chem: QUANTITIVE ANALYSIS

Prerequisite: None Titrimetry – acid-base, redox, complexometry. Gravimetry- determination of water of hydration, estimation of sulphate, chloride, aluminium, manganese, iron, nickel. Colorimetry – Beer's law, estimation of a metal ion (eg., manganese).

B: Phys: Coupled Oscillator- Measurement of Normal Mode Frequencies 2. KUNDT'S TUBE –Determination of Velocity of Sound in Air 3. SONOMETER –Resonance Modes of a Stretched String & Velocity of Wave Propagation 4. BREWSTER ANGLE METHOD –Measurement of Refractive Index of Dielectric Material 5. FRESNEL BIPRISM –Determination of Wavelength of Light by Interference 6. NEWTON'S RINGS –Determination of Radius of Curvature of a Lens 7. FABRY – PEROT INTERFEROMETER –Measurement of AirgapThickness 8. DIFFRACTION GRATING –Determination of Wavelengths of mercury vapor lamp.

C: Biology: Microscopy and Cell Biology

Different microscopes and their applications. Calibration of simple microscope and use of inverted microscope; sizes of different cells and organelles, Identification of different types of cells: plant, animal, bacteria, yeast and mammalian cells. Isolation of live cells from dead cells. Different types of blood cells, antigen-antibody test- disc diffusion test; Elisa, minimum inhibitory test, blood grouping and RH typing. Simple centrifugation techniques, preparation of organelles, chloroplasts, nuclei and mitochondria

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III Semester (II Year)

16. SB III: Molecules and Information Processing -3cr

Prerequsite: Introductory Biology and Structure of Macromolecules.

This is a comprehensive molecular biology course.

Flow of information in Biological Systems, Typical rules governing the synthesis of DNA, RNA and Proteins (E. coli as a model) The DNA language/chemistry, structure and the machinery of replication. Genomes, Gene-density, C value Paradox, Cot values 8 h. DNA Replication, Replication of chromosome ends. Repetitious DNA, Mobile/Transposan elements, mechamisms of transposition, Tm (melting temperature) of DNA and its practical application of DNA topology, Topoisomerases and Linking number. Chemicals that affect DNA structure, DNA sequencing, Methods 14 h. Regulatory elements in DNAs and mRNAs. Different types of (RNAs tRNA, mRNA, rRNASn RNAs, Micro RNAs and Silencing RNAs). RNA synthesis in brief in prokaryotes and eukaryotes, Co and post transcriptional modifications like alternative splicing, 5'Cap and ply A addition etc., Genetic code, and the machinery and mechanics of cytosolic and secretary protein synthesis. 14 h.

Books recommended: Molecular Biology of Gene: Watson et al., Molecular Cell Biology: By Darnell, Lodish, Baltimore. Concepts of Genetics William S Klug and M. R. Cummings

Instructor: Prof. K.V.A. Ramaiah

17. Phys-III: Heat and Thermodynamics- 4 cr

On the nature of matter and heat, Notion of temperature, Thermal equilibrium , Zeroth law of thermodynamics, Ideal gas law, Thermometers, Constant volume gas thermometers, Resistance thermometers, The Celsius and Farenheit scales, Ideal gas temperature scale. Specific heat, Molar specific heat of solids, Heat and work, Internal energy, Thermodynamc system, Thermodynamic transformations, Reversible and Irreversible transformations, quasistatic processes, First law of thermodynamics, Isothermal and adiabatic transformations, Second law of thermodynamics, Carnot engine, Entropy and second law, Entropy and disorder, Work done in different types of thermodynamic transformations, Exact differentials, Maxwell's relations. Microscopic description of an ideal gas, Kinetic theory of gases, Kinetic interpretation of temperature.

Books recommended 1. Fundamentals of Physics,by Resnick, Halliday and Walker, 6th edition, Wiley 2. University Physics by Sears and Zemansky, 10th edition, Addison –Wesley series 3. Introduction to electrodynamics by D.J. Griffiths, 3rd edition, Prentice Hall 4 Electricity and magnetism by A.S. Mahajan and A. A. Rangwala, McGraw Hill 5. Marion

18. Chemistry- III: STRUCTURAL CHEMISTRY- 3cr

Prerequisite: None

Electrons in atoms – the orbital concept –shapes and size of atomic orbitals-electron configurations and the periodic table. (4h) The chemical bond –ionic and covalent bonding. MO and VB pictures- hybridization, resonance. Bond parameters – energy, polarity, length (8h) Shapes of molecules – VSEPR theory. (4h) The hydrogen bond. Intermolecular forces and non-bonded intra- molecular interations. Molecular conformations. Examples of different structures and their stabilities from tri-atomics to bio-molecules. (6h) The solid state –molecular, ionic and metallic crystals. Crystal lattices – unit cells. Common crystal structures. Factors influencing crystal structures in ionic/molecular solids. Allotropes (of carbon and sulphur). Network solids – silicates. (8h) X-ray diffraction and elementary treatment of Bragg's law- NaCl and KCl. (6h).

19. Math-3(A) and Math-3(B) are 3rd semester courses.

Math-3A

3.1 Ordinary Differential Equations (20 Lectures)

Order and degree of a di_erential equation, _rst order equations: variables separable method, homogeneous equations of degree zero, nonhomogeneous equations, exact equations, integrating factor, linear equations, Bernoulli's equation. Higher order homogeneous linear equations with constant coefficients, second order homogeneous linear equation with variable coefficients, variation of parameters, 2 x2 autonomous system of equations, power series solution, meaning of existence and uniqueness of a solution and some counter examples.

3.2 Laplace Transforms (8 Lectures)

Definition, L.T. of some elementary function, e_ect of L.T. on translation, scaling, convolution. Inverse Laplace transform, applications of L.T. to ODE.

3.3 Fourier series (7 Lectures)

Fourier series of a periodic function, half range Fourier series.

3.4 Sets, relations and functions (5 Lectures)

Sets, relations, equivalence, partial ordered relations, mathematical induction, elements of mathematical logic.

4 Math-3(B)

Introductory Probability and Statistics Code: MM203

Random Experiments Sample spaces , Events, probability measures on events- definition, properties, examples. Conditional probability-definition, properties, examples, Bayes theorem, independent events. Definition of random variables, standard discrete and continuous random variables-viz. Bernoulli, Binomial, Geometric, Poisson, Exponential, Gamma, Normal. Expectation, variance, other properties.

Definition of bivariate random variables, joint distributions, covariance and correlation between two random variables, independence, distributions of sums.

Data collection methods, types of data, graphical summaries of data, numerical summaries of univariate data, bivariate summaries, measures of association.

Introduction to statistical inference, population parameters, variable(s) of interest, statistic, estimators as random variables.

References:

1. Ross, S. A First Course in Probability, sixth edition, Pearson Education, 2007.
2. Ramachandran, K.M. and Tsokos, C.P. Mathematical Statistics with applications, Academic Press, 2009.
3. Daniels, W.W. Biostatistics: a foundation for analysis in the health sciences, 9th edition, John Wiley & Sons, 2008
4. Moore, D.S. The Basic Practice of Statistics, W. H. Freeman, 2003.

20. Electives from Non-Science Schools- 2cr

21. LAB courses (Phys/Chem/Biol) (2cr X 3 = 6cr)

A. Physics: Heat & Thermodynamics Lab

1.Gas laws: Boyles law 2. Gas laws: Charles law 3. Constant volume gas thermometer 4. Electric Joule heating 5. Seebeck effect and thermocouple 6. Thermal conductivity of a poor conductor (Lees method) 7. Thermal conductivity of a good conductor (Searles method) 8. Specific heat capacity –Method of mixtures 9. Phase change-Latent heat 10. The Steffan-Boltzmann law

B. Physical chemistry lab

Equilibria in solution –phase diagrams. Colligative properties. Reaction rates. Electrochemistry – measurements and titrations

C. Biology Lab: Buffers and Physical Analyses of Nucleic Acids

Preparation of solutions (molar and normal), Buffers, pH estimation, preparation of buffers with different ingredients, final concentrations as indicated and their dilutions, UV and Visible spectrophotometry and their applications in Biology. Absorption spectra of RNA, DNA and proteins by spectrophotometry, melting curves of DNA, thin layer chromatography for isolation of nucleotides

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IV Semester (II Year)

22. SB IV: Structure and Function of Macromolecules- 3cr

Macromolecules in Biology: Carbohydrates, Lipid, protein and Nucleic acid Carbohydrates: Building block, structure, glycosidic bond, different forms of carbohydrates based on structure and function; Lipid: chemical structure and structural component of membrane; Nucleic acid: building blocks – purine and pyrimidine, biochemical structure, different forms of DNA, interaction of DNA with proteins, drugs, dyes and carcinogens, hydrogen bonding interactions, structure of RNA, basic differences between DNA and RNA structures, structure of yeast phenylalanine tRNA. Different forms of RNA, ribozyme and Riboswitch: structure and function, ribosome: subunits and structure; Protein: building block (amino acids), peptide bond, polypeptide, secondary structure, tertiary structure and quaternary structure. Forces that stabilize protein structure, Ramachandran plot, Structural classification of protein- fold/motif, class, family and superfamily, structure function correlation, functional conformation of protein, protein folding and denaturation, molecular chaperones assist protein folding, regulatory protein- transcription factor structure and function, structure of antibody, motor proteins (myocin, actin), structure and function of myoglobin and hemoglobin, proteins involve in signal transduction and structural change in receptor proteins.

Recommended books: Biochemistry, Lehninger A.H., Proteins: Structure, function and evolution. Dickerson & Geis, 2nd Edn, Protein: Structure and molecular properties: Thomas E. Creighton.

23. Physics-IV: Electricity and Magnetism-4cr

Charges and forces; Charge quantization; Coulomb's law, Electric field, Electric potential, Application of Coulomb's law to determine the potential and field due to one, two and three-dimensional charge distributions, Electric dipole and quadrupole, Gauss's theorem and its applications, Electrostatic energy Electrostatics in a dielectric medium, Capacitors, calculation of

capacitance of parallel plate, cylindrical and spherical capacitors, Capacitors in parallel and series. Moving charges and electric currents, current density, Ohm's law, Kirchhoff's law Magnetic field, magnetic forces on a particle and current carrying conductors, Magnetic induction, Biot-Savart law, Magnetic dipole moment, Vector potential, Ampere's circuital law Induction and inductance, Magnetic circuits, Faraday's law, Lenz's law, Self and mutual induction, Magnetic force between two circuits, Alternating current, LCR circuits with DC and AC sources. Displacement current,Maxwell's equations

Books recommended1. Fundamentals of Physics Resnick, Halliday and Walker, 6th edition, Wiley
2. University Physics, Sears and Zemansky, 10th edition, Addison –Wesley series

24. Chemisty- IV: Organic and Functional Groups -3cr

Nomenclature of organic compounds..Major classes –aliphatic, aromatic, alicyclic and heterocyclic compounds. Isomerism. Stereochemistry. Conformational analysis .Strained molecules. (10h) Hydrocarbons (alkanes, alkenes, alkynes) – substitution and addition reactions. (5h) Alcohols and ethers. (3h) Carbonyl compounds – oxidation, reduction reactions. (5h) Compounds with conjugated double bonds- dienes and □⍰□ – Unsaturated compounds – tautomerism (5h) Aromatic compounds- substitution reactions. (8h)

25. Math-4(A)

5.1 Continuity (15 Lectures)

Continuity (stick to sequential and □; □□definition), examples of continuous functions, some basic properties of continuous functions including intermediate value theorem.

5.2 Differentiation (15 Lectures)

Limit of a function, Differentiation, chain rule, mean value theorems and their applications, Taylor's theorem, l'H^ospital rule, maxima-minima problems in one variable case, curve tracing.

5.3 Integration (10 Lectures)

Integration, Riemann's original de_nition and applications to summation of infinite series, Statement of fundamental theorem of calculus.

Books: Calculus by Thomas & Finney; Kreysig's Engineering Mathematics; A First Course in Abstract Algebra by Fraleigh andContemporary Abstract Algebra by J.A.Gallian (4^{th} Ed.)

26. Elective: From any dept other than Science schools-2cr

27. LAB Courses (Phys/Chem/Biol) - (2 cr x 3= 6cr)

A) Chem Lab: Identification of organic compounds

Preparation and purification of organic compounds –melting point –boiling point. Characteristic reactions of functional groups. Identification of unknowns – chemical and spectral methods.

B) Phys Lab: Electricity Magnetism Lab.

Charging and Discharging a Capacitor 2. Resonance in LCR Circuits 3. Electromagnetic Induction 4. Measurement of Average Resistance of a Wire by Carey.Foster method and to determine the value of unknown resistance 5. Comparison of E.M.F.'s of Two Cells with the Help of Potentiometer 6. Measurement of E.M.F. of a Cell by Potentiometer, Using a Milli-ammeter 7. Hysteresis Curve 8. Determination of the Moment of a Bar Magnet and the Horizontal Component of Earth's Magnetic Field by Magnetometers 9. Kelvin Double Bridge for Measuring Very Low Resistance.

C) Biol Lab:

Molecular weight determination by SDS-PAGE; Estimation of protein concentration by different method: lowery, Bradford etc.; Applying error bar; Spectrophotometer: para-nitrophenol; Determination of binding constant of Protein-ligand interaction; Melting curve of DNA, Protein denaturation ; DNA and RNA estimation by diphenylamine and orcinol method.

New EVS Syllabus for IM Sc.

for August 2011 Batch

I Year / I Semester

SB-1- Environmental Studies (3 credit) (I Yr / I Sem)

1) Basic concepts of ecosystem and environment
2) Abiotic and biotic environment
3) Food chain, food web and ecological pyramids
4) Decomposition
5) Gaseous nutrient cycles
6) Sedimentary nutrient cycles
7) Hydrological cycle
8) Basics of ecological energetics
9) Energy flow in generalized ecosystem
10) Biotic interactions
11) Ecological succession
12) Natural Resources Management ~ YSL
13) Types of Forests and Biomes of India and world
14) Deforestation and desertification
15) Afforestation (Social/Urban)
16) Wildlife sanctuaries and Natural parks
17) Basics of Environmental microbiology •
18) Energy related Environmental issues
19) Environmental management systems •
20) Biodiversity and conservation
21) Trade related environmental issues •
22) Pollution (Air, Water soil) YSL
23) Elements of Environmental Toxicology •
24) Recycling of waste ~ YSL
25) Global environmental issues and solutions
26) Bioremediation •

11th, 16th, 18th Aug

8184922434

Prof. M. Ramanadham
Co-ordinator of IM Sc.
System Biology

1. Introduction
2. Hydrological cycle
3. Soils & Nutrient cycle
4. Natural (Mineral & water) Resources and Management
5. Energy Resources & Environmental issues
6. Afforestation & Deforestation
7. Global environmental Issues
8. Environmental Management Systems